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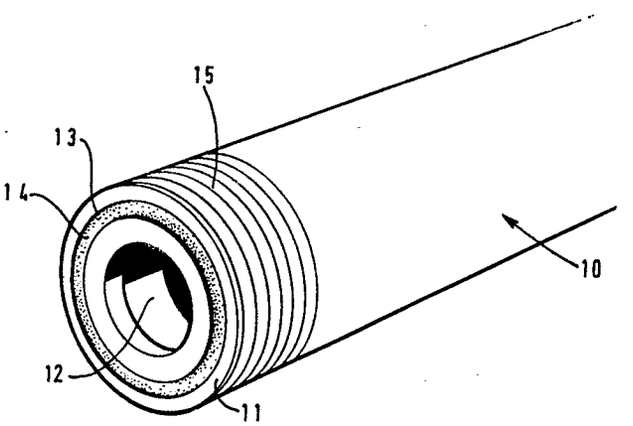
(71) Applicant: **IRACROFT LIMITED, Blandford Heights Industrial Estate Shaftsbury Lane, Blandford Forum Dorset (GB)**

(72) Inventor: **Bamford,David Charles, Alanda,The Avenue,Porton, Nr Salisbury,Wiltshire (GB)**

(74) Representative: **Leach, John Nigel et al, FORRESTER & BOEHMERT Widenmayerstrasse 4/I, D-8000 München 22 (DE)**

(54) Method of providing a face seal.

(57) A method of providing a face seal at an end (11) of a tube (10) comprises the steps of displacing an end (22) of the tube (10) to provide a radially inwardly extending region, providing a groove (13) in a longitudinally outwardly facing end (11) of the inwardly extending region to receive a seal (14).



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Title: "Method of providing a face seal"

Description of Invention

This invention relates to a method of providing a face seal at an end of a tube.

At present, to provide a face seal, it is necessary to secure, usually by welding or brazing, a fitting, usually a male fitting, on an end of a tube, the male fitting having a longitudinally outwardly facing surface thereof in which a groove is provided to receive a seal such as an O-ring.

It is an object of the present invention to provide a new or improved method of providing a face seal.

According to a first aspect of the invention, we provide a method of providing a face seal at an end of a tube comprising the steps of displacing an end of the tube to provide a radially inwardly extending region, providing a groove in a longitudinally outwardly facing end of the inwardly extending region to receive a seal.

Preferably the end of the tube is displaced radially inwardly so that the inwardly extending region comprises a thickened end of the tube wall. This may be achieved by a punching operation.

In one method in accordance with the invention, the punching operation comprises the steps of supporting the tube by a clamping means, moving a first punching tool longitudinally towards the tube, the punching tool having a part which receives and displaces the end of the tube inwardly, moving the first punching tool longitudinally away from the tube, moving a second punching tool longitudinally towards the tube, the second punching tool having a first part which is received in the end of the tube and a second part which engages the tube wall so that the displaced end of the tube is deformed into an annular space adjacent the first part of the second punching tool.

Alternatively, the punching operation may comprise the steps of supporting the tube by a clamping means, moving a punching tool longitudinally towards the tube so that a first part of the tool is received in the end of the tube, whilst a second part of the tool engages the tube wall,

continuing to move the tool so that the end of the tube is displaced and deformed into an annular space adjacent the first part of the tool.

In an alternative method in accordance with the invention, the displaced inwardly extending region may be provided by a spinning operation comprising the steps of supporting the tube in a clamping means, moving a spinning tool longitudinally of the tube so that a first part of the tool is received within the end of the tube, rotating the tool about the longitudinal axis of the tube whilst continuing to move the tool longitudinally of the tube so that a second part of the spinning tool engages with the tube wall and displaces and deforms the end of the tube into an annular space adjacent the first part of the tool.

Preferably, in each case, the tube is supported with the end region to be displaced projecting from the clamping means and the annular groove into which the end of the tube is deformed, is located between the clamping means and the first part of the tool. Further, in each case, preferably a longitudinally outwardly extending, generally planar, face is provided on the inwardly extending region in which the groove may subsequently be provided.

Preferably the groove is machined and is generally of channel configuration in cross-section, although a groove of another cross sectional configuration could alternatively be provided if required. The groove preferably surrounds the opening in the tube. Thus the seal may be an 'O' ring.

The external surface of the tube wall may be provided with a male thread if required to enable the tube to be secured to a female fitting or other member providing a female threaded opening.

Alternatively, the tube may be provided with an external abutment, such as a collar, which is engaged by a nut, in use, to enable the tube to be secured to a female fitting or member.

In each case, the seal may, prior to securing the tube to the fitting or member, extend from the groove and be urged into engagement with the fitting or member when the tube is secured to the fitting or member to provide a seal between the tube and the fitting.

According to a second aspect of the invention, we provide a tube having a face seal received in a groove in a longitudinally outwardly facing end of the tube, the groove being provided in an inwardly extending region of the tube wall, formed by a method in accordance with the first aspect of the invention.

The invention will now be described, by way of example only, with reference to the accompanying drawings wherein:-

FIGURE 1 is a perspective view of a tube provided with a face seal by a method in accordance with the first aspect of the invention;

FIGURES 2a and 2b show two stages in a punching operation which is part of a method in accordance with the invention;

FIGURES 3a and 3b show two stages of an alternative punching operation of a method in accordance with the invention;

FIGURE 4 shows a stage in a spinning operation for use in a method in accordance with the invention.

All of the drawings are intended only to be diagrammatic as will be apparent to a man skilled in the art.

Referring to Figure 1, a tube 10 has at one end a longitudinally outwardly extending face 11 which surrounds the central opening 12 of the tube 10.

Provided in the end face 11 is a channel cross section groove 13 in which an O-ring seal 14 is provided. For different configuration seals, a groove 13 of alternative cross section may be provided.

As shown, the seal 14 extends outwardly of the groove 13, although when the tube 10 is connected to a female fitting or a female threaded opening in another member, the seal 14 is deformed thereby providing a seal between the end face 11 and the fitting or member.

To facilitate this connection, the exterior surface of the tube 10 adjacent the end thereof, is provided with a male thread 15.

In an alternative arrangement, the exterior surface of the tube 10 may be provided with an abutment such as a collar which is engaged by a nut as the nut is slid along the tube 10, which nut may permit the tube 10 to be connected to the female fitting or member.

Conventionally, in order to provide an end face seal, it is necessary to secure, usually by welding or brazing, a male fitting on the end of the tube 10.

In accordance with the present invention however, the end face seal is provided by displacing the end of the tube 10 radially inwardly to provide a thickened portion of the tube wall at the end, in which the groove 13 may be cut by machining.

Referring now to Figures 2a and 2b, two stages in a punching operation are shown.

The tube 10 is shown held by a pair of clamping members 18 and 19 which are movable apart to release the tube, each clamping member having a part circular groove to receive the tube 10.

A first punching tool 20 is shown which has a recess 21 to receive the end of the tube 10, shown at 22, which projects from the clamping members 18, 19.

When the first punching tool 20 is moved longitudinally of the tube along central axis A thereof, towards the tube 10, the end 22 of the tube will be received in the recess 21, and as the first punching tool 20 continues to move, the end 22 of the tube will be deformed radially inwardly, as shown in Figure 2a.

Thereafter, the first punching tool 20 is moved longitudinally away from the tube 10 to permit a second punching tool 30 to be moved longitudinally towards the tube 10 along axis A.

As shown in figure 2b, the second punching tool has a first part 31 which is received within the central opening 12 of the tube 10, the first part 31 being of such dimension to be accommodated within the opening at the displaced end 22.

The punching tool 30 has a second part 32 which engages the end 22 of the tube 10 as the punching tool 30 is moved.

It can be seen that as the tool 30 continues to move along axis A, that the end of the tube is deformed into an annular space 33 adjacent the first part 31 of the second tool 30, which extends between the first part 31 and the adjacent parts 34 of the clamping members 18, 19.

Thus, the end of the tube is thickened to provide an end face 11 of generally planar form in which the groove 13 may subsequently be provided by machining.

When the punching operation is completed, the second punching tool 30 is moved longitudinally away from the tube 10 and the clamping members 18, 19 release the tube, thereafter the thread 15 on the exterior surface of the tube 10 may be provided, although the thread may be formed prior to punching, if required.

Figures 3a and 3b show an alternative punching operation, similar parts to those shown in Figures 2a and 2b being indicated by the same reference numerals.

In this operation, a single punching tool 40 is used, which has a first part 41 which is received within the central opening 12 of the tube 10 and a second annular part 42 which displaces and deforms the end 22 of the tube 10.

Again, clamping members 18 and 19 are provided to securely hold the tube 10 during the punching operation.

The punching tool 40 is again moved longitudinally towards the tube 10 along axis A until the projecting end 22 of the tube 10 is engaged by the second part 42 of the tool 40. In this position, the first part 41 of the tool 40 will be received within the opening 12.

Upon continued movement of the tool 40, the end 22 of the tube 10 will be displaced radially inwardly and deformed into an annular space 43 adjacent the first part 41 of the tool 40, as shown in Figure 3b, to provide a thickened tube wall at the end 22. The thickened end 22 has the generally planar longitudinally outwardly extending surface 11 in which a groove 13 may subsequently be provided by machining or any other method.

Referring now to Figure 4, one stage of a spinning operation is shown. Again, similar parts to those shown in Figures 2a and 2b are given the same reference numerals.

The tube 10 is shown held between two clamping members 18, 19 of a clamping means so that an end 22 of the tube projects from the clamping members 18, 19.

A spinning tool 50 is shown which comprises a first part 51 which, in use, is received within the internal opening 12 of the tube 10 and a second part 52 comprising an annular surface which engages the end 22 of the tube 10.

In the method, the tool 50 is moved towards the tube 10 along longitudinal axis A until the first part 51 is received in the opening 12 and the second part 52 engages the end 22. The tool 50 is continuously spun as indicated by the arrow 54 and thus the end 22 of the tube 10 is displaced and deformed into an annular space 53 adjacent the first part 51 of the tool 50, which lies between the first part 51 and adjacent regions 34 of the clamping members 18, 19.

Thus again, the end 22 of the tube 10 is thickened to provide a generally planar surface 11 in which the groove 13 may be cut to receive an O-ring or other seal 14.

After performing the punching operations described with reference to Figures 3a and 3b, or the spinning operation described with reference to Figure 4, the exterior surface of the tube 10 may be provided with a thread 15 as shown in Figure 1, or again the thread 15 may be provided prior to punching or spinning.

Thereafter, the seal 14 is introduced into the groove 13 so that the tube 10 may be connected to a female fitting or other member which provides a female threaded opening as required, the end face 11 being sealed with the fitting or member by virtue of the O-ring seal 14 which engages with a corresponding sealing face of the fitting or member to which the tube 10 is connected.

It will be appreciated that although punching and spinning operations have been described in order to provide the end of the tube with a thickened end wall in which the groove 13 may be provided, any other method for displacing the end of the tube radially inwardly and to provide an inwardly extending region, may be provided.

The invention has been found to be particularly applicable to tubes made of, for example, steel having a wall thickness of between 4.17 mm and 2.03 mm, although with different tools and clamping means, it is envisaged that the invention could be applied to tubes made of alternative materials and having wall thicknesses lying outside the range given.

The features disclosed in the foregoing description, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, or a class or group of substances or compositions, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A method of providing a face seal at an end (22) of a tube (10) comprising the steps of displacing an end (22) of the tube (10) to provide a radially inwardly extending region, providing a groove (13) in a longitudinally outwardly facing end (11) of the inwardly extending region to receive a seal (14).

2. A method according to claim 1 characterised in that the inwardly extending region is achieved by a punching operation which comprises the steps of supporting the tube (10) by a clamping means (18,19), moving a first punching tool (20) longitudinally towards the tube, the punching tool (20) having a part which receives and displaces the end (22) of the tube (10) inwardly, moving the first punching tool (20) longitudinally away from the tube (10), moving a second punching tool (30) longitudinally towards the tube (10), the second punching tool (30) having a first part (31) which is received in the end of the tube (10) and a second part (32) which engages the tube wall so that the displaced end (22) of the tube (10) is deformed into an annular space adjacent the first part (31) of the second punching tool (30).

3. A method according to claim 1 characterised in that the inwardly extending region is achieved by a punching operation which comprises the steps of supporting the tube (10) by a clamping means (18,19), moving a punching tool (40) longitudinally towards the tube (10) so that a first part (41) of the tool (40) is received in the end (22) of the tube (10), whilst a second part (42) of the tool (40) engages the tube wall, continuing to move the tool (40) so that the end (22) of the tube is displaced and deformed into an annular space adjacent the first part (41) of the tool (10).

4. A method according to claim 1 characterised in that the displaced inwardly extending region is provided by a spinning operation comprising the steps of supporting the tube (10) in a clamping means (18,19), moving a spinning tool (50) longitudinally of the tube (10) so that a first part (51) of the tool is received within the end (22) of the tube, rotating the tool (50) about the longitudinal axis (A) of the tube (10) whilst continuing to move the tool (50) longitudinally of the tube so that a second part (52) of the spinning tool engages with the tube wall and displaces and deforms the end (22) of the tube (10) into an annular space adjacent the first part (51) of the tool (50).

5. A method according to claim 2, or claim 3, or claim 4 characterised in that the tube (10) is supported with the end region (22) to be displaced projecting from the clamping means (18,19) and the annular space into which the end of the tube is deformed, is located between the clamping means (18,19) and the first part (31,41,51) of the tool (30,40,50).

6. A method according to any one of the preceding claims characterised in that the longitudinally outwardly extending region has a generally planar face (11) provided on the inwardly extending region, in which the groove (13) is subsequently provided.

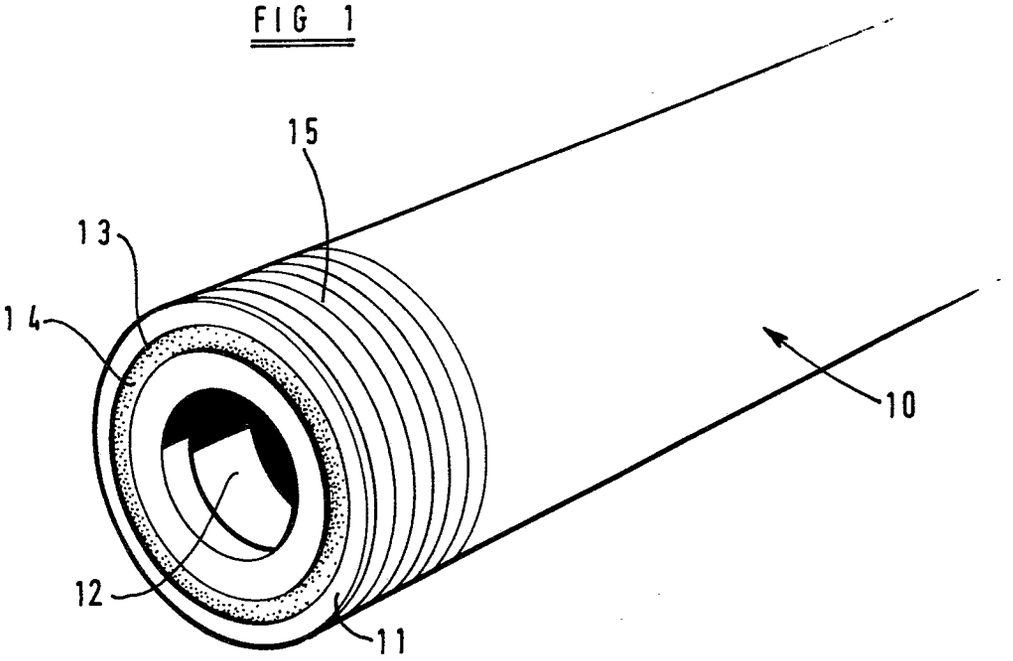
7. A method according to any one of the preceding claims characterised in that the groove (13) is machined and is generally of channel configuration in cross-section.

8. A method according to any one of the preceding claims characterised in that the external surface of the tube wall is provided with a male thread (15) to enable the tube (10) to be secured to a member providing a female threaded opening.

9. A method according to any one of claims 1 to 7 characterised in that the tube (10) is provided with an external abutment which is engaged by a nut, in use, to enable the tube to be secured to a female fitting or member.

10. A method according to claim 8 or claim 9 characterised in that the seal is an 'O' ring (14) and prior to securing the tube (10) to the fitting or member, the 'O' ring (14) extends from the groove (13) and is urged into engagement with the fitting or member when the tube (10) is secured to the fitting or member to provide a seal between the tube (10) and the fitting or member.

FIG 1



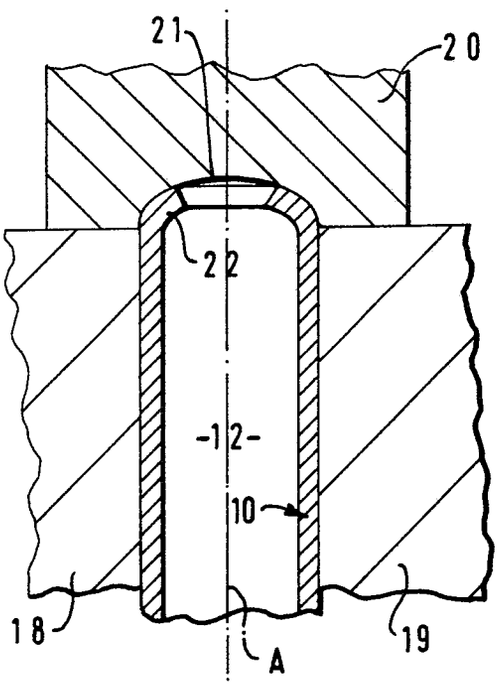


FIG 2a

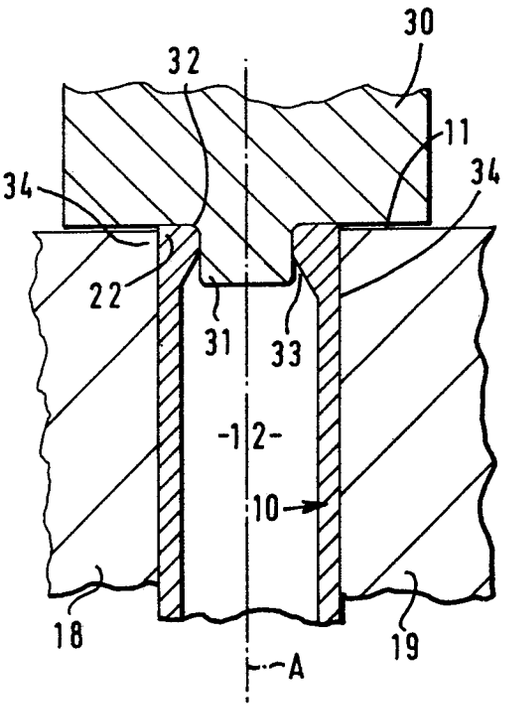


FIG 2b

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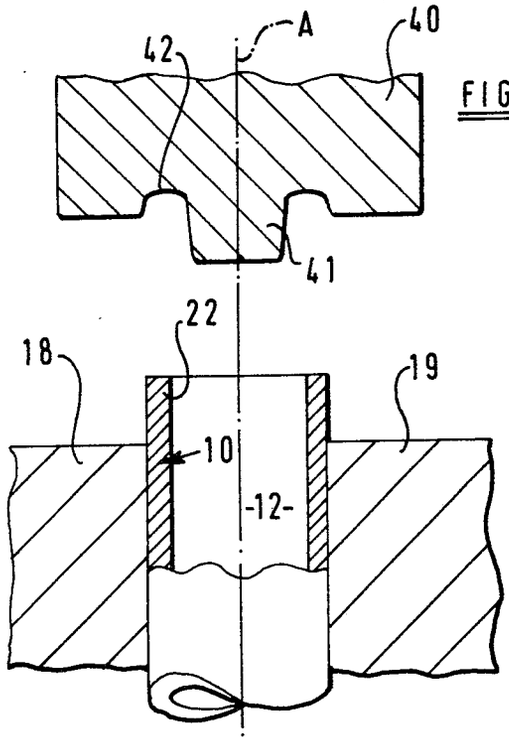
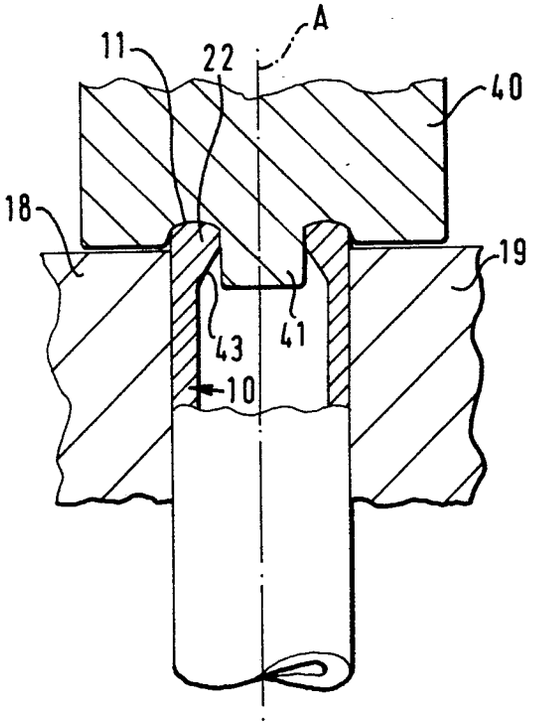


FIG 3a

FIG 3b



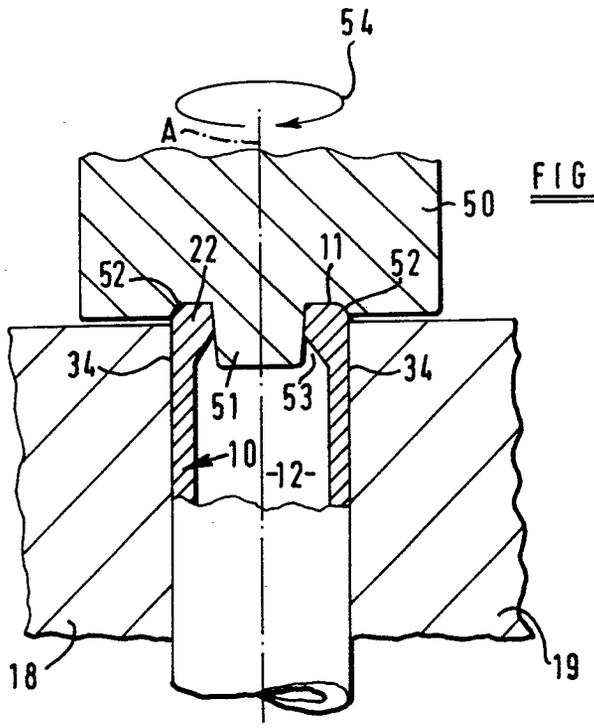


FIG 4