



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) **EP 0 769 337 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
17.04.2002 Bulletin 2002/16

(51) Int Cl.7: **B21D 41/04**

(21) Application number: **96116206.2**

(22) Date of filing: **10.10.1996**

(54) **A method of closing an end of a metal pipe**

Verfahren zum Schliessen eines Metallrohrenendes

Procédé pour fermer la fin d'un tube métallique

(84) Designated Contracting States:
DE ES FR GB SE

(72) Inventor: **Iarossi, Dante**
10060 Airasca, Torino (IT)

(30) Priority: **18.10.1995 IT TO950841**

(74) Representative: **Quinterno, Giuseppe et al**
Jacobacci & Partners S.p.A.,
Corso Regio Parco, 27
10152 Torino (IT)

(43) Date of publication of application:
23.04.1997 Bulletin 1997/17

(73) Proprietor: **DENSO THERMAL SYSTEMS S.p.A.**
10046 Poirino (Torino) (IT)

(56) References cited:
DE-A- 3 321 363 **US-A- 2 408 596**
US-A- 3 264 729 **US-A- 5 085 131**

EP 0 769 337 B1

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

[0001] The present invention relates to a method of closing an end of a metal pipe in a fluid-tight manner of the kind defined in the preamble of Claim 1.

[0002] The method according to the invention is used, in particular, in the field of the production of heat exchangers for vehicles and, more precisely, for the manufacture of a condenser distributor which is generally made from an extruded or drawn pipe of which one or both ends have to be closed in a fluid-tight manner, possibly after the insertion partitions for distributing the flow. However, the present invention is not limited to this specific field and may be used wherever it is necessary to form a fluid-tight closure at an end of a metal pipe.

[0003] When the ends of pipes made of copper and/or aluminium or of another metallic material have to be closed in a fluid-tight manner in applications in which the sealing region has to withstand high pressures and temperatures, a welded cover is generally used. The welding operation involves difficulties in the automation of the production process, often requires re-welding and finishing operations, and generally involves a fairly significant cost.

[0004] A method of the afore-mentioned kind for closing an end of a metal pipe is disclosed in US-A-5 085 131, with reference to figures 8-11 thereof. In this prior method the forming tool used to close a pipe end is a stationary arbor, which has a contact surface having an almost stepped profile, i.e. a contact surface having a radius of curvature which is by far smaller than the axial length of the portion of the pipe which protrudes from the pipe tightening support.

[0005] Another method for closing an end of a metal pipe is known from US-A-3 264 729. In this method the pipe end to be closed is brought to a plastic state by a preliminary application of heat. The pipe is thereafter clamped in a fixture which prevents the rotation thereof, and a forming tool (closing disk) progressively engages the pipe end to be closed. The forming tool rotates about its own axis and at the same time moves in an orbit about the pipe axis and moves radially towards the pipe axis. Still at the same time, two back-up or support rollers move in said orbit in unison with the forming tool, in tracking engagement with the outer surface of the stationary pipe. The forming tool has a contact surface having a radius of curvature which is by far smaller than the axial length of the pipe projecting about said back-up or support rollers. The whole system is mechanically complicated.

[0006] The object of the invention is to provide an improved method for the closure of pipe ends without the application of heat thereto.

[0007] According to the invention this object is achieved by the method of Claim 1. Further characteristics and advantages of the present invention will become clear in the course of the following detailed description, given purely by way of non-limiting example,

with reference to the appended drawings in which Figures 1 and 2 are schematic side views showing two steps of the method of the invention.

[0008] In Figure 1 a metal pipe, indicated 10, has an end 12 which is to be sealed by the method of the invention.

[0009] The tools required to close the end 12 comprise a tubular support 14 in which the pipe 10 is positioned. The support 14 is constituted, for example, by a resilient bush for insertion in a chuck 16 rotatable about an axis 18 coinciding with the longitudinal axis of the pipe 10. The support 14 has the main purpose of preventing damage to the external surface of the pipe 10 when it is gripped by the chuck 16. The support 14 has a flat surface 20 from which a portion A of the pipe 10 projects.

[0010] In order for the method of the invention to give good results, the dimension A must be determined with care. In fact, if the dimension A is too small in comparison with the diameter D of the pipe 10 it is not possible to close the end whereas, if the dimension A is too large, excessive back-flow and deformation of the material are produced. Experience has shown that the relationship between the dimension A and the diameter should be substantially in accordance with the following equation:

$$A = K + b D,$$

in which :

A is the measurement in mm of the portion of the pipe projecting axially from the surface 20 of the support 14,

D is the diameter of the pipe 10 in mm,

K is a constant, the value of which may vary from 1.5 to 2.5, and

b is a factor the magnitude of which may vary between 0.15 and 0.25.

[0011] For example, it has been found experimentally that good results are achieved with the relationship:

$$A = 2 + 0.2 D.$$

[0012] The rate of rotation of the pipe 10 about its axis during the operation to close the end 12 may vary from 600 to 1000 revolutions/minute. A normal value of the rate of rotation of the chuck 16 which achieves good results is about 800 revolutions/minute.

[0013] The tools for closing the end of the pipe 10 also comprise a wheel 22 fixed idly to a tool-holder 24. The wheel 22 can rotate freely about an axis 26 parallel or substantially parallel to the axis 18 of the pipe 10. The tool-holder 24 can move along a straight line perpendicular to the axis 18 of the pipe 10 and indicated by the arrow 28 in Figure 1.

[0014] The wheel 22 has a flat surface 30 which is substantially aligned with the flat surface 20 of the support 14. In order to achieve a good qualitative result and to avoid trimming and deburring of material during the closure operation, the distance between the surfaces 30 and 20 in a direction parallel to the axis 18 must be close to zero.

[0015] The surface of the wheel 22 which is intended to contact the wall of the pipe 10 has a curvature 32 having a radius R which is equal to or greater than the dimension A by which the end to be closed projects.

[0016] The idle wheel 22 represents the most appropriate tool for implementing the method according to the invention. However, a method could also be implemented with tools of different kinds not comprised in the invention. For example, a non-rotatable metal body having a profile similar to that of the cross-section of the wheel 22 could be used instead of the wheel 22. The idle wheel 22 has the advantage of reducing the contact friction and the heat which are generated during the deformation step of the pipe 10 and achieves a better result from the aesthetic point of view.

[0017] Starting from the configuration shown in Figure 1, the method according to the invention is implemented simply by the rotation of the pipe 10 and the movement of the tool-holder 24 towards the axis of 18 of the pipe 10 in the direction of the arrow 28. The forward movement of the tool-holder 24 is stopped when the junction between the arcuate surface 32 and the flat surface 30 is a little beyond the axis 18.

[0018] Figure 2 shows the configuration of the tools and of the pipe 10 upon completion of the forward stroke of the tool-holder 24. It can be noted that the projecting portion of the pipe 10 has been completely flattened and turned over inwardly. The upsetting of the material and the heat of friction generated during the process bring about plastic deformation of the material which completely seals the end. During the forward stroke of the tool-holder 24, the wheel 22 applies to the wall of the pipe 10 an inward deformation force the point of application of which varies continuously both circumferentially, as a result of the rotation of the pipe 10, and radially, as a result of the advance of the tool-holder 24. The effect of the inward deformation is to reduce the width of the hole progressively until it is completely closed.

[0019] The closure produced requires no re-welding operations since it seals itself as a result of the heat of friction produced. The closure is particularly resistant to high working pressures. The method of the invention can easily be automated and, in comparison with a conventional welding method, is very easy to implement and has a minimal cost.

Claims

1. A method of closing an end (12) of a metal pipe (10) without applying thereto any external source of

heat, the method comprising

rotating the pipe (10) about its longitudinal axis (18) while the pipe (10) is being held by a support (14) from which the pipe end (12) to be closed projects by a predetermined amount (A), and

applying a substantially radial force to the external surface of the rotating pipe (10) in the vicinity of said pipe end (12) by means of a forming tool (22) which is moved towards the pipe (10) along a line substantially perpendicular to the axis (18) of the pipe (10);

whereby the zone of application of the force is moved continuously, both circumferentially and radially, relative to the pipe (10), so as to bring about a progressive inward deformation of the lateral wall of the pipe (10) until said end (12) is completely closed;

characterised in that

said forming tool is a freely rotatable wheel (22) adapted to rotate about an axis (26) substantially parallel to the axis (18) of the pipe (10) and which has a convex contact surface (32) having a radius of curvature (R) of a length equal to or greater than the axial length (A) of the portion of the pipe (10) which projects from the support (14).

2. A method according to Claim 1, **characterized in that** the wheel (22) has a flat surface (30) which, during the forward movement towards the axis(18) of the pipe (10) remains substantially aligned with a flat surface (20) of the support (14) from which the end (12) to be closed projects.

Patentansprüche

1. Verfahren zum Verschließen eines Endes (12) eines metallischen Rohres (10) ohne dafür eine externe Hitzequelle zu verwenden, wobei das Verfahren folgende Schritte umfasst, das Rotieren des Rohres (10) um seine Längsachse (18) während das Rohr (10) von einer Unterstützung (14), von welcher das zu verschließende Rohrende (10) um einen vorbestimmten Betrag (A) hervorragt, gehalten wird und das Aufbringen einer im wesentlichen radialen Kraft auf die äußere Oberfläche des rotierenden Rohres (10) in der Nähe des Rohrendes (12) durch ein Formwerkzeug (22), welches in Richtung des Rohres (10), entlang einer im wesentlichen rechtwinklig zur Achse (18) des Rohres (10) verlaufenden Bahn bewegt wird; wobei der Bereich der Aufbringung der Kraft sowohl entlang des Umfangs als auch radial relativ zum Rohr (10) kontinuierlich bewegt wird, so dass eine fortschreitende innere Deformation der Seitenwand des Rohres (10) erzielt wird, bis das besagte Ende (12) völlig verschlossen ist;

dadurch gekennzeichnet, dass besagtes Formwerkzeug ein frei rotierendes Rad (22) ist, adaptiert um um eine Achse (26) im wesentlichen parallel zur Achse (18) des Rohres (10) zu rotieren und eine konvexe Kontaktfläche (32) aufweist, mit einem Krümmungsradius (R) gleich oder größer als die axiale Länge (A) jenes Teiles des Rohres (10), welcher von der Unterstützung (14) hervorragt.

2. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** das Rad (22) eine flache Oberfläche (30) aufweist, welche während der Vorwärtsbewegung gegen die Achse (18) des Rohres (10) im wesentlichen ausgerichtet bleibt mit einer flachen Oberfläche (20) der Unterstützung (14) von welcher das zu verschließende Ende (12) hervorragt.

Revendications

1. Procédé de fermeture d'une extrémité (12) d'un tube métallique (10) sans application de chaleur d'une source extérieure, le procédé comprenant :

la rotation du tube (10) autour de son axe longitudinal (18) lorsque le tube (10) est maintenu par un support (14) dont dépasse l'extrémité (12) de tube à fermer sur une distance prédéterminée (A), et

l'application d'une force pratiquement radiale à la surface externe du tube rotatif (10) au voisinage de l'extrémité du tube (12) à l'aide d'un outil de mise en forme (22) qui est déplacé vers le tube (10) suivant une droite pratiquement perpendiculaire à l'axe (18) du tube (10),

si bien que la zone d'application de la force se déplace de façon continue, à la fois circonférentiellement et radialement, par rapport au tube (10), et provoque une déformation progressive vers l'intérieur de la paroi latérale du tube (10) jusqu'à ce que l'extrémité (12) soit totalement fermée,

caractérisé en ce que

l'outil de mise en forme est une roue (22) qui tourne librement, qui est destinée à tourner autour d'un axe (26) pratiquement parallèle à l'axe (18) du tube (10) et qui a une surface convexe de contact (32) dont le rayon de courbure (R) a une valeur supérieure ou égale à la longueur axiale (A) de la partie de tube (10) qui dépasse du support (14).

2. Procédé selon la revendication 1, **caractérisé en ce que** la roue (22) a une surface plate (30) qui, pendant le mouvement d'avance vers l'axe (18) du tube (10), reste pratiquement alignée sur une surface plate (20) du support (14) dont dépasse l'extrémité (12) à fermer.

FIG. 1

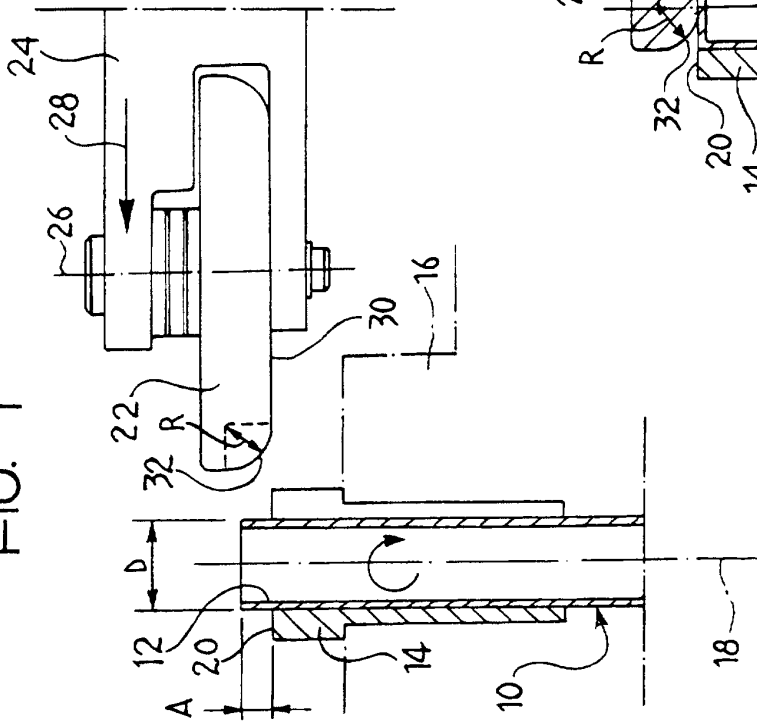


FIG. 2

