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(54) **COLD EXPANSION PIPE FITTING, PIPE CONNECTION, SYSTEM, EQUIPMENT, AND METHOD**

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Description

BACKGROUND

[0001] Pipe connections for various plumbing and heating applications may be formed by utilizing so called cold expansion, i.e. mechanical expansion of a pipe end section of a pipe made, for example, of cross-linked polyethylene. A tubular connecting part of a pipe fitting may then be inserted into the expanded pipe end. The memory properties of the pipe material make the initially expanded pipe end shrinkage back towards its original shape and dimensions, whereby it is pressed on the connecting part of the fitting. Thereby, a sealed connection is formed between the fitting and the pipe.

[0002] In many applications, the rapidity of the formation of a sufficiently secure sealing is an important factor affecting the effectiveness and productivity of the plumbing work. Shrinkage performance of the pipe materials typically depend on the ambient temperature: the formation of the sealed connection may become undesirably slow in cold conditions. In this sense, the design and way of operation of the tool used for expanding the pipe end, and the design of the connecting part of the pipe fitting, may be key factors for the feasibility of the cold expansion fittings especially in cold conditions.

[0003] Techniques related to various pipe connections are disclosed e.g. in WO 2015/191991 A1, US 2018/065282 A1, US 4 664 423 A, DE 10 2014 011122 A1, KR 2016 0057252 A, DE 20 2008 006416 U1, US 3 888 102 A, DE 195 04 968 A1, WO 2011/056065 A1, and US 2004/253340 A1. For example, US 4 664 423 A discloses a coupling element with a shoulder at one end and a series of annular radially projecting barbs on its outer diameter.

SUMMARY OF THE INVENTION

[0004] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0005] In first aspect, a pipe fitting is implemented according to claim 1 for forming a cold expansion pipe connection, the pipe fitting comprising a tubular connecting part extending substantially in an axial direction D_A and a shoulder extending radially outwards from one end of the connecting part; the tubular connecting part being configured to be inserted into a pipe end section of a pipe expanded by an expanding tool head comprising a plurality of radially movable outer spreading surfaces, the outer spreading surfaces comprising a first circumferential groove crossing each of the outer spreading surfaces and leaving, during expansion of a pipe end section, a first circumferential intact sealing region on the inner surface of the pipe end section at a first distance from the end of the pipe; whereby the tubular connecting part comprises a first radially outwards extending circumferential sealing barb positioned for engaging, when in use, with the circumferential intact sealing region during shrinkage of the pipe end section for forming a sealing between the pipe fitting and the pipe.

[0006] The sealing barb has a wedge-shape longitudinal section in the axial direction with a first facet with a first slope on the side of the free end of the tubular connecting part, and a second facet with a second slope steeper than the first slope on the side of the shoulder, the first and the second facets being connected via a tip. The tip has a radius of curvature in the range of 0,127 to 5,08 mm (0.005 to 0.020 inches).

[0007] The tubular connecting part has a wall thickness which is substantially constant outside the sealing barb.

[0008] In an embodiment, the radially movable outer spreading surfaces comprises a second circumferential groove crossing each of the outer spreading surfaces and leaving, during expansion of a pipe end section, a second circumferential intact sealing region on the inner surface of the pipe end section at a second distance, larger than the first distance, from the end of the pipe; whereby the tubular connecting part comprises a second radially outwards extending circumferential sealing barb positioned for engaging, when in use, with the second circumferential intact sealing region during shrinkage of the pipe end section for forming a sealing between the pipe fitting and the pipe.

[0009] In an embodiment, one of the first and the second sealing barbs lies at the free end of the tubular connecting part lying opposite to the shoulder.

[0010] In an embodiment, the first slope forms, or the first facet lies at, an angle of 10 to 30 degrees, for example, an angle of 20 to 25 degrees, with respect to the axial direction D_A of the tubular connecting part.

[0011] In an embodiment, the second slope forms, or the second facet lies at, an angle of 55 to 90 degrees, for example, an angle of 75 to 90 degrees, with respect to the axial direction D_A of the tubular connecting part.

[0012] In an embodiment, the radially movable outer spreading surfaces comprises an additional circumferential groove crossing each of the outer spreading surfaces and leaving, during expansion of a pipe end section, a circumferential intact retaining region on the inner surface of the pipe end section preferably between the end of the pipe and the first circumferential intact sealing region; whereby the tubular connecting part comprises a radially outwards extending circumferential retaining barb positioned for engaging, when in use, with the inner surface of the pipe end section behind the circumferential intact retaining region so as to prevent the pipe fitting from escaping out of the pipe during and/or after shrinkage of the pipe end section.

[0013] In an embodiment, the tubular connecting part has a chamfer enlarging the inner diameter of the tubular connecting part towards the free end thereof lying opposite to the shoulder.

[0014] In an embodiment, the pipe fitting is configured for forming a cold expansion pipe connection with a pipe having a pipe inner diameter outside the pipe end section, wherein the tubular connecting part has a connecting part inner diameter outside the possible chamfer that is substantially equal to or larger than the pipe inner diameter.

[0015] In another aspect, a pipe connection, which may be a cold expansion pipe connection, may be implemented which comprises: a pipe fitting in accordance with any of those of the first aspect discussed above; and a pipe; the tubular connecting part of the pipe fitting being inserted into a pipe end section of the pipe having a first circumferential intact sealing region on the inner surface of the pipe end section; the first radially outwards extending circumferential sealing barb of the tubular connecting part being engaged with the first circumferential intact sealing region to form a sealing between the pipe fitting and the pipe.

[0016] In an embodiment, the pipe has a pipe inner diameter outside the pipe end section, and the tubular connecting part has a connecting part inner diameter outside the possible chamfer that is substantially equal to or larger than the pipe inner diameter.

[0017] In yet another aspect, a cold expansion pipe connection system may be implemented which comprises: a pipe fitting in accordance with any of those of the first aspect discussed above; and a pipe to be connected to the pipe fitting at a pipe end section thereof.

[0018] In one embodiment, the pipe has a pipe inner diameter outside the pipe end section, and the tubular connecting part has a connecting part inner diameter outside the possible chamfer that is substantially equal to or larger than the pipe inner diameter.

[0019] In yet another aspect, a cold expansion pipe connection equipment may be implemented which comprises: an expanding tool head for expanding a pipe end section of a pipe, the expanding tool head comprising a plurality of radially movable outer spreading surfaces, the outer spreading surfaces comprising a first circumferential groove crossing each of the outer spreading surfaces and leaving, during expansion of a pipe end section, a first circumferential intact sealing region on the inner surface of the pipe end section; and a pipe fitting in accordance with any of those of the first aspect discussed above.

[0020] In an embodiment, the expanding tool head is configured to expand a pipe end section of a pipe having a pipe inner diameter outside the pipe end section, and the tubular connecting part has a connecting part inner diameter outside the possible chamfer that is substantially equal to or larger than the pipe inner diameter.

[0021] In yet another aspect, a cold expansion pipe connection method may be implemented which comprises: expanding a pipe end section of a pipe by an expanding tool head comprising a plurality of radially movable outer spreading surfaces, the outer spreading surfaces comprising a first circumferential groove crossing each of the outer spreading surfaces and leaving, during expansion of a pipe end section, a first circumferential intact sealing region on the inner surface of the pipe end section; inserting a pipe fitting in accordance with the first aspect above into the expanded pipe end section, the first radially outwards extending circumferential sealing barb being positioned for engaging, when in use, with the circumferential intact sealing region during shrinkage of the pipe end section; and letting the expanded pipe end section shrink to form a sealing between the pipe fitting and the pipe.

[0022] In an embodiment, the pipe has a pipe inner diameter outside the pipe end section, and the tubular connecting part has, outside a possible chamfer on its inner surface enlarging the inner diameter of the tubular connecting part towards the free end thereof lying opposite to the shoulder, a connecting part inner diameter that is substantially equal to or larger than the pipe inner diameter.

[0023] Many of the attendant features will be more readily appreciated as the same becomes better understood by reference to the following detailed description considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The present description will be better understood from the following detailed description read in light of the accompanying drawings, wherein:

FIG. 1 illustrates, as partial longitudinal sectional views, parts and formation of a cold expansion pipe connection;

FIG. 2 illustrates, as perspective views, structure and operation of an expanding tool head;

FIG. 3 illustrates, as a partial longitudinal sectional view and as two cross sectional views, the pipe of FIG. 1;

FIG. 4 illustrates, as a longitudinal cross sectional view, structure and operation on an expanding tool head; and

FIG. 5 illustrates a flow chart of a method for forming a cold expansion pipe connection.

[0025] The drawings of FIGs. 1 to 4 are schematic and not necessarily to scale.

DETAILED DESCRIPTION

[0026] The detailed description provided below in connection with the appended drawings is intended as a description of a number of embodiments and is not intended to represent the only forms in which the embodiments may be constructed, implemented, or utilized.

[0027] The pipe fitting 100 of FIG. 1 may be used to form a cold expansion pipe connection. "Expansion" refers basically to the pipe connecting techniques which are based on mechanically expanding a pipe end section,

followed by letting the expanded pipe end section shrinkage towards its original dimensions after a pipe fitting having been inserted into the expanded pipe end section. In "cold expansion" techniques, such expanding can be carried out purely mechanically, without heating the pipe end section. Also the shrinkage may take place without any activation by heat, thus automatically on the basis of the so called memory properties of the pipe material. Thus, a cold expansion pipe connection may be formed completely without applying external heat to the pipe end section to be heated.

[0028] A "pipe" refers basically to any tubing, thus a tubular structure with an internal flow channel for a fluid such as water. The flow channel may have substantially circular cross section.

[0029] A "pipe end section" refers to a section of a pipe extending from an end of the pipe to a predetermined distance therefrom. A pipe end section may be the section to be expanded when forming a cold expansion pipe connection.

[0030] A pipe to be used in forming a cold expansion pipe connection may be formed of any material, such as cross linked polyethylene PEX and its different variants, having appropriate memory properties for providing sufficient compressive force on the pipe fitting to ensure secure sealing. A reinforcing or clamping ring, also formed of a material such as cross-linked polyethylene having sufficient memory properties, may be used as positioned over the pipe end section during the expansion and shrinkage thereof. Such ring may further strengthen and secure the pipe connection.

[0031] The pipe fitting of FIG. 1 comprises a tubular connecting part 101. The connecting part has a first end 102 at which a shoulder 103 extends outwards from the connecting part, and a second or free end 104 lying opposite to the shoulder.

[0032] The connecting part 101 extends substantially in an axial direction D_A. The axial direction refers to the longitudinal direction of the connecting part, i.e. the direction in which the tubular connecting part has a length. Basically, said direction may also refer to the direction of a central axis of a tubular connecting part. The shoulder 103 extending "outwards" extends in a radial direction, i.e. perpendicularly to said axial direction D_A.

[0033] The pipe fitting 100 of FIG. 1 is configured to be used in connection with a pipe end section which has been expanded by a specific type of expanding tool head. Such expanding tool head may be in accordance with that illustrated in FIG. 4, and also basically in accordance with the expanding tool head illustrated in FIG. 2.

[0034] Drawing A of FIG. 1 shows the pipe fitting 100 with its tubular connecting part 101 inserted into such expanded pipe end section 111 of a pipe 110. Drawing B illustrates the situation after the initially expanded pipe end section has shrunk so that it is pressed against the tubular connecting part. The situation of drawing B of FIG. 1 showing the pipe end section shrunk so as to be pressed against the tubular connecting part may be considered as an illustration of a cold expansion pipe connection. It is possible that after the situation illustrated in drawing B, the pipe end section is still shrunk further. Then, it may become more conformal with the outer surface of the tubular connecting part.

[0035] An "expanding tool head" refers to a mechanical assembly which may be used as a releasable part of, or be integrated in, an expanding tool to expand pipe end sections. The expanding tool head then serves as the member of the tool assembly which actually contacts the pipe end section inner surface during the expanding operation.

[0036] The expanding tool head 220 of FIG. 2 comprises a plurality of spreading elements 221 which are radially movable in relation to a center longitudinal axis x of the tool head.

[0037] The spreading elements 221 have a starting position I illustrated in drawing A of FIG. 2, at which position the spreading elements lie close to said axis x and adjacent to each other. With the spreading elements in this starting position, the expanding tool head may be inserted into a pipe end section to be expanded.

[0038] The spreading elements 221 have also an outwardly extended expansion position *II* illustrated in drawing B of FIG. 2, at which position the spreading elements are radially distanced from said axis x to expand the pipe end section.

[0039] The expanding tool head may be actuated, i.e. the spreading elements may be transferred between the starting position and the expansion position by any appropriate means. For example, the spreading elements may have beveled inner surfaces, and the expander tool may have a piston with a tapered end configured to engage with and slide along those beveled surfaces. Then, the radial movement of the spreading elements may be effected by axial movement of the piston.

[0040] Each of the spreading elements has an outer spreading surface 222. In the example of FIG. 2, each outer spreading surface is an nth part of a substantially cylindrical surface, wherein n is the number of the spreading elements 221. When in use, during expansion of a pipe end section, the outer spreading surfaces may be pressed against the inner surface of the pipe end section.

[0041] As can be seen in FIG. 2, with the spreading elements 221 in their outwardly extended expansion position, the outer spreading surfaces are separated from each other by lateral gaps 223.

[0042] Due to said lateral gaps, the expansion of the pipe end section is effected by pressing the inner surface of the expanded pipe end section at discrete regions along the circumference of the inner surface only. Therefore, the expanded pipe end section may have an alternating inner radius or diameter. This is illustrated in FIG. 3 as the cross section A of the pipe end section 111.

[0043] The outer spreading surfaces 222 comprise a first circumferential groove 224 which extends circumferentially so that it crosses each outer spreading surface in the circumferential direction. During expansion, there

is no contact between the expanding tool head 220 and the inner surface 112 of the pipe end section at the location of the first circumferential groove. Therefore, this groove leaves a first circumferential intact, non-contacted and therefore undamaged sealing region 113 on the inner surface of the pipe end section. At the location of this sealing region, the expanded pipe end section may advantageously have a constant inner radius or diameter. This is illustrated in FIG. 3 as the cross section B.

[0044] Figure 3 thus shows two cross sections of the expanded pipe end section 111. Cross section A represents the situation at the location in the axial direction of the pipe outside any circumferential groove. Cross section B represents the situation at the location of the first circumferential groove of the expanding tool head.

[0045] In the cross-section A of FIG. 3, the inner radius or diameter of the connecting part changes along the circumference of the connecting part. Those regions 114 of the inner surface 112 of the pipe end section where the outer spreading surfaces pressed the inner surface of the pipe end section have been forced farther from the center longitudinal axis (x) than the regions 115 of the inner surface 112 of the pipe end section formed at the locations of the lateral gaps 223 between the adjacent outer spreading surfaces 221 of the expanding tool head.

[0046] Such non-uniform radius or diameter, meaning a non-circular circumference of the inner surface, make different regions of the inner surface circumference engage with the connecting part 101 of the pipe fitting 100 at different times during the shrinkage of the pipe end section 111. Those non-contacted regions 115 resulted from the lateral gaps reach the outer surface of the connecting part 101 first. After this engaging, the shrinkage may slow down, and it may therefore take a long time before the inner surface 112 of the pipe end section 111 is pressed on the connecting part throughout its circumference.

[0047] In the cross-section B, instead, the inner radius or diameter of the connecting part is substantially constant and the first circumferential sealing region is thus substantially circular.

[0048] In addition to the outer spreading surface, each spreading element 221 of the expanding tool head 220 of FIG. 2 has further a radial stop face 225.

[0049] The first circumferential groove 224 is located so that when using the expanding tool 220 at its intended way of use, the first circumferential intact sealing region 113 is formed at a first distance D_1 from the end 116 of the pipe. Said intended way of use may comprise, for example, positioning the end 116 of the pipe or, possible end of a clamping or reinforcing ring positioned on the pipe end section and extending beyond the end of the pipe, against the radial stop faces 225 of the spreading elements 221 of the expanding tool head. In the example of FIG. 1, such extension beyond the end 116 of the pipe 110 is defined by the thickness of the stop edge 131 of the clamping or reinforcing ring 130. Thus, the first circumferential groove 224 may lie at the first distance, or at a distance of the first distance D_1 plus the possible extension of an end of a clamping ring beyond the end of the pipe, from the radial stop faces 225 of the spreading elements 221 of the expanding tool head.

[0050] In the example of FIG. 2, a stop face 225 of is formed in each of the spreading elements. In other embodiments, a stop face may be arranged in an expanding tool head separately from the radially movable spreading surfaces.

[0051] Referring back to FIG. 1, the connecting part 101 of the pipe fitting 100 comprises a first radially outwards extending circumferential sealing barb 105'.

[0052] A "barb" refers to a rib or ridge structure. A sealing barb has, for ensuring reliable sealing, preferably substantially constant height in the radial direction.

[0053] The first radially outwards extending circumferential sealing barb 105' is advantageously positioned so that when using the expanding tool at its intended way of use, this first sealing barb engages with the first circumferential intact sealing region 113 during shrinkage of the pipe end section 111. Said intended way of use may comprise, for example, inserting the connecting part 101 into the pipe end section 111 so far that the end 116 of the pipe or, end of a possible clamping or reinforcing ring positioned on the pipe end section and extending beyond the end of the pipe, is set against the radial stop face 106 of the shoulder 103 of the pipe fitting 100. Thus the first radially outwards extending circumferential sealing barb 105' may lie at the first distance D_1, or at a distance of the first distance plus the possible extension of an end of a clamping ring beyond the end of the pipe, from the radial stop face 106 of the shoulder 103 of the pipe fitting 100.

[0054] Due to the substantially circular first circumferential intact sealing region 113, the sealing barb 105' may contact the pipe inner surface 112 substantially at the same time throughout the circumference thereof. This may enable a rapid formation of a sealed connection already before the pipe end section 111 have been shrunk so as to make the entire inner surface 112 thereof being pressed against the connecting part of the pipe fitting. This may facilitate forming cold expansion connections, in particular, in low assembling temperatures.

[0055] In the example of FIG. 2, there is also a second circumferential groove 226 extending circumferentially so as crossing each of the outer spreading surfaces 222 and leaving, during expansion of a pipe end section 111, a second circumferential intact sealing region 117 on the inner surface 112 of the pipe end section. The second circumferential groove is located so that when using the expanding tool at its intended way of use, the second circumferential intact sealing region is formed at a second distance D_2 from the end of the pipe. Thus, the second circumferential groove may lie at the second distance, or at a distance of the first distance plus the possible extension of an end of a clamping ring beyond the end 116 of the pipe 110, from the radial stop faces 225 of the spreading surfaces 221 the expanding tool head 220.

[0056] The second distance D_2 is larger than the first distance. So, the second circumferential groove lies farther from the stop faces of the spreading surfaces 221 than the first circumferential groove.

[0057] Referring again back to FIG. 1, the connecting part 101 of the fitting comprises also a second radially outwards extending circumferential sealing barb 105". This second sealing barb is advantageously positioned so that when using the expanding tool at its intended way of use, this sealing barb engages with the second circumferential intact sealing region 117 during shrinkage of the pipe end section 111. Thus, the second radially outwards extending circumferential sealing barb may lie at the second distance D_2, or at a distance of the second distance plus the possible extension of an end of a clamping ring beyond the end 116 of the pipe, from the radial stop face 106 of the shoulder 103 of the pipe fitting 100.

[0058] The second radially outwards extending circumferential sealing barb 105" may operate similarly to the first radially outwards extending circumferential sealing barb 105'. Thereby, it may further secure rapid formation of a sealed pipe connection.

[0059] In the example of FIG. 1, the second sealing barb 105" lies at the free end 104 of the tubular connecting part 101. This positioning may advantageously serve as a guiding member facilitating insertion of the connecting part of the pipe fitting into an expanded pipe end section. Further, it may serve as a stabilizer to reduce side to side rocking or motion during the shrinkage of the pipe end section.

[0060] In other embodiments, a second radially outwards extending circumferential sealing barb may lie elsewhere, between a first radially outwards extending circumferential sealing barb and the free end of the tubular connecting part.

[0061] In the example of FIG. 1, each of the sealing barbs 105', 105" has, in a longitudinal section plane along the center longitudinal axis of the pipe fitting, a wedge-shape cross section. The wedge shape has a first facet 107' with a first slope on the side of the free end 104 of the tubular connecting part. A second facet 107" with a second slope which is steeper than the first slope lies on the side of the shoulder 103 of the pipe fitting. Said basic configuration of the barbs may allow inserting of the connecting part properly into the pipe end section.

[0062] The facets are connected via a tip 108 at the top of the wedge shape. The tip is substantially or nearly sharp. It has a radius of curvature r in the range of 0,127 to 5,080 mm (0.005 to 0.020 inches). Appropriate sharpness, i.e. suitable radius of curvature, of the tip may facilitate formation of a sealed connection between the sealing barb and the sealing region of the inner surface of the pipe end section. Thereby, a rapid formation of a sealed pipe connection may be achieved.

[0063] In the example of FIG. 1, to ensure proper performance of the fitting, the first facet lies at an angle α of about 25 degrees, and the second slope lies at an angle β of about 55 degrees, with respect to the axial direction D_A. Said angles are defined as the smaller angles formed between the slopes of the facets and the axial direction. In other embodiments, the first facet may lie at an angle of 10 to 30 degrees, for example, an angle of 20 to 25 degrees, and/or the second facet may lie at an angle of 55 to 90 degrees, for example, an angle of 75 to 90 degrees, with respect to the axial direction D_A of the tubular connecting part.

[0064] The expanding tool head 420 of FIG. 4 differs from that of FIG. 2 in that the radially movable outer spreading surfaces 422 of the expanding tool head 420 comprise further an additional circumferential groove 427 which crosses each of the outer spreading surfaces. This additional groove lies substantially at the end of the outer spreading surfaces 422 where the stop faces 425 of the spreading elements 421 lie. This additional groove leaves, during expansion of a pipe end section, a circumferential intact retaining region 118 on the inner surface 112 of the pipe end section 111 substantially at the end of the pipe as illustrated in FIG. 1. In other embodiments, an additional groove may be positioned to leave such retaining region at some other location, preferably between the end of the pipe and the first circumferential intact sealing region.

[0065] In the example of FIG. 4, the expanding tool head 420 of FIG. 4 is connected to an expander tool 440. The expander tool comprises a radially movable piston 441. The piston has a tapered end configured to engage with beveled inner surfaces 428 of the spreading elements 421 to control radial movement thereof by axial movement of the piston.

[0066] Referring again back to FIG. 1, the connecting part 101 of the pipe fitting 100 comprises correspondingly a radially outwards extending circumferential retaining barb 105‴. This retaining barb is advantageously positioned so that when using the expanding tool head at its intended way of use, this retaining barb engages, during shrinkage of the pipe end section, the inner surface 112 of the pipe end section 111 behind the circumferential intact retaining region 118. In the example of FIG. 1, said positioning is achieved by having the tip of the cross section of the retaining ring lying at a distance from the stop face of the shoulder which is equal to the thickness of the stop edge of the clamping ring plus the width of the circumferential intact retaining region. In other embodiments, corresponding positioning of a retaining barb behind a circumferential intact retaining region may be achieved differently, depending on the position and width of the retaining region and the presence of a clamping ring on the pipe end section extending beyond the end of the pipe.

[0067] The retaining barb 105‴ positioned behind the circumferential intact retaining region 118 may retain the connecting part 101 within the pipe end section, thus prevent the pipe fitting from escaping out of the pipe end section, during and/or after the shrinkage of the pipe end section. Thereby, it may facilitate ensuring that the sealing barbs are positioned as properly aligned with the in-

tact sealing regions of the inner surface of the pipe end section.

[0068] In the example of FIG. 1, the retaining barb 105‴ has the same wedge-shaped cross section as the sealing barbs. In other embodiments, retaining barbs may be used with any appropriate longitudinal sectional shape suitable for providing said retaining function.

[0069] In the example of FIG. 1, there is a chamfer 109 on the inner surface of the tubular connecting part at the free end of the connecting part. The chamfer enlarges the inner diameter of the tubular connecting part towards the free end thereof lying opposite to the shoulder. The chamfer may advantageously reduce disturbances to the flow of a fluid between the pipe and the pipe fitting connected to it. In other embodiments, pipe fittings may be implemented without any chamfer.

[0070] Differently from the example of FIG. 1, other embodiments may be implemented with different number and/or of sealing and/or retaining barbs in the connecting part of a pipe fitting. For example, there may be only one, thus "first" sealing barb. Alternatively, connecting parts may have more than two retaining barbs. Preferably, at least one sealing barb lies in a middle section of the tubular connecting part between the ends thereof. Also the number of retaining barbs may vary; connecting pieces may be implemented without any retaining barb, or with two or more retaining barbs. In such other embodiments, one or more of the possibly several sealing barbs may be in accordance with any of the tip and facet/slope configurations discussed above.

[0071] Such pipe fittings differing form that of FIG. 1 may be configured to be inserted into pipe end sections expanded by expanding tool heads having a circumferential groove configuration correspondingly differing from that of FIG. 1.

[0072] In the example of FIG. 1, outside the first and the second sealing barb and the retaining barb and the chamfer, the wall thickness of t_X the tubular connecting part is substantially constant. Also in other embodiments, irrespective of the number and positioning of various sealing and/or retaining barbs, the wall thickness may be substantially constant outside the sealing barb(s), possible retaining barb (s), and possible chamfer.

[0073] Said substantially constant wall thickness may enable maximizing the volume of the flow channel formed within the tubular connecting part, as discussed further below.

[0074] Pipe fittings may be provided for different pipe sizes so that there is a specific pipe fitting size with specific outer diameter of the connecting part for each pipe inner diameter. Thereby, cold expansion pipe connection systems may be implemented for different pipe sizes, each such system comprising a pipe fitting and a pipe to be connected to the pipe fitting at a pipe end section thereof. An example of such system is illustrated in FIG 1.

[0075] On the other hand, expanding tool heads may be provided for different pipe sizes so that there is a specific expanding tool head size with specific outer diameter of cylinder formed by the outer spreading surfaces for each pipe inner diameter. Thereby, cold expansion pipe connection equipment may be implemented for each pipe sizes, each such system comprising an expanding tool head as discussed above with reference to FIG. 2 or FIG. 3, and a pipe fitting.

[0076] In the example of FIG. 1, the tubular connecting part is configured so that the connecting part inner diameter ID_F outside possible chamfer is substantially equal to the pipe inner diameter ID_P. In other embodiments, it may be even slightly larger. Equal or larger inner diameter may advantageously contribute to reducing disturbances to the flow of a fluid between the pipe and the pipe fitting connected to it.

[0077] Pipe inner diameter refers to the inner diameter of the pipe outside the pipe end section thereof.

[0078] Pipe fittings and/or expanding tool heads may be provided, for example, for pipe inner diameters in the range of 10 to 50 mm or 0.5 to 2 inches.

[0079] Any of the pipe fittings discussed above may also be used in connection with an expanded pipe end section expanded by using an expanding tool head different from those discussed above with reference to FIGs. 2 and 4. This is the case especially as far as after the expansion, the expanded pipe end section comprises on its inner surface a first possibly intact circumferential sealing region and possibly also a second possibly intact circumferential sealing region and/or a possibly intact circumferential retaining region corresponding to the first sealing barb and possible second sealing barb and/or retaining barb of the pipe end section, respectively.

[0080] In the method 500 of FIG. 5, any of the expanding tool heads and corresponding pipe fittings and pipes discussed above may be used.

[0081] In the method, a pipe end section of a pipe, possibly together with a clamping or retaining ring positioned over the pipe end section, is expanded by an expanding tool head in step 501. Then, the tubular connecting part of a pipe fitting is inserted into the expanded pipe end section in step 502. The expanded pipe end section is then let shrink in step 503 so that it is pressed against the tubular connecting part of the pipe fitting, whereby a sealed pipe connection is formed between the pipe fitting and the pipe.

[0082] Steps 501 and 502 may be carried out at least partially simultaneously so that the shrinkage of the pipe end section may already have been initiated when the connecting part of the pipe fitting is inserted into the initially expanded pipe section.

[0083] Preferably, the tubular connecting part of the pipe fitting used in the method has, outside a possible chamfer on its inner surface, a connecting part inner diameter that is substantially equal to or larger than the pipe inner diameter outside the pipe end section. It is to be noted that the present invention is not limited to the embodiments and examples above. Instead, the embodiments of the present invention can freely vary within the scope of the claims.

Claims

1. A pipe fitting (100) for forming a cold expansion pipe connection, comprising a tubular connecting part (101) extending substantially in an axial direction D_A and a shoulder (103) extending radially outwards from one end (102) of the tubular connecting part; the tubular connecting part being configured to be inserted into a pipe end section (111) of a pipe (110) expanded by an expanding tool head (220) comprising a plurality of radially movable outer spreading surfaces (222), the outer spreading surfaces comprising a first circumferential groove (424) crossing each of the outer spreading surfaces and leaving, during expansion of a pipe end section (111), a first circumferential intact sealing region (113) on the inner surface (112) of the pipe end section (111) at a first distance (D_1) from the end (116) of the pipe (110); the tubular connecting part comprising a first radially outwards extending circumferential sealing barb (105') positioned for engaging, when in use, with the first circumferential intact sealing region during shrinkage of the pipe end section for forming a sealing between the pipe fitting and the pipe, wherein the sealing barb (105') has a wedge-shape longitudinal section in the axial direction with a first facet (107') with a first slope on the side of the free end (104) of the tubular connecting part (101), and a second facet (107") with a second slope steeper than the first slope on the side of the shoulder (103), the first and the second facet being connected via a tip (108), **characterized in that** the tip (108) has a radius of curvature r in the range of 0,127 to 5,08 mm (0.005 to 0.020 inches), and wherein the tubular connecting part (101) has a wall thickness (t_W) which is substantially constant outside the sealing barb.

2. A pipe fitting (100) as defined in claim 1, the radially movable outer spreading surfaces (222) comprising a second circumferential groove (226) crossing each of the outer spreading surfaces and leaving, during expansion of a pipe end section (111), a second circumferential intact sealing region (117) on the inner surface (112) of the pipe end section (111) at a second distance (D_2) from the end (116) of the pipe (110), the second distance being larger than the first distance (D_1); the tubular connecting part further comprising a second radially outwards extending circumferential sealing barb (105") positioned for engaging, when in use, with the second circumferential intact sealing region (117) during shrinkage of the pipe end section for forming a sealing between the pipe fitting and the pipe.

3. A pipe fitting (100) as defined in claim 2, wherein the second sealing barb (105'') lies at the free end (104) of the tubular connecting part lying opposite to the shoulder (103).

4. A pipe fitting (100) as defined in any of claims 1 to 3, wherein the first facet lies at an angle of 10 to 30 degrees, for example, an angle of 20 to 25 degrees, with respect to the axial direction D_A of the tubular connecting part (101).

5. A pipe fitting (100) as defined in any of claims 1 to 4, wherein the second facet lies at an angle of 55 to 90 degrees, for example, an angle of 75 to 90 degrees, with respect to the axial direction D_A of the tubular connecting part (101).

6. A pipe fitting (100) as defined in any of claims 1 to 5, the radially movable outer spreading surfaces (422) of the expanding tool (420) head comprising an additional circumferential groove (427) crossing each of the outer spreading surfaces and leaving, during expansion of a pipe end section (111), a circumferential intact retaining region (118) on the inner surface (112) of the pipe end section preferably between the end (116) of the pipe (110) and the first circumferential intact sealing region (113); the tubular connecting part (101) comprising a radially outwards extending circumferential retaining barb (105''') positioned for engaging, when in use, with the inner surface of the pipe end section behind the circumferential intact retaining region so as to prevent the pipe fitting from escaping out of the pipe during and/or after shrinkage of the pipe end section.

7. A pipe fitting (100) as defined in any of claims 1 to 6, wherein the tubular connecting part (101) has a chamfer enlarging the inner diameter (ID_F) of the tubular connecting part towards the free end (104) thereof lying opposite to the shoulder (103).

8. A pipe fitting (100) as defined in any of claims 1 to 7, configured for forming a cold expansion pipe connection with a pipe (110) having a pipe inner diameter (ID_P) outside the pipe end section (111), wherein the tubular connecting part (101) has a connecting part inner diameter (ID_F) outside the possible chamfer (109) that is substantially equal to or larger than the pipe inner diameter.

9. A pipe connection comprising a pipe fitting (100) as defined in any of claims 1 to 8 and a pipe (110); the tubular connecting part (101) being inserted into a pipe end section (111) of the pipe (110) having a first circumferential intact sealing region (113) on the inner surface (112) of the pipe end section (111); the first radially outwards extending circumferential sealing barb (105') of the tubular connecting part being engaged with the first circumferential intact sealing region to form a sealing between the pipe fitting and the pipe.

10. A pipe connection as defined in claim 9, the pipe

(110) having a pipe inner diameter (ID_P) outside the pipe end section (111), wherein the tubular connecting part (101) has a connecting part inner diameter (ID_F) outside the possible chamfer (109) that is substantially equal to or larger than the pipe inner diameter.

11. A cold expansion pipe connection system comprising:

a pipe fitting (100) as defined in any of claims 1 to 11; and
a pipe (110) to be connected to the pipe fitting at a pipe end section thereof.

12. A pipe connection system as defined in claim 11, the pipe (110) having a pipe inner diameter (ID_P) outside the pipe end section (111), wherein the tubular connecting part (101) has a connecting part inner diameter (ID_F) outside the possible chamfer (109) that is substantially equal to or larger than the pipe inner diameter.

13. A cold expansion pipe connection equipment comprising:

an expanding tool head (220) for expanding a pipe end section (111) of a pipe (110), the expanding tool head comprising a plurality of radially movable outer spreading surfaces (222), the outer spreading surfaces comprising a first circumferential groove (224) crossing each of the outer spreading surfaces and leaving, during expansion of a pipe end section, a first circumferential intact sealing region (113) on the inner surface (112) of the pipe end section at a first distance (D_1) from the end of the pipe; and
a pipe fitting (100) as defined in any of claims 1 to 11.

14. A pipe connection equipment as defined in claim 13, the expanding tool head (220) being configured to expand a pipe end section (111) of a pipe (110) having a pipe inner diameter (ID_P) outside the pipe end section, wherein the tubular connecting part (101) has a connecting part inner diameter (ID_F) outside the possible chamfer (109) that is substantially equal to or larger than the pipe inner diameter.

15. A cold expansion pipe connection method (500) comprising:

expanding a pipe end section of a pipe by an expanding tool head comprising a plurality of radially movable outer spreading surfaces, the outer spreading surfaces comprising a first circumferential groove crossing each of the outer spreading surfaces and leaving, during expansion of a pipe end section, a first circumferential intact sealing region on the inner surface of the pipe end section at a first distance from the end of the pipe (501);
inserting a pipe fitting as defined in claim 1 into the expanded pipe end section, the first radially outwards extending circumferential sealing barb being positioned for engaging, when in use, with the first circumferential intact sealing region during shrinkage of the pipe end section (502); and
letting the expanded pipe end section shrink so as to be pressed against the connecting part to form a sealed pipe connection between the pipe fitting and the pipe (503).

16. A method as defined in claim 15, the pipe having a pipe inner diameter outside the pipe end section, wherein the tubular connecting part has, outside a possible chamfer on its inner surface enlarging the inner diameter of the tubular connecting part towards the free end thereof lying opposite to the shoulder, a connecting part inner diameter that is substantially equal to or larger than the pipe inner diameter.

Patentansprüche

1. Rohrarmatur (100) zum Bilden einer Kaltaufweitungsrohrverbindung, umfassend einen rohrförmigen Verbindungsteil (101), der sich im Wesentlichen in einer axialen Richtung D_A erstreckt, und eine Schulter (103), die sich von einem Ende (102) des rohrförmigen Verbindungsteils radial nach außen erstreckt, wobei der rohrförmige Verbindungsteil zum Einführen in einen mittels eines Aufweitungswerkzeugkopfs (220) aufgeweiteten Rohrendabschnitt (111) eines Rohrs (110) ausgestaltet ist, wobei der Aufweitungswerkzeugkopf eine Vielzahl von radial beweglichen äußeren Spreizflächen (222) umfasst, wobei die äußeren Spreizflächen eine erste Umfangsnut (424) umfassen, die jede der äußeren Spreizflächen kreuzt und während des Aufweitens eines Rohrendabschnitts (111) einen ersten intakten Umfangsdichtungsbereich (113) an der Innenfläche (112) des Rohrendabschnitts (111) mit einem ersten Abstand (D_1) von dem Ende (116) des Rohrs (110) belässt, wobei der rohrförmige Verbindungsteil einen ersten sich radial nach außen erstreckenden Umfangsdichtungswiderhaken (105') umfasst, der dazu positioniert ist, wenn er in Gebrauch ist, während des Schrumpfens des Rohrendabschnitts mit dem ersten intakten Umfangsdichtungsbereich in Eingriff zu kommen, um eine Dichtung zwischen der Rohrarmatur und dem Rohr zu bilden, wobei der Dichtungswiderhaken (105') einen keilförmigen Längsabschnitt in der axialen Richtung mit einer ersten Facette (107') mit einer ersten Neigung an der Seite des freien Endes (104) des rohrförmigen Ver-

bindungsteils (101) und einer zweiten Facette (107") mit einer zweiten Neigung an der Seite der Schulter (103) hat, die steiler als die erste Neigung ist, wobei die erste und die zweite Facette über eine Spitze (108) verbunden sind, **dadurch gekennzeichnet, dass** die Spitze (108) einen Krümmungsradius r im Bereich von 0,127 bis 5,08 mm (0,005 bis 0,020 Zoll) hat, und wobei der rohrförmige Verbindungsteil (101) eine Wanddicke (t_w) hat, die außerhalb des Dichtungswiderhakens im Wesentlichen konstant ist.

2. Rohrarmatur (100) nach Anspruch 1, wobei die radial beweglichen äußeren Spreizflächen (222) eine zweite Umfangsnut (226) umfassen, die jede der äußeren Spreizflächen kreuzt und während des Aufweitens eines Rohrendabschnitts (111) einen zweiten intakten Umfangsdichtungsbereich (117) an der Innenfläche (112) des Rohrendabschnitts (111) mit einem zweiten Abstand (D_2) von dem Ende (116) des Rohrs (110) belässt, wobei der zweite Abstand größer als der erste Abstand (D_1) ist, wobei der rohrförmige Verbindungsteil ferner einen zweiten sich radial nach außen erstreckenden Umfangsdichtungswiderhaken (105") umfasst, der dazu positioniert ist, wenn er in Gebrauch ist, während des Schrumpfens des Rohrendabschnitts mit dem zweiten intakten Umfangsdichtungsbereich (117) in Eingriff zu kommen, um eine Dichtung zwischen der Rohrarmatur und dem Rohr zu bilden.

3. Rohrarmatur (100) nach Anspruch 2, wobei der zweite Dichtungswiderhaken (105") an dem freien Ende (104) des rohrförmigen Verbindungsteils liegt, das der Schulter (103) gegenüberliegt.

4. Rohrarmatur (100) nach einem der Ansprüche 1 bis 3, wobei die erste Facette in einem Winkel von 10 bis 30 Grad, beispielsweise einem Winkel von 20 bis 25 Grad, bezüglich der axialen Richtung D_A des rohrförmigen Verbindungsteils (101) liegt.

5. Rohrarmatur (100) nach einem der Ansprüche 1 bis 4, wobei die zweite Facette in einem Winkel von 55 bis 90 Grad, beispielsweise einem Winkel von 75 bis 90 Grad, bezüglich der axialen Richtung D_A des rohrförmigen Verbindungsteils (101) liegt.

6. Rohrarmatur (100) nach einem der Ansprüche 1 bis 5, wobei die radial beweglichen äußeren Spreizflächen (422) des Aufweitungswerkzeugs (420) eine zusätzliche Umfangsnut (427) umfassen, die jede der äußeren Spreizflächen kreuzt und während des Aufweitens eines Rohrendabschnitts (111) einen intakten Umfangshaltebereich (118) an der Innenfläche (112) des Rohrendabschnitts, vorzugsweise zwischen dem Ende (116) des Rohrs (110) und dem ersten intakten Umfangsdichtungsbereich (113) belässt, wobei der rohrförmige Verbindungsteil (101) einen sich radial nach außen erstreckenden Umfangshaltewiderhaken (105‴) umfasst, der dazu positioniert ist, wenn er in Gebrauch ist, mit der Innenfläche des Rohrendabschnitts hinter dem intakten Umfangshaltebereich in Eingriff zu kommen, um zu verhindern, dass die Rohrarmatur während des und/oder nach dem Schrumpfen des Rohrendabschnitts aus dem Rohr entweicht.

7. Rohrarmatur (100) nach einem der Ansprüche 1 bis 6, wobei der rohrförmige Verbindungsteil (101) eine Abschrägung hat, die den Innendurchmesser (ID_F) des rohrförmigen Verbindungsteils zu dessen freiem Ende (104) hin, das der Schulter (103) gegenüberliegt, vergrößert.

8. Rohrarmatur (100) nach einem der Ansprüche 1 bis 7, die dazu ausgestaltet ist, eine Kaltaufweitungsrohrverbindung mit einem Rohr (110) zu bilden, das einen Rohrinnendurchmesser (ID_P) außerhalb des Rohrendabschnitts (111) aufweist, wobei der rohrförmige Verbindungsteil (101) einen Innendurchmesser (ID_F) des Verbindungsteils außerhalb der möglichen Abschrägung (109) hat, der im Wesentlichen gleich dem oder größer als der Rohrinnendurchmesser ist.

9. Rohrverbindung, umfassend eine Rohrarmatur (100) nach einem der Ansprüche 1 bis 8 und ein Rohr (110), wobei der rohrförmige Verbindungsteil (101) in einen Rohrendabschnitt (111) des Rohrs (110) mit einem ersten intakten Umfangsdichtungsbereich (113) an der Innenfläche (112) des Rohrendabschnitts (111) eingeführt wird, wobei der erste sich radial nach außen erstreckende Umfangsdichtungswiderhaken (105') des rohrförmigen Verbindungsteils mit dem ersten intakten Umfangsdichtungsbereich in Eingriff steht, um eine Dichtung zwischen der Rohrarmatur und dem Rohr zu bilden.

10. Rohrverbindung nach Anspruch 9, wobei das Rohr (110) einen Rohrinnendurchmesser (ID_P) außerhalb des Rohrendabschnitts (111) aufweist, wobei der rohrförmige Verbindungsteil (101) einen Innendurchmesser (ID_F) des Verbindungsteils außerhalb der möglichen Abschrägung (109) hat, der im Wesentlichen gleich dem oder größer als der Rohrinnendurchmesser ist.

11. Kaltaufweitungsrohrverbindungssystem, umfassend:

eine Rohrarmatur (100) nach einem der Ansprüche 1 bis 11 und
ein Rohr (110), das an einem Rohrendabschnitt davon mit der Rohrarmatur zu verbinden ist.

12. Rohrverbindungssystem nach Anspruch 11, wobei das Rohr (110) einen Rohrinnendurchmesser (ID_P) außerhalb des Rohrendabschnitts (111) aufweist, wobei der rohrförmige Verbindungsteil (101) einen Innendurchmesser (ID_F) des Verbindungsteils außerhalb der möglichen Abschrägung (109) hat, der im Wesentlichen gleich dem oder größer als der Rohrinnendurchmesser ist.

13. Kaltaufweitungsrohrverbindungsausrüstung, umfassend:

einen Aufweitungswerkzeugkopf (220) zum Aufweiten eines Rohrendabschnitts (111) eines Rohrs (110), wobei der Aufweitungswerkzeugkopf eine Vielzahl von radial beweglichen äußeren Spreizflächen (222) umfasst, wobei die äußeren Spreizflächen eine erste Umfangsnut (224) umfassen, die jede der äußeren Spreizflächen kreuzt und während des Aufweitens eines Rohrendabschnitts einen ersten intakten Umfangsdichtungsbereich (113) an der Innenfläche (112) des Rohrendabschnitts mit einem ersten Abstand (D_1) von dem Ende des Rohrs belässt, und
eine Rohrarmatur (100) nach einem der Ansprüche 1 bis 11.

14. Rohrverbindungsausrüstung nach Anspruch 13, wobei der Aufweitungswerkzeugkopf (220) dazu ausgestaltet ist, einen Rohrendabschnitt (111) eines Rohrs (110) mit einem Rohrinnendurchmesser (ID_P) außerhalb des Rohrendabschnitts aufzuweiten, wobei der rohrförmige Verbindungsteil (101) einen Innendurchmesser (ID_F) des Verbindungsteils außerhalb der möglichen Abschrägung (109) hat, der im Wesentlichen gleich dem oder größer als der Rohrinnendurchmesser ist.

15. Kaltaufweitungsrohrverbindungsverfahren (500), umfassend:

Aufweiten eines Rohrendabschnitts eines Rohrs mittels eines Aufweitungswerkzeugkopfs, der eine Vielzahl von radial beweglichen äußeren Spreizflächen umfasst, wobei die äußeren Spreizflächen eine erste Umfangsnut umfassen, die jede der äußeren Spreizflächen kreuzt und während des Aufweitens eines Rohrendabschnitts einen ersten intakten Umfangsdichtungsbereich an der Innenfläche des Rohrendabschnitts mit einem ersten Abstand von dem Ende des Rohrs (501) belässt,
Einführen einer Rohrarmatur nach Anspruch 1 in den aufgeweiteten Rohrendabschnitt, wobei der erste sich radial nach außen erstreckende Umfangsdichtungswiderhaken dazu positioniert ist, wenn er in Gebrauch ist, während des Schrumpfens des Rohrendabschnitts (502) mit dem ersten intakten Umfangsdichtungsbereich in Eingriff zu kommen, und
Schrumpfenlassen des aufgeweiteten Rohrendabschnitts, so dass er gegen den Verbindungsteil gepresst wird, um zwischen der Rohrarmatur und dem Rohr (503) eine abgedichtete Rohrverbindung zu bilden.

16. Verfahren nach Anspruch 15, wobei das Rohr einen Rohrinnendurchmesser außerhalb des Rohrendabschnitts hat, wobei der rohrförmige Verbindungsteil außerhalb einer möglichen Abschrägung an seiner Innenfläche, die den Innendurchmesser des rohrförmigen Verbindungsteils zu dessen freier Seite hin, die der Schulter gegenüberliegt, vergrößert, einen Innendurchmesser des Verbindungsteils hat, der im Wesentlichen gleich dem oder größer als der Rohrinnendurchmesser ist.

Revendications

1. Raccord de tuyau (100) destiné à former un raccordement de tuyau d'expansion à froid, comprenant une partie de raccordement tubulaire (101) s'étendant sensiblement dans une direction axiale D_A et un épaulement (103) s'étendant radialement vers l'extérieur à partir d'une extrémité (102) de la partie de raccordement tubulaire ; la partie de raccordement tubulaire étant configurée pour être insérée dans une section d'extrémité de tuyau (111) d'un tuyau (110) étendue par une tête d'outil d'expansion (220) comprenant une pluralité de surfaces d'étalement extérieures radialement mobiles (222), les surfaces d'étalement extérieures comprenant une première rainure circonférentielle (424) traversant chacune des surfaces d'étalement extérieures et laissant, pendant l'expansion d'une section d'extrémité de tuyau (111), une première région d'étanchéité intacte circonférentielle (113) sur la surface intérieure (112) de la section d'extrémité de tuyau (111) à une première distance (D_1) de l'extrémité (116) du tuyau (110) ; la partie de raccordement tubulaire comprenant une première barbe d'étanchéité circonférentielle s'étendant radialement vers l'extérieur (105') positionnée pour venir en prise, lors de l'utilisation, avec la première région d'étanchéité intacte circonférentielle pendant le retrait de la section d'extrémité de tuyau pour former une étanchéité entre le raccord de tuyau et le tuyau, dans lequel la barbe d'étanchéité (105') a une section longitudinale en forme de coin dans la direction axiale avec une première facette (107') ayant une première pente du côté de l'extrémité libre (104) de la partie de raccordement tubulaire (101), et une seconde facette (107") ayant une seconde pente plus raide que la première pente du côté de l'épaulement (103), la première et la seconde

facette étant reliées par une pointe (108), **caractérisé en ce que** la pointe (108) a un rayon de courbure r dans la plage de 0,127 à 5,08 mm (0,005 à 0,020 pouces), et dans lequel la partie de raccordement tubulaire (101) a une épaisseur de paroi (t_w) qui est sensiblement constante à l'extérieur de la barbe d'étanchéité.

2. Raccord de tuyau (100) selon la revendication 1, les surfaces d'étalement extérieures radialement mobiles (222) comprenant une seconde rainure circonférentielle (226) traversant chacune des surfaces d'étalement extérieures et laissant, pendant l'expansion d'une section d'extrémité de tuyau (111), une seconde région d'étanchéité intacte circonférentielle (117) sur la surface intérieure (112) de la section d'extrémité de tuyau (111) à une seconde distance (D_2) de l'extrémité (116) du tuyau (110), la seconde distance étant plus grande que la première distance (D_1) ; la partie de raccordement tubulaire comprenant en outre une seconde barbe d'étanchéité circonférentielle s'étendant radialement vers l'extérieur (105") positionnée pour venir en prise, lors de l'utilisation, avec la seconde région d'étanchéité intacte circonférentielle (117) pendant le retrait de la section d'extrémité de tuyau pour former une étanchéité entre le raccord de tuyau et le tuyau.

3. Raccord de tuyau (100) selon la revendication 2, dans lequel la seconde barbe d'étanchéité (105") se trouve à l'extrémité libre (104) de la partie de raccordement tubulaire située à l'opposé de l'épaulement (103) .

4. Raccord de tuyau (100) selon l'une quelconque des revendications 1 à 3, dans lequel la première facette forme un angle de 10 à 30 degrés, par exemple un angle de 20 à 25 degrés, par rapport à la direction axiale D_A de la partie de raccordement tubulaire (101).

5. Raccord de tuyau (100) selon l'une quelconque des revendications 1 à 4, dans lequel la seconde facette forme un angle de 55 à 90 degrés, par exemple un angle de 75 à 90 degrés, par rapport à la direction axiale D_A de la partie de raccordement tubulaire (101).

6. Raccord de tuyau (100) selon l'une quelconque des revendications 1 à 5, les surfaces d'étalement extérieures radialement mobiles (422) de la tête de l'outil d'expansion (420) comprenant une rainure circonférentielle supplémentaire (427) traversant chacune des surfaces d'étalement extérieures et laissant, pendant l'expansion d'une section d'extrémité de tuyau (111), une région de retenue intacte circonférentielle (118) sur la surface intérieure (112) de la section d'extrémité de tuyau, de préférence entre l'extrémité (116) du tuyau (110) et la première région d'étanchéité intacte circonférentielle (113) ; la partie de raccordement tubulaire (101) comprenant une barbe de retenue circonférentielle s'étendant radialement vers l'extérieur (105'") positionnée pour venir en prise, lors de l'utilisation, avec la surface intérieure de la section d'extrémité de tuyau derrière la région de retenue intacte circonférentielle pour empêcher le raccord de tuyau de s'échapper du tuyau pendant et/ou après le retrait de la section d'extrémité de tuyau.

7. Raccord de tuyau (100) selon l'une quelconque des revendications 1 à 6, dans lequel la partie de raccordement tubulaire (101) présente un chanfrein élargissant le diamètre intérieur (ID_F) de la partie de raccordement tubulaire vers son extrémité libre (104) située à l'opposé de l'épaulement (103).

8. Raccord de tuyau (100) selon l'une quelconque des revendications 1 à 7, configuré pour former un raccordement de tuyau d'expansion à froid avec un tuyau (110) ayant un diamètre intérieur de tuyau (ID_P) à l'extérieur de la section d'extrémité de tuyau (111), dans lequel la partie de raccordement tubulaire (101) a un diamètre intérieur de partie de raccordement (ID_F) à l'extérieur de l'éventuel chanfrein (109) qui est sensiblement égal ou supérieur au diamètre intérieur de tuyau.

9. Raccordement de tuyau comprenant un raccord de tuyau (100) selon l'une quelconque des revendications 1 à 8 et un tuyau (110) ; la partie de raccordement tubulaire (101) étant insérée dans une section d'extrémité de tuyau (111) du tuyau (110) ayant une première région d'étanchéité intacte circonférentielle (113) sur la surface intérieure (112) de la section d'extrémité de tuyau (111) ; la première barbe d'étanchéité circonférentielle s'étendant radialement vers l'extérieur (105') de la partie de raccordement tubulaire étant en prise avec la première région d'étanchéité intacte circonférentielle pour former une étanchéité entre le raccord de tuyau et le tuyau.

10. Raccordement de tuyau selon la revendication 9, le tuyau (110) ayant un diamètre intérieur de tuyau (ID_P) à l'extérieur de la section d'extrémité de tuyau (111), dans lequel la partie de raccordement tubulaire (101) a un diamètre intérieur de partie de raccordement (ID_F) à l'extérieur de l'éventuel chanfrein (109) qui est sensiblement égal ou supérieur au diamètre intérieur de tuyau.

11. Système de raccordement de tuyau d'expansion à froid comprenant :

un raccord de tuyau (100) selon l'une quelconque des revendications 1 à 11 ; et

un tuyau (110) à raccorder au raccord de tuyau à une section d'extrémité de tuyau de celui-ci.

12. Système de raccordement de tuyau selon la revendication 11, le tuyau (110) ayant un diamètre intérieur de tuyau (ID_P) à l'extérieur de la section d'extrémité de tuyau (111), dans lequel la partie de raccordement tubulaire (101) a un diamètre intérieur de partie de raccordement (ID_F) à l'extérieur de l'éventuel chanfrein (109) qui est sensiblement égal ou supérieur au diamètre intérieur de tuyau.

13. Équipement de raccordement de tuyau d'expansion à froid comprenant :

une tête d'outil d'expansion (220) pour l'expansion d'une section d'extrémité de tuyau (111) d'un tuyau (110), la tête d'outil d'expansion comprenant une pluralité de surfaces d'étalement extérieures radialement mobiles (222), les surfaces d'étalement extérieures comprenant une première rainure circonférentielle (224) traversant chacune des surfaces d'étalement extérieures et laissant, pendant l'expansion d'une section d'extrémité de tuyau, une première région d'étanchéité intacte circonférentielle (113) sur la surface intérieure (112) de la section d'extrémité de tuyau à une première distance (D_1) de l'extrémité du tuyau ; et
un raccord de tuyau (100) selon l'une quelconque des revendications 1 à 11.

14. Équipement de raccordement de tuyau selon la revendication 13, la tête d'outil d'expansion (220) étant configurée pour étendre une section d'extrémité de tuyau (111) d'un tuyau (110) ayant un diamètre intérieur de tuyau (ID_P) à l'extérieur de la section d'extrémité de tuyau, dans lequel la partie de raccordement tubulaire (101) a un diamètre intérieur de partie de raccordement (ID_F) à l'extérieur de l'éventuel chanfrein (109) qui est sensiblement égal ou supérieur au diamètre intérieur du tuyau.

15. Procédé de raccordement de tuyau d'expansion à froid (500) comprenant :

l'expansion d'une section d'extrémité de tuyau par une tête d'outil d'expansion comprenant une pluralité de surfaces d'étalement extérieures radialement mobiles, les surfaces d'étalement extérieures comprenant une première rainure circonférentielle traversant chacune des surfaces d'étalement extérieures et laissant, pendant l'expansion d'une section d'extrémité de tuyau, une première région d'étanchéité intacte circonférentielle sur la surface intérieure de la section d'extrémité de tuyau à une première distance de l'extrémité du tuyau (501) ;
l'insertion d'un raccord de tuyau selon la revendication 1 dans la section d'extrémité de tuyau étendue, la première barbe d'étanchéité circonférentielle s'étendant radialement vers l'extérieur étant positionnée pour venir en prise, lors de l'utilisation, avec la première région d'étanchéité intacte circonférentielle pendant le retrait de la section d'extrémité de tuyau (502) ; et
l'étape consistant à laisser la section d'extrémité de tuyau étendue se rétracter de manière à être pressée contre la partie de raccordement pour former un raccordement de tuyau étanche entre le raccord de tuyau et le tuyau (503).

16. Procédé selon la revendication 15, le tuyau ayant un diamètre intérieur de tuyau à l'extérieur de la section d'extrémité de tuyau, dans lequel la partie de raccordement tubulaire a, en dehors d'un éventuel chanfrein sur sa surface intérieure augmentant le diamètre intérieur de la partie de raccordement tubulaire vers son extrémité libre située à l'opposé de l'épaulement, un diamètre intérieur de la partie de raccordement qui est sensiblement égal ou supérieur au diamètre intérieur de tuyau.

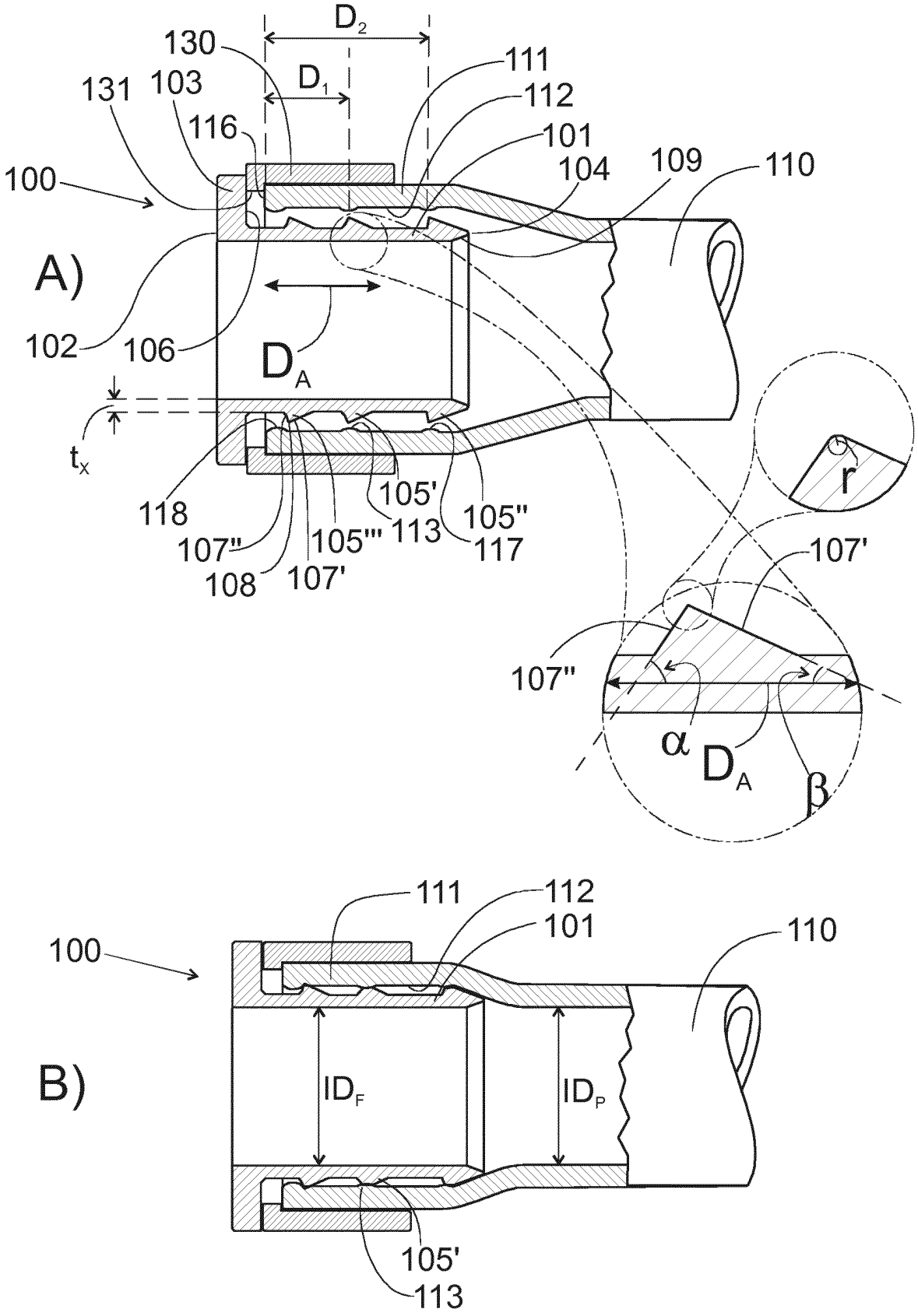
A)
B)
100
130
131
103
116
111
112
101
104
109
110
102
106
D_2
D_1
D_A
t_X
118
107'''
108
107'
105'''
113
105'
105''
117
r
107''
α
β
ID_F
ID_P
105'
113

FIG. 1

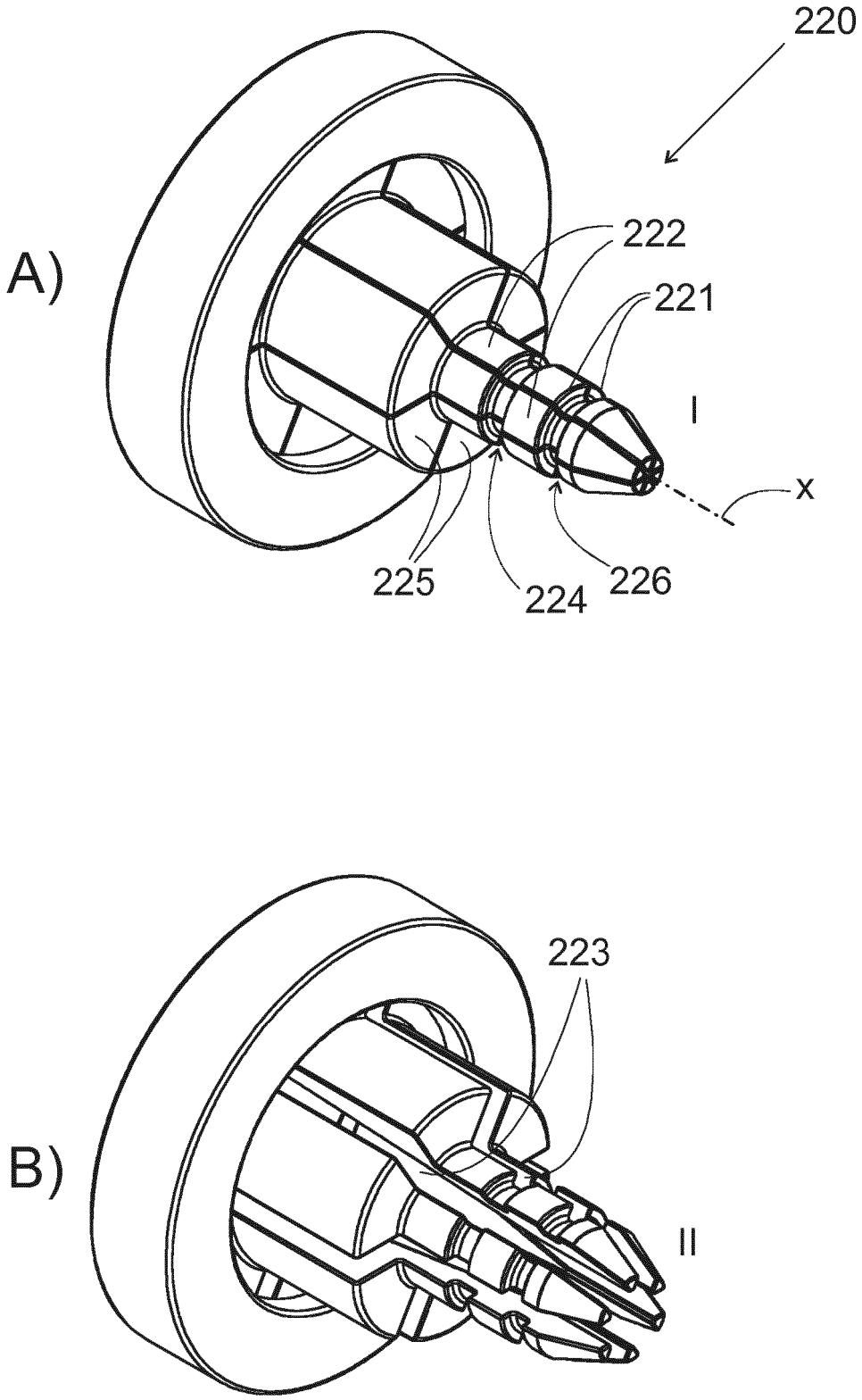

FIG. 2

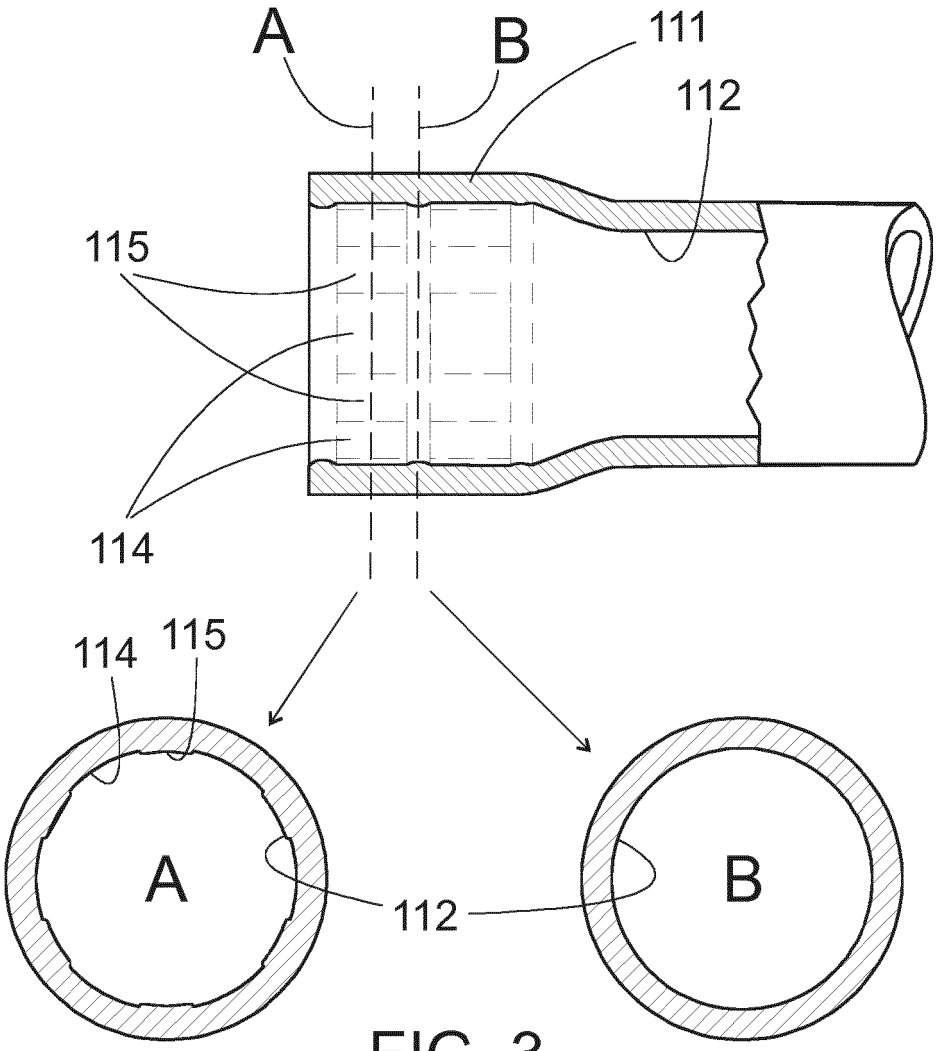
A
B
111
112
115
114
114
115
A
112
B

FIG. 3

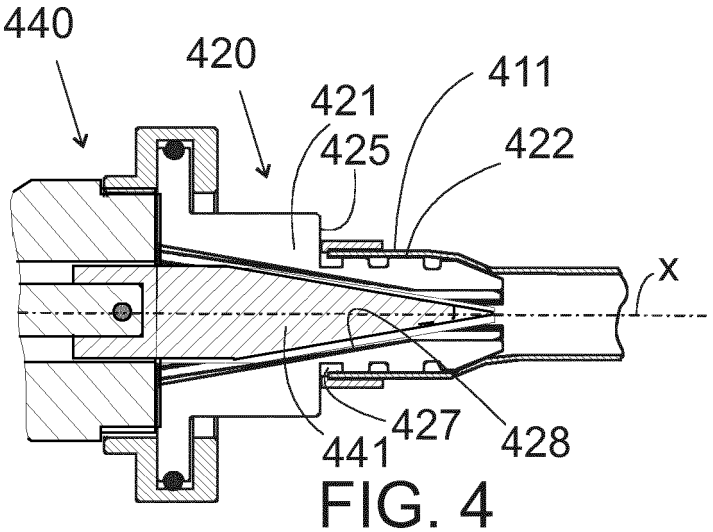
440
420
421
411
425
422
x
441
427
428

FIG. 4

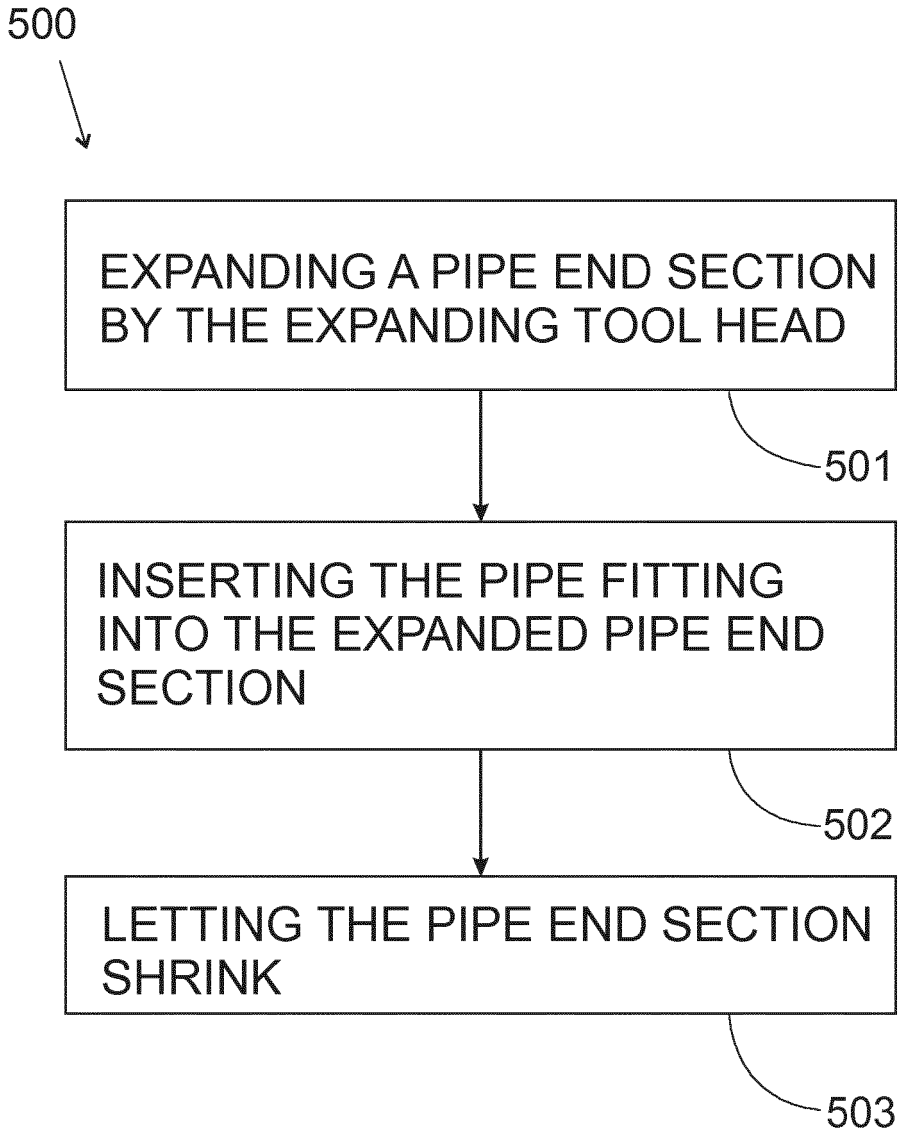
500
EXPANDING A PIPE END SECTION BY THE EXPANDING TOOL HEAD
501
INSERTING THE PIPE FITTING INTO THE EXPANDED PIPE END SECTION
502
LETTING THE PIPE END SECTION SHRINK
503

FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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