

## 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 in which, during one-side automatic welding, a backing member is pressed onto the underside of tack-welded steel plates to be welded together along a welding groove.

#### 2. Description of the Related Art

Generally, large steel plates are required for fabricating marine vessels. Such a large steel plate is obtained by welding together smaller steel plates. One-side welding equipment used for welding steel plates as described above includes a backing device that presses a backing member along the back side of a welding groove formed in tack-welded steel plates to be welded together.

For example, one-side welding equipment described in Japanese Unexamined Patent Application Publication No. 2005-319512 includes a flux-backing type first backing device and a flux-copper-backing type second backing device, which both press flux onto the back side of a welding groove formed by joined steel plates to be welded together, a horizontally-movable first frame on which the first backing device, and the second backing device are mounted and a second frame

disposed directly below the first frame. The second frame accommodates a first flux collecting part in which flux dropped from the first backing device is collected and a second flux collecting part in which flux dropped from the second backing device. The one-side welding equipment includes a flux supplying device that can move in the longitudinal directions of the first backing device and the second backing device.

The first backing device includes a gutter-like flux container that retains flux and two first air hoses that raise the flux container with respect to the first frame. The second backing device includes a copper plate that retains the flux and two second air hoses that raise the copper plate with respect to the first frame.

The one-side welding equipment having such a configuration uses a position control device interposed between the first frame and the second frame to move the first frame above the second frame such that position control of the first backing device or the second backing device is carried out to position the first backing device or the second backing device directly below the welding groove. Then, the flux supplying device is moved in the longitudinal direction to supply flux into the flux container or onto the copper plate. Subsequently, by introducing air into the first air hoses or the second air

hoses, the flux container or the copper plate is pressed against the welding groove such that the flux is pressed onto the back side of the welding groove, and welding is then carried out with a welder at the front side of the welding groove.

However, with one-side welding equipment according to the related art, the following problems are known.

In a second backing device (corresponding to a backing member according to the present invention) of one-side welding equipment, a long copper plate is retained at the upper side of the backing device in a secured state; therefore, when bend deformation is present in the steel plates before being welded and/or when vertical bending due to thermal strain occurs during welding, the contact between the lower surface of the steel plates and the backing device becomes insufficient, and penetration bead failure, or burn through, which is an even more serious failure, may occur.

When the copper plate is secured to the upper side of the backing device, buckling may occur in the copper plate due to expansion of the copper plate by heat from welding. As a result, the gap between the copper plate and the steel plates becomes uneven; the contact between the lower surface of the steel plates and the backing device becomes insufficient; and penetration bead failure, or burn through, which is an even more serious failure, may occur.

Accordingly, with the one-side welding equipment according to the related art, there is a problem in that a satisfactory welding form cannot be obtained on the underside.

#### SUMMARY OF THE INVENTION

The present invention has been conceived in light of such problems and provides a backing device and welding method that obtains a satisfactory welding form on the underside when one-side automatic welding is carried out.

To solve the problems described above, the backing device according to the present invention is used in one-side welding equipment that joins together steel plates to be welded together and carries out welding using backing flux, the device including a backing member, wherein the backing member includes a backing copper plate on which the backing flux is placed, the backing copper plate being disposed along the welding groove, and a support frame configured to support the backing copper plate in such a manner that the backing copper plate is slidable in the direction of the welding groove, and wherein the backing copper plate includes a plurality of copper plate pieces, each copper plate piece being joined together by a joining member.

With such a configuration, since the backing copper

plate includes copper plate pieces joined together, the backing copper plate can bend at the joints, and thus, the entire backing copper plate can be bent in the vertical direction. Therefore, even when there is bend deformation in the steel plates, the backing copper plate can bend in the vertical direction to follow the underside of the bend-deformed steel plates since the lower surface of the backing copper plate is pressed evenly along the entire length of the backing copper plate. Furthermore, since the backing copper plate can slide in the direction of the welding groove, even when the backing copper plate thermally expands, the backing copper plate slides in the direction of the welding groove in response to the thermal expansion, and normal backing positions of the steel plates and the backing copper plate are maintained. In this way, an even gap is provided between the backing copper plate and the steel plates, and, as a result, the contact between the back side of the welding groove and the backing flux becomes satisfactory.

Furthermore, the joining member may include a joining bracket on which adjoining copper plate pieces are placed, and a joining pin configured to join the joining bracket and the adjoining copper plate pieces placed on the joining bracket by being passed through through holes provided in advance, and a lower surface of the joining bracket has a

protruding part capable of sliding along the support frame.

With such a configuration, since the joining member includes a joining bracket and a joining pin and since a protruding part is provided on the lower surface of the joining bracket, the joined copper plate pieces can easily slide in the direction of the welding groove. As a result, the backing copper plate does not bend even when the copper plate pieces expand during welding, and the contact between the back side of the welding groove and the backing flux becomes even more satisfactory.

In the backing device according to the present invention, the support frame may include a plurality of rails disposed in the longitudinal direction of the backing copper plate on the underside of the backing copper plate and a support plate configured to support the rails.

With such a configuration, since the support frame includes rails and a support plate, the backing copper plate can even more easily slide in the direction of the welding groove. As a result, the contact between the back side of the welding groove and the backing flux becomes even more satisfactory.

The backing device according the present invention may further include an air hose interposed between the support frame and a support structure configured to support the support frame, the air hose being configured to press the

backing flux placed on the backing copper plate against the underside of the welding groove of the steel plates by expanding by compressed air.

With such a configuration, since there is provided an air hose configured to press the backing flux placed on the backing copper plate against the underside of the welding groove in the steel plates by expanding by compressed air, the adjustment of the gap between the backing copper plate and the steel plates becomes easy. Furthermore, since expansion is caused by compressed air, the pressing force can be easily adjusted by adjusting the air pressure inside the air hose. As a result, the contact between the back side of the welding groove and the backing flux becomes even more satisfactory.

The backing device according to the present invention may further include an elevating device configured to move the support structure upward and downward, wherein, when the backing member is moved upward to the upper edge of the backing copper plate by the elevating device, the gap between the backing member and the steel plates may be set smaller than or equal to 75% of the maximum expansion diameter of the air hose and the air pressure of the air hose is set between 0.05 and 0.5 MPa.

With such a configuration, since an elevating device that moves a support structure upward and downward is

provided, even when the steel plates are disposed above the backing device, by lowering the elevating device, a space that allows spraying of the backing flux onto the upper surface of the backing copper plate can be ensured.

Furthermore, when the gap between the backing copper plate and the steel plates is within a predetermined range by moving the elevating device after spraying the backing flux, the backing flux placed on the backing copper plate is pressed against the steel plates in a satisfactory manner, and thus, the contact between the back side of the welding groove and the backing flux becomes even more satisfactory.

A welding method according to the present invention, in which welding is carried out by moving steel plates to be welded to a position corresponding to a backing device and pressing a backing member of the backing device along a welding groove in the steel plates, the method includes the steps of moving a backing copper plate upward toward the welding groove in the steel plates by an elevating device, the backing copper plate having a length larger than or equal to the length of the welding groove; pressing backing flux placed on the front surface of the backing copper plate by expanding an air hose with compressed air injection, the air hose being interposed between a support frame configured to support the backing copper plate moved upward by the elevating device and a support structure configured to

support the support frame; and carrying out one-side welding by a welder of one-side welding equipment.

Through the steps of moving a backing copper plate upward by an elevating device and pressing the backing copper plate and backing flux placed on the front surface of the backing copper plate by expanding an air hose, the contact between the back side of the welding groove and the backing flux becomes satisfactory.

Since the backing device according to the present invention includes a backing copper plate that has a backing member with a minimum length larger than or equal to the length of a welding groove and that is constituted of a plurality of joined copper plate pieces and a support frame that supports the backing copper plate in a slidable manner, a satisfactory welding form can be obtained on the underside when performing one-side automatic welding.

In the backing device according to the present invention, since a joining bracket having a protruding part on the lower surface and a joining pin are provided, the support frame includes rails and a support plate, an air hose is provided, and an elevating device is provided, a satisfactory welding form can be obtained on the underside when performing one-side automatic welding.

With the welding method according to the present invention, through the steps of moving a backing copper

plate upward and pressing backing flux placed on the front surface of the backing copper plate by expanding an air hose, the contact between the back side of the welding groove and the backing flux becomes satisfactory.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of a backing device and one-side welding equipment (not showing a welder) according to present invention;

Fig. 2 is perspective view of a backing member in the backing device according to the present invention;

Fig. 3 is an exploded perspective view of the backing member in the backing device according to the present invention;

Figs. 4A and 4B illustrate the backing member in the backing device according to the present invention, where Fig. 4A is a plan view, and Fig. 4B is a front view;

Figs. 5A and 5B illustrate the backing member in the backing device according to the present invention in states moved upward and downward, where Fig. 5A is a schematic view of a state before a backing copper plate is pressed against steel plates to be welded, and Fig. 5B is a schematic view of a state in which the backing copper plate is being pressed by the steel plates;

Fig. 6 is a perspective view (not showing steel plates

to be welded) of one-side welding equipment according to the present invention on which a backing device is placed;

Fig. 7 is a sectional view of Fig. 6; and

Fig. 8 is a sectional view of a backing device and one-side welding equipment (not showing a welder) according to another embodiment of the present invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

##### Backing Device

A backing device according to an embodiment of the present invention will be described in detail with reference to the drawings. In this embodiment, the longitudinal direction is a direction parallel to a welding groove in steel plates to be welded together, whereas the width direction is a direction orthogonal to the welding groove on a plane of the backing steel plate.

As illustrated in Fig. 1, a backing device 10 according to the present invention is a device that carries out welding (such as one-side submerged arc welding) using backing flux. The backing device 10 is included in one-side welding equipment 1 that joins steel plates E and E to be welded together of which each side is 10 to 30 m long.

The backing device 10 according to the present invention has a backing member 11. The backing member 11 is a member used for pressing the backing flux that is placed

on a backing copper plate along the welding groove M on the underside of the steel plates E and E, which are disposed in contact. As illustrated in Fig. 2, the length L1 of the backing member 11 is a minimum length that is greater than or equal to the length L2 of the welding groove M of the steel plates E and E. Since length L1 is such a length, the backing member 11 can supply backing flux along the entire length of the welding groove M during welding in the steel plates E and E. As a result, a satisfactory welding form is obtained on the underside.

As illustrated in Fig. 2, 3, 4A, and 4B, the backing member 11 includes a backing copper plate 12 and a support frame 16. The backing copper plate 12 is disposed along the welding groove M of the steel plates E and E and is constituted of a plurality of copper plate pieces 13, which each have a predetermined length L3 (for example, between 100 and 500 mm) and are joined together with joining members 14.

The joining member 14 includes a joining bracket 14A and joining pins 14B; end sections of adjoining copper plate pieces 13 are placed on the joining bracket 14A; and, to join the joining bracket 14A and adjoining copper plate pieces 13, the joining pins 14B join the joining bracket 14A and the copper plate pieces 13 are passed through through holes 13a and 14Ac. It is preferable that slidable

protruding parts 14Ad be provided on the bottom surface of the joining bracket 14A along the support frame 16.

Specifically, each of the copper plate pieces 13 has through holes 13a formed in the width direction at both end sections in the longitudinal direction for joining adjoining copper plate pieces 13. The joining bracket 14A has a bottom part 14Aa on which adjoining copper plate pieces 13 are placed and side parts 14Ab that are provided vertically at both edges of the bottom part 14Aa. The bottom part 14Aa is substantially the same length as the length of a single copper plate piece 13 in the width direction. A plurality of protruding parts 14Ad is provided on the bottom surface of the bottom part 14Aa at positions corresponding to a plurality of rails 17 when the backing copper plate 12 is supported by the support frame 16, as described above. The distance between the protruding parts is slightly greater than the distance L4 between the rails (for example, the distance between the protruding parts is 132 mm and the distance L4 between the rails is 131 mm (see Figs. 3, 5A, and 5B)). The same number of the protruding parts 14Ad and rails 17 are provided. The height of the side parts 14Ab is substantially equal to the thickness of the copper plate pieces 13. Each of the side parts 14Ab has through holes 14Ac corresponding to the through holes 13a.

The copper plate pieces 13 are joined together by

disposing in contact the end sections of adjoining copper plate pieces 13, placing edge sections of the copper plate pieces 13 in contact on the bottom part 14Aa of the joining bracket 14A, and passing the joining pins 14B, which have a length substantially equal to the length of the copper plate pieces 13 in the width direction, through the through holes 13a of the copper plate pieces 13 and the through holes 14Ac of the side parts 14Ab of the joining bracket 14A. When the copper plate pieces 13 are supported by the support frame 16, the protruding parts 14Ad of the joining bracket 14A are guided by the rails 17 and are prevented from detaching from the rails 17. In this way, the copper plate pieces 13 can slide in the direction of the welding groove of the steel plates E and E, i.e., longitudinal direction of the joined copper plate pieces 13. As a result, during welding, the joined copper plate pieces 13 easily move in the direction of the welding groove, and consequently, good contact between the steel plates E and E and the backing flux is maintained. Therefore, a satisfactory welding form is obtained on the underside.

The backing flux is placed on the upper surface of the backing copper plate 12. The backing flux is supplied to the upper surface of the backing copper plate 12 by a hopper-shaped flux supplying unit 29 (see Fig. 6), which is disposed above the backing copper plate 12 and movable in

the longitudinal direction of the backing copper plate 12 by being driven by an endless chain or the like.

As described above, the support frame 16 supports the backing copper plate 12 in such a manner that it is slidable in the direction of the welding groove. The support frame 16 preferably includes a plurality of rails 17, which support the backing copper plate 12 and are disposed at predetermined outer intervals L4 (for example, between 50 and 300 mm), and a support plate 19 that supports the rails 17.

As described above, the rails 17 guide the protruding parts 14Ad of the joining member 14 such that the copper plate pieces 13 joined together by the joining member 14 are slidable in the direction of the welding groove. In Fig. 3, two rails 17 are illustrated. Instead, however, three or more rails 17 may be provided. Furthermore, the support plate 19 is constituted of a long plate provided along the entire length of the welding groove M.

In this way, the plate pieces 13 are joined together by the backing copper plate 12 and the backing copper plate 12 is slidable along the support frame 16 without being secured thereto; therefore, when the backing copper plate 12 is pressed against the steel plates E and E, the backing copper plate 12 slides in the direction of the welding groove, providing an even gap between the backing copper plate 12

and the steel plates E and E. The backing copper plate 12 can bend at the joints, allowing the entire backing copper plate 12 to bend in the vertical direction. Accordingly, even when there is bend deformation in the steel plates E and E, the backing copper plate 12 can bend in the vertical direction to follow the underside of the bend-deformed steel plates E and E since the lower surface of the backing copper plate 12 is pressed evenly along the entire length of the backing copper plate 12. As a result, satisfactory contact of the backing flux and the back side of the welding groove M is achieved.

As illustrated in Figs. 5A and 5B, the backing apparatus according to this embodiment of the present invention preferably includes air hoses 25 that are interposed between the support frame 16 and a support structure 20 supporting the support frame 16.

The air hoses 25 are disposed along the entire length of the support frame 16 and are expanded by compressed air to move the backing copper plate 12 upward, or more specifically, move the support frame 16 upward relative to the support structure 20, such that the backing flux placed on top of the backing copper plate 12 is pressed against the underside of the welding groove M in the steel plates E and E. Two air hoses 25 are illustrated in Figs. 5A and 5B. However, the number of air hoses 25 is not limited so long

as the backing copper plate 12 can be moved upward.

The support structure 20 is a frame on which the backing member 11 is mounted on its top. The support structure 20 includes, for example, a top plate 23 extending in the longitudinal direction of the backing member 11, side plates 22 and 22 that are vertically disposed at both edges of the top plate 23 in the width direction, and a bottom plate 21 that joins the side plates 22 and 22.

The air hoses 25 are disposed on top of the top plate 23 along the entire length in the longitudinal direction of the backing member 11. As illustrated in Fig. 1, the bottom plate 21 is supported by backing rollers 27a that are disposed on top of an elevating frame 27. Thus, the bottom plate 21 does not have to be provided along the entire length in the longitudinal direction and just has to have a predetermined length for being supported by the backing rollers 27a. Then, the support structure 20 moves horizontally in the width direction on the backing rollers 27a by being driven by a driving mechanism (not shown), which includes an engagement unit that engages with the bottom plate 21.

The backing device according to this embodiment of the present invention preferably includes elevating guides 24 that stabilize the upward movement of the backing copper plate 12 by the air hoses 25, specifically, move the support

plate 19 upward while maintaining a horizontal state.

Multiple elevating guides 24 are disposed at predetermined intervals in the longitudinal direction of the air hoses 25 disposed on top of the support structure 20. When two air hoses 25 are provided, the elevating guides 24 are disposed between the air hoses 25, whereas, when only one air hose 25 is provided, the elevating guides 24 are disposed on both sides of the air hose 25 in the width direction (not shown).

One of the end sections of the elevating guides 24 is secured to the support frame 16, which supports the backing copper plate 12, and the other end sections are passed through guiding holes formed in the top plate 23 in the support structure 20. When the air hoses 25 expand or contract, the support plate 19 moves upward or downward while keeping a horizontal state according to the guiding of the elevating guides 24.

The elevating guides 24 are constituted of, for example, rod-like members and each have a length sufficient for sliding and allowing the backing flux placed on the backing copper plate 12 to press the underside of the welding groove M. The elevating guides 24 may have stoppers (not shown), which have a diameter larger than the guiding holes, on the other end sections.

As illustrated in Fig. 1, the backing device 10

according to the present invention includes an elevating device 26 moving the support structure 20 upward and downward. When the backing member 11 is moved upward to an upper edge 12a of the backing copper plate 12 by the elevating device 26, it is preferable that the distance D between the backing member 11 and the steel plates E be set such that it is greater than or equal to 75% of the maximum expansion diameter of the air hoses 25, and the air pressure of the air hoses 25 be set within the range of 0.05 to 0.5 MPa (see Figs. 5A and 5B).

It is preferable that the elevating device 26 be disposed inside the elevating frame 27 having a configuration such as that described below. The elevating frame 27 is disposed directly below the support structure 20, moved upward and downward in the vertical direction, and supported by the elevating device 26. The backing rollers 27a are disposed on top of the elevating frame 27.

The elevating frame 27 is a substantially box-shaped frame formed by joining shaped steel and plates and has a lower frame 27b extending in the width direction, side frames 27c and 27c formed at both ends of the lower frame 27b in a ladder-like shape, and paired clamped plates 27d and 27d interposed between the side frames 27c and 27c. The paired clamped plates 27d and 27d clamp the backing rollers 27a by being separated by a predetermined distance in the

longitudinal direction. The lower edges of the clamped plates 27d and 27d are in contact with and support the upper edge of the elevating device 26. The paired clamped plates 27d and 27d are disposed in parallel at predetermined intervals along the entire length of the side frames 27c and 27c. The elevating device 26 is passed through the lower frame 27b.

In the backing device 10, the distance D between the backing copper plate 12 and the steel plates E and E when the backing member 11 is moved upward to the upper edge 12a of the backing copper plate 12 by the elevating device 26 is set as follows.

As illustrated in Figs. 5A and 5B, when the distance D between the backing copper plate 12 and the steel plates E and E exceeds 75% of the maximum expansion diameter of the air hoses 25, the distance D is too large, causing a reduction in the pressing force of the backing flux against the welding groove M due to expansion of the air hoses 25; as a result, failure in penetration bead and/or burn through are more likely to occur. Therefore, it is preferable that the distance D be smaller than or equal to 75% of the maximum expansion diameter of the air hoses 25.

In the backing device 10, the air pressure during expansion of the air hoses 25 is set as follows.

When the air pressure is smaller than 0.05 MPa, the

pressing force of the backing flux against the welding groove M is small; as a result, failure in penetration bead and/or burn through are more likely to occur. When the air pressure exceeds 0.5 MPa, the pressing force of the backing copper plate 12 against the steel plates E and E is too large, causing the steel plates E and E to lift up; as a result, weld cracking is more likely to occur. Therefore, it is preferable that the air pressure be between 0.05 and 0.5 MPa.

As illustrated in Fig. 1, it is preferable that the backing device 10 according to the present invention include a flux collecting unit 28 in which used backing flux scraped off after welding the welding groove M is collected. The flux collecting unit 28 is, for example, disposed inside the elevating frame 27 and includes a tapered part 28a spreading toward the upper side of the elevating frame 27 and a screw-shaped conveyer part 28b that ejects the collected backing flux to the outside.

#### One-side Welding Equipment

One-side welding equipment according to an embodiment of the present invention will be described below.

According to Figs. 1, 6, and 7, one-side welding equipment 1 preferably includes a backing device 10, a mounting frame 104, a delivering/securing unit 105, and a welder 30. Each configuration will be described below.

Since the backing device 10 is the same as that described above, description thereof will not be repeated.

As illustrated in Fig. 1, the mounting frame 104 has a concave cross-section and is formed of squared steel logs. The upper side of the mounting frame 104 is opened, and the backing device 10 is supported inside the mounting frame 104. The mounting frame 104 extends in the longitudinal direction of the backing device 10. The mounting frame 104 includes two main beams 104a arranged in parallel in the longitudinal direction, a joining beam 104b that joins, in a perpendicular manner, the main beams 104a and 104a, a joining beam 104c that is disposed orthogonal with the joining beam 104b, auxiliary beams 104d and 104d that are disposed in parallel at the upper side of the main beams 104a and 104a, and cantilever beams 104e that protrude from the auxiliary beams 104d and 104d toward the opposite side of the backing device 10. At the lower side of the joining beam 104b of the mounting frame 104, a carriage part 108 is provided. The mounting frame 104 moves in the width direction of the backing device 10 by moving the carriage part 108 on a plurality of rail 107 (see Fig. 6) disposed in parallel in the longitudinal direction of the backing device 10 at predetermined intervals.

As illustrated in Fig. 1, the delivering/securing unit 105 is disposed on the auxiliary beams 104d of the mounting

frame 104 to horizontally move the steel plates E and E at the upper side of the backing device 10 and includes a panel moving roller 105a and a magnet device 105b. An auxiliary roller 106 is disposed on the cantilever beams 104e of the mounting frame 104 to assist the delivery of the steel plates E and E by the delivering/securing unit 105.

As illustrated in Figs. 6 and 7, the welder 30 is disposed at the upper side of the backing device 10 and welds the steel plates E and E from the front side of the welding groove M. The welder 30 includes a travelling carriage 31 that travels a welder beam 101 extending in the longitudinal direction of the backing member 11 of the backing device 10, an adjustment jig 32 that is attached to the travelling carriage 31 in a movable manner, and a welding torch 33 that is attached to the adjustment jig 32.

By securing bearings 31a to the travelling carriage 31 and moving a rail 32a mounted on the adjustment jig 32 via the secured bearings 31a, the adjustment jig 32 moves in the width direction of the backing member 11 and the welding torch 33 attached to the adjustment jig 32 moves. In the welder 30, the bearings 31a is secured and the rail 32a, together with the adjustment jig 32 (welding torch 33), moves in the width direction of the backing member 11 by the bearings 31a. Therefore, the rail 32a and a welding wire W that is supplied to the welding torch 33 do not interfere

with each other.

#### Welding Method

A welding method, according to an embodiment of the present invention, using one-side welding equipment including a backing device will be described with reference to Figs. 1 to 7. The welding method according to this embodiment of the present invention is a method of welding by moving the steel plates E and E to a position corresponding to the backing device 10 and pressing the backing member 11 of the backing device 10 against the welding groove M of the steel plates E and E. Specifically, the welding method includes a first step of moving the backing copper plate 12 upward, a second step of pressing backing flux placed on the backing copper plate 12 to the underside of the welding groove M by expanding the air hoses 25, and a third step of carrying out one-side welding by the welder 30. The steps will be described below.

The welding method preferably includes a preparation step of carrying out position control of the steel plates E and E, before the first to third steps.

#### Preparation Step

As illustrated in Figs. 1 and 6, first, the endless chain or the like (not shown) that supports a flux supplying unit 29 disposed on the upper side of the backing member 11 is driven to move the flux supplying unit 29 in the

longitudinal direction of the backing member 11, and the backing flux is supplied onto the upper surface of the backing copper plate 12. The panel moving roller 105a and the auxiliary roller 106 move the tack-welded steel plates E and E such that the welding groove M formed by the steel plates E and E is disposed at the upper side of the backing device 10. A driving device (not shown) is operated to carry out fine control of the backing member 11 in the width direction such that the backing copper plate 12 is positioned directly below the welding groove M. Specifically, the support structure 20 on which the backing member 11 is mounted is moved horizontally in the width direction on the backing rollers 27a disposed at the upper side of the elevating frame 27 disposed directly below the support structure 20. After fine control in the width direction is completed, the magnet device 105b is started up to magnetically pull and secure the steel plates E and E downward.

#### First Step

As illustrated in Figs. 1 and 5A, the elevating device 26 is driven to move upward the backing copper plate 12 on which the backing flux is retained to a predetermined position set in advance. In the present invention, a predetermined position is a position at the upper edge 12a of the backing copper plate 12 that is greater than or equal

to 75% of the maximum expansion diameter of the air hoses 25, where the distance between the upper edge 12a and the steel plates E and E is set to a distant D.

#### Second Step

As illustrated in Fig. 5B, compressed air is introduced to the two air hoses 25 and 25 to expand the air hoses 25 and 25. The expansion of the air hoses 25 and 25 causes the elevating guides 24 inserted into the guide holes formed in the top plate 23 of the support structure 20 to slide and lift up the support frame 16 secured to one of the end sections of the elevating guides 24.

The pushing by the support frame 16 causes the backing copper plate 12 supported by the support frame 16 to be pressed against the underside of the welding groove M, causing the backing flux to be pressed against the welding groove M.

#### Third Step

As illustrated in Figs. 6 and 7, the steel plates E and E are welded by moving the welder 30 above the welder beam 101 at a predetermined speed and carrying out, for example, one-side submerged arc welding with the welding torch 33 from the front side of the welding groove M.

When there are multiple welding grooves M, the air inside the air hoses 25 are discharged to lower the elevating guides 24 and the support frame 16 such that the

backing copper plate 12 moves away from the back side of the steel plates E and E. Subsequently, the elevating frame 27 is lowered by the elevating device 26 such that the backing member 11 is also lowered from the back side of the steel plates E and E. The flux supplying means 29 capable of removing used flux from the upper surface of the backing copper plate 12 and spraying new backing flux is driven by an endless chain (not shown) to remove used flux on the upper surface of the backing copper plate 12 and to supply new backing flux onto the upper surface of the backing copper plate 12. Subsequently, the preparation step is carried out to perform fine control to position the backing copper plate 12 directly below the next welding groove M. Then, the first to third steps are carried out. Such operation is repeated several times.

In the above, embodiments of the present invention have been described. The present invention, however, is not limited to the embodiments described above, and various modifications are possible without departing from the scope of the invention.

For example, the above-described backing device and the one-side welding equipment have been described through examples for a case in which the steel plates are moved in the width direction (direction orthogonal to the longitudinal direction of the backing device). However, as

illustrated in Fig. 8, even when the steel plates E and E are moved in the longitudinal direction, a backing device 10A and one-side welding equipment 1A (the welder is not shown), which have the same configuration as the backing device 10 and the one-side welding equipment 1 (see Fig. 1) can be used. For example, the backing device 10A includes a backing member 11, a support structure 20, and a flux collecting unit 28. The one-side welding equipment 1A further includes a backing device 10A, a mounting frame 104, a delivering/securing unit 105, and a welder (not shown). In Fig. 8, the same components in the backing device 10 and the one-side welding equipment 1 are represented by the same reference numerals. The backing device 10A does not require an elevating device 26 (see Fig. 1) that moves the backing member 11 upward and downward.

Although the elevating guides 24 have been described as rod-like members, they may be plate-like members.

In the welding method, other steps may be included before and/or after each step and/or during each step, so long as there is no adverse effect on each step. Other steps include, for example, a step of scraping off backing flux solidified by welding from the front surface of the backing copper plate.

WHAT IS CLAIMED IS:

1. A backing device that is used in one-side welding equipment that joins together steel plates to be welded together and that carries out welding using backing flux, the device comprising:

a backing member,

wherein the backing member includes

a backing copper plate on which the backing flux is placed, the backing copper plate being disposed along the welding groove, and

a support frame configured to support the backing copper plate in such a manner that the backing copper plate is slidable in the direction of the welding groove, and

wherein the backing copper plate includes a plurality of copper plate pieces, each copper plate piece being joined together by a joining member,

wherein the support frame includes a plurality of rails disposed in the longitudinal direction of the backing copper plate on the underside of the backing copper plate and a support plate configured to support the rails.

2. The backing device according to Claim 1, wherein the joining member includes,

a joining bracket on which adjoining copper plate pieces are placed, and

a joining pin configured to join the joining bracket and the adjoining copper plate pieces placed on the joining bracket by being passed through through holes provided in advance, and

wherein a lower surface of the joining bracket has a protruding part capable of sliding along the support frame.

3. The backing device according to Claim 1, further

comprising:

an air hose interposed between the support frame and a support structure configured to support the support frame, the air hose being configured to press the backing flux placed on the backing copper plate against the underside of the welding groove of the steel plates by expanding by compressed air.

4. The backing device according to Claim 1, further comprising:

an elevating device configured to move the support structure upward and downward,

wherein, when the backing member is moved upward to the upper edge of the backing copper plate by the elevating device, the gap between the backing member and the steel plates is set smaller than or equal to 75% of the maximum expansion diameter of the air hose and the air pressure of the air hose is set between 0.05 and 0.5 MPa.

5. A welding method in which welding is carried out by moving steel plates to be welded to a position corresponding to a backing device and pressing a backing member of the backing device along a welding groove in the steel plates, the method comprising the steps of:

moving a backing copper plate upward toward the welding groove in the steel plates by an elevating device, the backing copper plate having a length larger than or equal to the length of the welding groove;

pressing backing flux placed on the front surface of the backing copper plate by expanding an air hose with compressed air injection, the air hose being interposed between a support frame configured to support the backing copper plate moved upward by the elevating device and a support structure configured to support the support frame; and

carrying out one-side welding by a welder of one-side welding equipment,

wherein the support frame includes a plurality of rails disposed in the longitudinal direction of the backing copper plate on the underside of the backing copper plate and a support plate configured to support the rails.

6. The welding method according to Claim 5, wherein the backing copper plate includes copper plate pieces joined together by joining members.