

METHOD FOR WELDING PIPES AND A PIPE-LAYER

The invention relates to a method as indicated in the preamble of claim 1. The welder must herein adapt the welding process to diverse, changing conditions and he selects a welding speed such that he can just still manage to perform the various adjustments. Needing adjustment for instance are the welding voltage, the welding wire feed, the speed of the welding lance in peripheral direction of the weld, the speed, width, rest time and position of the center line of the zigzag movement of the welding lance, the distance of the welding lance to the bottom of the weld and/or the gas speed to the welding lance.

The invention has for its object to improve the welding process on a pipe-layer, i.e. to improve the weld quality and/or increase the welding speed. According to the invention the welding process is automatically controlled for this purpose as claimed in claim 1. In this way the welding process is improved.

The welding process changes mainly with the slope of the welding melt. Once the ideal setting of all parameters has been determined for the diverse slopes, the settings associated with each momentary slope can be easily and rapidly controlled by a computer. In this manner a good weld quality can be combined with a high welding speed, while the roll movements of the pipe-layer are compensated.

In US-A-4144992, US-A-4554430, US-A-4283617 and FR-A-2412380 automatic welding processes are disclosed in which the parameters are adjusted in dependency on the angle displacement of the welding torch calculated from a reference point of the pipe periphery. In these methods the calculated momentary slope is not the exact momentary slope due to the fact that the pipeline is subject to roll movements of the pipe-layer. The method of claim 1 adjusts the welding conditions taking into account said roll movements.

US-A-4645902 discloses an automatic welding process, which is based on previous experience. The welding

operation is initially programmed with a set of welding parameters. This known method does not weld with ideal conditions as there is no correction of the recorded program concerning the differences between momentary roll angles during recording and during use of the program.

The invention also relates to and provides a pipe-layer according to claim 3 on which the invention can be used to particularly great advantage.

Mentioned and other features according to the invention will be elucidated in the description following hereinbelow with reference to a drawing. In the drawing in schematic form:

figures 1 and 4 show a perspective view of two different welding devices of a pipe-layer according to the invention;

figure 2 shows on a larger scale a lengthwise section along the line II-II of figure 1;

figure 3 shows a view along arrows III of figure 2;

figure 5 shows a circuit diagram of the welding device of figures 1 and 2; and

figure 6 is a graph diagram of an example for the control of the welding process with a welding device of figures 1 and 2.

The present invention is particularly of use on a pipe-layer in the form of a vessel, wherein a series of pipes are held mutually in line and are welded to each other to form a pipe string which sinks to the surface located under water. Welding work is herein carried out simultaneously at a number of welding stations.

In figure 1 can be seen only one welding station 6, where a ring weld 2 is applied between two pipes 1 held in mutual alignment. For this purpose one pipe 1 is applied at a time to a welding station 6 which carries a fixing band 3 preferably placed therearound in advance. This is a thin, elastic, metal, annular band which is cut through on the bottom and provided there with a band closure 4 with

which the fixing band 3 can be placed round a pipe 1 with considerable tension. During fitting of the fixing band care is taken that this has a predetermined distance g to the pipe end face 5.

5 At the location of the welding station 6 a support ring 7 and pipe alignment means 8 are arranged inside the pipes at the position of the ring weld to be arranged and are supported on a core (not drawn) held in the pipes 1.

10 Further placed on the fixing band 3 at the position of the welding station 6 is a ring frame 9 which is manipulated to this end by hoisting means 10 which grip onto hooks 11 of ring frame 9. The ring frame 9 comprises an upper ring piece 12 which grips with support blocks 13
15 onto both edges of fixing band 3 in addition to two lower ring pieces 15 which are pivotally attached to the piece 12 on shafts 14 and which can be opened and closed by means of pneumatic cylinders 16 and in closed position can be firmly coupled to one another by means of closing means 17. The
20 closed ring frame 9 has radial flanges 18 to which continuous rails 19 are fixed over the whole periphery by means of axial pins 20. A chassis 34 of a welding carriage 21 is guided over both rails 19 by means of guide rollers 22 which grip with V-shaped grooves 24 onto the wedge-shaped
25 inner and outer edges 23 of rails 19.

 Fixed to the chassis 34 of the welding carriage 21 is a gear rim 26, while fixedly attached to the ring frame 9 is an electric stepping motor 28 with reduction drive gear 29 which drives the gear rim 26 and therewith
30 the welding carriage 21 via a tooth wheel 30. The gear rim 26 is held between the tooth wheel 30 and two guide rollers 31. The mass of the welding carriage 21 is reduced because the motor 28 with the drive gear 29 thereof is supported by the fixed ring frame 9. A support frame 33 is connected
35 pivotally about a longitudinal axis 35 to the chassis 34 and is thus adjustable and is controlled subject to a pick-up 36 which picks up the pipe shape and consists of a

support roller bearing on the outer periphery of pipe 1 and connected to support frame 33 by means of a support 37. A lance carrying frame 38 is guided for adjustment in radial direction relative to the support frame 33 by means of pins 39 and is adjusted by means of an electric stepping motor 40 via a gear transmission 41 and a screw spindle 42.

A lance carrier 44 is connected to the lance carrying frame 38 for swivelling about a radial axis of pivot 45 and is driven in oscillating manner by an electric stepping motor 46 via a bevel drive gear 47, this such that the welding lance 48 carried by the lance carrier 44 covers the zigzag path 49 with curved zigzag lines 50 shown in figure 3. A better weld is hereby achieved. A slide frame is optionally built in between the lance carrying frame 38 and the lance carrier 44 in order to displace the swivel axis 45 in axial direction of ring frame 9 in the case a pipe end face 5 is cut at a slant.

The welding lance 48 is fixed to the lance carrier 44 by means of a lance holder 53 which can be swivelled into a cleaning position about a longitudinal axis 54 and which can be fixed into a selected, more or less oblique welding lance position by means of a hand control 55. Further, using means that are not drawn, the welding lance 48 is manually adjustable in a holding block 97 in order to orient the welding lance 48 into its position. The block 97 also allows the angle of the torch (leading or trailing the weld pool) to be adjusted. This angle is normally 90 degrees + or - 5 degrees.

In order to reduce the mass of the welding carriage 21 a welding wire carrier 57 is fixed to the ring frame 9 and carries a supply roll 56 of welding wire 59 and an electric stepping motor 60 for driving the welding wire 59 by means of a drive roller 61. In the case of thin welding wires, three rollers (not drawn) are disposed such that they together straighten the welding wire 59.

The welding wire 59 is guided to the welding lance via an elastic, flexible conduit 71 arranged close-

fittingly around the wire.

Further present are remote control means 64 for controlling the diverse mentioned motors.

5 An angle measuring device 66 is arranged on the welding carriage 21 for measuring the absolute inclination angle f of the welding melt. In reality it measures the angular distance b between the welding point 67 of the welding lance 48 on the weld periphery and a reference point 68 corrected with the roll angle is the momentary inclination of the pipe-layer together with the pipe-line about the longitudinal ships-axis which is substantially identical with the pipe-line axis.

10 The angle measuring device 66 is preferably situated in the lengthwise plane through the welding point 15 67 drawn in figure 2. It is noted that for obtaining a signal corresponding to the absolute inclination angle of the welding melt, it is possible to measure the angle path of the welding device from a reference point, e.g. reference point 68 and to correct such angle path with the momentary roll angle of the ship. Said roll angle of the ship is then measured with an inclination measuring device connected to the ship.

20 The motors 28, 58, 40 and/or 46 and optionally also a gas control (not drawn) for feeding gas to the welding lance are automatically controlled subject to the measured momentary angular distance b by means of a computer 70.

30 This method for controlling the welding process has the advantage that welding takes place automatically in a continually changing manner which takes into account the slope of the weld at the position of the welding point 67. This saves the welder a great deal of work and concentration so that he has only a supervisory function. The welding speed can hereby be increased to the welding speed permissible for each welding point 67, this in contrast to 35 the known method wherein a speed permissible for all welding points 67 is set. The mentioned stepping motors can -

although not in preference - consist of hydraulic or electromagnetic motors or electric DC or AC motors which are provided with a suitable control with feedback signal.

The welding device 25 of figure 4 corresponds with those of figures 1 and 2, with the difference that two welding carriages 21 are now present each having connected to their chassis 34 a gear rim 26 which are each gripped by their own motor 28. There are of course two motors 58 likewise present for the welding wire feed.

It is noted that the ring frame 9 and the welding carriage(s) 21 belonging thereon can be used for all kinds of pipe diameters if an adapted fixing band 3 is employed with adapted support blocks 13 which are releasably attached to the upper ring piece 12.

The invention can be used for pipes of diverse steel types and with dimensions varying from 4 to 20" with wall thickness from 6 to 30 mm.

Six welding stations 6 are for instance present, each equipped with two main control units 80 and each provided with a remote control element 81 so that a welder, while observing the welding process, can intervene at a random place and position with such an element 81.

The main control units 80 of a plurality of welding stations 6 are all connected to a common central computer 82. There are optionally two central computers present, each for three welding stations 6, which are then provided with identical welding programs. The welding program comprises a control of the welding process for six parameters each of which are adjusted to an ideal setting subject to the angular distance α . This setting can take place step-wise, for instance per 15° of angular distance α , this differing if necessary for the various welding beads of a weld lying one above another. For the welding bead to be carried out the associated series of functions is therefore selected, each of which as noted is dependent on the angular distance α . The six controlled parameters are:

welding wire feed W.S. = $f(a)$ with switch 91 of motor 58
 lance speed W.W. = $f(a)$ with switch 92 of motor 28
 lance voltage W.V. = $f(a)$ with switch 93
 oscillation speed

5 O.S. = $f(a)$ signal 95 to switch 94
 of motor 46

oscillation width

O.A. = $f(a)$ signal 96 to switch 94

oscillation rest time

10 O.D. = $f(a)$ signal 97 to switch 94

The cassette with a programmed welding process for a determined pipe dimension and material is entered in the common computer 82 and the memory of the computer 82 is loaded. The computers 80 are now connected to computer 82
 15 so that the welding parameters are entered into the memories of computer 82 as a function of the angular distance α . Each of the welding lances 48 welds a sector of 180° , to the left and right, wherein a mutual collision is prevented by position measuring of the welding lances 48. It is
 20 possible for one welding lance 48 to wholly or partially take over the welding work in the region of the other if this other fails. With small pipe diameters there is only one welding lance 48 present per welding station which finishes the whole periphery (figure 1).

25 If a change has to be made in the welding programme, this is then carried out simultaneously for all welding stations 6 in the central computer 82. The parameter functions may however only be modified to a small extent in order to prevent the standard weld quality falling outside that agreed with the customer for the pipe string. It is therefore recommended to leave the cassette
 30 in the central computer 82 so that when it is switched off the modifications made on the panel of the central computer 82 are deleted and the original parameter functions remain
 35 preserved. During performing of the method it is possible to see the whole stored welding program on a screen 85 as well as the selected parameters for the diverse welding

beads and any modifications thereto.

In addition the maximum time values will be programmed in the common computer 82 in order to realize the ring weld 2 distributed over the various stations in the shortest possible time.

Depending on individual problems it may be necessary to alter the welding parameters for a particular welding lance 48, for which purpose the computer 80 is then operated either from the panel thereof or by remote control. The newly set parameter value will be automatically performed only in the memory of computer 80. As soon as the problem has been overcome the value set in computer 80 is removed and only the program of the central computer 82 is again followed. The value set in a computer 80 is not entered into central computer 82 in order to avoid transmission to other computers 80.

During performing of the welding work the central computer 82 can provide information about the welding process to an onboard computer arranged for instance on the bridge of the pipe-layer so that the captain of the pipe-layer can take this into account in controlling the propulsion or warping of the pipe-layer. It is conceivable for such information to be generated as control signals to an automatic navigation or warping device in order to control the pipe-layer subject to these signals.

Each welding lance 48 is under the control of a welder working practically independently of other welders. He places his welding lance 48 in a start position, automatically or using motors, while making use of switches on the panel of computer 80 or the remote control 81. He selects the welding bead to be carried out and adjusts the position of the welding lance 48, i.e. in peripheral direction in the start position, in lance direction and transverse direction and then switches on the start switch.

It is noted that the operator can select the starting and finishing points of each weld run. Preferably he selects staggered start-stop points of successive weld

runs.

The welding carriage 21 then begins to run according to the programmed speed. One after the other the oscillation movement starts, the gas feed is opened, the welding voltage is applied and the welding wire feed starts moving. During welding the welder can alter the welding lance position slightly and adjust the oscillation amplitude within a margin of $\pm 0,5$ mm and adjust the welding voltage.

The welding lance position is measured with the angle measuring device 66 and generates angular distance signals to the computer 80 which, subject thereto, supplies the control signals as according to figure 5. At the end of the welding sector the welding lance 48 will automatically cease its welding operation, switching off in sequence the welding wire feed, welding voltage, carriage displacement, shield gas feed and oscillation movement.

The welding lance 48 will return to its starting position at maximum speed. Having arrived there the following welding bead is automatically selected and starting and further operations take place automatically. If necessary, the welder can at any time bring to a halt the welding operation of a welding lance 48.

Data relating the process of the welding operation of all welding lances 48, i.e. all control values as a function of the angular distance α with their modifications as set by the welder, can be recorded in the central computer 82. The computer 82 receives from an angle measuring device 90 signals relating to the momentary angle of pitch φ of the pipe-layer and delivers these continually to the computers 80. The six mentioned parameters are now set subject to the angular distance α which is corrected for the angle of pitch φ .

Shown in the diagram of figure 5 are communication hardware 99, connected to the computer 80 via control electronics 98, and electronics 100 of the stepping motors.

It is noted that the control of the welding

process subject to the angular distance a can also be used with welding devices wherein a ring for clamping round a pipe also comprises the rails and the gear rim for a welding carriage.

The device for measuring the angular distance can be an angle measuring device based on measurement of the angular displacement relative to a permanently vertical pendulum. In preference the covered angular distance a is measured by measuring and recording the path traversed by the gear rim 26 by measuring and recording the number of revolutions of the stepping motor 28. This is very simple using a computer.

Attention is directed to GB 2 274 420 which is divided from this disclosure and relates to a method for welding together pipe ends of pipes wherein pipe ends of a plurality of pipes held mutually in line of a pipe string are welded to each other on a pipe-layer floating on water, wherein at a plurality of welding stations a weld is applied simultaneously between pipe ends, characterized in that the welding process of the plurality of welding stations are controlled from a common computer, wherein signals concerning the progress of the welding process are provided to the common computer from each of this plurality of welding stations and that the forward displacement of the pipe-layer is controller subject to the information generated by the common computer.



CLAIMS

1. Method for welding together pipe ends of pipes (1) wherein pipe ends of a plurality of pipes (1) held mutually in line of a pipe string are welded to each other on a pipe-layer floating on water, wherein at a plurality of welding stations a weld is applied simultaneously between pipe ends, characterized in that at least at one of said welding stations the welding process is automatically carried out in dependency on at least one inclination measurement providing a signal which is dependent on the inclination of the pipe-line due to roll movements of said pipe-layer.

2. Method as claimed in claim 1 or 2, characterized in that the peripheral displacement of at least one welding lance (48) over the periphery of the weld (2), the welding wire feed of said welding lance (48), the radial distance of said welding lance (48) relative to the weld inner diameter and the zigzag movement of said welding lance (48) are each controlled with the use of an electric stepping motor (28, 60, 40, 46).

3. Pipe-layer comprising a vessel carrying a device for welding together pipe ends of pipes held mutually in line of a pipe string, said device comprising a plurality of welding devices situated at a plurality of welding stations (6), characterized by at least one angle measuring device (66, 90) providing a signal which is dependent on the inclination of the pipe line due to roll movements of said pipe-layer.

4. Pipe-layer as claimed in claim 3, characterized by at least one stepping motor (28) for driving the peripheral displacement of a welding lance (48) over the periphery of the weld (2);



at least one stepping motor (60) for driving a welding wire feed of a welding lance (48);

at least one stepping motor (40) for driving the radial distance of a welding lance (48) relative to the weld inner diameter; and/or

at least one stepping motor (46) for driving the zigzag movement of a welding lance (48).

5. Method for welding together pipe ends of pipes as claimed in claim 1 or claim 2, substantially as hereinbefore described with reference to the accompanying drawings.

6. Pipe-layer as claimed in claim 3 or claim 4, substantially as hereinbefore described with reference to the accompanying drawings.