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(71) Applicant: **Machinefabriek van de Weert Helmond B.V.**
5705 BH Helmond (NL)

(72) Inventors:
- **Tourné, Johannes Willem**
  5709 EL Helmond (NL)
- **Mulkens, Edwin Wilhelmus Leonardus**
  5702 JT Helmond (NL)
- **Tresser, Dietfried**
  75181 Pforzhelm (DE)

(74) Representative: **Valkonet, Rutger et al**
Algemeen Octrooi- en Merkenbureau
P.O. Box 645
5600 AP Eindhoven (NL)

(54) Method and device for increasing the wall thickness of the end of a thin-walled tube

(57) The invention relates to a method and a device for increasing the wall thickness of the end of a thin-walled tube (2). The tube (2) is clamped down near one end, in such a manner that said end of the tube extends freely. In a first step, the end of the tube is deformed in a direction transversely to the longitudinal direction of the tube. Furthermore, a supporting mandrel (7) is inserted into said end of the tube and said end of the tube is furthermore surrounded by a supporting body, all this in such a manner that the distance between the outer circumference of the supporting mandrel (7) and the inner circumference of the supporting body is greater than the wall thickness of the tube. In a second step, a pushing force acting in the longitudinal direction of the tube is exerted on the free end of the tube, causing the end of the tube to be deformed in such a manner that the end of the material that forms the tube fills the space between the outer circumference of the supporting mandrel (7) and the inner circumference of the supporting body (3).

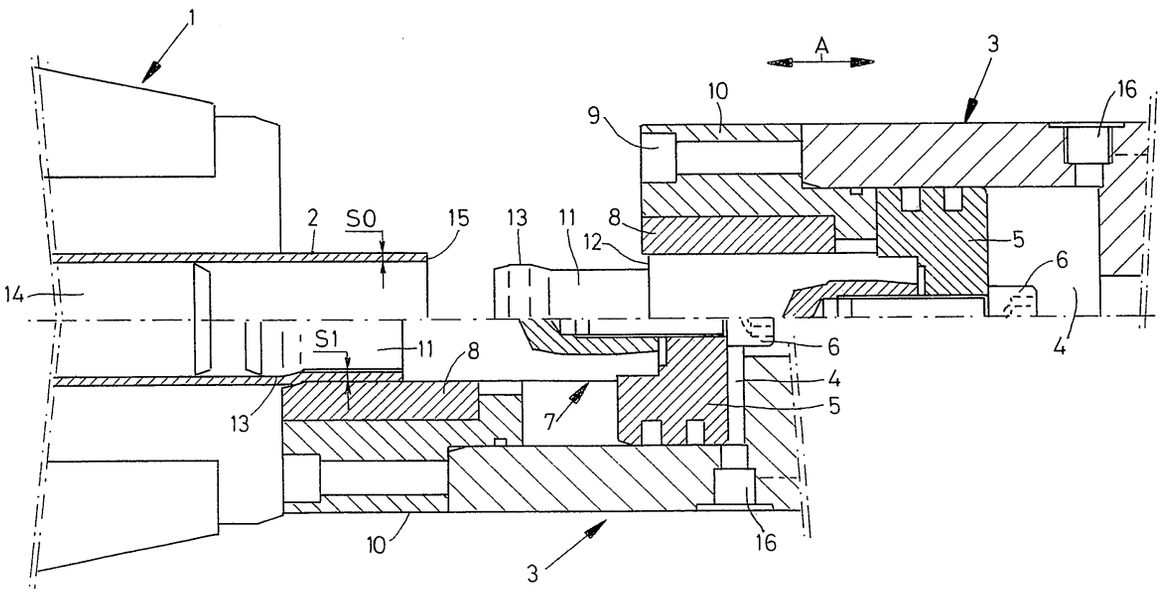

FIG.1

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Description

[0001] The invention relates to a method for increasing the wall thickness of the end of a thin-walled tube, wherein the tube is clamped down near one end, in such a manner that said end of the tube extends freely.

[0002] So far it has been usual to use a uniform thickness for thin-walled tubes, such as the tubes used for exhausts of passenger cars and trucks, which thickness is determined by, for example, the possibility to provide welded joints near the ends of the tube in question. When tubes are used of which only the end portions have the wall thickness that is required for providing joints or the like, it is possible in many cases to select a wall thickness for the part of the tube between said ends that is 20-30% less than the wall thickness of the ends of the tube. In this way a considerable saving of material as well as a saving in weight is achieved, and it is in particular a saving in weight that is important in the case of passenger cars and/or trucks.

[0003] It has been proposed to provide the ends of thin tubes with strengthening sleeves, for example, but such parts provided with sleeves are very susceptible to corrosion and exhibit a sudden diameter change and a stepped stress curve, so that such a solution is generally not acceptable.

[0004] According to the invention, the end of the tube is deformed in a direction transversely to the longitudinal direction of the tube in a first step, and in a second step directly following the first step, in which the deformed end of the tube is retained between a supporting mandrel that is inserted into the tube and a supporting body that surrounds the tube, all this in such a manner that the distance between the outer circumference of the supporting mandrel and the inner circumference of the supporting body is greater than the wall thickness of the tube, a pushing force acting in the longitudinal direction of the tube is exerted on the free end of the tube, causing the end of the tube to be deformed in such a manner that the end of the material that forms the tube fills the space between the outer circumference of the supporting mandrel and the inner circumference of the supporting body.

[0005] When using the method according to the invention, a first plasticisation of the material that forms the end of the tube is effected in a first step, which has an advantageous effect on the deformation of the material of the end of the tube in the second step, such that no undesirable wrinkling or the like will take place.

[0006] A further aspect of the invention relates to a device for carrying out the method according to the invention, which device is provided with a clamping device for clamping down the tube and with a supporting body for surrounding the tube, which clamping device and which supporting body are movable relative to each other in a direction parallel to the central axis of a tube to be clamped down in the clamping device, whilst the device is furthermore provided with a supporting mandrel supported by the supporting body, which is movable with respect to the supporting body in a direction parallel to the central axis of a tube to be clamped down in the clamping device.

[0007] According to this aspect of the invention, a simple and robust device can be obtained by means of which the wall thickness of tube ends can be increased in an economically sound manner.

[0008] The invention will be explained in more detail hereinafter with reference to the accompanying figures, which schematically show an embodiment of a device according to the invention.

[0009] Figure 1 is a sectional view of the device according to the invention, in which the upper part of figure 1 shows the various parts of the device in a first position and the lower part of figure 1 shows the various parts of the device in a second position.

[0010] Figure 2 is a sectional view corresponding to figure 1, in which the upper part of figure 1 shows the various parts of the device in a third position and the lower part of figure 1 shows the various parts of the device in a fourth position.

[0011] The device that is shown in figure 1 is provided with a clamping device or chuck 1, by means of which a tube 2 can be clamped down. Since such round clamping devices or chucks suitable for clamping down tubes or the like round objects are generally known, they will not be described in more detail herein.

[0012] The device is furthermore provided with a supporting body 3, which can be moved forwards and backwards by adjusting means (not shown) in the directions indicated by the double arrow A, i.e. parallel to the central axis of a tube 2 that is clamped down in the clamping device 1.

[0013] A chamber 4 is recessed in the interior of the supporting body, which chamber accommodates a piston 5, in such a manner that the piston 5 can reciprocate in the chamber 4 in the directions indicated by the double arrow A. The end of a supporting mandrel 7 is fixed to the piston 5 by means of a bolt 6. The supporting mandrel 7 extends through a calibrating ring 8, which is accommodated in a supporting ring 10 that is fixed to the supporting body 3 by means of bolts 9.

[0014] As will furthermore be apparent from the figure, the supporting mandrel 7 has a freely extending end 11, the external diameter of which is smaller than that of the part of the supporting mandrel 7 that is fixed to the piston 5, so that a shoulder 12 is formed at the transition between the two parts. Furthermore, the free end 13 of the thinner part 11 is slightly thickened, in such a manner that first the diameter of said second end 13 gradually increases and then gradually decreases again, with the largest diameter of said second end being at least substantially equal to the internal diameter of the tube 2.

[0015] While the tube 2 is being clamped down in the clamping device 1, the supporting body 3 and the supporting mandrel 7 will take up the position that is shown in the upper part of figure 1. An auxiliary mandrel 14 may

be inserted in the part of the thin walled tube 2 that is clamped down in the clamping device 1 so as to prevent undesirable deformation of the part of the tube 2 that is present in the clamping device 1 when very large upsetting forces are to be exerted on the tube 2.

[0016] Subsequently, the supporting body 3 and the supporting mandrel 7 are moved to the left, seen in figure 1, to the position that is shown in the lower part of figure 1. At some point, the shoulder 12 will abut against the crosscut end 15 of the thin-walled tube 2, so that the supporting mandrel 7 cannot be moved to the left any further, seen in figure 1. Upon further movement ahead of the supporting body 3, the supporting body 3 will move with respect to the supporting mandrel 7 and the piston 5 that is fixed thereto, so that the volume of the space 4 located to the right of the piston, seen in figure 1, is reduced.

[0017] The internal diameter of the calibrating ring 8 has been selected to be slightly smaller than the external diameter of the undeformed thin-walled tube 2. As a result, the free end of the tube that is located to the right, seen in figure 1, of the second end 13 of the mandrel 7 that is present inside the tube 2 is slightly deformed in inward direction.

[0018] As figure 1 furthermore shows, the wall thickness S0 of the undeformed tube 2 is slightly smaller than the distance S1 between the inner circumference of the calibrating ring 8 and the outer circumference of the thinner part 11 of the supporting mandrel 7.

[0019] By supplying a pressurised fluid to the chamber 4 via an inlet opening 16 in the position of the various parts that is shown in the lower part of figure 1, the piston 5 and the supporting mandrel 7 fixed thereto will be forced further to the left, seen in the figures, as a result of which the shoulder 12 of the supporting mandrel 7 that abuts against the crosscut end 15 of the tube 2 will exert a force in the direction of the central axis of the tube 2 on the crosscut end 15 of the tube 2. This causes the free end of the tube 2 to be plastically deformed, in such a manner that the space between the inner circumference of the calibrating ring 8 and the outer circumference of the part of 11 of the supporting mandrel 7 is filled up entirely whilst said free end of the tube 2 is shortened, as a result of which the free end 1 will obtain a wall thickness S2.1, as shown in the upper part of figure 2. Then the supporting body 3 is moved in a direction away from the clamping device 1, and when the piston 5 comes into contact with the end of the supporting ring 10 present in the supporting body 3, the piston 5 and the supporting mandrel 7 fixed thereto will likewise be moved in a direction away from the clamping device 1. The second end 13 of the supporting mandrel 7 will push the second end of the tube 2 in outward direction to the position that is shown in the lower part of figure 2, so that eventually a thin-walled tube 2 is obtained which exhibits a uniform internal diameter along its entire length and which has an end having a wall thickness S2.2.

[0020] Modifications and additions to the method and device as described above are conceivable within the spirit and scope of the invention, of course. Thus it is possible to apply a lubricant to the inner wall and/or the outer wall of the projecting end of the tube prior to the deformation.

Claims

1. A method for increasing the wall thickness of the end of a thin-walled tube, wherein the tube is clamped down near one end, in such a manner that said end of the tube extends freely, **characterized in that** the end of the tube is deformed in a direction transversely to the longitudinal direction of the tube in a first step, and in a second step directly following the first step, in which the deformed end of the tube is retained between a supporting mandrel that is inserted into the tube and a supporting body that surrounds the tube, all this in such a manner that the distance between the outer circumference of the supporting mandrel and the inner circumference of the supporting body is greater than the wall thickness of the tube, a pushing force acting in the longitudinal direction of the tube is exerted on the free end of the tube, causing the end of the tube to be deformed in such a manner that the end of the material that forms the tube fills the space between the outer circumference of the supporting mandrel and the inner circumference of the supporting body.

2. A method according to claim 1, **characterized in that** the wall of the end of the tube is urged in the direction of the outer circumference of the supporting mandrel by means of the supporting body for exerting the pushing force on the crosscut end of the tube.

3. A method according to claim 2, **characterized in that** the material forming the free end of the tube is urged in the direction of the outer circumference of the supporting mandrel by exerting the pushing force on the crosscut end of the tube.

4. A method according to any one of the preceding claims, **characterized in that** use is made of a supporting mandrel whose free end has a larger diameter than the part of the supporting mandrel which, together with the supporting body, forms the space in which the material of the free end of the tube is deformed, all this in such a manner that when the supporting mandrel is withdrawn from the tube, the thickened end of the supporting mandrel restores the internal diameter of the thickened end to the original diameter of the tube.

5. A method according to any one of the preceding

claims, **characterized in that** an auxiliary mandrel is placed in the interior of the part of the tube that is present in the clamping device before the deformation of the free end of the tube takes place.

6. A device for carrying out the method according to any one of the preceding claims, **characterized in that** the device is provided with a clamping device for clamping down the tube and with a supporting body for surrounding the tube, which clamping device and which supporting body are movable relative to each other in a direction parallel to the central axis of a tube to be clamped down in the clamping device, whilst the device is furthermore provided with a supporting mandrel supported by the supporting body, which is movable with respect to the supporting body in a direction parallel to the central axis of a tube to be clamped down in the clamping device.

7. A device according to claim 6, **characterized in that** the supporting body is provided with a chamber in which a piston can reciprocate in directions parallel to the direction of movement of the clamping device, whilst one end of the supporting mandrel is fixed to the piston.

8. A device according to claim 6 or 7, **characterized in that** the supporting mandrel is provided with a shoulder, which forms the transition between a part of the supporting mandrel that is fixed to the piston and an adjoining, thinner part of the supporting mandrel.

9. A device according to claim 8, **characterized in that** the end of the supporting mandrel is provided with a collar having a larger diameter.

10. A device according to any one of the preceding claims, **characterized in that** the supporting mandrel is movable within a calibrating ring that is supported by the supporting body.

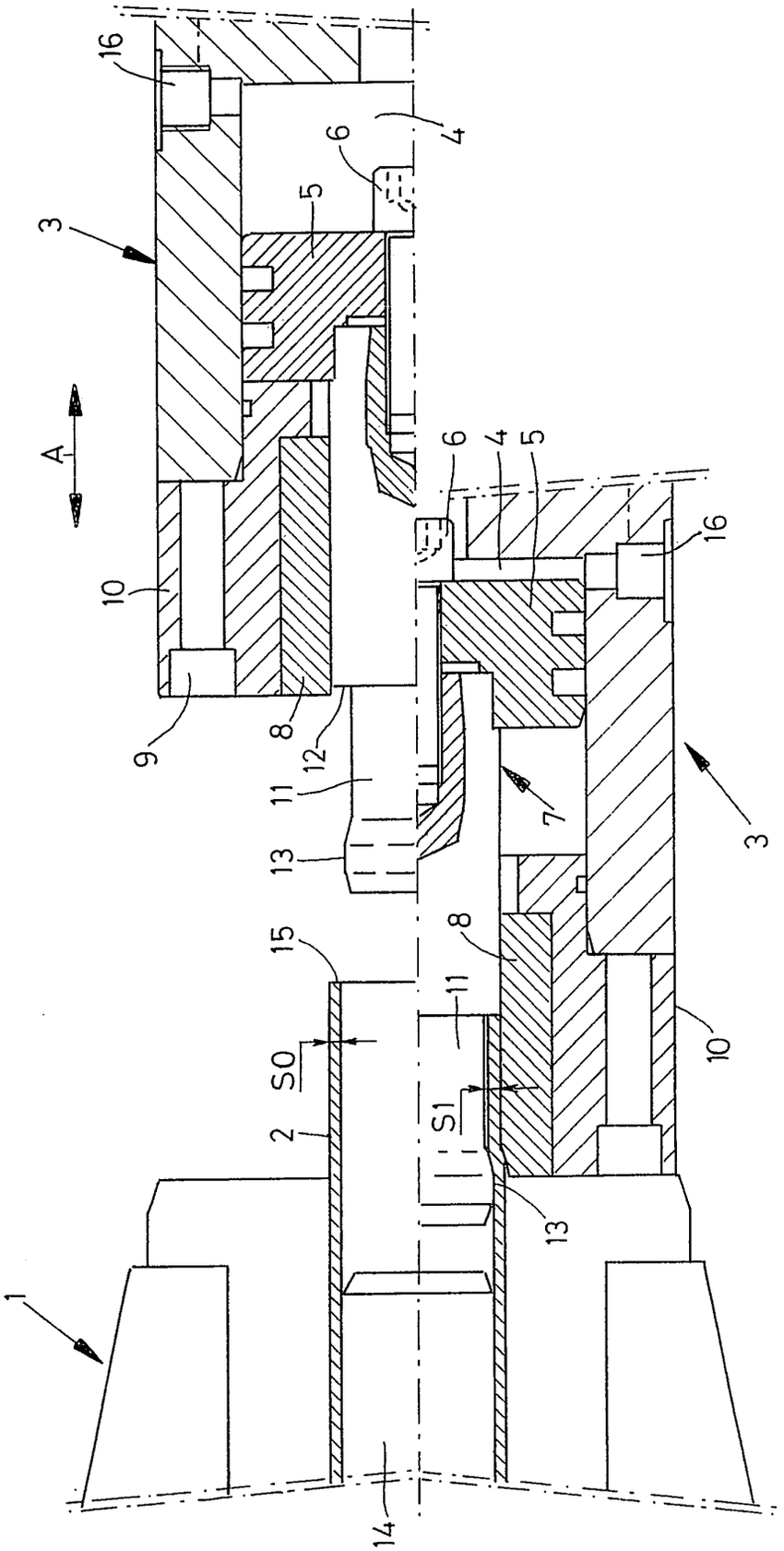

FIG. 1

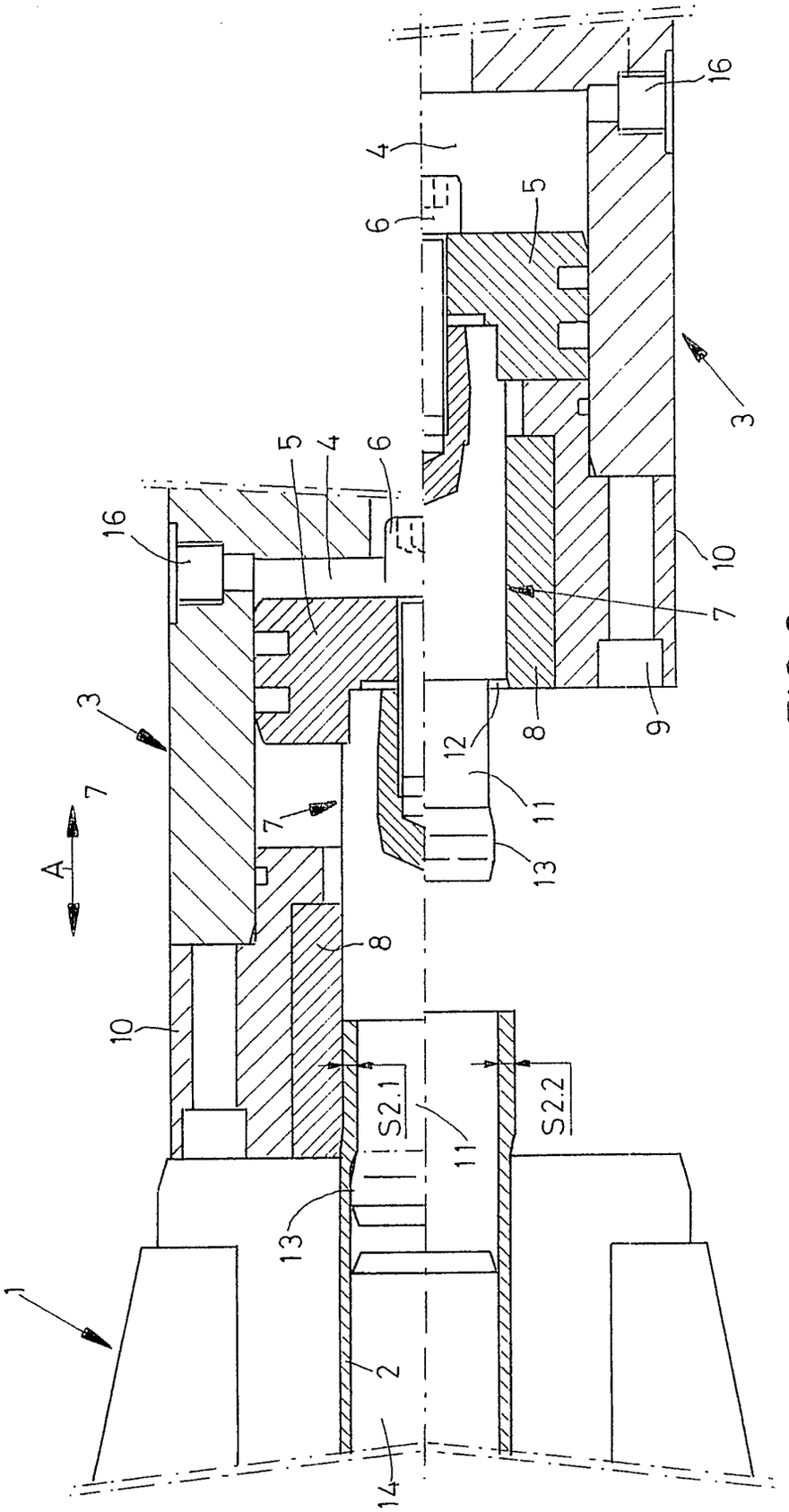

FIG.2

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EUROPEAN SEARCH REPORT

Application Number
EP 05 07 5634

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	6 June 2005	Peeters, L

CATEGORY OF CITED DOCUMENTS

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