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DESCRIPTION

METHOD OF WELDING PIPE

Background of the Invention

1. Field of the Invention

This invention relates to the field of welding sections of pipe together to form a long, continuous pipeline. It relates especially to a system whereby the welding is done with machines.

5 2. Background of the Invention

One of the major systems for transporting products such as oil, gas, and water, is by the use of pipelines. These pipelines are usually laid underground and literally crisscross the United States and many other countries. A trench is normally dug by ditch diggers along the prescribed route of the pipeline.

10 Sections of pipe, e.g. 30 to 60 feet or so, are hauled into the area through which the pipeline is being laid. Ends of adjacent joints of pipe are connected by welding. These welds must be very precise. Even little pinholes in the weld cannot be tolerated. The ends of the pipe are normally beveled to improve the welding. These pipes are clamped together to get as good an alignment between the two
15 sections of pipe as possible. On the inside of the pipe at the welding joints the welding material should form a rather smooth surface next to the interior of the pipe. In any event, the weld on the inside of the pipe should have very little protrusion. Excessive protrusion can cause all sorts of problems when one runs apparatuses down inside the pipe, such as apparatus useful to detect any possible flaw which
20 may have developed in the pipeline. Also, introduced in the pipelines are pipeline pigs which separate one product present in a pipeline from a second. It should be understood that sometimes gasoline will be piped through a pipeline. A plug will be put in to separate the two products, and then crude oil will then be pumped through the same pipe. One must maintain a consistent separation of the two
25 materials.

In order to prevent the protrusion of welded molten welding material into the inside of a pipe, the more common practice today is to make the first or root pass of the weld from inside the pipe. Special elaborate, costly machines are commercially available for this purpose. The cost of renting such elaborate
5 equipment for working on the inside of a three foot (3') diameter pipe may be as much as \$1,200.00 per weld, or the rental could be nearly Two Million Dollars per month. This is a very time-consuming and costly welding procedure. It is seen that there is a need for a better, less expensive way of welding pipe sections together.

In modern pipeline welding, welding bugs are sometimes used as semi-
10 automatic welding machines. In conjunction with the welding bug is a track which is secured about the periphery of the pipe at the point it is desired for the welding bug to rotate around the pipe. The bug has a drive motor which with the help of rollers, drives the bug around the track. The rollers hold the welding bug along the track, even when the welding bug is nearly upside down. Special clamping means
15 are provided to secure the bug to the track. Means are also provided to accommodate different size pipe. The welding bug has an oscillator to cause the welding tip to oscillate across the welding puddle.

The bug also has a wire feeder which has a motor which drives the wire through the welding head for the actual welding of the two sections of pipe together.
20 In operation, the drive motor drives the bug around the track at a selected constant rate of speed. However, when the bug is traveling from 12 o'clock, which is the top of the pipe, to about 9 o'clock, which is midway around, the speed is constant. However, for the balance of the down movement of the welding bug to 6 o'clock, the movement must be speeded up because of the gravity pulling the
25 puddle at a faster rate. In order to accommodate this, in current practice, the bug drive motor is stopped. Then the operator will adjust the speed of the drive motor so that it will be speeded up. He then starts the drive motor, and the welding process continues. The movement of the bug is always stopped when making this change in speed.

Stopping the drive motor causes a loss of time in completing the weld. Other associated problems such as maintaining the continuity of the bead must be considered. However, even with these problems, the procedure just discussed is widely used, mainly because it is better than the prior procedures.

- 5 It is therefore one object of this invention to provide an apparatus and system whereby the initial or root welding pass can be made from outside the pipe and in which there is no internal protrusion of the welding puddle.

Summary of the Invention

This is a method and an apparatus of welding the end of a first pipe section to the end of a second pipe second by use of an improved welding bug. The welding bug is provided with a wire feeder, means to drive the wire feeder, and driving means for driving the bug around a track on the outside of a periphery of pipe. Control means are provided for varying the speed of the bug while the bug is continuously driven around the track. When the pipe is welded, it is in a horizontal position, that is, the axis of the pipe is normally horizontal. The initial welding pass or root pass is applied adjacent to the ends of the first and second pipe from outside the first and second pipe. No internal line-up clamps with back-up shoes are used or needed in this process.

Normally two bugs are used, one around one-half of the track and the other around approximately the other half. From 12 o'clock to 9 o'clock one bug goes from nearly horizontal to nearly vertical. During this time the speed of the bug must be varied so as to keep the electrode with the welding wire just ahead of the welding puddle. The other bug moves from 12 o'clock, through 3 o'clock, to 6 o'clock. The two bugs are rotating or moving at the same time. However, one bug will start slightly before the other and one will stop slightly before the other and be removed from that immediate area so there is a continuous weld where the welding passes from the two bugs meet. In the root pass a surface tension transfer (STT) power source is used. This is new in this combination. By using this system with proper bug speed and welding wire speed, there is only a slight burn through on each edge of the bevel. The surface tension of the welding mode causes it to blend together, tying in each side of the bevel leaving a small flat weld on the interior of the pipe. Thus, the need to run the initial or root pass from the inside of the pipe, or use equipment inside the pipe is no longer necessary. Before this invention when welding pipe together with systems involving welding bugs, the root or initial pass was always from the inside or involved placing equipment such as clamps, back-up shoes, etc. inside the pipe. No such equipment is needed with this

invention.

Means are also provided for varying the speed of the wire feeder so that there is the desired amount of wire being fed into the welding puddle. In another embodiment the speed of the wire feeder drive is controlled by and varies in accordance with varying the speed of the drive motor for the bug such that the desired rate of feeding the wire is achieved.

In operation, the welding operator will continuously observe the welding puddle in relation to the electrode or the end of the welding wire being fed. The operator will want to keep the end of the welding wire just ahead of the puddle. Therefore, the operator will vary the speed of the bug to maintain the proper position of the welding head. This is done while the bug and welding operation proceeds with no stops required. During the actual movement of the welding bug, the wire feed drives can be varied to get the desired amount of welding wire to the electrode. Further, if desired, a control can be made such that the wire feeder speed will vary in accordance with the speed of the welding bug.

Brief Description of the Drawings

FIG. 1 is a schematic drawing illustrating key components of the invention.

FIG. 2 illustrates a welding bug mounted on a track showing a piece of pipe which is to be welded to another piece.

5 FIG. 3 is a front elevation of the welding bug of FIG. 2.

FIG. 4 is a rear elevation of the welding bug of FIG. 3.

FIG. 5 is a left-side evaluation of portions of the welding bug of FIG. 4.

FIG. 6 illustrates clamping means for releasably clamping the guide rollers and travel drive rollers of the bug to the guide track.

10 FIG. 7 is similar to FIG. 6 except that the clamp is illustrated in the disengaged position.

FIGS. 8 and 9 when taken together shows the wobble of the welding head.

FIG. 10 illustrates the bottom view of the welding bug.

15 FIG. 11 illustrates the connection between a potentiometer for driving the wire feeder and the potentiometer for the travel motor such that the drive wire feeder is adjusted in accordance with the change of the travel speed of the welding bug.

FIG. 12 is a schematic of a system for controlling the speed of the travel motor on the welding bug.

20 FIG. 13 illustrates pulses in the control system of FIG. 12.

Description of the Preferred Embodiment

Attention is first directed to FIG. 1 which is a schematic drawing showing the key components of a welding system using a modified welding bug. Shown thereon is a first pipe joint 10 and second pipe joint 12 which are to be welded together. A
5 guide track 14 is positioned and secured to the outside of the welding pipe near the position where the pipe ends are to be welded. It is upon this guide track that the welding bug 16 travels. There will normally be two welding bugs, but only one is shown. Position or guide bearings or rollers 20 maintain the welding bug on track 14 as the bug travels thereon. There is a travel motor 18 in the welding bug which
10 drives knurled travel rollers 21 about the track 14. The speed of the travel motor is controlled by a potentiometer control 22.

A welding head 30 is supported from the welding bug 16 and supports a welding wire 28 which extends through the welding head 30 as the electrode 29. A track 14 is positioned on pipe 12 so that the end of welding wire 28 is properly
15 positioned with respect to the ends of the pipes 10 and 12. A CO₂ solenoid valve 32 is supported from the welding bug 16 and provides CO₂ or other desired gas to be expelled at the lower end of the welding head 30 about the end of the welding wire tip 29.

In operation of the device in FIG. 1, the CO₂ solenoid is first opened so that
20 all other gas is flushed out from around the electrode 29 before it is supplied with electrical power. The power for welding head 30 is provided via conduit 84 from surface-tension-transfer power source 32 which will be explained further as a new type power source for the automatic welding system using a welding bug. This STT power source is now started.

25 Next the wire feed motor 24 and the welding bug travel motor 18 are simultaneously started. This causes the welding bug 16 to start moving along track 14. The operator watches the operation, especially the welding puddle. The speed of the welding bug should be such that the wire tip 29 should just maintain itself in

advance of the puddle. As the welding bug goes around the pipe, the gravity varies the movement of the puddle. The operator will compensate for this by operating potentiometer control to change the drive speed 22 speed while the welding is in progress. If the wire feed motor is not feeding the wire sufficiently fast, then
5 potentiometer control 26 for wire drive speed can be increased or, if the situation demands, it can be decreased. This too is done while the welding bug 16 is moving along track 14. (Never before has the speed of the welding bug along the track been varied while the welding is actually taking place.)

Instead of controlling the drive speed of the travel motor 18 independently
10 from the speed of wire feed motor 24, one may make the wire feed motor speed a function of the speed of the travel motor. This apparatus for permitting this is illustrated in FIG. 11. In this apparatus the operator of the welding bug would turn knob 38 to adjust the travel speed of the welding bug. This change would be in the general manner of changing potentiometer settings for controlling the speed of a
15 motor. In this case, there is a drive chain or belt 40 connected between the shafts or rotor 34 of potentiometer for drive wire feeder 26 and the rotor 36 for potentiometer for travel motor 28. Thus when wheel 38 is rotated, the drive chain 40 will drive the rotor 34 to adjust the potentiometer for drive wire feeder 26. Thus, as the speed of the welding bug varies, the speed of the drive wire feeder can vary
20 accordingly.

A pipeline tractor 42 has a generator which provides electrical power to the surface-tension-transfer (STT) power source 32. In principle, the STT power source is a power source which has the capability of delivering and changing electrode current in the order of microseconds, for example about 750
25 microseconds has been effective. The STT power source is commercially available from the Lincoln Electric Company, Cleveland, Ohio 44117-1199, U.S.A.

Attention is next directed to FIG. 2 which shows a modified welding bug 16 mounted upon track 14 which encircles the pipe 44. Track 14 may be a conventional track which guides a welding bug around pipe. The principal

components of welding bug 16 include a welding tip or electrode 31 at welding head 30 having a gas cone 50 which directs welding gas, typically CO₂, about the electrode 31. Conduit 84 connects STT power source 31 to welding head 30. The welding wire, which is an electrode, is wound on wire reel 58, passes through shield 60 and 62, with a wire feeder 64 between the two shields. The wire feeder is conventional and has tension adjustment 65. This wire feeder 64 is used to drive a wire at a selected speed through the welding head 30. CO₂ supply hose 82 connects the welding head 30 in a conventional manner. An oscillating motor 66 is provided to drive oscillating mechanism 68 which is connected through connector 70 to oscillate the welding head 30 so that the electrode is moved back and forth across the opening between the ends of the pipe being welded. Connector 70 can be used to adjust the positioning of welding head 30. Knob 85 is used for adjusting the height of the welding head.

Attention is now best directed to FIG. 3 which shows the welding bug 16 in enlarged form. It shows an oscillator adjusting mechanism 74 to adjust the height of the oscillation curve, i.e. the width of oscillation. (This oscillating system may be the same as shown as used on conventional welding bugs.)

Attention is next directed to FIG. 8 which shows oscillator tip in one position and in FIG. 9 wherein the welding tip is in a second position. The welding tip 52 is supported by welding head 30. This oscillating system is used in the conventional welding bugs and is shown here only for ease of understanding the overall system.

FIG. 3 also shows an adjustment knob 85 for adjusting the height of the welding head with respect to the welding bug and in effect the height in relation to the pipe being welded.

It is essential to provide an insert gas which is preferably carbon dioxide to the welding head. This is provided as shown in FIG. 4 from a gas source hose 78 which is connected to a solenoid valve 80 which has an outlet hose 82 which goes to the welding head. Gas is provided through the solenoid when it is opened. A

power conduit **84** from the STT power source **32** provides the operating current for welding head **30**.

A variable swivel adjustment **86** provides means for adjusting the angle of the welding head as may be needed.

5 Attention will next be directed to the travel motor **18** and travel and drive rollers **20** as they relate to staying on and moving along track **14**. Travel and drive rollers may be conventional and are shown here to complete the overall new combination. Attention is next directed to FIGS. 6, 7, and 10. FIG. 10 is a bottom
10 view of the welding bug **16**. Shown thereon are blocks for housings **88A**, **88B**, **88C**, and **88D** for the rollers. Shown within the blocks **88A** and **88C** are the side rollers **90**; and in blocks **88B** and **88D** are shown knurled wheels **92A** and **92B** which are driven by drive motor **18**. The side rollers keep the welding bug snug on the track. The knurled roller causes the welding bug to move along the track. FIGS. 6 and 7 show the clamping lever for clamping the rollers in position. FIG. 7 shows a
15 clamping mechanism disengaged so that the rollers can be properly positioned. The rollers should be snug against the track band. Thus there is provided a spring and adjusting nuts **104**.

As shown in FIG. 5, support bearings **141** and **143** on top of track **14** and bearings **145** and **147** on the bottom of track **14** keep the welding bug **16** in contact
20 with track **14**.

Also shown in FIG. 10 are: Bottom view of the welding head **30**, oscillator drive motor **66**, and oscillator adjustment **74**.

The wire guide mechanism has been modified from that of the previous wire drive systems on conventional welding bugs. Conventional welding bugs require
25 the bug to be stopped before a change of speed of the wire feed motor or drive motor for the bug was made. In this invention, a modification has been made such that the drive speed of the wire can be changed without stopping the movement of the welding bug. The drive mechanism for driving the welding bug about tracks **14** has been modified from that of the conventional welding bugs mostly in that the

speed of the travel motor can be varied without stopping the welding process.

Control means for controlling the speed of the bug travel motor and the speed of the wire drive motor will now be discussed in relation to FIGS. 12 and 13.

Attention is next directed to FIG. 12 which shows one control means in schematic form for use in controlling the speed of travel motor 18. (The illustrated system may also be used to control the speed of wire feed motor 24.) It includes a pulse width oscillator 120 which has a power input 122. The pulse width oscillator 120 has a reference voltage 124 which typically is 2 1/2 volts. The power circuit 132 connects to motor 18. The speed of motor 18 varies as a function of the voltage of the current on line 132. The outlet of the motor is provided through line 134 and variable resistor 128 back to oscillator 120. There is a feedback line 130 from lines 134 to the oscillator 120. This has a resistance 126 and provides a minute feedback to oscillator 120. Resistor 128 can be varied to change the speed of motor 18 (as by moving knob on potentiometer 22). As the resistance of resistor 128 is varied, the output voltage varies on line 132. This voltage on line 130 is then compared to the oscillator reference voltage 124. The width of the pulses 140, 142 shown in FIG. 13 changes until the minute feedback on line 130 equals the reference voltage. This will then control the speed of motor 18. One skilled in the art could easily implement this speed control system from the above schematic drawing and explanation. Other means of providing this motor control speed may be used.

FIGS. 4 and 5 illustrate potentiometer welding bug travel speed control knob 26A and wire drive speed control knob 26A mounted on control box 27. These knobs can be used in cooperation with the control of FIG. 2 to adjust either or both of the speed of the bug travel motor or the wire feed motor. Control conduits 147 and 149 connect the control box 27 respectively to travel motor 18 and wire feed motor 24.

Having described the principal components of the invention, attention will now be directed briefly at the operation thereof. In operation, the ends of pipe

sections 10 and 12 will be placed adjacent each other, as shown in FIG. 1. A track 14 is connected about the pipe section 12. The STT power source 31 is connected to pipeline tractor generator 33 to provide the power for the welding operation. Track 14 is set so the welding tip 29 is positioned properly with respect to the gap
5 between pipe sections 10 and 12. Normal adjustments will be made to the height and oscillation of welding head 30.

Carbon dioxide solenoid 80 is then energized to open up the CO₂ supply source so that the CO₂ can be transported to the welding head 30. Now the travel motor 18 and wire feed motor 24 will be started essentially simultaneously after the
10 wire tip 29 is in proper position.

The initial or root pass of the welding operation is made on the outside of the pipe in the position shown in FIG. 1. The use of the surface-tension-transfer (STT) power source 31 is most essential. The STT power source operates neither in the constant current (CC) or constant voltage (CV) mode. Rather, it is a high frequency
15 (wide-band-width), current-controlled machine wherein the power to the arc is based on the instantaneous arc requirements, not on an "average DC voltage". It is a power source which has the capability of delivering and changing electrode current in the order of microseconds.

As the travel motor causes the welding belt 16 to progress around track 14,
20 the operator closely watches the welding puddle to keep the welding tip 29 just ahead of the puddle. As the welding bug 16 moves downwardly, the force of gravity causes the welding puddle to want to move faster. Therefore, the welding operator will merely turn a knob 22A as shown in FIG. 4 to adjust the speed as required. The operator can also adjust the speed of the wire feed motor 24 by adjusting knob
25 26A as shown in FIG. 4. This is done without stopping either the travel motor 18 or the wire feed motor 24. There is another welding head (not shown) which is on the other side of the pipe from that viewed in FIG. 1. The second operator will operate that welding bug in the same manner as just described. One of the bugs will start slightly before the other, so that there will be no gap at the top where the

welding beads begin; and one of the bugs will stop before the other so that the one bug can continue the welding bead until it is continuous at the bottom. This operation is all from the outside of the pipe. There is no protrusion into the pipe of drippings and the like because of this new system described herein. There is no
5 need for the root pass to be made on the inside. This eliminates a very costly procedure. After the root pass has been made, then additional welding passes may be made using conventional welding techniques as desired.

While the invention has been described with a certain degree of particularity, it is manifest that many changes may be made in the details of construction without
10 departing from the spirit and scope of this disclosure. It is understood that the invention is not limited to the embodiment set forth herein for purposes of exemplification, but is to be limited only by the scope of the attached claim or claims, including the full range of equivalency to which each element thereof is entitled.

Claims

- 1 1. A method of welding the end of a first pipe to the end of a second pipe by
2 use of a welding bug having a welding wire feeder and means for driving the bug
3 along a track on the outside periphery of pipe which comprises:
4 continuously moving said bug along said track;
5 applying the initial welding pass to the adjacent ends of said first and
6 second pipe from outside said first and second pipe without use of internal
7 equipment;
8 varying the speed of said welding bug without stopping it while it is
9 continuously moving about said track on said pipe to maintain a desired
10 welding puddle.
- 1 2. A method as defined in claim 1 in which after the initial pass applying
2 additional passes.
- 1 3. A method as defined in claim 1 in which said initial pass is made by
2 using a surface-tension-transfer power source in said initial welding pass.
- 1 4. A method as defined in claim 3 in which the power source has the
2 capability of delivering and changing electrode current in the order of
3 microseconds.
- 1 5. A method as defined in claim 1 including varying the speed of said
2 bug in response to an observation of the welding puddle as the welding bug is
3 moving about the periphery.

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1 6. A method as defined in claim 4 in which the speed of wire discharged
2 by said welding wire feeder is a function of the speed of the means for driving the
3 bug around the track.

1 7. An apparatus for welding one end of a first pipe to a first end of a
2 second pipe which comprises:
3 a welding tractor;
4 a power generator on and powered by said tractor;
5 a surface-tension-transfer (STT) power source connected to said power
6 generator;
7 a welding bug including a wire feeder, a welding head, and means to guide
8 said bug around the periphery of said pipe;
9 connection means for connecting the welding head of said bug to said STT
10 power source;
11 speed control means for remotely varying the speed of said welding bug as
12 it moves about said track on said pipe.

1 8. An apparatus as defined in claim 7 including means for remotely
2 varying the speed of the wire fed from said wire feeder.

1 9. An apparatus as defined in claim 7 including means for varying the
2 rate at which said wire is fed from said wire feeder as a function of the speed of said
3 welding bug.

1 10. An apparatus for welding one end of a first pipe to another end of a
2 second pipe with power from a power generator which comprises:
3 a welding bug including a wire feeder, a welding head, and means to drive
4 the wire feeder to have output wire;
5 a surface-tension transfer (STT) power source connected to said welding

6 head and connected to receive power from said power generator, said STT power
7 source having the capability of delivering and changing electrode current in the
8 order of microseconds;
9 a removable track mounted about said pipe to guide said welding bug along
10 the track about the outside periphery of said pipe near the two ends to be welded;
11 a drive motor for driving said welding bug along said track;
12 a welding bug including a wire feeder, a welding head, and means to drive
13 the wire feeder to have output wire;
14 connecting means for connecting the STT power source to the welding head
15 of said bug.

1 11. An apparatus as defined in claim 10 including means to vary the
2 speed of said drive motor connected to said wire feeder.

1 12. An apparatus as defined in claim 10 including means to vary the
2 speed of said welding wire being fed from said wire feed in response to the speed
3 of the bug.

1 13. A method of welding the end of a first pipe to the end of a second pipe
2 by use of a welding bug having a welding wire feeder and means for driving the bug
3 along a track on the outside periphery of pipe which comprises:
4 continuously moving said bug along said track;
5 applying the initial welding pass to the adjacent ends of said first and
6 second pipe from outside said first and second pipe using only equipment
7 external of the pipe;
8 varying the speed of said welding bug without stopping it while it is
9 continuously moving about said track on said pipe to maintain a desired
10 welding puddle;
11 when applying the initial welding pass using power from a surface-

12 tension-transfer power source.

1 14. A method as defined in claim 13 in which after the initial pass applying
2 additional passes.

1 15. An apparatus as defined in claim 10 in which the STT power source
2 can deliver and change the electrode current in the order of about 750
3 microseconds.

1 16. A method of welding a first pipe to the end of a second pipe by use of
2 a welding bug having a welding wire feeder and means for driving the bug along a
3 track on the outside periphery of said pipe which comprises:
4 connecting the welding bug to an STT power source,
5 continuously moving said bug along said track,
6 applying the initial welding pass to the adjacent ends of said first and second
7 pipe from outside said first and second pipe without use of internal equipment,
8 observing the end of the welding wire in relation to the welding puddle,
9 varying the speed of said welding bug without stopping it while it is
10 continuously moving about said track on said pipe to keep the end of the welding
11 wire just ahead of the puddle.

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