

Method and apparatus for cold joining flanges and coupling elements to pipes

The invention relates to a method and a tool for joining a coupling element, e.g. a joining flange means, to a pipe, said coupling element surrounding the pipe and having grooves facing the pipe and intended to receive a corresponding plurality of beads provided on the pipe and a coupling element connectable to a pipe, said coupling element configured to surround the pipe and having grooves to face the pipe and to receive a corresponding plurality of beads provided on the pipe, as dedined in the preamble of claims 1, 2 and 5.

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Flanges of many types and varieties are used extensively in industry when pipe-to-pipe or pipe-to-other component connections are to be provided. The welding of flanges to pipes is the most common method in the case of steel pipes and standard weldable metals, whilst, for example, screw flanges are used in connection with, for instance, galvanised pipes.

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In recent years a number of methods have been developed for the fastening of coupling elements and the joining of pipes by deforming the pipe inside the coupling so as to secure it. Other methods and equipment which clamp the coupling to the outside of the pipe without any or with little deformation of the pipe have also been developed.

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Examples of such methods are taught in US 4,593,448 and US 4,147,385. DE 27 24 257 and US 2,252,274 teach tools with rollers which by means of a rotating cone in the centre with rollers therearound will deform the pipe so that it fits into grooves in the coupling elements. DE 3144385 teaches a joining system for pipes where radially movable ridges, with the aid of hydraulic pressure against underlying pistons, press in beads. However, as discussed further below, the pipe wall on the side of the beads will buckle inwards, and when the ridges of the tool are retracted, the actual bead in the pipe will also retract somewhat, which makes the connection weak. In addition, there will be a metal-to-metal seal between pipe and coupling element, and therefore the system taught in the said document will require sealing material in the grooves of the coupling element. It has been found that with radial pistons as taught in DE 3144385 it is not possible to obtain an especially large radial force, and this principle could perhaps be used with particularly thin-walled pipes.

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To deform a pipe wall into grooves in a surrounding coupling element requires very large forces if the pipe wall is to be pressed radially outwards. The use of rollers as described in DE 27 24 257 and US 2,252,274 means that less radial force is required, but on the other hand the tool must be secured to the pipe and therefore becomes large and heavy. Rolling subjects the material to harsher treatment and also takes longer than radial pressing.

The object of the invention is to provide for joining flanges or other coupling elements to pipes where a tool is only operated radially so that a fixing of the pipe is not necessary. Furthermore, it is an object to obtain a tool which even in connection with small pipe dimensions has enough force to deform beads in relatively thick pipe walls. It is also an object that the tool should function so that inward tapering of the pipe end, which has been found to be a problem in connection with the radial pressing of beads, is avoided.

The new and characteristic features of the method for joining a coupling element to a pipe appear from the attached claim 1.

According to a first aspect of the present invention, there is provided a method for joining a coupling element, e.g. a joining flange means, to a pipe, said coupling element surrounding the pipe and having grooves facing the pipe and intended to receive a corresponding plurality of beads provided on the pipe, characterised in the steps of: providing said coupling element to surround the pipe at an end region thereof, providing a first and dedicated radial directed pressing action on the inside wall of the pipe at axial locations of the pipe corresponding to location of said grooves on the surrounding coupling element to deform the pipe thereat to create said beads and cause said beads to project into said grooves, and providing a second and dedicated radial directed post-pressing action on the inside wall of the pipe at buckled-in regions of the pipe wall that naturally occur between and adjacent the created beads during and caused by the first pressing action, to cause a post-pressing of said regions in an outward direction, thereby providing an outward tension in the pipe at the location of the coupling element.

The new and characteristic features of the tool for joining a coupling element to a pipe appear from the attached claim 2, and further embodiments of the tool appear from

related subclaims 3 and 4.

According to a second aspect of the present invention, there is provided a tool for joining a coupling element, e.g. a joining flange means, to a pipe, said coupling element intended to surround the pipe and having grooves facing the pipe and intended to receive a corresponding plurality of beads provided on the pipe, characterised in - that the tool has a plurality of axially separated, radially movable segments (10), each segment having a plurality of circle sector formed ridges, said plurality of segments thereby providing circumferentially extending ridges (11) capable of deforming the pipe wall by a first pressing action on the inside wall of the pipe to create on the outside of the pipe circumferential beads (5; 6) in the pipe wall and cause said beads (5;6) to extend into corresponding ones of said grooves (3; 4) in the coupling element, and - that the segments have circumferentially extending portions (13) located adjacent and between the ridges, said portions (13) in a second, subsequent pressing action to cause post-pressing of buckled-in areas that occur naturally in the pipe wall between and adjacent the beads during the first pressing action, so that an outward tension is obtained in the pipe at the location of the coupling element.

The new and characteristic features of the coupling element appear from the attached claim 5, and a further feature thereof appears from the related subclaim 6.

The invention is now to be described in further detail with reference to the attached drawing figures,

Fig. 1a is a side view of a pipe and a coupling.

Fig. 1b is a section A-A of fig. 1a without beads created on the pipe

Fig.1c is an enlargement of encircled region B in fig. 1b.

Fig.1d is a modified section A-A of fig.1a with beads created on the pipe

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Fig. 2a shows a modified coupling element with inserted pipe.

Fig.2b shows a section A-A of fig. 3b.

Fig. 3a shows a side view of a pipe, a coupling element and an inserted tool in a first
10 operational stage prior to coupling operation.

Fig.3b shows a section A-A through the assembly of pipe, coupling element and tool
part of fig.3a.

15 Fig.3c shows a side view of the assembly shown in fig. 4a in a second operational stage
of the tool after coupling has been made thereby between the pipe and the coupling
element.

Fig. 3d shows a section B-B through the assembly of fig. 4c.

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Fig. 4a is a side view of the tool, and fig. 5b is a section A-A of fig. 5a.

Fig. 5a is a perspective view of the tool from a first angle, and fig. 5b is a perspective
view of the tool from a second angle.

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Fig. 6 is a side view of the tool.

Fig. 7a is a side view of a modified tool, and fig. 7b is a functional expansion acting
element of the tool.

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Fig. 8a is a side view of a pipe with a modified coupling element structure, and fig. 8b
is a section A-A through the embodiment of fig. 8a.

Fig.9 illustrates final adjustment of an established coupling.

Figs. 1a – 1c show a pipe 1 and a coupling element 2 before beads 5, 6 are created.

5 Fig. 1d shows the same after the beads 5, 6 created on the pipe 1 have been pressed into recesses 3, 4, respectively in the coupling element 2.

Figs. 2a and 2b show a coupling element 2' fitted onto a pipe 1 and with beads 5, 6 pressed into place into recesses in the coupling element 2'', the coupling element having
10 a flange 2''' for attachment to another coupling element (not shown).

Fig. 8 shows a coupling element structure 30 with flanges 30', 30'' being tiltable relative to the structure 30 by [spherical] movability over the partially spherical surface of the coupling element 30.

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The principle of the tool is shown on Figs. 4a and 4b, whilst different applications of a cone shaped member 20, used as a mechanical force amplifier, fitted into the tool, to cause expansion of tool diameter to create beads in the pipe wall are shown in Figs. 4 - 6.

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Fig. 7a shows a tool with a hydraulic force amplifier.

During the development of the apparatus according to the invention, which comprises both an interior configuration of the external coupling element 2; 2' and the tool 10 which forms the beads 5, 6, it was quickly discovered that a most critical parameter for
25 optimal attachment of the coupling element 2; 2' to the pipe resides in the configuration of the parts 11, 11' of the tool that presses the beads 5, 6 out from the pipe and also a part 14 of the tool that is to prevent the end of the pipe 1 from tapering inwards during the pressing operation.

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Figs. 1a – 1d show that an outermost portion 2' of the coupling element 2 against which pipe end 1' rests is flared outwards. This is to allow the tool to give the pipe end

1' an overbending outwards, which is necessary because the pipe end, as mentioned, will otherwise tend to taper inwards. Thus, the pipe 1 will appear almost straight after the beads 5, 6 have been pressed, as can be seen in the section shown in Fig. 1d.

- 5 The same basic interior configuration of the coupling elements will apply to a coupling element or collar intended for loose flanges, movable flanges as shown in Fig. 8, and other types which may be suitable for a same fastening method.

10 It should be mentioned that the cylindrical part of the coupling element 2; 2" as shown on Figs. 1, 2 and 3 may advantageously be quite thin-walled. To a certain extent, the wall will then be resilient and yield a little during the pressing operation, and this will then mean that afterwards it is under inward tension and thus provides further pressure in the connection where the pipe 1 is in tension outwards.

- 15 Laboratory tests carried out in show that a mechanically good seal is obtained between the grooves 3, 4 and the beads 5, 6. Nevertheless, it may be appropriate to insert a sealing material in one or more of the grooves.

According to Figs. 4a and 4b, the principle of the tool is based on a plurality of
20 segments 10, each having circle segment ridges 11 intended for being pressed out towards the inside of the pipe wall and thus forming the beads 5, 6 first. Towards the end of the pressing operation, the cylinder segment parts 13 of each of the segments forming a cylindrical assembly of segments is pressed against the inside of the pipe at the portions thereof located sideways relative to the beads 5, 6 to prevent said portions
25 from buckling inwards. This process is shown on Figs. 3a - 3d as well as on Fig. 9. Figs. 3a and 3b show the pipe 1 and the coupling 2 before the pressing operation, and Fig. 9 is an enlarged view of an intermediate stage during the pressing where the aforementioned buckled-in areas 1" of the pipe sideways relative to the beads 5, 6 can be seen. In Figs. 3c and 3d it is seen that the cylindrical parts 13 of the segments 10
30 have pressed the buckled-in areas 1" back towards the coupling element 2 so that they lie almost flush with the inside wall of the pipe and its diameter. This after-pressing gives a powerful radial tensioning effect in the pipe which increases the contact pressure

between pipe 1 and coupling element 2 the sealing points between beads 5, 6 and grooves 3, 4, and prevents the retraction of the pipe 1 as mentioned above when referring to plain ridges as previously described in, for example, DE 3144385. A projection 14 is located innermost on the segments 10, i.e. close to a tool element
5 flange 21, said projection 14 intended to cause pressure against the end 1''' of the pipe, as indicated also on fig. 9. In a corresponding portion of the coupling element 2 there is a recess 15 which may be made in the form of a bevel edge or a cut-out. This cut-out 15 can, for some uses, be partially filled with sealing material, or it may have an O-ring fitted therein. This special design of the tool and the coupling element has been found
10 to be necessary in order to prevent the pipe from tapering or buckling inwards as previously mentioned.

The segments 10 and especially the ridges 11 are subjected to extremely large stresses during the pressing operation and are therefore made of hardened steel. Consequently
15 large radial forces are also required to operate the segments 10. As an example thereof, the pressing of a connection between a coupling element 2 and a steel pipe 1 with an outer diameter of 76 mm and a wall thickness of 3.2 mm as shown on Figs. 1d, 2a and 2b, by using eight segments 10 would require a radial force per segment of about 200 kN, in total a required force of about 1600 kN. These are huge forces within a very
20 narrow space, and the tool according to the invention therefore uses a power actuator located outside the pipe 1 combined with a force amplifier 20 inside the pipe 1.

Fig. 5a shows the tool with segments 10 and with a circular cone 20 acting as force amplifier, Fig. 5b shows the tool with the cone 20 drawn in and the segments 10 in
25 expanded position, and Fig. 6 shows the same tool with a polygonal pyramid 20' acting as force amplifier.

Figs. 7a and 7b show a tool with hydraulically operated segments 22. A segment 22 is shown separately and it can be seen that the segment 22 is fastened to a piston
30 27 which can move in a corresponding cylinder 28 in a housing 24 which is filled with oil. The segments 22 have circle sector ridges 23 to create beads. The illustrated tool has a total of eight pistons 27 and eight cylinders 28. When a rod 25 is pressed into the

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housing, the oil in the housing 24 will press the pistons 27 outwards. The greater the diameter of the piston 27 in relation to the diameter of the rod 25, the greater the force amplification. Reference numeral 21 denotes a tool attachment flange, the flange having a plurality of attachment holes 26.

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A cold joining of the coupling element 2 to the pipe 1 in this manner, unlike, for example, welding, that the material of the coupling is not given a modified surface structure. Therefore, the invention is suitable for couplings as shown on Figs. 8a and 8b where a coupling element 30 has an outer surface being part of a spherical surface, the coupling element 30 to be fastened to the pipe 1 and where a two-part flange has parts 10 30', 30'' which can be joined to each other by screw action attachment, the two parts 30', 30'' located on each side of the coupling element and facing one another. The flange with its flange parts 30', 30'' will then be capable of being mounted at an angle which can be variably set relative to the pipe. The flange with its parts 30', 30'' will 15 either be freely movable, even after screwing the flange parts 30', 30'' together, or will be such that it is locked to the coupling element 30 when the flange 30', 30'' is tightened to another flange (not shown).

P a t e n t c l a i m s

1.

A method for joining a coupling element , e.g. a joining flange means, to a pipe, said
5 coupling element surrounding the pipe and having grooves facing the pipe and intended
to receive a corresponding plurality of beads provided on the pipe, characterised in the
steps of:

- providing said coupling element to surround the pipe at an end region thereof,
- providing a first and dedicated radial directed pressing action on the inside wall
10 of the pipe at axial locations of the pipe corresponding to location of said grooves on
the surrounding coupling element to deform the pipe thereat to create said beads and
cause said beads to project into said grooves, and
- providing a second and dedicated radial directed post-pressing action on the
inside wall of the pipe at buckled-in regions of the pipe wall that naturally occur
15 between and adjacent the created beads during and caused by the first pressing action,
to cause a post-pressing of said regions in an outward direction, thereby providing an
outward tension in the pipe at the location of the coupling element.

20 2.

A tool for joining a coupling element, e.g. a joining flange means, to a pipe, said
coupling element intended to surround the pipe and having grooves facing the pipe and
intended to receive a corresponding plurality of beads provided on the pipe,
characterised in

- 25 - that the tool has a plurality of axially separated, radially movable segments (10),
each segment having a plurality of circle sector formed ridges, said plurality of
segments thereby providing circumferentially extending ridges (11) capable of
deforming the pipe wall by a first pressing action on the inside wall of the pipe to
create on the outside of the pipe circumferential beads (5; 6) in the pipe wall and cause
30 said beads (5;6) to extend into corresponding ones of said grooves (3; 4) in the coupling
element, and

- that the segments have circumferentially extending portions (13) located adjacent and between the ridges, said portions (13) in a second, subsequent pressing action to cause post-pressing of buckled-in areas that occur naturally in the pipe wall between and adjacent the beads during the first pressing action, so that an outward
5 tension is obtained in the pipe at the location of the coupling element.

3.

A tool according to claim 2, characterised in

- that a part of the segments which is to lie axially aligned with the end of the
10 pipe has a projection (14) which is configured to press the pipe end out slightly further than the diameter proper of the pipe.

4.

A tool according to claim 2 or 3, characterised in

- 15 - that the segments provide an internal conical shaped or polygonal pyramid shaped space, and
- that a cone or polygonal pyramid is locatable internally of and coaxially with the segments, said cone or pyramid when pulled towards a narrow end of said shape causing the segments to move radially outwards .

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5.

A coupling element connectable to a pipe, said coupling element configured to surround the pipe and having grooves to face the pipe and to receive a corresponding plurality of beads provided on the pipe, for use with a tool according claims 2, 3 and

25 4, characterised in

- that the coupling element at its foremost portion has a recess with a diameter greater than an outer diameter of the pipe, so that when the coupling elements surrounds the pipe and said recess is aligned with the end of the pipe, the pipe end is pressable into said recess through an outward bending action thereon

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6.

A coupling element according to claim 5, characterised in that the coupling element (30) has a part of its outer surface spherically shaped to allow a two-part flange device with internal space thereof configured to be clamped to the surface of the coupling
5 element, whereby a longitudinal axis through said two-part flange device is angularly adjustable relative to a longitudinal axis of the pipe.