

## BACKING DEVICE AND WELDING METHOD

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to a backing device and a welding method for performing welding by pressing backing flux against the back side of a weld groove when performing one-side automatic welding along a weld groove between steel plates to be welded that have been previously tack-welded.

#### 2. Description of the Related Art

Generally, steel plates used for ships or the like are required to have a large surface area, and thus such steel plates are formed by joining steel plates of a given size together by welding. One-side welding equipment used in the welding operation of steel plates mentioned above uses a backing device that presses a backing member against and along a weld groove between steel plates to be welded that have been previously tack-welded, from the back side of the steel plates.

With the one-side welding equipment, to form weld bead on the back side, welding is performed while pressing backing flux against the back side of the steel plates to be welded. The backing flux is conveyed by a conveying device and supplied. As such a conveying device according to the related art, for example, there is a conveying device

including a troughed belt that advances while deforming its shape from flat to semi-circular, a pair of pulleys provided at both ends of this troughed belt and between which the troughed belt is stretched, and vertical rollers for supporting the both end portions in the width direction of the troughed belt (see, for example, Japanese Examined Utility Model Registration Application Publication No. 49-8919).

When the troughed belt of the conveying device described in Japanese Examined Utility Model Registration Application Publication No. 49-8919 is fed to a position under the steel plates to be welded, protrusions formed at the both end portions of the troughed belt are inserted in between the flange portions of a pair of vertical rollers, thereby supporting the troughed belt. The one-side welding equipment performs one-side welding by using the conveying device as a backing device, by filling a pressing body arranged under the troughed belt with compressed air or a fluid to inflate the pressing body to push the troughed belt upwards, thereby pressing upper-layer flux against the back side of a weld groove that is the joint of members to be welded.

After welding is finished, the troughed belt is rotated, and the flux that has been used in welding is dropped onto a sifter arranged near a conveyor end, thereby separating

solidified flux from unused flux to recover the unused flux.

However, the backing device described in the utility model mentioned above has the following problems.

The backing device requires arrangement of a large number of vertical rollers to shape the flat troughed belt into a "U" shape between the pair of pulleys, and support the troughed belt in a movable manner. Such a backing device has a problem in that the structure for supporting the troughed belt by the vertical rollers is complex, and the troughed belt can be easily damaged.

If the vertical rollers break down, the troughed belt becomes unable to keep its normal shape. As a result, the gap between the troughed belt and the steel plates to be welded becomes uneven, and so does the state of intimate contact between the backing flux and the back side of the steel plates to be welded which is provided by the troughed belt. The pressing force with which the backing flux is pressed against the steel plates to be welded thus becomes weaker, which can result in situations where the backing flux is not firmly pressed against the back side of the weld groove.

Accordingly, the backing device according to the related art has a problem in that a good welding back bead shape cannot be obtained.

For this reason, there has been a demand for a backing

device including a backing member that can press the flux against the back side of a weld groove between steel plates to be welded, with an appropriate pressing force and in a stable manner, instead of the above-mentioned conveying device formed by a belt conveyor that supports the troughed belt by the vertical rollers.

#### SUMMARY OF THE INVENTION

The present invention has been conceived in view of the above problems, and accordingly it is an object of the present invention to provide a backing device and a welding method which make it possible to obtain a good weld shape when performing one-side automatic welding.

To solve the above-mentioned problems, according to the present invention, there is provided a backing device used in one-side welding equipment for performing one-side welding of steel plates to be welded, the backing device including a backing member, in which the backing member includes a trough frame, and a trough fixed to the trough frame and in which flux is accommodated, the trough frame and the trough being arranged along a weld groove.

According to the above-mentioned configuration, the backing member is formed by a trough and flux of simple shape and material arranged along the weld groove. Thus, a sufficient amount of flux is supplied to the weld groove.

If the length of the weld groove is shorter than the length of the backing member, a sufficient amount of flux is supplied across the entire length of the weld groove. Also, in the backing device, the backing member has a trough frame and a trough fixed to the trough frame, which are arranged along the weld groove, and flux accommodated in the trough. Since both ends in the width direction of the trough can be thus securely supported by the trough frame, there is no unevenness in the gap between the trough and the steel plates to be welded. As a result, by pressing the trough and the flux in the trough as appropriate against the steel plates to be welded, the flux is pressed against the back side of the steel plates to be welded in a satisfactory manner. In this way, a sufficient amount of flux is pressed against and across the entire length of the weld groove, particularly in the vicinity of the welding start end and the welding finish end, thereby making it possible to obtain a good weld shape when performing one-side welding. Further, the flux can be always pressed into intimate contact with the steel plates to be welded with an appropriate pressing force, thereby preventing welding failure.

The backing device according to the present invention configured as mentioned above may further include an air hose provided between the trough, and the trough frame to which the trough is fixed, the air hose being inflated with

compressed air to press the flux against an underside of the weld groove of the steel plates to be welded.

According to the above-mentioned configuration, with the provision of an air hose that is inflated with compressed air to press the flux against the underside of the weld groove of the steel plates to be welded, adjustment of the gap between the trough and the steel plates to be welded is facilitated. Moreover, the use of inflation by compressed air also facilitates adjustment of the force with which the backing flux is pressed by adjustment of the air pressure in the air hose.

The backing device may be configured so that the backing device further includes an elevating device that raises and lowers the trough frame, the air hose is provided between the trough frame and a support structure on the elevating device, and when the backing member is raised to a raising end of the trough by the elevating device, a gap between the backing member and the steel plates to be welded is smaller than or equal to 75% of a diameter of the air hose at maximum inflation, and an air pressure of the air hose is in a range of 0.05 MPa to 0.5 MPa.

According to the above-mentioned configuration, the gap between the trough and the steel plates to be welded is within a predetermined range, and the air pressure of the air hose is within a predetermined range. Thus, the state

of pressing of the flux against the steel plates to be welded can be adjusted.

In the backing device according to the present invention configured as mentioned above, the air hose provided between the trough and the trough frame to which the trough is fixed may include two air hoses having different sectional dimensions that are arranged above and below each other.

According to the above-mentioned configuration, an air hose that is inflated with compressed air to press the flux against the underside of the weld groove of the steel plates to be welded, and an air hose that pushes up used flux from the trough after welding are provided above and below each other, and the flux in the trough can be pushed up in a manner suited for each of those functions. Thus, a series of one-side welding processes can be performed properly.

In the backing device according to the present invention configured as mentioned above, a length of an opening width of the trough orthogonal to a longitudinal direction is in a range of 50 mm to 200 mm.

According to the above-mentioned configuration, by setting the length of the opening width of the trough orthogonal to the longitudinal direction to be within the range of 50 mm to 200 mm, a sufficient amount of flux is supplied across the entire length of the weld groove.

The backing device according to the present invention configured as mentioned above may be configured so that the backing device further includes an elevating device that raises and lowers the trough frame, and an air hose provided between the trough frame and a support structure on the elevating device, in which the air hose includes a first air hose arranged between the trough and an upper portion of the trough frame, a second air hose arranged between the trough and the upper portion of the trough frame so as to be vertically aligned with the first air hose, the second air hose being smaller in diameter than the first air hose, and a third air hose arranged between the trough frame and the support structure on the elevating device, and internal pressures of the first air hose, the second air hose, and the third air hose are controlled individually by a pressure device that injects compressed air into each of the first air hose, the second air hose, and the third air hose.

According to the above-mentioned configuration, the internal pressures of the first air hose, the second air hose, and the third air hose are individually controlled by a pressure device that injects compressed air into each of the air hoses, and each of these air hoses inflates when injected with compressed air at a corresponding set pressure.

According to the present invention, there is provided a welding method for performing a welding operation by moving

steel plates to be welded so as to arrange the steel plates to be welded at a position corresponding to a position where a backing device of one-side welding equipment is installed, and pressing a backing member of the backing device against and along a weld groove between the steel plates to be welded, the welding method including a first step of raising a trough having a length larger than or equal to a length of the weld groove, and a trough frame by an elevating device toward the weld groove between the steel plates to be welded, a second step of inflating a third air hose arranged between the trough frame and a support structure on the elevating device by injection of compressed air into the third air hose to cause the trough raised by the elevating device to be brought into close proximity with or pressed against a back side of the weld groove, a third step of inflating a first air hose arranged between the trough and the trough frame by injection of compressed air into the first air hose to cause flux in the trough to be pressed against the back side of the weld groove, and a fourth step of performing one-side welding by a welding torch of the one-side welding equipment.

According to the above-mentioned procedure, since the welding method includes the first step of raising the trough by the elevating device, the second step of inflating the third air hose to cause the trough to be brought into close

proximity with or pressed against the back side of the weld groove, and the third step of inflating the first air hose to press the flux in the trough, the flux can be pressed against the steel plates to be welded in a favorable state.

The welding method according to the present invention mentioned above may further include the step of deflating the first air hose and the third air hose after finishing the one-side welding in the fourth step, lowering the elevating device, and then inflating a second air hose arranged between the trough and an upper portion of the trough frame by injection of compressed air into the second air hose to push up the flux in the trough.

According to the above-mentioned procedure, by selectively pushing up used backing flux in the trough to the outside of the trough, and scraping off the used backing flux by a flux recovery carriage in the next step, used backing flux can be selectively removed, which offers the economic advantage of preventing excess consumption of backing flux.

In the welding method according to the present invention mentioned above, the flux may include a layer of backing flux to be pressed against the steel plates to be welded, and a layer of underlaying flux laid under the layer of backing flux, the layer of backing flux and the layer of underlaying flux being laminated in the trough.

According to the above-mentioned configuration, the flux includes a layer of backing flux to be pressed against the steel plates to be welded, and a layer of underlaying flux laid under this layer, the layer of backing flux and the layer of underlaying flux being laminated in the trough. Thus, the amount of backing flux used when performing welding can be reduced.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view illustrating a backing device and a welding method according to the present invention;

FIGS. 2A and 2B illustrate a backing device and a welding method according to the present invention, of which FIG. 2A is a main-part plan view illustrating how a first air hose and a second air hose are installed, and FIG. 2B is an enlarged main-part sectional view of a backing member illustrating a state before flux is pressed against steel plates to be welded;

FIG. 3 illustrates a backing device and a welding method according to the present invention, and is an enlarged main-part sectional view of a backing member illustrating a state where flux is pressed against steel plates to be welded;

FIG. 4 illustrates a backing device and a welding

method according to the present invention, and is an enlarged main-part sectional view illustrating the state of a backing member when recovering backing flux that has been used;

FIG. 5 is a perspective view illustrating the configuration of one-side welding equipment including a backing device according to the present invention;

FIG. 6 is a main-part perspective view illustrating a backing device according to the present invention and steel plates to be welded when performing welding; and

FIG. 7 is a main-part vertical sectional view of the one-side welding equipment illustrated in FIG. 5.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

##### <Backing device>

A backing device and a welding method according to an embodiment of the present invention will be described in detail with reference to the drawings. In the following description of the embodiment, the longitudinal direction means the direction parallel to a weld groove M between steel plates to be welded E, and the width direction means the direction orthogonal to the weld groove M.

As illustrated in FIG. 1, a backing device 10 is, for example, a device that presses flux F against the back side of the weld groove M where the steel plates to be welded E,

such as steel plates with a length of 10 to 30 m along one side, are butted together. The backing device 10 is installed in one-side welding equipment 1 that performs one-side submerged arc welding.

The backing device 10 has a backing member 11. The backing device 10 may additionally include an air hose 22, a support structure 17, an elevating frame 24, and single flux recovery means 25.

Hereinbelow, the respective components will be described.

As illustrated in FIG. 2B, the backing member 11 is a portion that presses the flux F against the back side of the weld groove M where the steel plates to be welded E are butted together. The backing member 11 includes the flux F, a trough 40 that holds the flux F, and a trough frame 41. As illustrated in FIG. 6, the entire length L1 of the backing member 11 is such that the backing member 11 has a minimum length of larger than or equal to the length L2 of the weld groove M between the steel plates to be welded E, thus allowing welding to be performed across the steel plates to be welded E from the welding start end to the welding finish end. Because the backing member 11 has such a length L1 and is arranged along the weld groove M, when welding the steel plates to be welded E, a sufficient amount of flux F is supplied over the entire length of the weld

groove M, thereby providing a good weld shape.

The flux F illustrated in FIG. 2B is a powdery material used for purposes such as removing oxides or hazardous substances produced during welding, sealing off the weld part from atmosphere, and shaping the weld part. The flux F is accommodated in the trough 40, and supplied to the back side of the weld part between the steel plates to be welded E. The flux F has a layer of backing flux F1 and a layer of underlaying flux F2 that are laminated and arranged in the trough 40. The backing flux F1 is held in intimate contact with the back side of the weld groove M between the steel plates to be welded E. The underlaying flux F2 is laid under the layer of this backing flux F.

The trough 40 is a long container-like component that supports the flux F in such a way that the flux F supplied from flux supplying means 26 (see FIG. 5) of the one-side welding equipment 1 is supplied to a position below the weld groove M. The trough 40 is arranged below the steel plates to be welded E and along the weld groove M, and is formed as a channel that has a substantially U-shape in front view and a substantially linear shape in plan view. The trough 40 is fixed in place together with fixing plates 41b by fixing members 41c, in a state with the fixing plates 41b held against the inner sides at the top end portions of a pair of trough support frames 41a, 41a of a trough frame 41 via both

upper end portions of the trough 40. Thus, the trough 40 is arranged so as to run between the top end portions of the trough support frames 41a, 41a. The trough 40 is formed of a material that allows its bottom portion to deform when pushed upwards by inflation of a first air hose 22a or a second air hose 22b that is arranged below the bottom portion.

The length of the opening width D of the trough 40 orthogonal to the longitudinal direction is in the range of 50 mm to 200 mm. The trough 40 is formed by, for example, an elastic body with some rigidity and heat resistance. The trough 40 is formed substantially like a fire hose that is made of cloth on the outer side and made of rubber on the inner side, for example.

As illustrated in FIG. 2B, the trough frame 41 is a frame member that holds the left and right end portions of the trough 40 in a state where the bottom side portion (lower end portion) of the trough 40 having a U-shape in vertical section is lifted above the top side of a support plate 42. The trough frame 41 is formed by integrally fixing together the trough support frames 41a, 41a erected on both the left and right sides of the trough 40, the fixing plates 41b, 41b for fixing the trough 40 to the trough support frames 41a, 41a, the fixing members 41c, 41c for fixing the fixing plates 41b, 41b to the trough support

frames 41a, 41a, the support plate 42 on which the trough support frames 41a, 41a are erected, and an elevating guide 21 suspended from the middle portion of the underside of the support plate 42. The trough frame 41 is configured to ascend and descend by two kinds of elevating means, including inflation and deflation of third air hoses 22c described later, and an elevating device 23.

The trough support frames 41a, 41a are a pair of long thick plate members provided vertically on the top side of the support plate 42. The trough support frames 41a, 41a extend at positions on the left and right along the weld groove M between the steel plates to be welded E.

The fixing plates 41b, 41b are plate-like holding members arranged so as to be held against the top end portions of the left and right inner walls of the trough support frames 41a, 41a via the trough 40. The fixing plates 41b, 41b are formed in a long, narrow shape along the upper portions of the trough support frames 41a, 41a.

The fixing members 41c, 41c are formed by bolts or the like for fastening the fixing plates 41b, 41b to the trough support frames 41a, 41a.

As illustrated in FIGS. 2A and 2B, the support plate 42 is a long plate on which each of the trough support frames 41a, an inclined plate 43, and the air hose 22 are placed and which is formed across the longitudinal direction of the

backing member 11. The support plate 42 is a thick plate member that is arranged horizontally so as to be movable up and down with respect to the top of the support structure 17. The first air hose 22a, the second air hose 22b, a hose band 22d, and a hose-band fixing clip 22e are placed between the trough support frames 41a, 41a on the support plate 42. The inclined plate 43 for guiding dropped flux F further downwards is arranged on the outside of the trough support frames 41a, 41a on the support plate 42, above the support plate 42. The left and right end portions of the underside of the support plate 42 are supported by side plates 19, 19 of the support structure 17 when the third air hoses 22c are deflated. As illustrated in FIG. 3, when the third air hoses 22c are inflated, the support plate 42 is pushed upwards by the pair of inflated third air hoses 22c, 22c.

The elevating guide 21 guides the support plate 42 when the support plate 42 ascends and descends. The elevating guide 21 is formed by a column that is installed so as to be suspended from the middle portion of the underside of the support plate 42, and passed through a top plate 20 and a bottom plate 18 of the support structure 17 so as to be movable up and down. A large number of such columns are arranged at a predetermined interval in the longitudinal direction of the air hose 22. The elevating guide 21 is formed in such a way that its top end portion is fixed to

the support plate 42, and its bottom end side passes through guide holes 27, 27 formed in the top plate 20 and the bottom plate 18, so that the elevating guide 21 is guided along the side plates 19 of the support structure 17.

The elevating guide 21 is formed by, for example, a rod-like member. The elevating guide 21 has a sufficient length for bringing the trough 40 held by the trough frame 41 into close proximity or abutment with the back side of the weld groove M when the elevating guide 21 slides upwards. The elevating guide 21 has a stopper 21c and a fixing member 21a. The stopper 21c is formed at the bottom end portion of the elevating guide 21 so as to be larger in diameter than the guide holes 27, 27, and comes into abutment with the underside of the bottom plate 18 of the support structure 17 when the elevating guide 21 ascends. The fixing member 21a is formed by a nut or the like for fixing the stopper 21c in a predetermined position on the elevating guide 21.

As the third air hoses 22c, 22c inflate and deflate, on the side of the middle portion between the third air hoses 22c, the elevating guide 21 slides while being guided by the guide holes 27, 27 of the support structure 17, causing the support plate 42 to ascend and descend in a horizontal state, thus preventing tilting of the trough frame 41 and maintaining a horizontal state.

As illustrated in FIGS. 3 and 4, the air hose 22 is a

hose whose height is made variable by inflation or deflation of the air hose 22 by compressed air fed into the air hose 22. The air hose 22 functions as elevating means for directly or indirectly raising and lowering the trough 40 accommodating the flux F to thereby press the flux F against the back side of the weld groove M of the steel plates to be welded E. The air hose 22 includes three kinds of hoses made up of four hoses in total, a single first air hose 22a, a single second air hose 22b, and two third air hoses 22c. The first air hose 22a, the second air hose 22b, and the third air hoses 22c are each connected to a pressure device (not illustrated) from which compressed air is supplied.

The first air hose 22a, the second air hose 22b, the hose band 22d, and the hose-band fixing clip 22e are placed on the inner bottom of the trough frame 41 formed in a concave shape in section, below the trough 40 that is U-shaped in section. Between the trough 40 and the top of the trough frame 41, the first air hose 22a and the second air hose 22b are arranged along the longitudinal direction of the trough frame 41 in a state where the first air hose 22a and the second air hose 22b are stacked above and below each other so that the second air hose 22b with a diameter smaller than that of the first air hose 22a is vertically aligned with the first air hose 22a.

As illustrated in FIG. 3, the first air hose 22a serves

to raise and lower the trough 40 accommodating the flux F by inflating and deflating. The first hose 22a extends along the trough frame 41, between the bottom of the trough 40 and the top of the trough frame 41. When performing welding, as the first air hose 22a inflates with compressed air fed into the first air hose 22a from the pressure device (not illustrated), the first air hose 22a pushes the bottom side of the trough 40 upwards, thereby pressing the flux F against the back side of the steel plates to be welded E. As illustrated in FIG. 2A, the outside diameter D1 of the first air hose 22a is larger than the outside diameter D2 of the second air hose 22b, and corresponds to the maximum stroke width in the vertical direction of the trough 40 when its middle portion is pushed up by the air hose 22.

As illustrated in FIG. 4, the second air hose 22b serves to raise and lower the trough 40 accommodating the flux F by inflating and deflating. The second air hose 22b is placed on the support plate 42 and under the first air hose 22a, and extends along the trough 40. When recovering used backing flux F1 in the upper layer that has solidified after welding, as the second air hose 22b inflates with compressed air fed into the second air hose 22b from the pressure device (not illustrated), the second air hose 22b pushes the bottom end portion of the trough 40 upwards. The second air hose 22b is held by the hose band 22d, and the

hose-band fixing clip 22e (see FIG. 2A). The second air hose 22d is formed by a hose with the outside diameter D2 (see FIG. 2A) smaller than that of the first air hose 22a, because the second air hose 22b only needs to have a short stroke sufficient for lifting the flux F that has solidified by welding above the top end portion of the trough frame 41. The diameter B2 of the second air hose 22b at maximum inflation is such that the outside diameter D2 is the maximum stroke width in the vertical direction.

As illustrated in FIG. 3, the third air hoses 22c, 22c serve to raise and lower the trough 40 accommodating the flux F via the support frame 42 and the trough support frames 41a, 41a by inflating and deflating. The third air hoses 22c, 22c extend along the trough frame 41. When performing welding, as the third air hoses 22c, 22c inflate with compressed air fed into the third air hoses 22c, 22c from the pressure device (not illustrated), the third air hoses 22c, 22c push the bottom side of the trough frame 41 upwards, thereby pressing the trough 40 held by the trough frame 41 into close proximity or abutment with the back side of the steel plates to be welded E. The third air hoses 22c, 22c are formed by a pair of hoses placed on the left and right with respect to the elevating guide 21 arranged at the middle portion of the top plate 20, between the support plate 42 that is a part of the trough frame 41, and the top

plate 20 of the support structure 17 placed on the elevating device 23 (see FIG. 1).

As illustrated in FIG. 2A, the hose band 22d is a member for holding the second air hose 22b at the middle portion of the concave-shaped inner bottom of the trough frame 41. The hose band 22d is arranged so as to be passed through a pair of cutouts 22f, 22f formed in the hose-band fixing clip 22e at the interval of the width of the second air hose 22b, thereby clutching the hose-band fixing clip 22e and the second air hose 22b.

The hose-band fixing clip 22e is a member for holding the second air hose 22b, which is fixed to the hose-band fixing clip 22e by the hose band 22d, on the support plate 42. The hose-band fixing clip 22e is installed on or engaged with the concave-shaped inner bottom of the trough frame 41.

The above-mentioned pressure device (not illustrated) is a compressed-air supply device that is connected to each of the first air hose 22a, the second air hose 22b, and the third air hoses 22c via a tube (not illustrated), and supplies compressed air to each of those hoses. The pressure device is formed by, for example, a compressor. Further, between the pressure device and each of the first air hose 22a, the second air hose 22b, and the third air hoses 22c, there is an air supply control device (not

illustrated) that controls the internal pressures of the respective hoses individually, in order to inflate or deflate these hoses by sending compressed air.

As illustrated in FIG. 3, the support structure 17 is a frame on the top of which the backing member 11 is mounted. The support structure 17 includes the top plate 20 extending along the longitudinal direction of the backing member 11, the side plates 19 erected on both sides in the width direction of the top plate 20, and the bottom plate 18 connected between both the side plates 19, 19.

The top plate 20 extends across the entire length in the longitudinal direction of the backing member 11. The third air hoses 22c, 22c are arranged on the top of the top plate 20. In the top plate 20, the guide hole 27 for guiding the elevating guide 21 is formed on the side of the middle portion in the width direction between the third air hoses 22c, 22c.

As illustrated in FIG. 1, the bottom plate 18 is supported on a backing roller portion 24a arranged at the top of the elevating frame 24 described later, and regulates the position in the width direction of the backing member 11 with respect to the weld groove M. The stopper 21c of the elevating guide 21 comes into abutment with the bottom plate 18 when the elevating guide 21 ascends. Therefore, the bottom plate 18 needs not to be provided across the entire

length in the longitudinal direction, but only needs to have a predetermined length along which the bottom plate 18 is supported on the backing roller portion 24a.

The support structure 17 is moved horizontally on the backing roller portion 24a along the width direction by a drive mechanism (not illustrated) including an engaging portion that engages with the bottom plate 18.

As illustrated in FIG. 1, the elevating frame 24 is a frame that is arranged directly below the support structure 17, and ascends and descends in the vertical direction. The elevating frame 24 is supported on the elevating device 23, and has the backing roller portion 24a arranged at the top. The elevating frame 24 is formed by joining shape steels and plate members together into a substantially box-like frame. The elevating frame 24 has a bottom frame 24b extending in the width direction, side frames 24c, 24c formed in a ladder-like fashion at both ends of the bottom frame 24b, and a pair of clamping plates 24d, 24d provided between the side frames 24c, 24c. The pair of clamping plates 24d, 24d are separated by a predetermined interval in the longitudinal direction of the backing member 11, and clamp the backing roller portion 24a. The top end of the elevating device 23 is abutted on and supported by the bottom end of each of the pair of clamping plates 24d, 24d. Also, a large number of such pairs of clamping plates 24d,

24d are provided in parallel at a predetermined interval across the entire length of the side frames 24c. Further, the elevating device 23 is passed through the bottom frame 24b.

The flux recovery means 25 is arranged inside the elevating frame 24, and recovers used flux F scrapped off after welding of the weld groove M. The flux recovery means 25 includes a tapered portion 25a that spreads toward the upper portion of the elevating frame 24, and a screw-like conveyor portion 25b that discharges recovered flux F to the outside.

The backing device 10 includes the elevating device 23 that raises and lowers the trough frame 41, and also elevating means formed by the above-mentioned air hose 22 provided between the trough 40 and the support structure 17 on the elevating device 23. The backing device 10 is configured so that when the backing member 11 is raised to its raising end by the elevating device 23, a gap S (see FIG. 2B) between the top side of the trough frame 41 and the back side of the steel plates to be welded E is provided by setting a height B1, B3 smaller than or equal to 75% of the diameter at maximum inflation of each of the first air hose 22a and the third air hoses 22c upon inflation into a cylindrical shape, and the air pressure of each of the first air hose 22a and the third air hoses 22c is set to be in the

range of 0.05 MPa to 0.5 MPa.

In the backing device 10, the position of the raising end of the trough 40 after the trough 40 is raised by the elevating device 23 is specified for the following reason.

As illustrated in FIG. 2B, if the gap S between the flux F (backing member 11) and the back side of the steel plates to be welded E exceeds 75% of the diameter of the third air hoses 22c at maximum inflation, the gap S is so large that the amount of the flux F supplied to the weld groove M by inflation of the first air hose 22a and the third air hoses 22c is small, and the pressing force is also weak, making back bead failure or burn through liable to occur. Therefore, it is preferable that the gap S be smaller than or equal to 75% of the diameter of each of the first air hose 22a and the third air hoses 22c at maximum inflation.

Also, in the backing device 10, the air pressure of the air hose 22 at inflation is specified for the following reason.

If the air pressure is smaller than 0.05 MPa, the force with which the flux F is pressed against the welding groove M is small, making back bead failure or burn through liable to occur. If the air pressure exceeds 0.5 MPa, the force with which the trough 40 is pressed against the back side of the steel plates to be welded E becomes excessive, causing the

steel plates to be welded E to be lifted up, which makes weld cracking liable to occur. Therefore, it is preferable that the air pressure be in the range of 0.05 MPa to 0.5 MPa as mentioned above.

As illustrated in FIG. 5, the backing device 10 includes the flux supplying means 26 for supplying the flux F to the trough 40 (see FIG. 2B). The flux supplying means 26 includes, for example, a hopper that supplies the flux F, and a carriage that moves on the trough 40 along the direction of its length by driving of an endless chain or the like to thereby sprinkle the underlaying flux F2 (see FIG. 2B) and the backing flux F1 onto the trough 40, and scrapes off and recovers the flux F that has solidified.

<One-side welding equipment>

Next, the one-side welding equipment 1 according to the present invention will be described.

As illustrated in FIGS. 1, 5, and 7, the one-side welding equipment 1 includes the backing device 10 having the backing member 11, a rack frame 104, conveying and fixing means 105, and a welder 30.

The rack frame 104 is formed by putting together square bars made of steel into a frame so as to have a recessed shape in section. The rack frame 104 is a frame that is open at the top with the backing device 10 supported inside, and extends along the longitudinal direction of the backing

device 10. The rack frame 104 includes two main beams 104a provided in parallel along the longitudinal direction, a connecting beam 104b connected between the main beams 104a, 104a at right angles, a connecting beam 104c erected perpendicularly on the connecting beam 104b, auxiliary beams 104d, 104d installed above the main beams 104a, 104a in parallel to each other, and a cantilever beam 104e that hangs over to the side opposite to the backing device 10 from the auxiliary beams 104d, 104d. Also, in the rack frame 104, a carriage portion 108 is installed below the connecting beam 104b. The rack frame 104 moves in the width direction of the backing device 10 as the carriage portion 108 moves on each of a plurality of rails 107 that are provided in parallel at a predetermined interval in the longitudinal direction of the backing device 10.

The conveying and fixing means 105 is arranged on the top of each of the auxiliary beams 104d of the rack frame 104, and horizontally moves the steel plates to be welded E above the backing device 10. The conveying and fixing means 105 includes a panel moving roller 105a, a magnet device 105b, and the like. Also, to assist the conveyance of the steel plates to be welded E by the conveying and fixing means 105, an auxiliary roller 106 is arranged at the top (cantilever beam 104e) of the rack frame 104.

As illustrated in FIG. 7, the welder 30 is arranged

above the backing device 10, and welds the steel plates to be welded E from the front side of the weld groove M. The welder 30 includes a travelling carriage 31 that travels on a welder beam 101 extending along the longitudinal direction of the backing member 11 of the backing device 10, an adjusting jig 32 movably attached to the travelling carriage 31, and a welding torch 33 attached to the adjusting jig 32.

A bearing 31a is fixed to the travelling carriage 31. As a rail 32a provided to the adjusting jig 32 moves via the fixed bearing 31a, the adjusting jig 32 moves in the width direction of the backing member 11, and the welding torch 33 attached to the adjusting jig 32 moves. In the welder 30, the bearing 31a is fixed, and the adjusting jig 32 (welding torch 33) moves via the bearing 31a in the width direction of the backing member 11 together with the rail 32a. However, the welder 30 may be configured so that the rail 32a is fixed to the travelling carriage 31, and the bearing 31a moves together with the adjusting jig 32.

#### <Welding method>

Next, a welding method using the one-side welding equipment 1 including the backing device 10 will be described with reference to FIGS. 1 to 7.

A welding method according to the present invention performs a welding operation by moving the steel plates to be welded E so as to be arranged at a position where the

backing device 10 is installed, and pressing the backing member 11 of the backing device 10 against and along the weld groove M between the steel plates to be welded E. Specifically, the welding method includes a first step of raising the trough 40, a second step of injecting compressed air into the third hoses 22c to inflate the third hoses 22c to bring the top end of the trough 40 into close proximity or abutment with the back side of the weld groove M, a third step of inflating the first air hose 22a to press the flux F in the trough 40 against the back side of the weld groove M, and a fourth step of performing one-side welding. The respective steps will be described below.

The welding method according to the present invention preferably includes, prior to the first to fourth steps mentioned above, a preparatory step of supplying the flux F, and adjusting the position of the steel plates to be welded E.

(Preparatory step)

The flux F is supplied from the flux supplying means 26 illustrated in FIG. 5 into the trough 40 of the backing member 11. At that time, as illustrated in FIG. 2B, the first air hose 22a, the second air hose 22b, and the third air hoses 22c are in a deflated state. Thus, the bottom end portion of the trough 40 accommodating the flux F hangs down from the trough frame 41 with the weight of the flux F.

Also, the trough frame 41 is in a lowered state with the support plate 42 placed on the top ends of the side plates 19, 19.

When supplying the flux F, while causing the flux supplying means 26 to travel along the longitudinal direction of the trough 40 by driving the endless chain or the like (not illustrated) supporting the flux supplying means 26, the underlaying flux F2 and the backing flux F1 received in the hopper are sequentially sprinkled, thereby supplying the flux F to the backing member 11 (trough 40).

Then, as illustrated in FIG. 1, the steel plates to be welded E, E that have been previously tack-welded are moved by the panel moving roller 105a and the auxiliary roller 106, and the weld groove M formed by the steel plates to be welded E, E is positioned above the backing device 10. Then, an unillustrated driving device is activated to perform fine adjustment of the backing member 11 in the width direction so that the trough 40 is positioned directly below the weld groove M.

Specifically, the support structure 17 mounted with the backing member 11 is horizontally moved in the width direction on the backing roller portion 24a arranged at the top of the elevating frame 24 arranged directly below the support structure 17.

After the fine adjustment in the width direction is

finished, the magnet device 105b is activated, and the steel plates to be welded E are attracted downwards by magnetism for fixation. At this time, each air hose 22 is in a deflated state as mentioned above. Thus, the trough 40 and the trough frame 41 are in a lowered state.

(First step)

As illustrated in FIG. 1, by driving the elevating device 23, the trough 40 in which the flux F is held and which has the length L1 that is a minimum length of larger than or equal to the length L2 of the weld groove M is raised toward the weld groove M between the steel plates to be welded E, to a predetermined position near the steel plates to be welded E.

According to the present invention, the predetermined position refers to such a position that when the backing member 11 is raised to the raising end of the trough 40 by the elevating device 23, the gap S between the backing member 11 and the steel plates to be welded E is smaller than or equal to 75% of the diameter of the third air hoses 22c at maximum inflation.

(Second step)

As illustrated in FIG. 3, the two third air hoses 22c, 22c arranged between the support plate 42 of the trough frame 41 and the top plate 20 of the support structure 17 on the elevating device 23 are inflated by injecting compressed

air into the third air hoses 22c, 22c by the pressure device (not illustrated). As the third air hoses 22c, 22c inflate, on the side of the middle portion between the third air hoses 22c, 22c, the elevating guide 21 ascends while being guided by the guide holes 27, 27 in the top plate 20 and the bottom plate 18, pushing up the support plate 42 fixed to the top end portion of the elevating guide 21 by a height H (see FIG. 2B). Thus, the trough frame 41 as a whole is raised by the height H.

Then, the inflation of the third air hoses 22c is continued until the stopper 21c provided at the bottom end portion of the elevating guide 21 comes into abutment with the underside of the bottom plate 18 of the support structure 17. At this time, as the support plate 42 is pushed up, the trough support frames 41a, 41a and the trough 40 integrated with the support plate 42 ascend simultaneously, causing the top end of the trough 40 to be raised to a position in close proximity or abutment with the back side of the weld groove M of the steel plates to be welded E.

That is, when the amount of the flux F accommodated in the trough 40 is relatively small, and the flux F does not rise above the trough 40, the top end of the trough 40 ascends to a position where the top end is pressed against the back side of the weld groove M.

When the amount of the flux F accommodated in the trough 40 is relatively large, and the flux F rises greatly above the trough 40, the top end of the trough 40 is lifted to a position in close proximity with the back side of the weld groove M between the steel plates to be welded E, thereby pressing the backing flux F1 against the back side of the weld groove M.

(Third step)

Air is introduced to the first air hose 22a by the pressure device (not illustrated) to inflate the first air hose 22a. Owing to the inflation of the first air hose 22a arranged under the trough 40, the bottom end portion of the trough 40 accommodating the flux F is pushed up, and the flux F is completely pushed up to a height that makes contact with the steel plates to be welded E. Thus, the flux F is pressed with an appropriate pressing force against the back side of the weld groove M of the steel plates to be welded E.

(Fourth step)

Then, as illustrated in FIG. 7, one-side welding is applied by the welding torch 33 from the front side of the weld groove M while moving the welder 30 on the welder beam 101 at a predetermined speed, thereby welding the steel plates to be welded E, E.

Next, when there are a plurality of weld grooves M, the

air in each of the first air hose 22a and the third air hoses 22c, 22c is discharged to lower the elevating guide 21, the support plate 42, and the trough 40, thereby separating the flux F apart from the back side of the steel plates to be welded E. Then, the elevating frame 24 is lowered by the elevating device 23 to further lower the backing member 11 apart from the back side of the steel plates to be welded E, thereby separating the backing flux F1 apart from the back side of the steel plates to be welded E. Next, the portion of the backing flux F1 at the top side of the trough 40 which has been used is removed, and then the endless chain (not illustrated) connected to the above-mentioned flux supplying means 26 is driven to supply new backing flux F1 to the top side of the trough 40. Then, fine adjustment is performed (preparatory step is performed) so that the flux F and the trough 40 are positioned directly below the next weld groove M, and the above-mentioned first to fourth steps are performed. Such an operation is performed several times until there is no more weld groove M.

(Case when flux is recovered)

After welding by the welder 30, the backing flux F1 solidifies with welding heat. Then, to perform the next welding, it is necessary to remove the solidified backing flux F1, and replenish the upper layer of the trough 40 with new backing flux F1. At this time, the underlaying flux F2

is used as it is, so it is preferable to leave the underlaying flux F2 as much as possible when removing solidified backing flux F1.

To remove solidified backing flux F1 from the trough 40, although it is possible to scrape off the backing flux F1 by inflating the first air hose 22a, in this case, a large amount of underlaying flux F2 is often scraped off at the same time. To avoid such inconvenience, it is also conceivable to inflate the first air hose 22a not fully but only by about half. In this case, however, the extent of inflation of the first air hose 22a does not become uniform across the entire length, which can result in areas where solidified backing flux F1 cannot be recovered in a satisfactory manner or where a large amount of underlaying flux F2 is scraped off.

Accordingly, as illustrated in FIG. 4, the flux F in the trough 40 is lifted up by using the second air hose 22b that can lift up the flux F in the trough 40 uniformly with a lifting width that is about half of that of the first air hose 22a across the entire length L1 of the trough 40.

When recovering solidified backing flux F1 that has been used, the recovery is performed after the trough frame 41 is lowered by the elevating device 23, and a predetermined space is secured above the trough 40. In this case, as illustrated in FIG. 4, in a state where the trough

frame 41 as a whole is lowered by deflating the first air hoses 22a and the third air hoses 22c, 22c, by sending compressed air to the second air hose 22b from the pressure device (not illustrated), the second air hose 22b is inflated and the flux F is raised before the recovery is performed.

When recovering the flux F, the flux recovery means 25, the trough 40 of the backing member 11, the trough frame 41, the second air hose 22b, and the support structure 17 are used.

In this case, as illustrated in FIG. 4, upon inflating the second air hose 22b, the backing flux F1 that has been used rises above the top side of the trough 40, and after the rising portion is leveled to a predetermined height by scraping off the surface of the backing flux F1 by a flux scraper (not illustrated) attached to the flux supplying means 26, new backing flux F1 is sprinkled by the flux supplying means 26 for replenishment. The flux F that has been scraped off is recovered by the flux recovery means 25.

After recovery of solidified flux F is finished, the second air hose 22b is deflated by releasing compressed air from the second air hose 22b. As a result, a depression corresponding to the removed flux F is produced in the trough 40, and new backing flux F1 is supplied to that portion of the trough 40 by the flux supplying means 26. It

should be noted that the underlaying flux F2 can be repeatedly used because the underlaying flux F2 does not solidify with welding heat.

While an embodiment of the present invention has been described above, the present invention is not limited to the above-mentioned embodiment, and various modifications are possible without departing from the scope of the present invention.

For example, the backing device 10 and the one-side welding equipment 1 mentioned above may move the steel plates to be welded E in the width direction (direction orthogonal to the longitudinal direction of the backing device 10).

Also, while the elevating guide 21 has been described as being a rod-like member in the foregoing, the elevating guide 21 may have a plate-like shape.

## CLAIMS

1. A backing device used in one-side welding equipment for performing one-side welding of steel plates to be welded, comprising:

a backing member,

wherein the backing member includes a trough frame,

a trough fixed to the trough frame, the trough in which flux is stored,

an air hose provided between the trough and the trough frame,

wherein the air hose being inflated with compressed air to press the flux against an underside of the weld groove of the steel plates to be welded; and

an elevating device that raises and lowers the trough frame,

wherein the trough frame and the trough being arranged along a weld groove;

wherein the air hose is provided between the trough frame and a support structure on the elevating device; and

wherein when the backing member is raised to a raising end of the trough by the elevating device, a gap between the backing member and the steel plates to be welded is smaller than or equal to 75% of a diameter of the air hose at maximum inflation, and an air pressure of the air hose is in a range from 0.05 MPa to 0.5 MPa.

2. The backing device according to Claim 1, wherein the air hose provided between the trough and the trough frame to which the trough is fixed includes two air hoses having different sectional dimensions that are arranged above and below each other.

3. The backing device according to Claim 1, wherein a length of an opening width of the trough orthogonal to a longitudinal direction is in a range of 50 mm to 200 mm.

4. The backing device according to Claim 1, further comprising:  
an elevating device that raises and lowers the trough frame;  
and

an air hose provided between the trough frame and a support structure on the elevating device,

wherein the air hose includes

a first air hose arranged between the trough and an upper portion of the trough frame,

a second air hose arranged between the trough and the upper portion of the trough frame so as to be vertically aligned with the first air hose, the second air hose being smaller in diameter than the first air hose, and

a third air hose arranged between the trough frame and the support

structure on the elevating device, and

internal pressures of the first air hose, the second air hose, and the third air hose are controlled individually by a pressure device that injects compressed air into each of the first air hose, the second air hose, and the third air hose.

5. A welding method for performing a welding operation by moving steel plates to be welded so as to arrange the steel plates to be welded at a position corresponding to a position where a backing device of one-side welding equipment is installed, and pressing a backing member of the backing device against and along a weld groove between the steel plates to be welded, comprising:

a first step of raising a trough having a length larger than or equal to a length of the weld groove, and a trough frame by an elevating device toward the weld groove between the steel plates to be welded, and having a gap between the backing member and the steel plates to be welded to be smaller than or equal to 75% of a diameter of the air hose at maximum inflation, when the backing member is raised to a raising end of the trough by the elevating device;

a second step of inflating a third air hose arranged between the trough frame and a support structure on the elevating device by injection of compressed air, a pressure of which being in a range from 0.05 MPa to 0.5 MPa, into the third air hose to cause the trough raised by the elevating device to be brought into close proximity with or pressed against a back side of the weld groove;

a third step of inflating a first air hose arranged between the trough and the trough frame by injection of compressed air into the first air hose to cause flux in the trough to be pressed against the back side of the weld groove; and

a fourth step of performing one-side welding by a welding torch of the one-side welding equipment.

6. The welding method according to Claim 5, further comprising the step of deflating the first air hose and the third air hose after finishing the one-side welding in the fourth step, lowering the elevating device, and then inflating a second air hose arranged between the trough and an upper portion of the trough frame by injection of compressed air into the second air hose to push up the flux in the trough.

7. The welding method according to Claim 5, wherein the flux includes a layer of backing flux to be pressed against the steel plates to be welded, and a layer of underlaying flux laid under the layer of backing flux, the layer of backing flux and the layer of underlaying flux being laminated in the trough.