

Description

Technical Field

This invention relates to the bending of pipe, and in particular to the support of the inner wall of the pipe during bending to maintain the pipe cross section.

An apparatus and method according to the pre-characterising parts of the independent claims is known from DE-A-2,932,055.

Background Art

In bending pipe, and particularly larger diameter pipe from 15 cm (6 inch) diameter and larger, it is often beneficial or necessary to support the inner wall of the pipe near the bend. If unsupported, the bending forces exerted on the exterior of the pipe can cause severe deformation of the cross section of the pipe, reducing its strength and carrying capacity. It is particularly helpful to support the inner wall of the pipe in the portion which becomes the inside of the bend to prevent wrinkling of the pipe in this area.

In the past, large and complex internal mandrel devices have been employed. Such devices include the devices disclosed and illustrated in US-A-3,834,210 and US-A-3,851,519. These prior devices are typically provided with a plurality of metal shoes or strips which are expanded into contact with the inner walls of the pipe by a plurality of hydraulic cylinders. While these devices are effective, the complexity of the devices increase cost and maintenance requirements.

US-A-3,580,044 discloses a tube bending mandrel. The mandrel has a body portion which can be of polyurethane. Fittings are cast into the body portion at opposite ends and a cable extends between the fittings. The distance between the fittings can be decreased to reshape the body portion to provide support for the tube during bending.

A need exists for an internal mandrel overcoming the disadvantages of the prior devices. The improved mandrel should have a minimum of operating components and operate with a minimum number of controls. The improved mandrel should be relatively lightweight and easy to move through the interior of the pipe prior to and after bending.

Summary of the Invention

In accordance with one aspect of the present invention, an internal mandrel is provided for use with a pipe bender to bend the pipe. The internal mandrel having a first end structure and a resilient material positioned on one side of the first end structure, said mandrel being suitable for positioning within the pipe and further having means for deforming the resilient material against the first end structure to form the resilient material to support the internal walls of the pipe proximate the bend, characterized by:

the deformable resilient material having a first face and a second face with the first face abutting the first end structure;

said deformation means having a first portion comprising a single acting fluid cylinder positionable within the interior of the pipe and having a fluid chamber and a piston and a second portion, said second portion attached to the piston with the second portion abutting the second face of the deformable resilient material, said deformation means for moving said second portion towards said first portion when a pressurized fluid is entered into the fluid chamber to act on the piston;

connector means forming a connector, said connector for extending along a path between the first end structure and the first portion of the deformation means, said connector being non-extendable along the direction of the path, said connector for supporting the first end structure and deformation means so that when the second portion moves relative to the first portion toward the second face of the deformable resilient material when pressurized fluid is entered into the fluid chamber to extend the piston in the cylinder, the deformable resilient material is deformed between the second portion of the deformation means and the first end structure to expand the deformable resilient material to support the internal walls of the pipe proximate the bend, the release of pressurizing fluid from the fluid chamber after bending permitting the deformed material to return to its undeformed condition and thereby retract the piston within the cylinder.

In accordance with another aspect of the present invention, an internal mandrel is provided for use with a pipe bender to bend a pipe of the type having a first end structure and a resilient material positioned on one side of the first end structure, said mandrel being suitable for positioning within the pipe and further having means for deforming the resilient material against the first end structure to form the resilient material to support the internal walls of the pipe proximate the bend, characterized by:

the deformable resilient material having a first face and a second face with the first face abutting the first end structure;

said deformation means having a first portion comprising a single acting fluid cylinder positionable within the interior of the pipe and having a fluid chamber and a piston and a second portion, said second portion attached to the piston with the second portion abutting the second face of the deformable resilient material, said deformation means for moving said second portion towards said first portion when a pressurized fluid is entered into the fluid chamber to act on the piston;

connector means forming a connector, said connector for extending along a path between the first end structure and the first portion of the deformation means, said connector means being capable of deflection in a direction perpendicular to its longitudinal axis,

said connector being non-extendable along the direction of the path, said connector for supporting the first end structure and deformation means so that when the second portion moves relative to the first portion toward the second face of the deform-

able resilient material when pressurized fluid is entered into the fluid chamber to extend the piston in the cylinder, the deformable resilient material is deformed between the second portion of the deformation means and the first end structure to expand the deformable resilient material to support the internal walls of the pipe proximate the bend, the release of pressurizing fluid from the fluid chamber after bending permitting the deformed material to return to its undeformed condition and thereby retract the piston within the cylinder.

Brief Description of the Drawings

A more complete understanding of the invention and its advantages will be apparent from the foregoing Detailed Description when taken in conjunction with the accompanying Drawings in which:

FIGURE 1 is a perspective view of an internal mandrel forming a first embodiment of the present invention;

FIGURE 2 is a vertical cross-sectional view of the internal mandrel forming the first embodiment;

FIGURES 3a and 3b illustrate a cross section of the internal mandrel and pipe perpendicular the length of the pipe in the relaxed and deformed positions, respectively;

FIGURES 4a and 4b illustrate a side view of the bending machine and cross section of the internal mandrel and pipe taken along the length of the pipe, respectively, illustrating the relative positions of the mandrel and pipe prior to bending;

FIGURES 4c and 4d illustrate a side view of the bending machine and a cross section of the internal mandrel and pipe taken along the length of the pipe, respectively, illustrating the relative positions of the mandrel and pipe subsequent to bending;

FIGURES 5a and 5b illustrate a cross section of an internal mandrel forming a second embodiment of the present invention and pipe perpendicular the length of the pipe in the relaxed and deformed positions, respectively; and

FIGURES 6a and 6b illustrate a cross section of the relative positions of the internal mandrel forming the second embodiment and pipe prior to and subsequent to bending, respectively.

Detailed Description

Referring now to the Drawings, wherein like reference numerals designate like or corresponding parts through several views, there is shown in FIGURES 1-4 an internal mandrel 10 forming a first embodiment of the present invention. The internal mandrel 10 is designed for use in bending pipe 12 in a pipe bending machine 14. One such pipe bending machine is described and illustrated in US-A-3,834,210, issued September 10, 1974.

As seen in FIGURES 4a-d, the pipe 12 to be bent is moved into the machine 14 and positioned under the bending die 16 at the point where the bend is to commence. A pin-up cylinder 18 forces

a wedge 20 underneath a pin-up shoe 22. The pin-up shoe 22 moves upwardly to engage the pipe 12. An inboard cylinder 24 acts between the frame of the machine 14 and a stiff back 26. The inboard cylinder 24 urges the stiff back up to push the pipe against the bending die 16. With the bending die acting as a fulcrum, the outboard cylinder 28 pushes the outer end of the stiff back up, bending the pipe to the radius and length of curve determined by the bending die configuration in contact with the pipe.

Typically, the pipe 12 is moved through the machine 14 toward the pin-up shoe 22 in small increments with the bending operation repeated until a final desired pipe curvature is achieved. The pipe 12 is always moved toward the pin-up shoe 22 during bending to keep a straight portion of the pipe in the stiff back 26.

The internal mandrel 10 is typically inserted within pipe 12 from the stiff back end and is positioned proximate the bend. In a manner described hereinafter, the internal mandrel supports the internal wall 30 of the pipe proximate the bend about the entire 360° circumference of the interior wall for a predetermined length of the pipe. As noted previously, the use of the internal mandrel assists the maintenance of a circular internal cross section in the bent pipe to insure strength and capacity. Resilient deformable plug 31, formed of individual discs 32 made of urethane 34, is deformed from both ends. While urethane is the preferred material for plug 31, any other suitable material can be used. The plug 31 expands into contact with the internal wall 30 to support the wall during bending.

The construction of the internal mandrel 10 is best illustrated in FIGURES 1 and 2. A first circular end plate 36 is used which has an exterior diameter slightly less than the internal diameter of the pipe to be bent so that the end plate 36 can move freely through the pipe while maintaining a minimal gap between the outer periphery of the end plate and internal wall 30. A similar, second end plate 38 is also provided. The end plate 38 is rigidly secured to a cylinder adapter plate 40. The end plates 36 and 38 and adapter plate 40 are supported and interconnected by four tie rods 42. The tie rods have threaded ends 44. Threaded holes 46 are provided in the end plate 38 for receiving one end of the tie rods. Holes 48 are formed in end plate 36 through which the tie rods extend. Nuts 50 are threaded onto the ends 44 of the tie rods passing through the end plate 36 to limit the motion of end plate 36, although end plate 36 can slide along tie rods 42 between end plate 38 and nuts 50.

Four hydraulic cylinder tie rods 52 extend from the cylinder adapter plate 40 to a hydraulic cylinder rear plate 54. The plates 40 and 54 support a hydraulic cylinder 56 therebetween having a piston rod 58 and an external piston 60. The piston rod 58 extends through a hole 62 in the cylinder adapter plate 40 and a hole 64 in the end plate 38. The hole 64 mounts a bushing 66 to support the piston rod 58. The end of piston 60

has a threaded portion 68 to be received in a threaded hole 70 in the piston 60. The piston 60 includes apertures 72 having a diameter exceeding the diameter of tie rods 42 distributed on the piston which permit free movement of the piston 60 along the tie rods 42. When hydraulic fluid enters chamber 74 of the hydraulic cylinder 56, the fluid acts against the internal piston 76 to move the piston 60 toward the end plate 36 and away from the end plate 38.

In order to insert the internal mandrel 10 within the pipe 12, a control or reach rod 78 is pivotally secured to the hydraulic cylinder rear plate 54 by a clevis 80 and pin 82. A hydraulic line 84 extends from the hydraulic cylinder 56 along the control rod 78 exterior of the pipe for supplying the cylinder with pressurized hydraulic fluid. The internal mandrel 10 can be mounted on wheels, permitting the mandrel to be rolled into the pipe, or can be self powered by hydraulic or compressed air motors to move through the pipe.

The resilient deformable discs 32 forming plug 31 are positioned between the piston 60 and end plate 36. The discs 32 have apertures 86 for passage of the tie rods 42. Each disc 32 is separate from the others and is stacked along the tie rods 42 to form whatever length of plug 31 is needed.

A number of resilient flexible strips 88 are positioned along the length of the mandrel between the end plates 36 and 38. The strips can be formed of spring steel and secured either to the end plates, the discs 32, or both. For example, the strips 88 can be welded or tied at their ends to end plates 36 and 38. Strips 88 can also be bonded to discs 32, either by a special bonding compound or by the urethane itself. The strips are positioned in a closely spaced arrangement about a portion of the circumference of the plug 31 near the inner portion 73 of the bend in pipe 12.

In operation, the internal mandrel 10 is initially moved into the pipe to position the discs 32 at the point of bending. Hydraulic fluid under pressure is permitted to flow through hydraulic line 84 and into the chamber 74. As the pressurized hydraulic fluid enters the chamber 74, the internal piston 76 moved toward the cylinder adapter plate 40, which causes the piston 60 to move away from the end plate 38 and toward the end plate 36.

As the piston 60 moves toward end plate 36, the discs 32 are deformed between the piston 60 and end plate 36. As the discs 32 are deformed in the linear direction along the central axis of the pipe, they expand radially into contact with the internal wall 30 of the pipe 12 as seen in FIGURES 3b, 4c and 4d.

Sufficient hydraulic force is provided by the fluid in chamber 74 to expand the discs 32 to support the internal wall of the pipe 12 during bending. The strips 88, compressed between the discs 32 and the internal wall 30 at the inner portion of the bend, conform to the shape of the internal wall and act to increase the effective thickness of the pipe 12 at the inner portion of the bend, reducing the incidence of wrinkling and other deformation.

As can be seen in FIGURES 4c and 4d, there is sufficient freedom of motion in the discs 32 and strips 88 relative to the remainder of mandrel 10 to permit the discs 32 and strips 88 to conform to the bending curvature in the pipe while the remainder of the internal mandrel 10 remains centered along a linear axis. Upon release of the hydraulic pressure from chamber 74, the resiliency in the discs 32 forces the piston 60 toward the end plate 38 as the discs 32 relax to their predeformation state. This resiliency moves the discs 32 out of contact with the internal wall 30 of the pipe 12 and permits the internal mandrel 10 to be readily removed from the pipe or repositioned for further bending. The natural resiliency of the urethane automatically returns the mandrel to its pre-bending configuration upon removal of external forces, eliminating the need for any spring return mechanism as required in prior devices. In addition, the mandrel 10 is operated by use of a single hydraulic control controlling inlet and outlet of fluid from the chamber 74.

If desired, the strips 88 can extend about the entire periphery of the discs 32, or to any extent desired. The individual strips 88 can be substituted for by a half cylindrical section, slotted to achieve a range of motion similar to individual strips. The discs 32 can also be substituted for by a single cylinder extending between the piston 60 and end plate 36.

In operation, it is anticipated that the stroke of piston 60 will be approximately 10 to 11.5 cm (4 to 4-1/2 inches) for a 15 cm (6 inch) diameter pipe, 15 cm (6 inches) for a 20 cm (8 inch) diameter pipe and 20 cm (8 inches) for a 25 cm (10 inch) diameter pipe. The natural resiliency of the urethane in discs 32 also makes the general configuration of mandrel 10 useful as an energy accumulator. If surplus energy exists, it can be stored in mandrel 10 by compression of the urethane and the energy can be recovered at a later time by relaxation of the discs.

FIGURES 5 and 6 illustrate an internal mandrel 200 forming a second embodiment of the present invention. A number of elements of the mandrel 200 are identical in form and function to those described previously with respect to internal mandrel 10. These portions have been identified in FIGURES 5 and 6 by identical reference numerals and reference is directed hereinabove for a description of their design and function.

A resilient flexible cylinder 202 is secured between the end plates 36 and 38. The cylinder 202 can, for example, be formed of a spring steel. An annular resilient deformable plug 204 surrounds the exterior of the cylinder 202. Again, the plug 204 is preferably formed of urethane. A piston 206 having an annular configuration is mounted at the end of rods 208 passing through holes 210 in the end plate 38. Rods 208, in turn, are secured to a back piston 212 secured to the piston rod 58. Piston 206 is therefore mounted for free motion along the exterior of the cylinder 202 and for contact with the end of the plug 204.

The internal mandrel 200 is also moved into the

pipe 12 prior to bending with the plug 204 positioned at the point of bending. FIGURES 5a and 6a illustrate the configuration of the mandrel prior to bending with the plug 204 in its relaxed state, subject to no external forces. As pressurized hydraulic fluid enters the chamber 74, the piston rod 58 and piston 206 move toward the end plate 36. The piston 206 deforms the plug 204 between the piston 206 and end plate 36, expanding the plug 204 against the outer surface of cylinder 202 and against the internal wall 30 of the pipe 12 to support the pipe during bending. FIGURES 5b and 6b illustrate the configuration of the mandrel during and immediately subsequent to bending. As can be seen in FIGURE 6b, the resilient cylinder 202 conforms to the shape of the bend in pipe 12 as does the plug 204. The use of cylinder 202 permits a reduction in the quantity of urethane or similar material used in the plug 204. It further permits the use of a single piece plug 204. These advantages permit the internal mandrel 200 to be particularly effective on large pipes having diameters greater than 0.58m (20 inches).

Claims

1. An internal mandrel for use with a pipe bender (14) to bend a pipe (12) of the type having a first end structure (36) and a resilient material (31, 204) positioned on one side of the first end structure (36) said mandrel being suitable for positioning within the pipe (12) and further having means (56, 60, 76, 206) for deforming the resilient material (31, 204) against the first end structure (36) to form the resilient material to support the internal walls of the pipe proximate the bend, characterized by:

the deformable resilient material (31, 204) having a first face and a second face with the first face abutting the first end structure (36);

said deformation means (56, 60, 76, 206) having a first portion (56) comprising a single acting fluid cylinder positionable within the interior of the pipe and having a fluid chamber (74) and a piston (76) and a second portion (60, 206), said second portion attached to the piston (76) with the second portion abutting the second face of the deformable resilient material (31, 204), said deformation means for moving said second portion towards said first portion when a pressurized fluid is entered into the fluid chamber to act on the piston;

connector means (42, 202) forming a connector that is rigid in a direction parallel the length of the pipe, said rigid connector for extending between the first end structure (36) and the first portion (56) of the deformation means for supporting the first end structure and deformation means so that when the second portion moves relative to the first portion toward the second face of the deformable resilient material when pressurized fluid is entered into the fluid chamber to extend the piston (76) in the cylinder, the deformable resilient material is deformed between the second portion of the deformation means and the first

end structure to expand the deformable resilient material to support the internal walls of the pipe proximate the bend, the release of pressurizing fluid from the fluid chamber after bending permitting the deformed material to return to its undeformed condition and thereby retract the piston (76) within the cylinder.

2. The internal mandrel of Claim 1 further characterized by said resilient mandrel (301, 204) resiliently returning to its relaxed shape after deformation for movement of the mandrel within the pipe.

3. The internal mandrel of Claim 1 further characterized by said deformable resilient material (31, 204) being urethane.

4. The improved internal mandrel of Claim 1 further characterized in that a number of resilient flexible strips (88) are positioned along the length of the mandrel between the end structures (36, 38).

5. The improved internal mandrel of Claim 1 further characterized by said connector means comprising at least one member (202), said member being rigid in a direction parallel the length of the pipe, but bending with the pipe and deformable resilient material as the pipe is bent.

6. The internal mandrel of Claim 1 further comprised by said deformable resilient material being formed of a plurality of separate of disc shaped members (32).

7. The internal mandrel of Claim 1 further characterized by said connector means comprising a plurality of rigid member (42).

8. An internal mandrel for use with a pipe bender (14) to bend a pipe (12) of the type having a first end structure (36) and a resilient material (31, 204) positioned on one side of the first end structure (36), said mandrel being suitable for positioning within the pipe (12) and further having means (56, 60, 76, 206) for deforming the resilient material (31, 204) against the first end structure (36) to form the resilient material to support the internal walls of the pipe proximate the bend, characterized by:

the deformable resilient material (31, 204) having a first face and a second face with the first face abutting the first end structure (36);

said deformation means (56, 60, 76, 206) having a first portion (56) comprising a single acting fluid cylinder positionable within the interior of the pipe and having a fluid chamber (74) and a piston (76) and a second portion (60, 206), said second portion attached to the piston (76) with the second portion abutting the second face of the deformable resilient material (31, 204), said deformation means for moving said second portion towards said first portion when a pressurized fluid is entered into the fluid chamber to act on the piston;

connector means (202) forming a connector, said connector for extending along a path between the first end structure (36) and the first portion (56) of the deformation means, said connector means (202) being capable of deflection in a direction perpendicular to its longitudinal axis,

pipe 12 prior to bending with the plug 204 positioned at the point of bending. FIGURES 5a and 6a illustrate the configuration of the mandrel prior to bending with the plug 204 in its relaxed state, subject to no external forces. As pressurized hydraulic fluid enters the chamber 74, the piston rod 58 and piston 206 move toward the end plate 36. The piston 206 deforms the plug 204 between the piston 206 and end plate 36, expanding the plug 204 against the outer surface of cylinder 202 and against the internal wall 30 of the pipe 12 to support the pipe during bending. FIGURES 5b and 6b illustrate the configuration of the mandrel during and immediately subsequent to bending. As can be seen in FIGURE 6b, the resilient cylinder 202 conforms to the shape of the bend in pipe 12 as does the plug 204. The use of cylinder 202 permits a reduction in the quantity of urethane or similar material used in the plug 204. It further permits the use of a single piece plug 204. These advantages permit the internal mandrel 200 to be particularly effective on large pipes having diameters greater than 0.58m (20 inches).

Claims

1. An internal mandrel for use with a pipe bender (14) to bend a pipe (12) of the type having a first end structure (36) and a resilient material (31, 204) positioned on one side of the first end structure (36) said mandrel being suitable for positioning within the pipe (12) and further having means (56, 60, 76, 206) for deforming the resilient material (31, 204) against the first end structure (36) to form the resilient material to support the internal walls of the pipe proximate the bend, characterized by:

the deformable resilient material (31, 204) having a first face and a second face with the first face abutting the first end structure (36);

said deformation means (56, 60, 76, 206) having a first portion (56) comprising a single acting fluid cylinder positionable within the interior of the pipe and having a fluid chamber (74) and a piston (76) and a second portion (60, 206), said second portion attached to the piston (76) with the second portion abutting the second face of the deformable resilient material (31, 204), said deformation means for moving said second portion towards said first portion when a pressurized fluid is entered into the fluid chamber to act on the piston;

connector means (42, 202) forming a connector that is rigid in a direction parallel the length of the pipe, said rigid connector for extending between the first end structure (36) and the first portion (56) of the deformation means for supporting the first end structure and deformation means so that when the second portion moves relative to the first portion toward the second face of the deformable resilient material when pressurized fluid is entered into the fluid chamber to extend the piston (76) in the cylinder, the deformable resilient material is deformed between the second portion of the deformation means and the first

end structure to expand the deformable resilient material to support the internal walls of the pipe proximate the bend, the release of pressurizing fluid from the fluid chamber after bending permitting the deformed material to return to its undeformed condition and thereby retract the piston (76) within the cylinder.

2. The internal mandrel of Claim 1 further characterized by said resilient mandrel (301, 204) resiliently returning to its relaxed shape after deformation for movement of the mandrel within the pipe.

3. The internal mandrel of Claim 1 further characterized by said deformable resilient material (31, 204) being urethane.

4. The improved internal mandrel of Claim 1 further characterized in that a number of resilient flexible strips (88) are positioned along the length of the mandrel between the end structures (36, 38).

5. The improved internal mandrel of Claim 1 further characterized by said connector means comprising at least one member (202), said member being rigid in a direction parallel the length of the pipe, but bending with the pipe and deformable resilient material as the pipe is bent.

6. The internal mandrel of Claim 1 further comprised by said deformable resilient material being formed of a plurality of separate of disc shaped members (32).

7. The internal mandrel of Claim 1 further characterized by said connector means comprising a plurality of rigid member (42).

8. An internal mandrel for use with a pipe bender (14) to bend a pipe (12) of the type having a first end structure (36) and a resilient material (31, 204) positioned on one side of the first end structure (36), said mandrel being suitable for positioning within the pipe (12) and further having means (56, 60, 76, 206) for deforming the resilient material (31, 204) against the first end structure (36) to form the resilient material to support the internal walls of the pipe proximate the bend, characterized by:

the deformable resilient material (31, 204) having a first face and a second face with the first face abutting the first end structure (36);

said deformation means (56, 60, 76, 206) having a first portion (56) comprising a single acting fluid cylinder positionable within the interior of the pipe and having a fluid chamber (74) and a piston (76) and a second portion (60, 206), said second portion attached to the piston (76) with the second portion abutting the second face of the deformable resilient material (31, 204), said deformation means for moving said second portion towards said first portion when a pressurized fluid is entered into the fluid chamber to act on the piston;

connector means (202) forming a connector, said connector for extending along a path between the first end structure (36) and the first portion (56) of the deformation means, said connector means (202) being capable of deflection in a direction perpendicular to its longitudinal axis,



said connector being non-extendable along the direction of the path, said connector for supporting the first end structure and deformation means so that when the second portion moves relative to the first portion toward the second face of the deformable resilient material when pressurized fluid is entered into the fluid chamber to extend the piston (76) in the cylinder, the deformable resilient material is deformed between the second portion of the deformation means and the first end structure to expand the deformable resilient material to support the internal walls of the pipe proximate the bend, the release of pressurized fluid from the fluid chamber after bending permitting the deformed material to return to its undeformed condition and thereby retract the piston (76) within the cylinder.

9. The internal mandrel of Claim 1 further characterized by said second portion of said deformation means being a piston (60, 206);

said deformable resilient material comprising a urethane plug (31, 204) positioned between said piston and said first end structure;

the resiliency of the urethane plug moving said piston away from said first end structure after bending and permitting the urethane plug to relax radially inward for free movement of the internal mandrel within the pipe.

10. The internal mandrel of Claim 8 further characterized by said cylinder (202) being a metal cylinder.

11. A method for internally supporting a pipe (12) during bending including the steps of positioning a first end structure (36) and a resilient material (31, 204) within the pipe and deforming the resilient material (31, 204) against the first end structure (36) with a deformation means (56, 60, 76, 206) to deform the resilient material to support the internal walls of the pipe proximate the bend, characterized by the steps of:

positioning said deformation means (56, 60, 76, 206) at the opposite end of the deformable resilient material and entirely within the pipe, said deformation means having a first portion (56) comprising a single acting fluid cylinder having a fluid chamber (74) and a piston (76), said deformation means further having a second portion (60, 76, 206) for movement with the piston (76), said deformation means for moving the second portion relative to the first portion;

supporting the first end structure and the first portion of the deformation means with a connector (42, 202) that is rigid along a direction parallel the length of the pipe; and

deforming the deformable resilient material between the second portion of the deformation means and the first end structure by supplying pressurized fluid to the fluid chamber (74) to extend the piston (76) moving the second portion relative to the first portion towards the deformable resilient material so that the material expands radially outward into contact with the internal wall of the pipe to support the pipe during bending, releasing the pressurized fluid from the fluid chamber after bending permitting the

deformed material to return to its undeformed condition and thereby retract the piston (76) within the cylinder.

12. The method of Claim 11 further characterized by the step of positioning flexible material (88) between the deformable resilient material and the internal wall of the pipe at the inside of the bend in the pipe to increase the effective wall thickness of the pipe.

13. The method of Claim 11 characterized by said deformable resilient material comprising urethane.

14. The method of Claim 12 characterized by said flexible members (88) comprising spring steel strips extending longitudinally parallel the central axis of the pipe.

Patentansprüche

1. Innendorn zur Verwendung mit einem Rohrbieger (14) zum Biegen eines Rohrs (12) von der Art, die eine erste Endstruktur (36) und ein nachgiebiges Material (31, 204) an einer Seite der ersten Endstruktur (36) aufweist, wobei der Dorn dazu geeignet ist, in dem Rohr (12) positioniert zu werden und ferner Mittel (56, 60, 76, 206) besitzt, die das nachgiebige Material (31, 204) gegen die erste Endstruktur (36) verformen, um das nachgiebige Material so zu formen, daß es die Innenwände des Rohrs in der Nähe der Biegung stützt, dadurch gekennzeichnet,

daß das verformbare nachgiebige Material (31, 204) eine erste Fläche und eine zweite Fläche besitzt, wobei die erste Fläche an der ersten Endstruktur (36) anliegt;

daß das Verformungsmittel (56, 60, 76, 206) einen ersten Teil (56) besitzt, der einen in einer Richtung wirkenden Fluidzylinder aufweist, der in das Innere des Rohrs einsetzbar ist und eine Fluidkammer (74) und einen Kolben (76) hat und ein zweites Teil (60, 206), wobei das zweite Teil an dem Kolben (76) angebracht ist und an der zweiten Fläche des verformbaren, nachgiebigen Materials (31, 204) anliegt, wobei das Verformungsmittel zum Bewegen des zweiten Teils in Richtung auf das erste Teil dient, wenn ein unter Druck stehendes Fluid in die Fluidkammer eingeleitet wird, um auf den Kolben zu wirken;

daß ein Verbindungsmittel (42, 202) vorgesehen ist, das einen Verbindler bildet, der in Richtung parallel zur Länge des Rohres starr ist und der sich zwischen der ersten Endstruktur (36) und dem ersten Teil (56) des Verformungsmittels erstreckt, um die erste Endstruktur und das Verformungsmittel derart zu stützen, daß dann, wenn das zweite Teil sich in bezug auf das erste Teil in Richtung auf die zweite Fläche des verformbaren, nachgiebigen Materials bewegt, wenn unter Druck stehendes Fluid in die Fluidkammer eingeleitet wird, um den Kolben (76) bezüglich des Zylinders auszufahren, das verformbare, nachgiebige Material zwischen dem zweiten Teil des Verformungsmittels und der ersten Endstruktur verformt wird, um das verformbare, nachgiebige Material zu dehnen und die Innenwände des



Rohres in der Nähe der Biegung zu stützen, wobei ein Ablassen des unter Druck stehenden Fluids aus der Fluidkammer nach dem Biegen es erlaubt, daß das verformte Material in seinen unverformten Zustand zurückkehren kann und dadurch den Kolben (76) in dem Zylinder zurückzieht.

2. Innendorn nach Anspruch 1, ferner dadurch gekennzeichnet, daß der nachgiebige Dorn (301, 204) in seine entspannte Form nachgiebig zurückkehrt, nachdem eine Verformung zur Bewegung des Dorns in dem Rohr erfolgte.

3. Innendorn nach Anspruch 1, ferner dadurch gekennzeichnet, daß das verformbare, nachgiebige Material (31, 204) Urethan ist.

4. Verbesserter Innendorn nach Anspruch 1, ferner dadurch gekennzeichnet, daß eine Anzahl von nachgiebigen, flexiblen Streifen (88) entlang der Länge des Dorns zwischen den Endstrukturen (36, 38) angeordnet ist.

5. Verbesserter Innendorn nach Anspruch 1, ferner dadurch gekennzeichnet, daß das Verbindungsmittel mindestens ein Teil (202) aufweist, das parallel zur Länge des Rohrs starr ist, sich jedoch beim Biegen des Rohres zusammen mit dem Rohr und dem verformbaren, nachgiebigen Material biegt.

6. Innendorn nach Anspruch 1, dadurch gekennzeichnet, daß das verformbare nachgiebige Material aus einer Anzahl von getrennten scheibenförmigen Teilen gebildet ist.

7. Innendorn nach Anspruch 1, ferner dadurch gekennzeichnet, daß das Verbindungsmittel eine Anzahl starrer Teile (42) aufweist.

8. Innendorn zur Verwendung mit einem Rohrbieger (14) zum Biegen eines Rohrs (12) von der Art, die eine erste Endstruktur (36) und ein nachgiebiges Material (31, 204) an einer Seite der ersten Endstruktur (36) aufweist, wobei der Dorn dazu geeignet ist, in dem Rohr (12) positioniert zu werden und ferner Mittel (56, 60, 76, 206) besitzt, die das nachgiebige Material (31, 204) gegen die erste Endstruktur (36) verformen, um das nachgiebige Material so zu formen, daß es die Innenwände des Rohrs in der Nähe der Biegung stützt, dadurch gekennzeichnet,

daß das verformbare nachgiebige Material (31, 204) eine erste Fläche und eine zweite Fläche besitzt, wobei die erste Fläche an der ersten Endstruktur (36) anliegt;

daß das Verformungsmittel (56, 60, 76, 206) einen ersten Teil (56) besitzt, der einen in einer Richtung wirkenden Fluidzylinder aufweist, der in das Innere des Rohrs einsetzbar ist und eine Fluidkammer (74) und einen Kolben (76) hat und ein zweites Teil (60, 206), wobei das zweite Teil an dem Kolben (76) angebracht ist und an der zweiten Fläche des verformbaren, nachgiebigen Materials (31, 204) anliegt, wobei das Verformungsmittel zum Bewegen des zweiten Teils in Richtung auf das erste Teil dient, wenn ein unter Druck stehendes Fluid in die Fluidkammer eingeleitet wird, um auf den Kolben zu wirken;

daß ein Verbindungsmittel (202) vorgesehen ist, das einen Verbinder bildet, der sich zwischen der ersten Endstruktur (36) und dem ersten Teil

(56) des Verformungsmittels erstreckt und der senkrecht zu seiner Längsachse biegsam ist,

daß der Verbinder in Richtung seiner Erstreckung nicht ausdehnbar ist und dazu dient, die erste Endstruktur und das Verformungsmittel derart zu stützen, daß dann, wenn das zweite Teil sich in bezug auf das erste Teil in Richtung auf die zweite Fläche des verformbaren, nachgiebigen Materials bewegt, wenn unter Druck stehendes Fluid in die Fluidkammer eingeleitet wird, um den Kolben (76) bezüglich des Zylinders auszufahren, das verformbare, nachgiebige Material zwischen dem zweiten Teil des Verformungsmittels und der ersten Endstruktur verformt wird, um das verformbare, nachgiebige Material zu dehnen und die Innenwände des Rohres in der Nähe der Biegung zu stützen, wobei ein Ablassen des unter Druck stehenden Fluids aus der Fluidkammer nach dem Biegen es erlaubt, daß das verformte Material in seinen unverformten Zustand zurückkehren kann und dadurch den Kolben (76) in dem Zylinder zurückzieht.

9. Innendorn nach Anspruch 1, ferner dadurch gekennzeichnet, daß das zweite Teil des Verformungsmittels ein Kolben (60, 206) ist;

daß das verformbare, nachgiebige Material einen Urethan stopfen (31, 204) aufweist, der zwischen dem Kolben und der ersten Endstruktur angeordnet ist; und

daß die Nachgiebigkeit des Urethanstopfens den Kolben von der ersten Endstruktur nach dem Biegen wegbewegt und es erlaubt, daß sich der Urethanstopfen radial nach innen entspannt, damit der Innendorn im Rohr frei bewegbar ist.

10. Innendorn nach Anspruch 8, ferner dadurch gekennzeichnet, daß der Zylinder (202) ein Metallzylinder ist.

11. Verfahren zum internen Abstützen eines Rohrs (12) während des Biegens, mit den Schritten des Anordnens einer ersten Endstruktur (36) an einer nachgiebigen Material (31, 204) in dem Rohr und Verformen des nachgiebigen Materials (31, 204) gegen die erste Endstruktur (36) mit einem Verformungsmittel (56, 60, 76, 206) um das nachgiebige Material zu verformen, damit die Innenwände des Rohrs in der Nähe der Biegung abgestützt werden, gekennzeichnet durch die Schritte:

Positionieren des Verformungsmittels (56, 60, 76, 206) am gegenüberliegenden Ende des verformbaren, nachgiebigen Materials und zur Gänze in dem Rohr, wobei das Verformungsmittel ein erstes Teil (56) aufweist, das einen einseitig wirkenden Fluidzylinder mit einer Fluidkammer (74) und einem Kolben (76) aufweist, wobei das Verformungsmittel ferner ein zweites Teil (60, 76, 206) für die Bewegung mit dem Kolben (76) besitzt, wobei das Verformungsmittel dazu dient, das zweite Teil gegenüber dem ersten Teil zu bewegen;

Abstützen der ersten Endstruktur und des ersten Teils des Verformungsmittels mit einem Verbinder (42, 202), der parallel zur Länge des Rohrs starr ist; und

Verformen des verformbaren, nachgiebigen



Materials zwischem dem zweiten Teil des Verformungsmittels und der ersten Endstruktur durch Zuführen von Druckfluid zu der Fluidkammer (74), damit der Kolben (76) ausgefahren wird und das zweite Teil in bezug auf das erste Teil in Richtung auf das verformbare, nachgiebige Material bewegt, so daß sich das Material radial nach außen in Kontakt mit der Innenwand des Rohres ausdehnt, um das Rohr während des Biegens abzustützen, durch Ablassen des Druckfluids aus der Fluidkammer nach dem Biegen, wodurch das verformte Material in seinen unverformten Zustand zurückkehren und dadurch der Kolben (76) in den Zylinder eingefahren werden kann.

12. Verfahren nach Anspruch 11, ferner gekennzeichnet durch den Schritt des Einbringens des flexiblen Materials (88) zwischen dem verformbaren, nachgiebigen Material und der Innenwand des Rohrs an der Innenseite der Biegung in dem Rohr, um die effektive Wandstärke des Rohrs zu erhöhen.

13. Verfahren nach Anspruch 11, dadurch gekennzeichnet, daß das verformbare, nachgiebige Material Urethan aufweist.

14. Verfahren nach Anspruch 12, dadurch gekennzeichnet, daß die flexiblen Teile (88) Federstahlstreifen aufweisen, die sich in Längsrichtung parallel zur Mittellinie des Rohres erstrecken.

Revendications

1. Mandrin intérieur destiné à être utilisé avec une machine (14) à cintrer les tubes pour le cintrage d'un tube (12), du type comportant une première structure d'extrémité (36) et un matériau élastique (31, 204) disposé d'un côté de la première structure d'extrémité (36), ledit mandrin convenant pour réaliser un positionnement à l'intérieur du tube (12) et comportant en outre des moyens (56, 60, 67, 206) servant à déformer le matériau élastique (31, 204) contre la première structure d'extrémité (36) de manière à mettre en forme le matériau élastique pour qu'il supporte les parois intérieures du tube à proximité du coude, caractérisé en ce que:

le matériau élastique déformable (31, 204) possède une première face et une seconde face, la première face étant en butée contre la première structure d'extrémité (36);

lesdits moyens de déformation (56, 60, 76, 206) possèdent une première partie (56) comportant un vérin hydraulique à simple effet pouvant être disposé à l'intérieur du tube, et ayant une chambre (74) pour le fluide et un piston (76), et une seconde partie (60, 206), ladite seconde partie étant fixée au piston (76) et étant en aboutement contre la seconde face du matériau élastique déformable (31, 204), lesdits moyens de déformation servant à déplacer ladite seconde partie en direction de ladite première partie lorsqu'un fluide sous pression est introduit dans la chambre pour le fluide de manière à agir sur le piston; et

des moyens de raccordement (42, 202) forment un dispositif de raccordement qui est rigide dans une direction parallèle à la longueur du tube, ledit

dispositif rigide de raccordement s'étendant entre la première structure d'extrémité (36) et la première partie (56) des moyens de déformation de manière à supporter la première structure d'extrémité et les moyens de déformation de manière que, lorsque la seconde partie se déplace par rapport à la première partie en direction de la seconde face du matériau élastique déformable lorsqu'un fluide sous pression est introduit dans la chambre pour le fluide de manière à déployer le piston (76) dans le cylindre du vérin, le matériau élastique déformable est déformé entre la seconde partie des moyens de déformation et la première structure d'extrémité de manière à provoquer une dilatation du matériau élastique déformable pour supporter les parois intérieures du tube à proximité du coude, la libération du fluide sous pression à partir de la chambre logeant le fluide après le cintrage permettant au matériau déformé de reprendre son état non déformé et de rétracter, de ce fait, le piston (76) à l'intérieur du cylindre.

2. Mandrin intérieur selon la revendication 1, caractérisé en outre en ce que ledit mandrin élastique (301, 204) reprend élastiquement sa forme détendue après la déformation de manière à déplacer le mandrin à l'intérieur du tube.

3. Mandrin intérieur selon la revendication 1, caractérisé en outre en ce que ledit matériau élastique déformable (31, 204) est de l'uréthane.

4. Mandrin intérieur perfectionné selon la revendication 1, caractérisé en outre en ce qu'un certain nombre de bandes flexibles élastiques (88) sont positionnées sur l'étendue en longueur du mandrin entre les structurés d'extrémité (36, 38).

5. Mandrin interne perfectionné selon la revendication 1, caractérisé en outre en ce que lesdits moyens de raccordement comprennent au moins un élément élastique (202), que ledit élément est rigide dans une direction parallèle à l'étendue en longueur du tube, mais est cintré conjointement avec le tube et le matériau élastique déformable lors du cintrage du tube.

6. Mandrin intérieur selon la revendication 1, caractérisé en ce que ledit matériau élastique déformable est constitué par une pluralité d'éléments séparés en forme de disques (32).

7. Mandrin intérieur selon la revendication 1, caractérisé en outre en ce que lesdits moyens de raccordement comprennent une pluralité d'éléments rigides (42).

8. Mandrin intérieur destiné à être utilisé avec une machine (14) à cintrer les tubes pour le cintrage d'un tube (12) du type comportant une première structure d'extrémité (36) et un matériau élastique (31, 204) disposé d'un côté de la première structure d'extrémité (36), ledit mandrin convenant pour réaliser un positionnement à l'intérieur du tube (12) et comportant en outre des moyens (56, 60, 67, 206) servant à déformer le matériau élastique (31, 204) contre la première structure d'extrémité (36) de manière à mettre en forme le matériau élastique pour qu'il supporte les parois intérieures du tube à proximité du



coude, caractérisé en ce que:

le matériau élastique déformable (31, 204) possède une première face et une seconde face, la première face étant en butée contre la première structure d'extrémité (36);

lesdits moyens de déformation (56, 60, 76, 206) possèdent une première partie (56) comportant un vérin hydraulique à simple effet pouvant être disposé à l'intérieur du tube, et ayant une chambre (74) pour le fluide et un piston (76), et une seconde partie (60, 206), ladite seconde partie étant fixée au piston (76) et étant en aboutement contre la seconde face du matériau élastique déformable (31, 204), lesdits moyens de déformation servant à déplacer ladite seconde partie en direction de ladite première partie lorsqu'un fluide sous pression est introduit dans la chambre pour le fluide de manière à agir sur le piston; et

des moyens de raccordement (202) constituent un dispositif de raccordement qui s'étend le long d'un trajet situé entre la première structure d'extrémité (36) et la première partie (56) des moyens de déformation, lesdits moyens de raccordement (202) pouvant fléchir dans une direction perpendiculaire à leur axe longitudinal,

lesdits moyens de raccordement ne pouvant pas être déployés dans la direction du trajet, et servant à supporter la première structure d'extrémité et des moyens de déformation de telle sorte que, lorsque la seconde partie se déplace par rapport à la première partie en direction de la seconde face du matériau élastique déformable lorsqu'un fluide sous pression est introduit dans la chambre recevant le fluide de manière à déployer le piston (76) dans le cylindre du vérin, le matériau élastique déformable est déformé entre la seconde partie des moyens de déformation et la première structure d'extrémité de manière à provoquer une dilatation du matériau élastique déformable pour supporter les parois intérieures du tube à proximité du coude, la libération du fluide sous pression à partir de la chambre logeant le fluide après le cintrage permettant au matériau déformé de reprendre son état non déformé et de rétracter, de ce fait, le piston (76) à l'intérieur du cylindre.

9. Mandrin intérieur selon la revendication 1, caractérisé en outre en ce que ladite seconde partie desdits moyens de déformation est un piston (60, 206); et

ledit matériau élastique déformable est constitué par un bouchon d'uréthane (31, 204) disposé entre ledit piston et ladite première structure d'extrémité;

l'élasticité du bouchon d'uréthane écartant ledit piston de ladite première structure d'extrémité après le cintrage et permettant au bouchon d'uréthane de se détendre radialement vers l'intérieur de manière à permettre un libre déplacement du mandrin intérieur dans le tube.

10. Mandrin intérieur selon la revendication 8,

caractérisé en outre en ce que ledit cylindre (202) est un cylindre métallique.

11. Procédé pour supporter intérieurement un tube (12) pendant le cintrage, incluant les étapes consistant à positionner une première structure d'extrémité (36) et un matériau élastique (31, 204) à l'intérieur du tube et à déformer le matériau élastique (31, 204) contre la première structure d'extrémité (36) à l'aide de moyens de déformation (56, 60, 76, 206) pour qu'il supporte les parois intérieures du tube à proximité du coude, caractérisé par les étapes consistant à:

positionner lesdits moyens de déformation (56, 60, 76, 206) sur l'extrémité opposée du matériau élastique déformable et entièrement à l'intérieur du tube, lesdits moyens déformables possédant une première partie (56) constituée par un vérin hydraulique à simple effet comportant une chambre (74) pour le fluide et un piston (76), lesdits moyens de déformation comportant en outre une seconde partie (60, 76, 206) destinée à se déplacer avec le piston (76), lesdits moyens de déformation servant à déplacer la seconde partie par rapport à la première partie;

supporter la première structure d'extrémité et la première partie des moyens de déformation à l'aide d'un dispositif de raccordement (42, 202), qui est rigide le long d'une direction parallèle à l'étendue en longueur du tube; et

déformer le matériau élastique déformable entre la seconde partie des moyens de déformation et la première structure d'extrémité, en envoyant un fluide sous pression à la première chambre (74) logeant le fluide de manière à déployer le piston (76) qui déplace la seconde partie par rapport à la première partie en direction du matériau élastique déformable de sorte que le matériau se dilate radialement vers l'extérieur en venant en contact avec la paroi intérieure du tube de manière à supporter ce dernier pendant le cintrage, à libérer le fluide sous pression à partir de la chambre logeant le fluide après le cintrage de manière à permettre au matériau déformé de reprendre son état non déformé et de ce fait de permettre le retrait du piston (76) à l'intérieur du vérin.

12. Procédé selon la revendication 11, caractérisé par l'étape opératoire consistant à positionner un matériau flexible (88) entre le matériau élastique déformable et la paroi intérieure du tube à l'intérieur du coude du tube de manière à accroître l'épaisseur effective de la paroi du tube.

13. Procédé selon la revendication 11, caractérisé en ce que ledit matériau élastique déformable est formé d'uréthane.

14. Procédé selon la revendication 12, caractérisé en ce que lesdits éléments flexibles (88) comportent des bandes d'acier pour ressorts, qui s'étendent longitudinalement, parallèlement à l'axe central du tube.

