

PIPE JOINTS AND METHODS OF PRODUCING SUCH JOINTS

The present invention relates to pipe joints and methods of producing such joints.

5 Pipe joints can be achieved in many ways, one of which is by welding. Welding is used particularly in the case of large-diameter pipes, such as pipe-lines for gas, oil or other industrial products. The pipes may even be for district heating systems. In such pipes the demands for tightness and
10 strength are generally extremely high and accurate welding methods are therefore necessary. Such pipes often have to be welded in unfavourable weather conditions and out at building sites. Due to the high demands on the finished welds, the use of
15 welding becomes expensive and time-consuming. Welding also requires skilled labour. A normal welding joint cannot prevent running cracks which can occur in pipe-lines. These cracks have a tendency to run along a pipe-line for several kilometers, even
20 passing welded joints.

The object of the present invention is to produce a joint which fulfils high demands for tightness.

25 According to the invention there is provided a pipe joint having outer and inner parts at the point of joining of two pipes, wherein the inner part is applied to the two pipes by means of explosive welding and that the outer part is radially deformed by said explosive welding.

30 According to the invention there is also provided a fitting for effecting a joint between two pipes, the fitting comprising inner and outer annular sleeves defining an annular space for recovering the adjacent ends of the two pipes to be welded, an
35 explosive packing and a detonator mounted within the

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-1A-

inner sleeve, whereby when the detonator ignites the explosive, the inner sleeve is urged against and becomes welded to the inner surfaces of the two pipes to be welded and deforms the said pipes into contact with the outer sleeve which is thereby also at least partially deformed.

The joint is formed by applying an outer peripheral part or support ring at the point of joining, and an inner peripheral part or overlap ring at the point of joining. The overlap ring is provided with an explosive charge which is detonated in some way. When the charge is detonated, an explosive weld is obtained on the inner side of the point of joining, at the same time the pipe ends at the joining point are deformed and bent outwards together with said outer peripheral part or support ring. An explosive weld is thus obtained internally around the point of joining, as well as a mechanical joint being formed externally due to deformation of the pipe ends and the outer peripheral part or support ring. A double joint is thus obtained by means of the new joint unit; a mechanical joint and an explosive joint. The mechanical joint provides reliable strength and tightness of the joint, the internal explosive weld also contributing to said tightness. Of the two sealing processes, the explosive weld is the most important, the mechanical seal being merely a consequence thereof.

Great accuracy is obtained thanks to the fact that both the outer peripheral part and the inner peripheral part with its explosive charge can be factory-made with great accuracy.

The explosive charge is also tubular in shape, and an initiating charge is arranged to initiate a detonator in a known manner. The

explosive charge is detonated simultaneously around its inner circumference. The detonation in the explosive charge continues in axial direction in both directions if the charge is detonated between its ends on the inner periphery.

The inner peripheral part or overlap has a wall which is preferably triangular in section and the smallest distance to the inner surface of the pipe varies between 0 and 10 mm, depending on the thickness of the peripheral part. The thinner the peripheral part, the greater the distance may be to the inner surface of the joined pipes.

In order to avoid fringe effects in explosive welding, a detonation speed of between 3000 meter/second and 6000 meter/second is used, preferably between 4500 m/s and 5000 m/s.

The outer peripheral part may have lesser wall thickness between its ends. This can be achieved either by means of an outer circumferential groove or an inner circumferential groove. This results in a smoother external surface on the outer peripheral part.

The outer peripheral part may consist of thin material. In this case a rigid peripheral ring is applied to function as a support ring and is removed after explosive welding. The support ring can preferably be split in order to facilitate removal.

Both the outer peripheral part and the inner peripheral part may be of different material, and of different material with respect to the pipes to be joined.

However, if the pipes to be joined consist of compound material it is

advisable for the inner peripheral part to be of the same material as the inner surface of the two pipes to be joined.

It may be advisable to arrange aids between the outer peripheral part and the pipes to be joined, in order to achieve the best possible seal.

5 These additional aids may comprise ridges or various inserts of different types of material.

If a weld is to be inspected ultrasonically, it is advisable to arrange a layer of material permitting ultra-sound to pass through, between the two pipes to be joined and the outer peripheral part. Suitable materials are zinc or plastics.

10 The triangular cross-section of the inner peripheral part, mentioned earlier, should be such that the triangle section is equilateral and the sides incline between 3 and 20° in relation to the inner surface of the pipes to be joined. An increased angle reduces the speed of the collision front.

The tubular explosive charge mentioned may consist of dynamite, dynamex, trinitrotoluene, and may be mixed with inert material such as cardboard, wood-fibre, wood meal, plastic dolomite or cooking salt. The detonation speed of the charge can be modified by the addition of inert material. The inert material may be added in the form of powder or as a layer. The explosive charge may thus consist of several layers one on top of the other, the layers being alternately inert material and explosive, for instance.

20 The detonating charge may be in the form of a disc or a spoke system. In the latter case the explosive is limited.

25 Explosive charge, initiating charge and detonator shall be suitably encased. Plastic is a suitable material for this purpose, but other materials such as aluminium are also feasible.

It is even possible to produce a joint according to the present inven-

tion under water. This seals both the outer peripheral part and the inner peripheral part to the point of joining, as well as the surfaces to be joined together mechanically by means of explosive welding. Sealed parts are completely free from water by a suction system.

Pipe joints embodying the invention will be described by way of example, with reference to the accompanying six sheets of drawings, in which:

Fig. 1 shows a joint before detonation of an explosive charge;

Fig. 2 shows the same joint as in Fig. 1, after detonation of the explosive charge;

Figs. 3, 4, 5 show different embodiments of an outer peripheral part or support ring;

Fig. 6 shows a peripheral part of thinner material, cooperating with an outer tool acting as support ring;

Fig. 7 shows a support means under water prior to detonation of the explosive charge;

Fig. 8 shows an embodiment of an explosive charge with initiating charge and detonator; and

Fig. 9 shows another example of a unit comprising an explosive charge, an initiating charge and a detonator.

Fig. 1 shows two pipes 1 and 2 to be joined. An outer peripheral part 3 is applied around the joining point. The peripheral part also acts as a support ring. On the inside of the joint an inner peripheral part or overlap ring 4 with a wall of triangular section is arranged. Of course, the inner peripheral part may have a wall of any other suitable section,

but it has been found that a triangular ~~cross~~-section is to be preferred. The smallest distance between the peripheral part 4 and the inner surfaces of the pipes 1 and 2 may vary between 0 and 10 mm. Both the inner peripheral part 4 and the outer peripheral part 3 are preferably of the same type of material as the two pipes 1 and 2. Other materials are of course also possible. However, if pipes 1 and 2 are compound pipes, it is recommended that the material in the inner peripheral part is of the same type as that forming the inner layer of the pipes. The inside of the inner peripheral part is provided with a tubular layer of explosive material. The layer is designated 5 and consists of an explosive charge such as dynamite, dynamex, trinitrotoluene, etc. A disc 6 is placed in the hollow of the tubular explosive charge 5, equidistant from the ends of the charge. The disc 6 consists of an initiating charge which may be pentyl, explosive paste or some other equivalent explosive. In the centre of the disc is a detonator 7 which may be of any type. A detonation speed higher than that normally used for explosive welding is chosen for the explosive charge. The most suitable speed is probably between 3000 m/s and 6000 m/s, most preferably between 4500 m/s and 5000 m/s.

If the explosive charge is now detonated by the detonator 7 via the initiating charge 6, the detonation in charge 5 will move axially in both directions in relation to the initiating charge 6. The velocity of the collision front and the impulse of the explosive charge are fully satisfactory in relation to the detonation speed selected, to obtain a perfectly satisfactory weld between the inner peripheral part 4 and the inner surfaces of the pipes 1 and 2. Had a lower detonation speed been selected, the risk of fringe effects in the form of lack cohesion near the edges of the inner peripheral part would have been considerable. This is unacceptable from the point of view of corrosion in the gaps. The weld obtained by means of explosive welding has the appearance shown in Fig.2. This reveals that the inner surface of the joint is uniform and aligned with the inner surfaces of the two pipes 1 and 2. The explosive welding causes the end surfaces of the two pipes 1 and 2 to be bent up, taking with them the central part of peripheral part 3, which thus becomes curved. The curved, outer peripheral part 3

is designated 3'. This curving of the outer peripheral part 3' and the bending up of the two pipe ends 1 and 2 gives an extremely strong joint, as well as satisfactory sealing. Should even more reliable sealing be required between the inner surface of the outer peripheral part and the outer surface of the pipes, various sealing layers may be applied or other mechanical measures be taken such as the provision of grooves or ridges.

The joint illustrated in Figs.1 and 2 achieves double sealing through the explosive weld and also through the deformed outer peripheral part 3' and deformed pipe ends.

To facilitate the joining procedure it is advisable to prefabricate both the outer peripheral part and the unit comprising inner peripheral part 4, explosive charge 5, initiating charge 6 and detonator 7. Prefabrication ensures high quality of the parts 3-7. The parts 3-7 may even be made as a unit and this is then extremely easy to apply on the end of one pipe, after which the other pipe end is applied. In this case, it is advisable to provide the outer peripheral part 3 and the inner peripheral part 4 with a connecting member in the form of a circumferential strip of a number of pins joining the two peripheral parts 3 and 4 together.

The outer peripheral part 3 may be designed differently. Fig.3, for instance, shows a peripheral part 8 with reduced wall thickness in the form of an inner, concave circumferential groove and Fig.4 shows an outer peripheral part with reduced wall thickness 11 caused by an outer concave circumferential groove. A more uniform external surface is obtained after explosive welding by using an outer peripheral part according to Figs.3 and 4.

Fig.5 shows an embodiment of a peripheral part 12 provided at the ends with two outwardly directed flanges 13 and 14. This gives a stronger peripheral part.

It is even feasible to use a peripheral part 15 of thin material. To

prevent this from being destroyed during explosive welding, the peripheral part 15 is surrounded by an outer tool 16 acting as support and preventing the peripheral part from being destroyed during explosive welding.

5 Fig.7 shows a finished joint construction prior to performing explosive welding. The joint is to be produced under water and the joint area must therefore be free from moisture as follows: an outer peripheral part 17 is provided at the surface, close to its outer edges with milled grooves in which sealing rings 18 and 19 are inserted.
10 These may comprise a hose to which compressed air can be supplied, thus producing a good seal between the intermediate part of the inner surface of the peripheral part and the outer surface of the pipes 1 and 2. An annular part 20 of plastic, for instance, is arranged inside the point for joining, said part having U-shaped cross-section. At the
15 outer ends of the annular body, grooves are milled for annular sealing rings 22 and 23, preferably made of hosing which can be supplied with compressed air to ensure satisfactory sealing in the area between the legs of the U-shaped cross-section. The annular body thus includes a circumferential space 21. The inner peripheral part 4 is applied in
20 and under said circumferential space and embedded in the annular part is the annular explosive charge 24. The annular part 20 has a central, disc-shaped part 25 which is preferably made as a unit together with the annular part 20. A disc-shaped initiating charge 26 is embedded or located in the disc and communicates with the explosive charge 24 in
25 exactly the same way as the initiating charge 6 communicates with the explosive charge 5 in Fig.1. The disc 25 is provided centrally with a hub in the form of a tube, a detonator 27 being located in said hub.

The joint construction described in Fig.7 is applied to the pipe ends 1 and 2 as follows: Moisture is evacuated through a conduit 28 from the
30 circumferential space 21, as well as any moisture which may be located between the inner surface of the outer peripheral part and the outer surfaces of pipes 1 and 2. When all moisture has been removed, the initiating charge is initiated by the detonator 7 in the same way as in Fig.1.

Fig.8 shows an example of the design of an explosive charge. This is constructed of three annular layers 29,30,31 of explosive matter, and two intermediate, annular layers 32 and 33 made of inert material. It has been found that if 10 mm thick layers of the explosive known as dynamex and 4 mm layers of masonite, a detonation speed of ca. 4500 m/s is obtained.

Fig.9, finally, shows an explosive charge 5, annular in shape and enclosing a network of rings 34 and 36 and spokes 35 and 37. This network forms an initiating charge and is initiated by a detonator 7.

To protect the explosive charge 5, initiating charge 6 and detonator 7, it may be advisable to enclose the whole construction in plastic or some other suitable material such as aluminium. The same can be done with the other embodiments.

CLAIMS

1. A pipe joint having outer and inner parts at the point of joining of two pipes, wherein the inner part is welded to the inner surfaces of the two pipes by means of explosive welding and that the outer part is radially deformed by said explosive welding.
2. A pipe joint according to Claim 1, wherein the outer part comprises a tube of uniform wall thickness.
3. A pipe joint according to Claim 1, wherein the outer part varies in thickness along its length.
4. A pipe joint according to Claim 3, wherein the outer peripheral part is thicker at its ends.
5. A method of producing a pipe joint according to any one of the preceding claims, comprising the steps of coupling a unit on to one end of one of said two pipes to be joined together, said unit comprising said outer and inner peripheral parts joined together by one or more spacers and including an explosive agent to effect an explosive weld between the inner peripheral part and the two pipe ends, and coupling one end of the other of said two pipes to the unit and detonating the explosive agent.
6. A method according to Claim 5, wherein the inner part has a wall of triangular section before explosive welding.
7. A method according to Claim 5 or to Claim 6, wherein the distance from the inner part to the inner surface of the pipes to be joined varies, the distance increasing with increased wall thickness.
8. A method according to any one of Claims 5 to 7, wherein an explosive charge of tubular form is used and is positioned inside the inner peripheral

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part.

9. A method according to Claim 8, wherein the charge is formed of several annular layers having one or more intermediate layers of non-detonating material.

10. A method according to Claim 9, wherein the non-detonating material is cardboard, wood-fibre, rubber, salt or wood meal.

11. A method according to Claim 8 or to Claim 9, wherein the tubular explosive charge has, in a plane perpendicular to its axis an explosive and a detonator, the detonator being located along the said axis.

12. A method according to Claim 11, wherein the explosive of the explosive charge is of disc or string-like form.

13. A method according to any one of Claims 5 to 12, wherein before an explosive welding is initiated, a layer is applied between the inner surface of the outer peripheral part and the outer surface of the pipes to be joined.

14. A method according to Claim 13, wherein the layer is of plastics, metal, rubber or flexible material.

15. A method according to any one of Claims 5 to 14 including the step of evacuating the space between the inner and outer parts prior to explosive welding.

16. A fitting for effecting a joint between two pipes, the fitting comprising inner and outer annular sleeves defining an annular space for receiving the adjacent ends of the two pipes to be welded, an explosive packing and a detonator mounted within the inner sleeve, whereby when the detonator ignites the explosive, the inner sleeve is urged against and



29

-11-

becomes welded to the inner surfaces of the two pipes to be welded and deforms the said pipes into contact with the outer sleeve which is thereby also at least partially deformed.

- 5 17. A fitting according to Claim 16, including means interconnecting the inner and outer sleeves to hold them in spaced relationship to define said annular space.
- 10 18. A fitting according to Claim 16 or 17, wherein the inner and outer sleeves are of metal.
19. A pipe joint effected by the fitting according to any one of Claims 16 to 18.
20. A pipe joint substantially as hereinbefore described with reference to any one of the
- 15 accompanying drawings.
21. A method of producing a pipe joint substantially as hereinbefore described with reference to the accompanying drawings.
22. A fitting for effecting a joint between two
- 20 pipes substantially as hereinbefore described with reference to the accompanying drawings.
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