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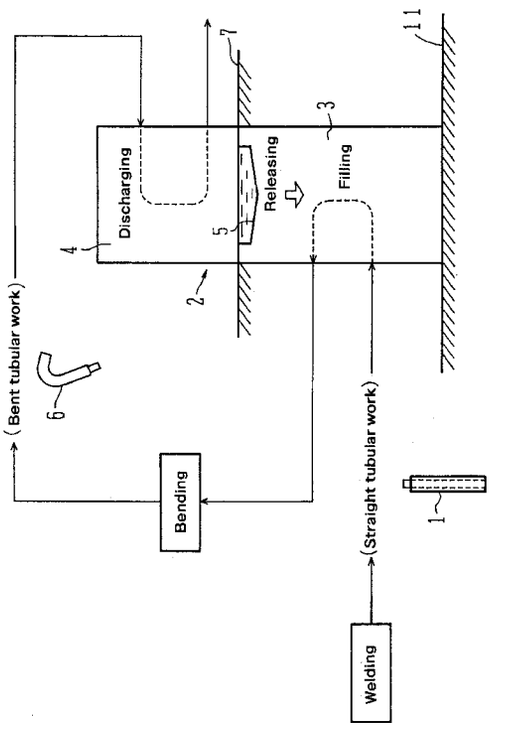
## (54) Method and apparatus for filling and discharging a filling material.

(57) A discharging furnace (4) and a filling furnace (3) are disposed in the upper and lower parts of a filling and discharging furnace (2). The discharging furnace has a reservoir (5), with a sloping bottom surface protruding toward the filling furnace and provided with a valve (9). Hot air heated by a duct heater (18) through a duct (16) is fed mainly into the discharging furnace while a remaining portion of the hot air is fed into the filling furnace. In the discharging furnace molten filling material from a bent (worked) workpiece (6) is collected in the reservoir and, when the valve is opened, is introduced into a straight (unworked) workpiece (1) which is carried by a filling carrier (12) in the filling furnace. The filling carrier is divided into three parts comprising a filling deck (30), a carrier body (31) and a sealing deck (32), the filling deck (30) having a nozzle (52) and the sealing deck a seal member (60). When the sealing deck (32) is moved upwards, a workpiece lifting deck (38) is also moved up to a condition in which the seal member is engaged with the lower end of the unworked workpiece, and the top end of the latter engages with the nozzle. The filling material is now be filled through the nozzle into the workpiece. If the specification of the workpiece 1 is changed, the nozzle and the seal member are replaced.

Fig.1

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This invention relates to a method and apparatus for filling and discharging a molten filling material of low melting point into and out of a workpiece, for example a tube which is to be bent.

When it is required to bend a workpiece in the form of a tube, a filling material of low melting point is introduced into the straight tubular workpiece to enable it to be bent with accuracy. However, conventionally the steps of filling the filling material into the straight workpiece, bending the workpiece and then heating the same to melt and discharge the filling material have been carried out at different locations.

Consequently, the filling material, once melted and discharged, has to be kept in a heated reservoir and then delivered to the straight workpiece by means of a pump.

Also, generally, the straight workpiece is supported by a carrier which is provided with a nozzle adapted to engage with the upper end portion of the workpiece for filling the filling material therein to, whilst a sealing member engages with the lower end of the workpiece.

Thus, since each of the steps of filling, and melting and discharging the filling material, are carried out at different places, making it necessary to have a heated reservoir for the discharged molten filling material, a large working space is needed, together with energy for keeping hot a large quantity of filling material. Further, it takes a comparatively long time to finish a series of workpieces. It is therefore desired not only to decrease the working space, but also to improve the working efficiency, by eliminating the heated reservoir for the discharged filling material.

Still further, since the aforementioned nozzle and sealing member can only be used for one specification of the workpiece, relative to its length and inner and outer diameters, it becomes necessary to reassemble the carrier whenever the specification of the workpiece is changed, and this is clearly inconvenient. It is therefore desired to provide for such changes in the specification of the workpiece in more efficient manner.

Viewed from one aspect the present invention provides a method of treating a tubular workpiece by working upon it while it contains a filling material, comprising the steps of:

introducing the molten filling material into an unworked tubular workpiece;

then working on the workpiece to bring it to a worked condition; and

then heating the workpiece to melt and discharge the filling material;

characterised in that there is provided a single filling and discharging furnace having in the lower part thereof a filling furnace for filling the filling material into an unworked tubular workpiece, and in the upper part thereof a discharging furnace, the filling material being melted and then discharged from a worked workpiece in the discharging furnace, and the molten discharged filling material being gathered in a reservoir in the discharging furnace and thence introduced into an unworked workpiece disposed in the filling furnace.

Viewed from another aspect the invention provides a filling and discharging furnace for carrying out the method set forth above, comprising

a discharging furnace for melting and discharging filling material of low melting point from a worked tubular workpiece;

a filling furnace for introducing the filling material into an unworked tubular workpiece;

the discharging furnace being arranged above the filling furnace;

hot air circulating means communicating with both the discharging furnace and the filling furnace and arranged to feed the majority of the hot air flow into the discharging furnace and a remaining portion thereof into the filling furnace; and

a reservoir in the discharging furnace for collecting the molten filling material and having an outlet valve for releasing the collected filling material into the filling furnace.

Viewed from a further aspect the invention provides a carrier for a workpiece which is to be worked upon whilst filled with a material, comprising:

a carrier body;

a filling deck disposed at the upper part of the carrier body;

a sealing deck disposed at the lower part of the carrier body; and

a lifting deck arranged to move up and down whilst supporting an unworked tubular workpiece;

the filling deck comprising an upwardly open receptacle for holding molten filling material and provided with a nozzle which extends downwardly from a through bore formed in the bottom of the receptacle and which has an inner diameter substantially equal to the outer diameter of the workpiece, the upper end of which is adapted to engage with the nozzle when moved upwardly; and

the sealing deck being arranged to move up and down and having a seal member which has an outer diameter substantially equal to the inner diameter of the workpiece, the lower portion of which is adapted to engage with the seal member when the sealing deck is moved upwardly.

Since, according to the present invention, there is provided a filling and discharging furnace with a discharging furnace and a filling furnace disposed at the upper and lower parts thereof respectively, it is possible at the same time to fill a filling material in the filling furnace and to melt and discharge it in the discharging furnace, and as a result a heated reservoir for the discharged molten filling material is no longer necessary. Thus, it is not only possible to reduce the working space and save the heat in the filling materi-

al, but also to improve the working efficiency by carrying out a plurality of operations in one place. It is also possible to recycle the filling material in a minimum quantity.

If, as is preferred, the filling furnace is heated by utilizing a part of the hot air which is mainly sent to the discharging furnace, it is also possible to save energy and simplify the structure of the heat keeping equipment within the filling and discharging furnace.

Also, when as is preferred the opening and closing operations of a valve of a hot air exhaust duct are linked with those of doors respectively provided for the discharging furnace and the filling furnace, for the workpieces to be moved in and out, hot air may be prevented from escaping through the doors when they are open.

If, as is preferred, the bottom of the discharging furnace is formed with a sloping surface, it is also possible to effect quick and sure release of the filling material into the filling furnace.

On the other hand, when a filling carrier for filling the filling material into a workpiece is situated within the filling furnace and under a valve formed at the bottom of a reservoir in the discharging furnace, it is possible efficiently to release the filling material into such a filling carrier situated in the filling furnace.

Further, if as is preferred a plurality of workpiece carriers are arranged to be accommodated in both the filling furnace and the discharging furnace at the same time, the working efficiency is further improved.

A workpiece carrier according to the present invention is preferably divided into three parts, comprising a carrier body, a filling deck and a sealing deck, the carrier body being provided with a lifting deck adapted to move up and down while supporting a workpiece thereon, the filling deck being provided with a nozzle, and the sealing deck being provided with a seal member and being arranged to move up and down. When it is desired to change the specification of the workpiece, it is not necessary to change the carrier body, but only to change the nozzle and the seal member. Since the number of parts to be changed can thus be kept as low as possible, costs are reduced, and since it is no longer necessary to keep different kinds of carriers, less space is needed.

If, as is preferred, a number of workpieces are supported on such a carrier and also a plurality of nozzles and seal members are provided, arranged to correspond to these workpieces, it is possible to fill the filling material into a number of workpieces at the same time and thus notably improve the working efficiency.

Also, when as is preferred the workpieces are detachably secured at their peripheries to the sides of the carrier by resilient engaging members, their manner of attachment or detachment becomes simple and reliable.

Further, when as is preferred the lifting deck is elevated by the elevation of the sealing deck, which is also adapted to be elevated by a lifter provided separately from the carrier body, so that the upper end of the workpiece may be connected to the nozzle and the opening at the lower end of the workpiece may be sealed by the seal member, it is not only possible to make the construction of the carrier simple, but also to carry out both the processes of connecting and sealing the workpiece at the same time, and thus reduce the number of the steps involved in filling.

In this case, if as is preferred the nozzle and the seal member are designed to be replaceable in response to changes in the specification of the workpiece, and the filling deck is held relative to the carrier body by a removable support, it is possible to cope with such changes of specification of the workpiece more flexibly.

Further, if the sealing deck is designed to be held by a removable support relative to the lower portion of the lifting deck when lifted, it is possible to make the manner of positioning of the lifting deck simple and reliable.

Still further, if the filling deck is provided with a detachably mounted guide pin which is adapted to engage with the inside of the upper end portion of the workpiece with a certain clearance formed therebetween, and if the guide pin is situated concentrically with the nozzle, it is possible to make the manner of positioning of the workpiece and the filling deck simple and to cope with changes in the specification of the workpiece more easily.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:-

Fig. 1 is a view showing diagrammatically a bending process according to a preferred embodiment of the present invention;

Fig. 2 is a sectional side elevation of apparatus for carrying out the process of Fig. 1;

Fig. 3 is a cross-sectional view showing basic parts of the apparatus;

Fig. 4 is a cross-sectional view showing basic parts of a workpiece filling carrier of the apparatus;

Fig. 5 is a plan view of the filling carrier;

Fig. 6 is a sectional side elevation of the filling carrier;

Fig. 7 is a cross-sectional view taken along line C-C of Fig. 4;

Fig. 8 is an enlarged sectional view taken along line D-D of Fig. 6;

Fig. 9 is a partially enlarged sectional view showing further parts of the apparatus;

Fig. 10 is a partially enlarged sectional view showing other parts of the apparatus;

Fig. 11 is a sectional side elevation of a workpiece discharging carrier of the apparatus; and

Fig. 12 is a front view of the discharging carrier.

Referring to the drawings, Fig. 1 is a view which diagrammatically illustrates a bending process of an exhaust pipe for a motorcycle.

First, a straight tubular workpiece 1 in the form of a double tube comprising inner and outer pipes is formed by welding and is introduced into a filling furnace 3 which forms the lower part of a filling and discharging furnace 2. At the same time, a tubular workpiece 6 which has already been bent is introduced into a discharging furnace 4 which forms the upper part of the furnace.

Then, when the discharging furnace 4 has been heated above the melting point of a filling material, molten filling material discharged from the bent tubular workpiece 6 is collected in a reservoir 5 formed in a floor 7 of the discharging furnace 4. Filling material from the reservoir is then used to fill the space between the inner and outer pipes of the straight tubular workpiece 1 located in the lower filling furnace 3.

Following that, the bent tubular workpiece 6, emptied of filling material, is moved out of the discharging furnace 4 to a succeeding process station. Also, the straight tubular workpiece 1 filled with the filling material is taken out of the filling furnace 3 to undergo the next bending process. Since the workpiece 1 is filled with the filling material, it is possible to accurately carry out bending operations on the inner and outer pipes so as to form a bent tubular workpiece 6. The bent tubular workpiece 6 is then introduced into the discharging furnace 4, where the filling material is melted and discharged as described above.

Fig. 2 is a sectional side elevation schematically showing the filling and discharging furnace 2, while Fig. 3 is a cross-sectional view showing only a portion of the furnace 2 and a carrier therein, as seen from a front of the furnace (arrow A in Fig. 2). The inside of the furnace 2 is divided into upper and lower sections by the floor 7 of the discharging furnace 4, which also serves as a partition wall. Two reservoirs 5 (Fig. 3) are formed to extend in opposite directions from the central region of the floor 7, the bottoms 8 of which slope downwardly toward the interior of the filling furnace 3. A valve 9 is provided at the lowest point of each reservoir, operable from outside by a suitable means to open and close it.

Discharging carriers 10 for carrying the bent tubular workpieces 6 are located on the floor 7 of the discharging furnace 4, while filling carriers 12 for carrying the straight tubular workpieces 1 are located on a floor 11 of the filling furnace 3. Two such carriers are provided, one on each side, in each of the furnaces 3 and 4. A wall 13 stands up from the floor 11 of the filling furnace 3, with its top at the same level as the floor 7 of the discharging furnace 4.

A doorway of the discharging furnace 4 which faces the wall 13 is opened and closed by a door 14 which is movable up and down, while a doorway of the filling furnace 3 is situated on the opposite side and is opened and closed by a double-leafed hinged door 15.

Hot air circulating means, including a main duct 16, an axial-flow fan 17 and a duct heater 18, is provided in a top portion of the filling and discharging furnace 2, the axial-flow fan 17 being driven by a motor 19. The main duct 16 communicates with a suction duct 20, an exhaust duct 21, and a supply duct 22.

The suction duct 20 opens in the upper region of the discharging furnace 4, while the exhaust duct 21 opens to the atmosphere to discharge the hot air fed from the axial-flow fan 17, being opened and closed by a valve 23. The opening and closing operations of the valve 23 are linked to those of the doors 14 and 15. The valve 23 is arranged to quickly decrease the temperature, especially within the discharging furnace 4, by opening the exhaust duct 21 to atmosphere after the filling and discharging of the filling material but before the doors 14 and 15 are opened, so that hot air does not blow out of the doors. The valve 23 is arranged to be closed while the doors 14 and 15 are closed, during the operations to fill and discharge the filling material.

The supply duct 22 extends vertically within the filling and discharging furnace 2 and is arranged to supply a larger proportion of the hot air flow into the discharging furnace 4, through a supply port 24 opening into the lower proportion of the furnace 4, and the remaining portion thereof into the filling furnace 3 through a supply port 25 opening into the upper part of the filling furnace.

The inside of the discharging furnace 4 is heated by the hot air fed through the supply port 24 to about 1500°C, which is higher than the melting point of the filling material, while the inside of the filling furnace 3 is kept at a temperature of about 600°C. The hot air flow entering the discharging furnace 4 through the supply port 24 heats the bent tubular workpieces 6 mounted on the discharging carrier 10 and then exits through the suction duct 20, while the hot air flow entering into the filling furnace 3 through the supply port 25 also passes to the suction duct 20 through a communicating port 26 formed in the floor 7 of the discharging furnace 4. The hot air is then heated again by the duct heater 18 before being recirculated through the furnace 2.

One of the workpiece filling carriers 12 will now be described in more detail with reference to Figs. 4 to 10.

Fig. 4 is a cross-sectional view showing the filling carrier 12 from the front thereof (arrow A in Fig. 2) in the condition of carrying a number of straight tubular workpieces 1. The filling carrier is divided into three parts, namely a filling deck 30, a carrier body 31 and a sealing deck 32. The sealing deck 32 is arranged to be moved up and down by lifting means such as a hy-

draulic device (not shown).

Fig. 5 is a plan view showing the filling carrier before it is loaded with workpieces. Fig. 6 is a side elevation thereof showing, on the left, the condition of the carrier before receiving the straight tubular workpieces 1 and, on the right, a cross-section after receiving the same. Figs. 9 and 10 are enlarged cross-sectional views showing the upper and lower end portions of the straight tubular works 1 in the condition as shown on the right of Fig. 6.

As is apparent from these Figures, the filling carrier body 31 is loaded with two rows of straight tubular workpieces 1, the rows extending in the front to rear direction. The workpieces are supported by detachably engaging their middle portions in substantially C-shaped support clips 34, the circumference of which is partially cut away as shown in Fig. 7.

The support clips 34 are arranged in two rows, supported by a central cross member 35 which extends from front to rear in the central region of the carrier body 31. The ends of the cross member 35 are secured to reinforcement members 37 extending between frame members 36.

The carrier body 31 is provided at its lower part with a lifting deck 38 arranged to support the lower ends of the straight tubular workpieces 1. The lifting deck 38 is supported to move up and down by guides located in the four corners between the frame members 36. When the lifting deck 38 has been moved up, together with the sealing deck 32, by a lifter (not shown), it is supported against moving down by inserting supporting pipes 40 under the sealing deck 32 (see Figs. 5 and 6), the ends of the pipes 40 extending through brackets 42 mounted on frame members 41.

As is apparent from Fig. 6, the filling deck 30 extends downwardly between upper frame members 43 and forms an upwardly open receptacle 44, provided at its upper periphery with a flange 45. The flange portion 45 is mounted on the upper surfaces of the frame members 43, and the filling deck 30 is supported by pipes 46, similar to the pipes 40, which pass through holes 48 (Fig. 4) formed in upstanding edge portions 47 of frame members 43.

Inside the receptacle 44 guide pins 51 are detachably secured by bolts 49 to brackets 50 at positions corresponding to each straight tubular workpiece 1. The lower end of each guide pin 51 extends downwardly through the bottom of the receptacle 44 and is there enclosed by a pipe-shaped nozzle 52 secured to the receptacle 44.

As is apparent from Fig. 9, the inner diameter of the nozzle 52 is slightly more than the outer diameter of the upper end portion of the outer pipe 53 of the straight tubular workpiece 1, while the outer diameter of the guide pin 51 is slightly less than the inner diameter of the upper end portion of the inner pipe 54, which extends beyond the outer pipe 53. Accordingly, when the lifting deck 38 is moved upwards, the upper end portion of the workpiece 1 has its outer pipe 53 and inner pipe 54 engaged closely between the guide pin 51 and the nozzle 52.

As is apparent from Fig. 8, the upper end region of the inner pipe 54 is non-circular in cross-section, whereby a clearance 55 is formed between the outer pipe 53 and the inner pipe 54. Also, as is apparent from Fig. 9, a through bore 57 is formed in the bottom 56 of the receptacle 44, and the space between the outer pipe 53 and the inner pipe 54 communicates with the inside of the receptacle 44 through the bore 57, the nozzle 52 and the clearance 55, as shown in Fig. 9. The bore 57 allows the guide pin 51 to pass therethrough, having a larger diameter than the pin. The nozzle 52 is detachably secured by bolts 58 to the bottom 56 of the receptacle 44.

On the other hand, the lower end region of the straight tubular workpiece 1 is, as shown in Fig. 10, arranged such that the outer pipe 53 and the inner pipe 54 are in close contact with each other. A seal member 60 made of heat-resistant elastic material such as a silicone rubber closely engages the inside the inner pipe 54 so that it can seal a weep hole formed in the inner pipe 54. A through bore 62 is formed in an upper surface panel 61 of the lifting deck 38, in which a ring 63 is secured. A stopper ring 64 engages with the ring 63 and the lower end of the workpiece 1.

The seal member 60 is detachably secured at its base 65 to the sealing deck 32, through bolts 66. As is apparent from Figs. 4 and 6, the sealing deck 32 is provided, at the center region of both of its ends, with upwardly protruding positioning pins 67 adapted to engage with holes 68 (Fig. 6) formed in the lifting deck 38, when the sealing deck 32 is moved upwardly.

The carrier body 31 is arranged to carry different kinds of straight tubular workpieces 1 with different specifications, such as in their inner and outer diameters and their lengths. When the specifications of the workpieces are changed, it is possible to cope with such changes by simply changing the nozzle 52 and the seal member 60, and also the guide pin 51 if necessary.

Figs. 11 and 12 respectively show a sectional side elevation and a front view of a discharging carrier 10. As shown in Fig. 11, a pair of intermediate frame members 71 are arranged between front and rear frame members 70, and supporting plates 72 and 73 are mounted on the frame members 71. Plates 72 and 73 are provided with supporting clips 74 and 75 similar to the supporting clips 34 (Fig.7).

The top end of the supporting plate 72 extends upwardly, while the top end of the supporting plate 73 extends substantially horizontally. As a result, the supporting plates 72 and 73 are at about 90° to each other. Consequently, when a bent tubular workpiece 6 is engaged in the supporting clips 74 and 75, one

end region of the workpiece 6, where its inner and outer pipes are sealed up, is supported substantially horizontally by clip 74, while the other end region where the inner and outer pipes are open (i.e. the end into which the filling material was introduced), is supported to face downwardly, as shown.

The bent tubular workpieces 6, supported in such manner, are arranged in two rows facing each other, as shown in Fig. 12.

Reference numeral 76 indicates an auxiliary bracket for use in a case where the shape of the bent tubular workpiece 6 is different from what is shown, when another supporting plate 73 formed in a suitable shape may be attached thereto. Reference numeral 77 indicates a pin for attachment of a lifting chain when it is desired to lift the discharging carrier 10 for relocation.

The operation of the illustrated embodiment will now be described. Referring to Figs. 2 and 3, the discharging carrier 10 is located on the floor 7 of the discharging furnace 4, while the filling carrier 12 is located on the floor 11 of the filling furnace 3. In such a condition, when the doors 14 and 15 are closed and hot air is fed into the filling and discharging furnace 2 by the hot air circulating means, the inside of the discharging furnace 4 is heated to approximately 1500°C, which is higher than the melting point of the filling material, so that the filling material in the bent tubular workpieces 6 on the discharging carrier 10 melts and is discharged into the reservoir 5, because the open ends of the bent tubular workpieces 6 face downwardly, as seen in Fig. 11. At the same time, the inside of the filling furnace 3 is kept at a temperature of about 600°C.

Next, when the valve 9 is opened, the filling material collected in the reservoir 5 is discharged toward the filling carrier 12 situated in the lower filling furnace 3 and is there received in the receptacle 44 of the filling deck 30. The filling material then passes through the through bore 57, the upper end portion of each straight tubular workpiece 1, and the clearance 55 (Fig. 8), to be filled into the space between the outer pipe 53 and the inner pipe 54 of each workpiece 1.

In a case where the specification, such as the length or the inner or outer diameter, of the straight tubular workpiece 1 is changed, it is only necessary to change the nozzle 52 and the seal member 60, and possibly also the guide pin 51, without changing the carrier body 31. Accordingly, the necessary changes to the filling carrier 12 resulting from such a change in specification of the workpiece 1 is minimised, and it is therefore no longer necessary to maintain many kinds of filling carriers each of which has been exclusively prepared for a particular specification of the straight tubular workpiece 1. It is thus possible to save the cost of such carriers and the space for storing them.

Since one carrier 10 or 12 is adapted to carry many workpieces 1, and two each of the carriers 10 and 12 are put into the filling and discharging furnace 2 at a time, it is possible to greatly improve the working efficiency.

Since the carrier body is not provided with a seal member, then even if hot straight tubular workpieces are placed thereon immediately after welding there is no damage of a seal member being damaged by heat.

Moreover, since one filling and discharging furnace 2 has a filling furnace 3 and a discharging furnace 4 arranged in the lower and upper parts thereof, it is possible to carry out the filling of the filling material and the melting and discharging thereof at the same time, thus reducing the working space considerably and improving the working efficiency. Also, since the conventional heat keeping reservoir for discharged filling material is not needed any more, it is not only possible to save the heat of the discharged filling material, but also to make the construction of the equipment simpler and more compact, and to increase the degree of freedom in the equipment layout.

Also, since the hot air is circulated within the discharging furnace 4 by the hot air circulating apparatus, it is possible to utilize the heat effectively and to accelerate the increase in the temperature during heating. Further, since the interior of the filling furnace 3 is also arranged to be kept warm by utilizing a proportion of the hot air fed to the discharging furnace 4, heat energy is saved.

The present invention is of course not limited to the above embodiments, but may be modified and changed in many ways. For example, the workpiece can be a multiple pipe of three or more layers, or indeed a single walled pipe.

## Claims

1. A method of treating a tubular workpiece by working upon it while it contains a filling material, comprising the steps of:

   introducing the molten filling material into an unworked tubular workpiece (1);

   then working on the workpiece to bring it to a worked condition (6); and

   then heating the workpiece to melt and discharge the filling material;

   characterised in that there is provided a single filling and discharging furnace (2) having in the lower part thereof a filling furnace (4) for filling the filling material into an unworked tubular workpiece, and in the upper part thereof a discharging furnace (3), the filling material being melted and then discharged from a worked workpiece in the discharging furnace, and the molten discharged filling material being gathered in a reservoir (5) in the discharging furnace and thence

introduced into an unworked workpiece disposed in the filling furnace.

2. A filling and discharging furnace for use in carrying out the method claimed in claim 1, comprising:

a discharging furnace (4) for melting and discharging filling material of low melting point from a worked tubular workpiece;

a filling furnace (3) for introducing the filling material into an unworked tubular workpiece;

the discharging furnace being arranged above the filling furnace;

hot air circulating means (16) communicating with both the discharging furnace and the filling furnace and arranged to feed the majority of the hot air flow into the discharging furnace and a remaining portion thereof into the filling furnace; and

a reservoir (5) in the discharging furnace for collecting the molten filling material and having an outlet valve (9) for releasing the collected filling material into the filling furnace.

3. Apparatus according to claim 2, wherein the hot air circulating means comprises a valved exhaust duct (21) for releasing the hot air in the discharging furnace to the exterior, a first supply port (24) for supplying the hot air flow into the discharging furnace (4), and a second supply port (25) for supplying the hot air flow into the filling furnace (3), and wherein the opening and closing of the valve (23) of the exhaust duct are linked with the operation of doors (14,15) respectively provided in the discharging furnace and the filling furnace for movement of the workpieces in and out.

4. Apparatus according to claim 2 or 3, wherein the said reservoir (5) has an sloping bottom surface (8) which protrudes downwardly towards the filling furnace (3).

5. Apparatus according to any of claims 2 to 4, wherein a filling carrier (12) is disposed in the filling furnace (3) below the outlet valve (9) of the said reservoir (5).

6. Apparatus according to any of claims 2 to 5, wherein a plurality of workpiece carriers (10,12) are arranged to be accommodated in both the filling furnace (3) and the discharging furnace (4) at the same time.

7. A carrier for a workpiece (1) which is to be worked upon while containing a filling material, comprising:

a carrier body (31);

a filling deck (30) disposed at the upper part of the carrier body;

a sealing deck (32) disposed at the lower part of the carrier body; and

a lifting deck (38) arranged to move up and down while supporting an unworked tubular workpiece (1);

the filling deck comprising an upwardly open receptacle (44) for holding molten filling material and provided with a nozzle (52) which extends downwardly from a through bore formed in the bottom of the receptacle and which has an inner diameter slightly greater than the outer diameter of the workpiece, the upper end of which is adapted to engage with the nozzle when moved upwardly; and

the sealing deck being arranged to move up and down and having a seal member (60) which has an outer diameter slightly less than the inner diameter of the workpiece, the lower portion of which is adapted to engage with the seal member when the sealing deck is moved upwardly.

8. A carrier of according to claim 7, wherein the carrier body (31) is adapted to support a plurality of workpieces, the said filling deck (30) being provided with a plurality of said nozzles (52) and the said sealing deck being provided with a plurality of said seal members (60), the nozzles and seal members being arranged to cooperate with a said plurality of workpieces.

9. A carrier according to claim 8, including resilient engaging clips (34) for supporting the workpieces (1).

10. A carrier according to any of claims 7 to 9, wherein the said lifting deck is arranged to be lifted as the said sealing deck (32) is lifted, so as to allow the upper end of a workpiece to be connected to a said nozzle (52) and the opening of the lower end thereof to be sealed by a said sealing member (60).

11. A carrier according to any of claims 7 to 10, wherein the said nozzle (52) and the said sealing member (60) are replaceable in response to a change in the specification of the workpiece.

12. A carrier of according to any of claims 7 to 11, wherein the said sealing deck is arranged to be lifted by a lifter separate from the carrier body (31).

13. A carrier according to any of claims 7 to 12, wherein the said sealing deck (32) is arranged to be held by support means (40) against the lower part of the lifting deck (38) when lifted.

**14.** A carrier according to any of claims 7 to 13, wherein the filling deck (30) is arranged to be detachably held relative to the carrier body (31) by support means (46).

**15.** A carrier according to any of claims 7 to 14, wherein the filling deck (30) is provided with a detachably mounted guide pin (51) which is adapted to engage with the inside of the upper end of a workpiece with a clearance formed therebetween, the guide pin being concentric with the said nozzle (52).

Fig.1

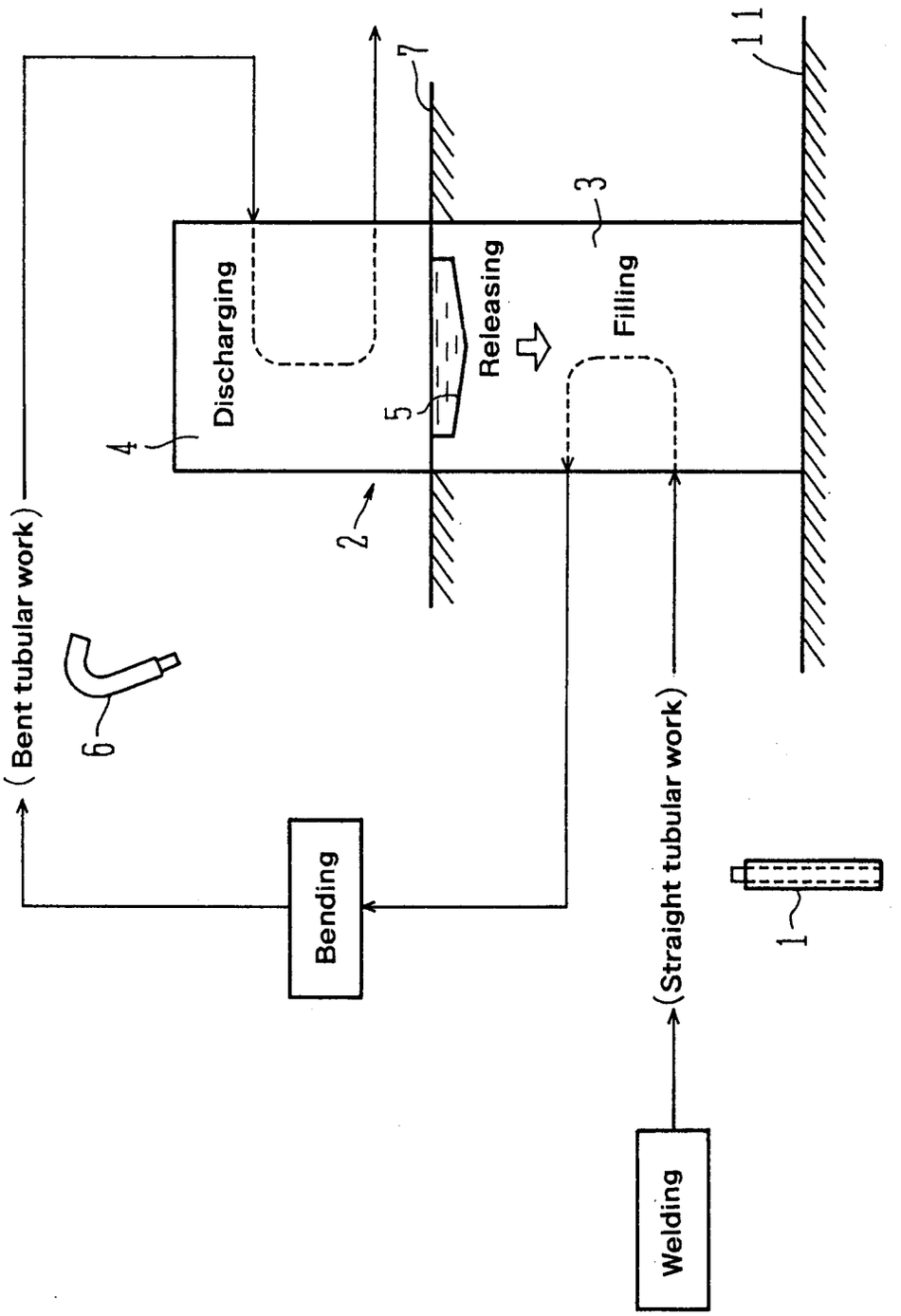
(Bent tubular work)
6
Bending
4
Discharging
2
5
7
Releasing
3
Filling
11
(Straight tubular work)
Welding
1

Fig.2

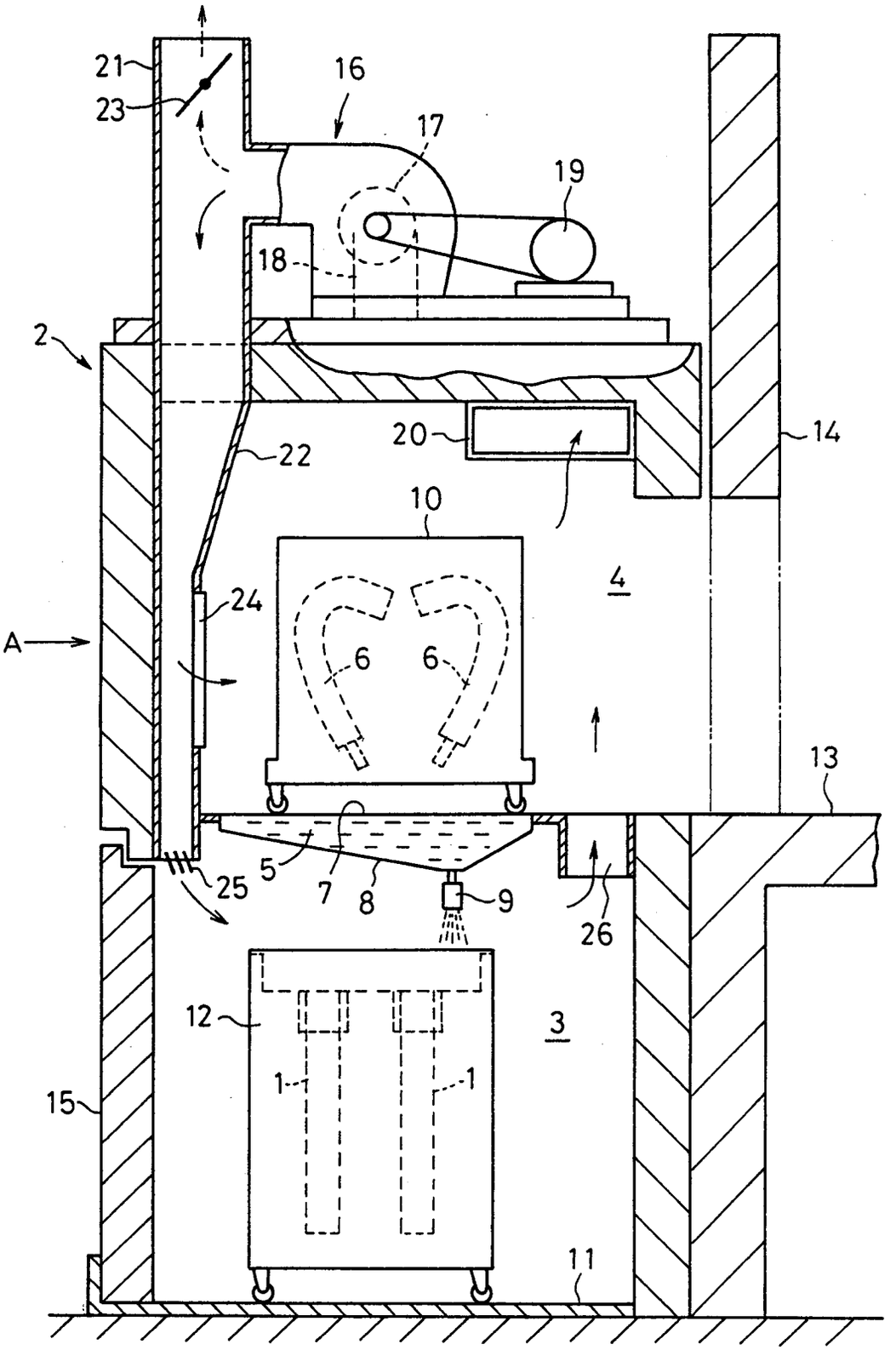

Fig.3

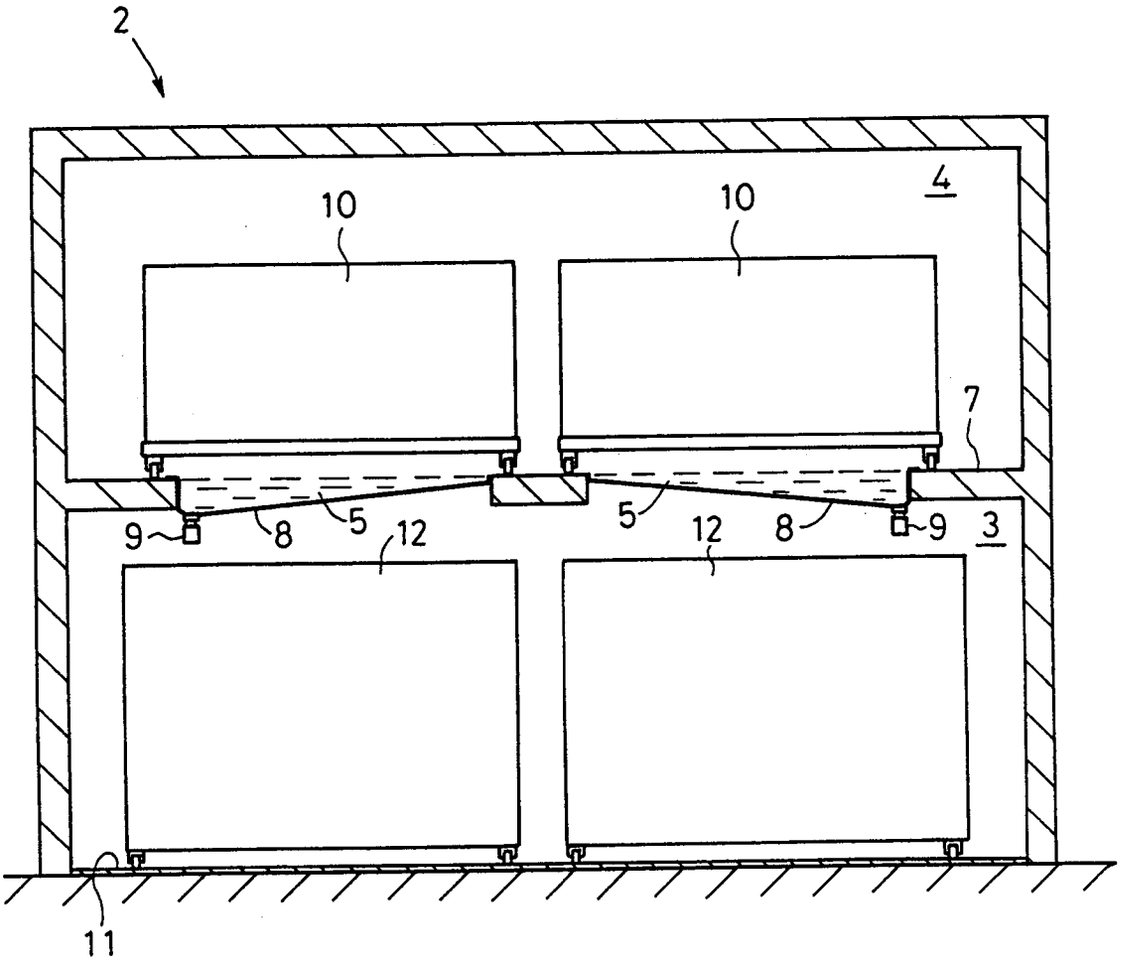

Fig.4

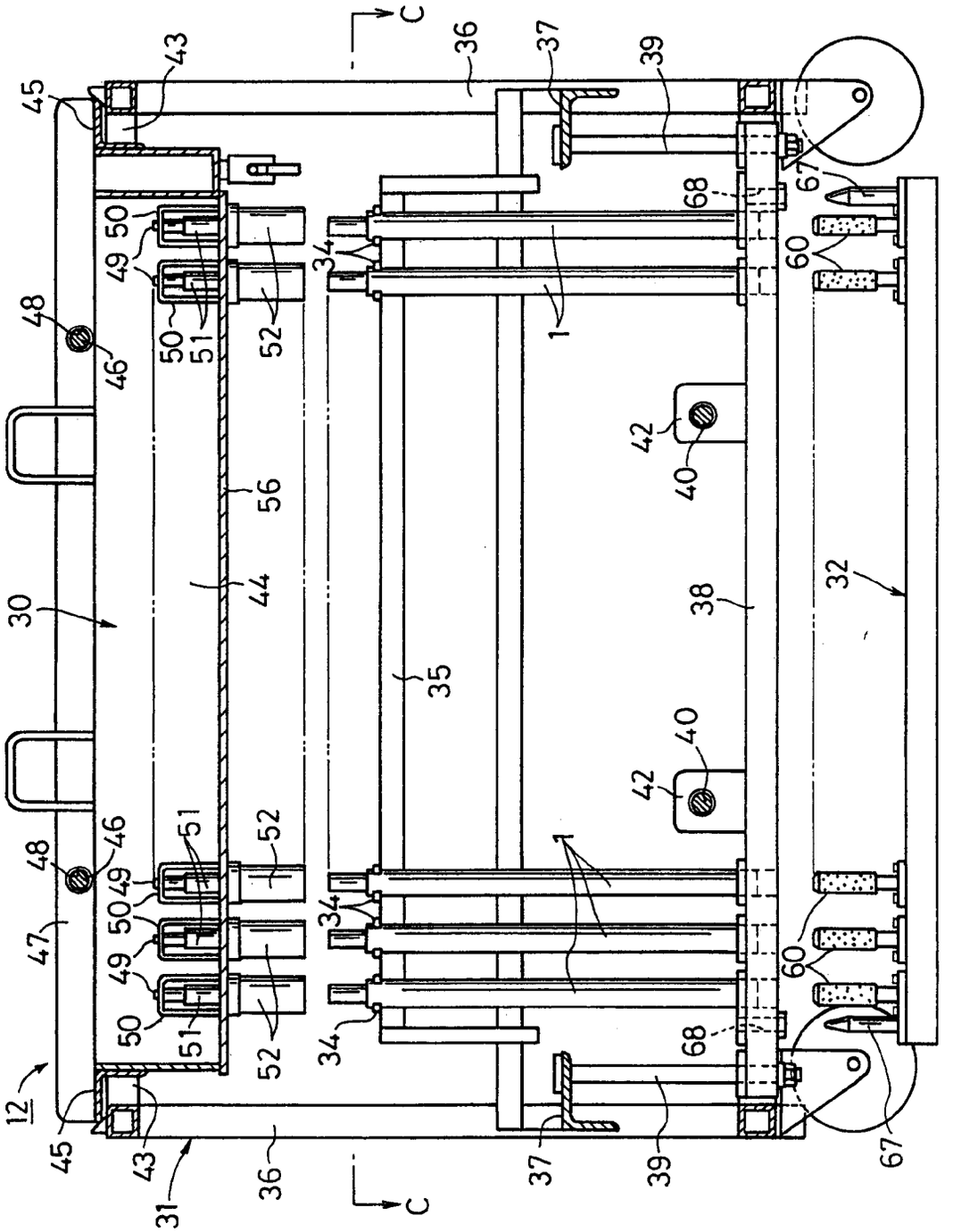
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Fig.5

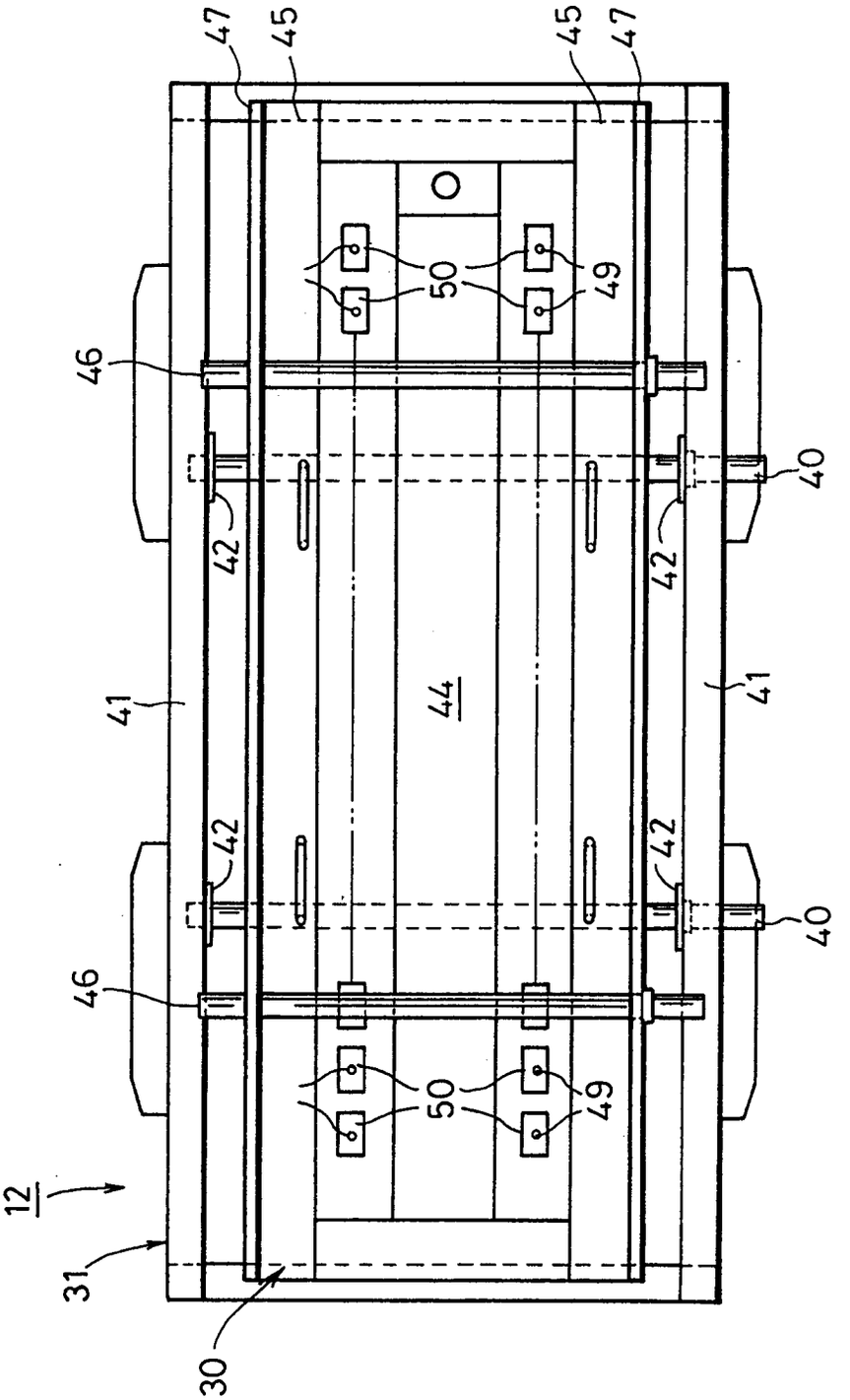

Fig.6

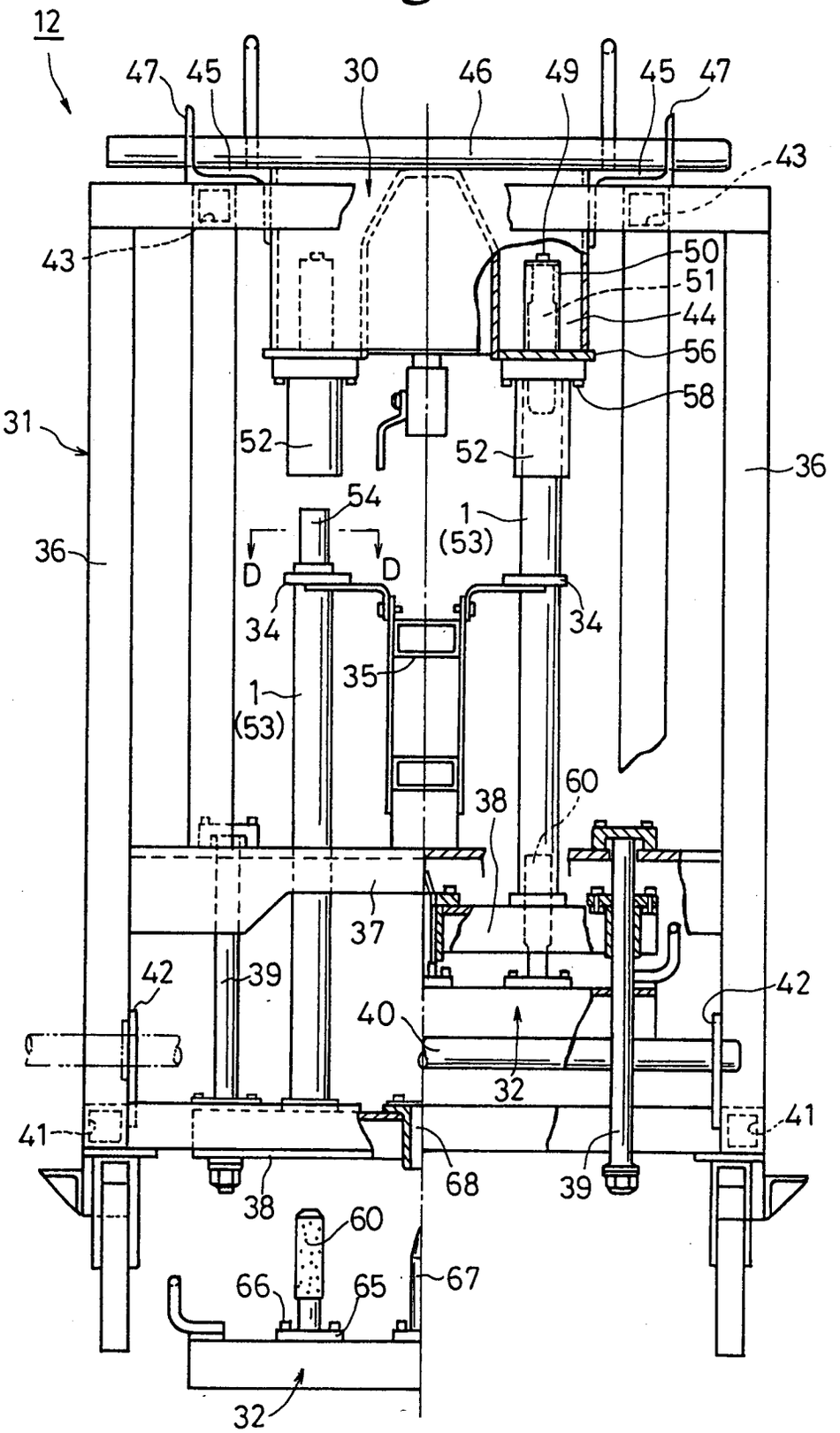
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Fig.7

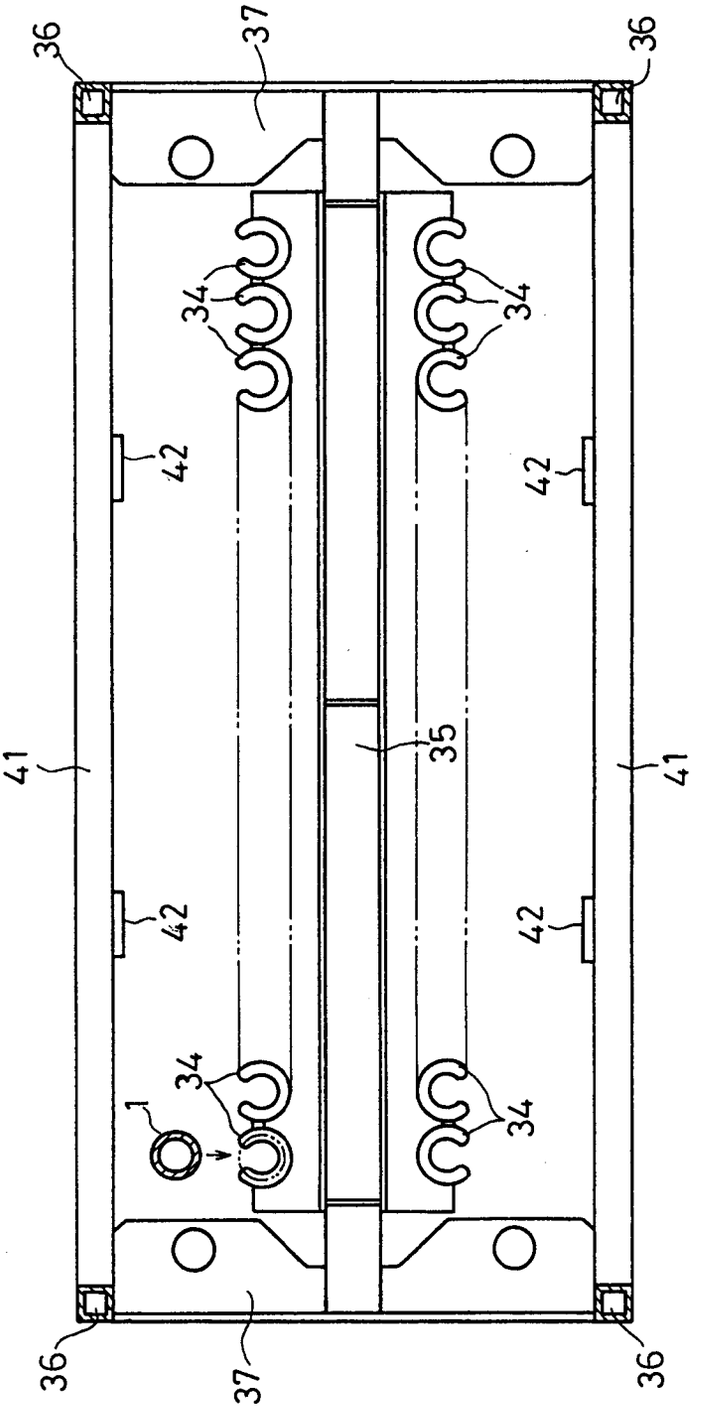

Fig.8

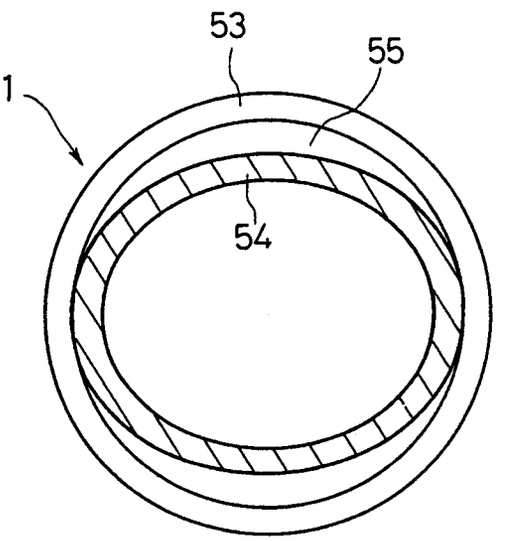

Fig.9

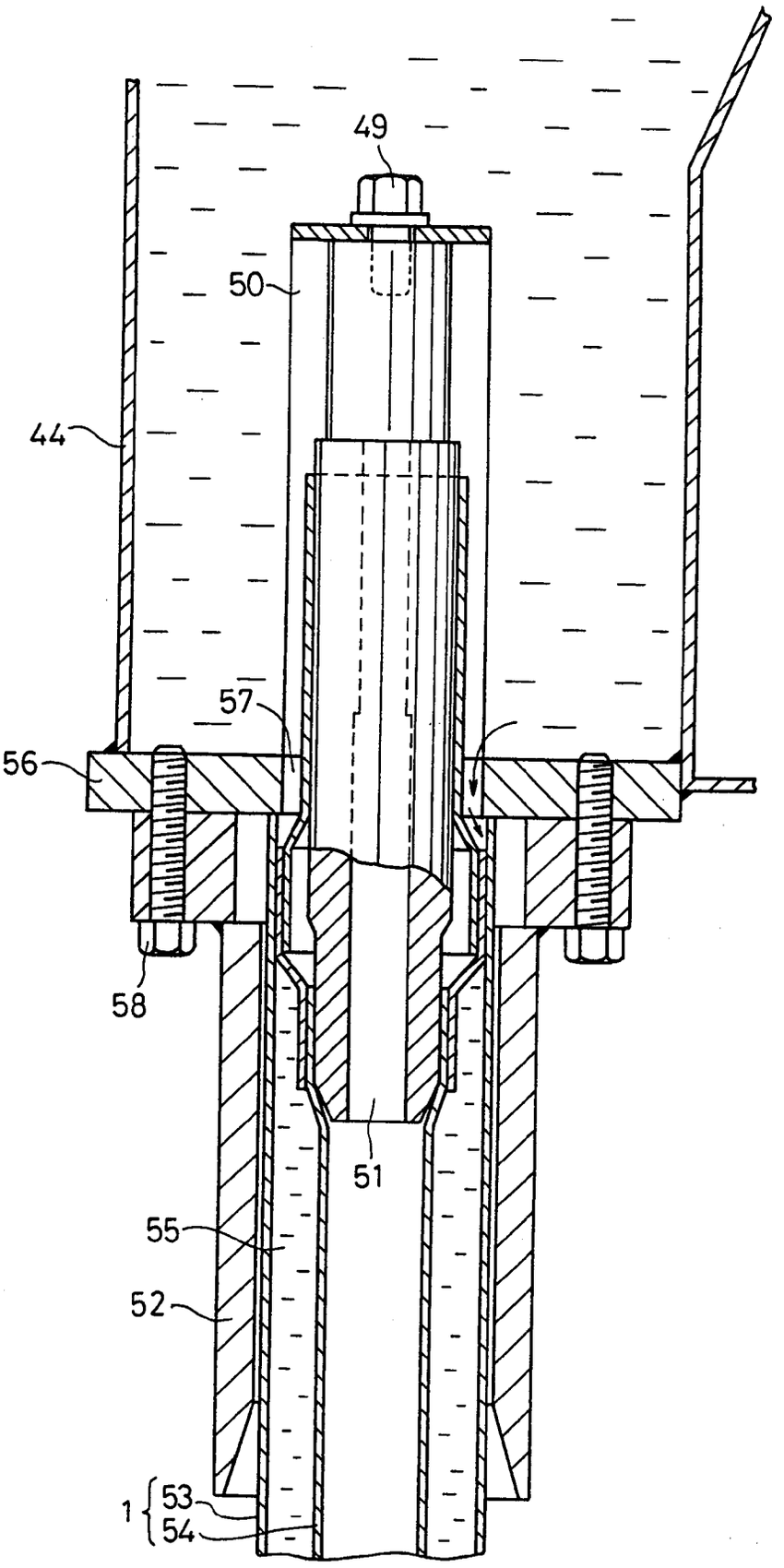

Fig.10

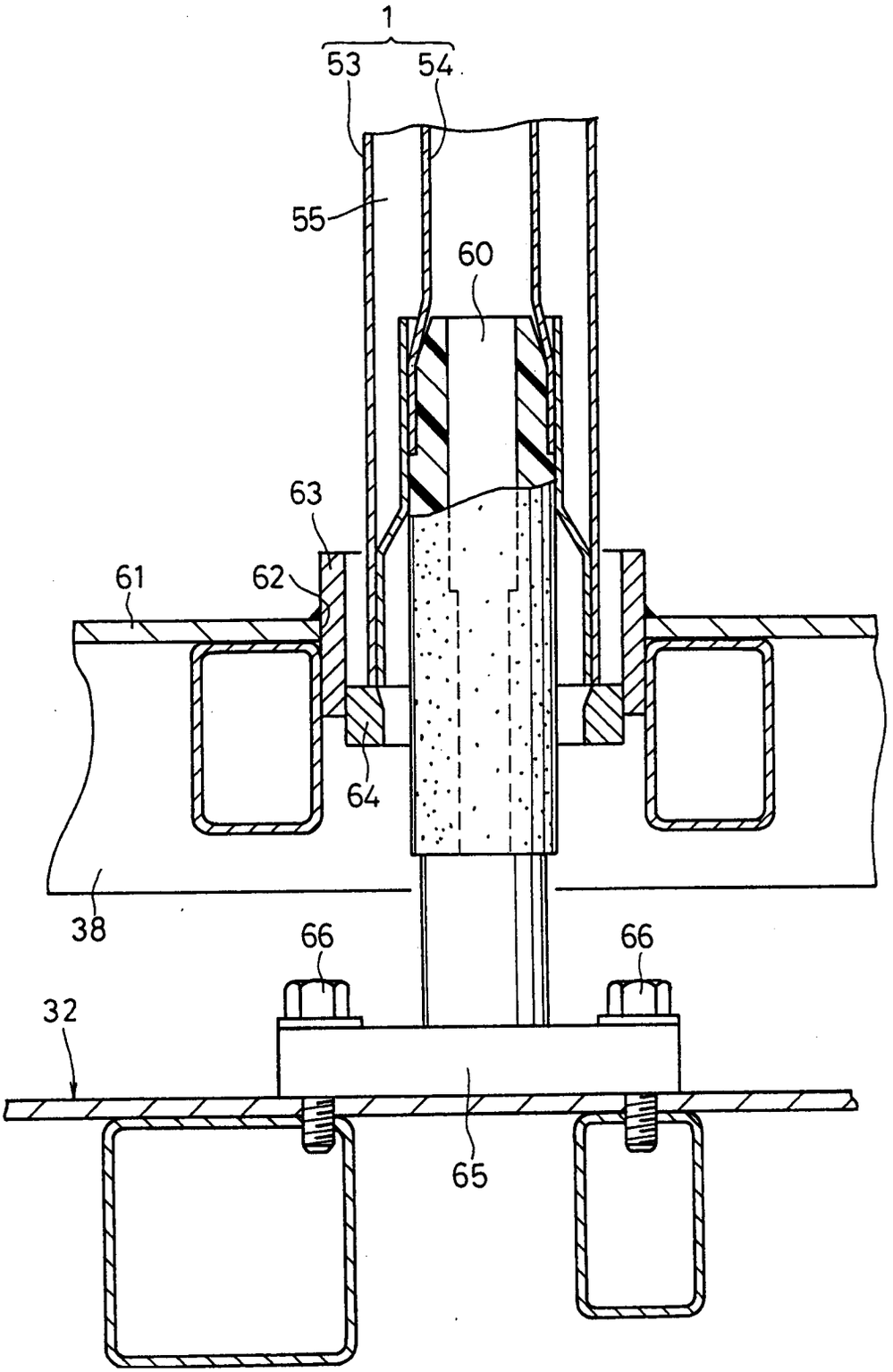

Fig.11

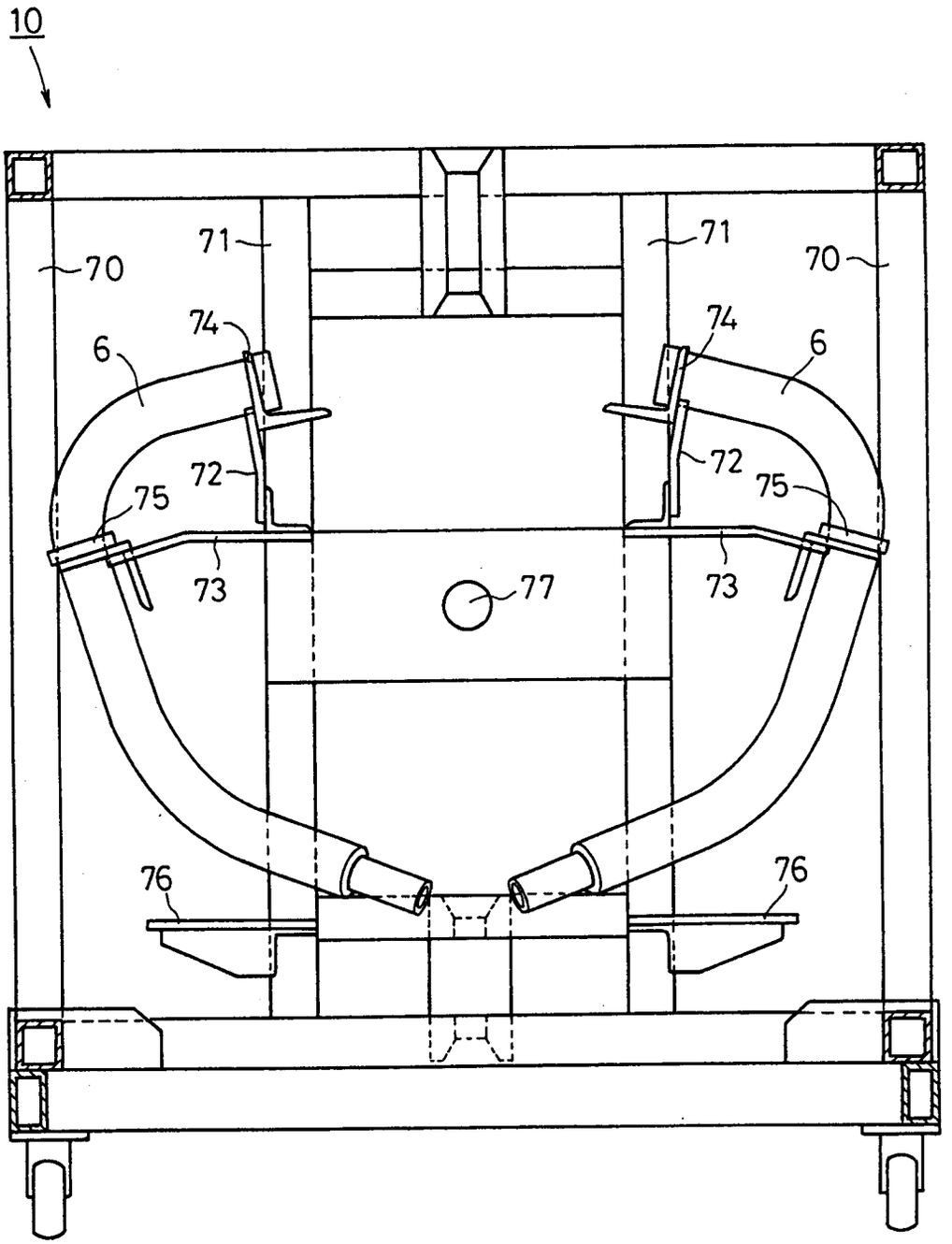

Fig.12