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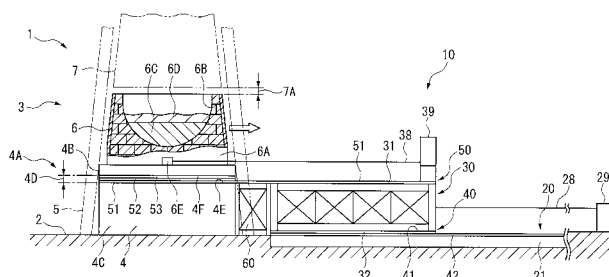
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(54) **RING BLOCK CONVEYING APPARATUS, AND REMEDY METHOD FOR BLAST FURNACE CASING**

(57) A ring block transporter and method of relining a furnace body of a blast furnace with use of no dolly are provided. The method includes: preparing a transport route (20) extending from an installation site (2) to a work site and a transportation platform (30) being slidable on the transport route (20) and having a placement surface (31) on its top surface; separating a hearth block by horizontally cutting a base (4) portion of the furnace body

(3) at a height of the placement surface (31) and horizontally cutting a portion of the furnace body (3) between an upper portion (7) of the furnace body (3) and the hearth block; transferring the hearth block (6) onto the placement surface (31) by horizontally moving the hearth block (6); and transporting the transportation platform (30) upon which the hearth block (6) is placed to the work site along the transport route (20).

FIG. 1



Description

Technical Field

[0001] The present invention relates to a transporter for ring block(s) and a method of relining a furnace body of a blast furnace, which is applicable to carrying-in and carrying-out of ring block(s) in renewing or dismantling the blast furnace. Particularly, the invention relates to an apparatus and a method usable for effective carrying-in and carrying-out of a hearth block of great weight.

Background Art

[0002] Construction work for a furnace body of a blast furnace is conducted when the blast furnace is newly built or relined while dismantling work for the same furnace body is conducted when the blast furnace is relined or shut down.

For such construction or dismantling of a furnace body of a blast furnace, the so-called furnace-body-ring large block method has been developed (see patent document 1), which uses a plurality of ring blocks shaped as if the blast furnace has been cut into round slices.

This method uses a ring block for each section of: a gas collection mantle at the top of the furnace; a middle shaft mantle and furnace belly mantle; and a furnace hearth mantle at the base portion.

Each of the ring blocks has a furnace shell on its outer circumference and is internally attached with staves and refractory material. By linking the ring blocks together, a unified furnace body of a blast furnace can be constructed.

[0003] In constructing the furnace body, a work site is established in the vicinity of an installation site. After the ring blocks are assembled at work site, the ring blocks are transported to the installation site to be sequentially carried-in to the inner side of furnace-body supporting columns. Then, the ring blocks are suspended from above and linked together. Specifically, the block for the gas collection mantle at the top of the furnace is initially carried-in from the side to above the base at the level of the top surface of the base of the furnace body, and then suspended from above. Then, the block for the middle shaft mantle is carried-in and suspended under the block for the gas collection mantle. Following that, the block for the furnace belly mantle is carried-in and suspended under the block for the middle shaft mantle. Finally, the block for the furnace hearth mantle is carried-in and installed under the block for the furnace belly mantle, and then the suspended blocks are sequentially brought down to be connected to each other, whereby a unified furnace body is assembled.

In dismantling the furnace body, the furnace body is separated into ring blocks in the order reverse to that for the above-described construction of the furnace body. Then, the block for the gas collection mantle, the block for the shaft mantle and the block for the furnace belly mantle

are suspended from above. In this state, the block for the furnace hearth mantle is removed, and each of the blocks is then sequentially brought down to a floor so as to be sequentially carried-out to the outside of the furnace-body supporting columns. The carried-out blocks are transported from the installation site to the nearby work site, and then dismantled.

By using such a furnace-body-ring large block method, the period of time required for relining the blast furnace or similar can be considerably shortened.

[0004] In such a furnace-body-ring large block method, the ring blocks are transported between the installation site and the work site. To this end, a plurality of rows of wheeled platforms (dollies) for transportation of the furnace body that are equipped with frame structures for regulation of load levels (furnace-body support platform) are used (see paragraphs 0008 and 0009, and Figs. 8 (A) and 8(B) and the like in the above-mentioned patent document 1).

The furnace-body support platform, on top surface of which the ring blocks are mountable, has a space capable of receiving the dollies at its bottom side.

[0005] While each of the dollies can support a considerable load, the ring blocks, which are of an extremely large weight, are supported and transported by the plurality of dollies in order to disperse the load of the ring blocks.

Specifically, a plurality of trailing cars are linked to a lead car that has a driver's seat to form a row of wheeled platforms. Then, a plurality of these rows of wheeled platforms, which are arranged in parallel, are cooperated together to support the large furnace-body support platform, and travels on the ground for transporting the furnace-body support platform to a designated position.

[0006] Patent Document 1: Japanese Patent No. 3583354

Disclosure of the Invention

Problems to Be Solved by the Invention

[0007] Each of the above-described wheeled platforms (dollies) for transportation of the furnace body has a set loading weight, so that the maximum loading weight is determined by the number of linked dollies.

Of the ring blocks described above, the hearth block when a blast furnace is dismantled has an especially large weight. This is because hot metal having been present inside the furnace when the blast furnace is blown-out for dismantling is solidified by cooling to deposit in the hearth as residual iron and other residue (pig iron and slag and coke).

Accordingly, even when the weight of the other ring blocks when the furnace body is dismantled does not exceed the maximum loading weight for the linked dollies, the hearth block when the furnace body is dismantled weighs heavier than the loading weight because of the residual iron, pig iron and slag and other content.

[0008] In order for the hearth block not to weigh heavier than the loading weight, attempts have been made in weight reduction of the hearth block by removing the residual in the hearth such as the residual iron, pig iron and slag and coke or by removing the stave coolers and refractory bricks attached to the interior of the furnace before the hearth block is loaded on the dollies.

However, such weight reduction process, which is conducted at the installation site of the blast furnace prior to the carrying-out of ring blocks, is not compatible with the furnace-body ring large block method for reducing the work processes conducted at the installation site, thereby hindering shortening of the overall work period.

[0009] On the other hand, another usable technique for the hearth block not to weigh heavier than the loading weight may be to increase the number of dollies for supporting the furnace-body support platform.

However, the space on the bottom side of the furnace-body support platform is limited, so that the number of dollies is restricted. By increasing the size of the furnace-body support platform in plan view, the number of dollies accommodatable therein may be increased. However, when the load of the hearth block placed on the platform is concentrated at the central region but is dispersively supported by the dollies, such an arrangement as to considerably enhance the rigidity of the placement surface of the furnace-body support platform may be required. Thus, such a technique is practically less adoptable.

[0010] A still further usable technique may be to increase the loading weight of each dolly while keeping the size of the furnace-body support platform the same, so as to increase the overall loading weight of the furnace-body support platform.

However, the dollies, which are vehicles specialized for a restricted use, are high in unit cost but low in use frequency. Thus, it is difficult to use order-made ones, so that there is no option other than to use existing standardized products.

As described above, weight restriction has pertained to the transportation of the hearth block on the furnace-body support platform with use of the dollies, so that a weight reduction process as described above has been indispensable. Thus, a resolution therefor has been demanded.

[0011] An object of the invention is to provide a transporter for a ring block(s) that is free from a weight restriction pertaining to transportation of a hearth of a blast furnace and to provide a method of relining a furnace body of a blast furnace.

Means for Solving the Problems

[0012] A ring block transporter according to an aspect of the invention is a ring block transporter that transports a plurality of ring blocks between an installation site for a blast furnace and a work site that is separate from the installation site, the ring blocks being included in a furnace body of the blast furnace, the ring block transporter

including: a transport route installed between the installation site and the work site; a transportation platform being slidable on the transport route and having a placement surface on its top surface, the placement surface being at a height of a base of the furnace body; a bottom slider provided between the transport route and an underside of the transportation platform; and a top slider provided between the placement surface and an underside of the ring block.

[0013] In the aspect of the invention, the transport route is installed between the installation site and the work site in advance, and the transportation platform is arranged on the transport route as well as the bottom slider and the top slider. In transportation, the ring block is moved with the top slider to be placed on the placement surface of the transportation platform. Then, the transportation platform is driven by tractors or the like provided at the transport route to move the ring blocks along the transport route. At this time, the bottom slider enables the transportation platform and the transport route to slide with respect to each other. Transportation can be efficiently conducted by applying a low-friction mechanism or a sliding material to the bottom slider. As a result, the transportation platform can be transported without use of conventional dollies.

[0014] The transporter according to the aspect of the invention is not only usable for transporting the ring blocks from the installation site to the work site at the time of dismantling the blast furnace but also usable for transporting ring blocks from the work site to the installation site at the time of constructing a blast furnace. In this case, locations of tractors installed at the transport route are adjusted, so that the pulling is conducted in a suitable direction.

The ring blocks to be transported by the transporter according to the aspect of the invention are not limited to hearth blocks but may be other blocks.

The transporter according to the aspect of the invention may use tractors arranged on an extension of the transport route or tractors or drivers arranged along the transport route for moving the transportation platform along the transport route. Examples of a tractor include: a traction mechanism in which a wire and a winch are combined; and a drive mechanism or a traction mechanism using a jack or other hydraulic device. Furthermore, a self-propelled tractor vehicle may be used. Alternatively, combinations of any of the above may be selected for the tractor as needed.

[0015] The transporter according to the aspect of the invention may employ such configurations as follows.

It is preferable that the transport route includes: one linear sectional transport route or a plurality of linear sectional transport routes linked together; and a tractor provided on an extension of each of the one or plurality of sectional transport routes.

It is preferable that the tractor includes: a plurality of traction mechanisms juxtaposed in a width direction of each of the one or plurality of sectional transport routes; and

a traction controller that synchronizes pulling operations of the traction mechanisms.

Such traction control can prevent the transportation platform pulled on the transport route from obliquely moving (i.e., inclining with respect to the movement direction) and from meandering (i.e., being repeatedly displaced in a width direction with respect to the movement direction).

[0016] It is preferable that the traction controller includes: a position detector that detects movement amounts of pulled portions of the transportation platform in a pulling direction, the pulled portions corresponding to the traction mechanisms; an oblique-movement detector that determines an inclination of the transportation platform with respect to the pulling direction based on each of the detected movement amounts; and an oblique-movement corrector that corrects operations of the traction mechanisms so that the inclination is reduced. By using such detection and calculation from each of the traction mechanism systems, the movement amounts of the traction mechanisms can be easily and reliably controlled and synchronized. Specific control thereof, to which known machine control techniques are suitably applicable, can be suitably realized by using a programmable controller and software.

[0017] It is preferable that the oblique-movement detector calculates an average value of the movement amounts and calculates deviations between the average value and the movement amounts, and the oblique-movement corrector performs corrections to the traction mechanisms, correction amounts of the corrections corresponding to the deviations.

As described above, by adjusting each of the traction mechanisms based on the deviations from the average value, the pulled portions can be applied with corrections by suitable correction amounts even when the transportation platform is deformed due to the pulling such that linearity is no longer maintained in a difference (foregoing or lagging) between widthwise movement amounts of the pulled positions. Thus, the pulled portions can be adjusted in such a direction that can correct the deformation.

[0018] Prevention of meandering of the transportation platform with respect to the transport route may not be necessarily conducted by preventing oblique movements through the above-described traction control, but may be conducted by a mechanical engagement structure provided between the transport route and the transportation platform or by a mechanical meander-prevention mechanism using cross-sectional shapes of the transport route and the transportation platform in a direction intersecting with the transporting direction. Such a meander-prevention method and meander-prevention mechanism can also be employed in combination.

[0019] It is preferable that the transport route extends into an interior of the work site, and the transportation platform is accommodatable in the interior of the work site with the ring block being placed on the transportation platform.

By extending the transport route into the interior of the

work site, the ring block can be dismantled or manufactured on the transportation platform placed on a portion of the transport route located in the interior of the work site. With this arrangement, it is no longer necessary to transfer the ring block to or from the transportation platform, thereby further shortening the work period.

[0020] In the transporter according to the aspect of the invention, the bottom slider may include: a slide member laid on the transport route; and a slide member attached on the underside of the transportation platform, the pair of slide members being slidably in contact with each other, and the pair of slide members may include any one of: a combination where both are panel members; a combination where one of the pair is a panel member while the other is a long member; and a combination where both are long members, the slide members being made from steel material, stainless material or a low-friction layered panel.

Alternatively, the bottom slider may include: a combination of a roller rail laid on the transport route and a roller mechanism attached on the underside of the transportation platform; or a combination of a roller mechanism laid on the transport route and a roller rail attached on the underside of the transportation platform, the roller mechanism rollably contacting the roller rail.

Advantages provided by the above configurations will be described later in relation to the method of relining a furnace body of a blast furnace. Thus, redundant descriptions therefor will be omitted here.

[0021] In the transporter according to the aspect of the invention, the top slider may include: a slide member laid on the placement surface; and a slide member attached on the underside of the ring block, the pair of slide members being slidably in contact with each other, and the pair of slide members may include any one of: a combination where both are panel members; a combination where one of the pair is a panel member while the other is a long member; and a combination where both are long members, the slide members being made from steel material, stainless material or a low-friction layered panel.

Alternatively, the top slider may include: a combination of a roller rail laid on the placement surface and a roller mechanism attached on the underside of the ring block; or a combination of a roller mechanism laid on the placement surface and a roller rail attached on the underside of the ring block, the roller mechanism rollably contacting the roller rail.

the top slider may include a flotation transporter mounted between the underside of the ring block and the placement surface, the flotation transporter floating and moving above the placement surface by ejecting fluid..

Advantages provided by the above configurations will be described later in relation to the method of relining a furnace body of a blast furnace. Thus, redundant descriptions therefor will be omitted here..

[0022] It is preferable that the top slider that uses the above-described slide members or the rolling rail extends from the placement surface to the base.

According to the aspect of the invention, since the top slider is formed continuously from the placement surface to the base, smooth sliding can be realized. Thus, work efficiency can be enhanced.

[0023] The transporter according to the aspect of the invention preferably further includes an intermediate platform installed between the base and the transport route, a top surface of the intermediate platform being flat and at a same height as the placement surface.

According to the aspect of the invention, the intermediate platform can fill a space between the transportation platform and the base. In other words, for instance, when the transport route cannot be installed sufficiently close to the base due to interference with structures or the like in the vicinity of the base, or when the transportation platform cannot be brought to within close proximity of the base, a space may be formed between the transportation platform and the base. Even when such a space is formed, the intermediate platform can bridge between the transportation platform and the base. Thus, the ring blocks can be reliably transferred between the transportation platform and the base.

[0024] A method of relining a furnace body of a blast furnace according to another aspect of the invention includes a dismantling process group that includes: horizontally cutting the furnace body installed at an installation site to divide the furnace body into a plurality of ring blocks; transporting the ring blocks from the installation site to a work site; and further dismantling the ring blocks at the work site, in which the dismantling process group further includes: preparing: a transport route extending from the installation site to the work site; and a transportation platform being slidable on the transport route and having a placement surface on its top surface; separating a hearth block by horizontally cutting a base portion of the furnace body at a height of the placement surface and horizontally cutting a portion of the furnace body between an upper portion of the furnace body and the hearth block; transferring the hearth block onto the placement surface by horizontally moving the hearth block; and transporting the transportation platform upon which the hearth block is placed to the work site along the transport route.

[0025] According to the aspect of the invention, when the furnace body is dismantled, the hearth block is placed upon the transportation platform, and the transportation platform is moved along the transport route for transporting the hearth block. At this time, by arranging the transportation platform and the transport route to be slidable against each other, the transportation platform can be moved with suitable use of the later-described tractors or the like. Thus, use of dollies is not required. In addition, the transport route is installed continuously from the installation site to the work site, so that desired slidability between the transport route and the transportation platform can be ensured along the entire length of the transport route.

In order to ensure desired slidability between the trans-

port route and the transportation platform, known friction reduction techniques can be used as appropriate. Examples of such friction reduction techniques include a method of using a slide member made of a predetermined material for each member and a method of using a roller mechanism.

[0026] Preferably in the method of relining a furnace body of a blast furnace according to the aspect of the invention, the separating of the hearth block includes: setting a plurality of cut sections when the base portion of the furnace body is horizontally cut, the plurality of cut sections being parallel to a transporting direction of the transferring of the hearth block in a plan view; horizontally cutting each of the cut sections at a position corresponding to a height of the placement surface and at a position higher than the placement surface by a predetermined height to form a bottom cut surface and a top cut surface; removing portions between the top and bottom cut surfaces to form a vacant portion; arranging a slide member on a top surface of the bottom cut surface, the slide member extending in a movement direction of the transferring of the hearth block and arranging a load support on a top surface of the slide member to filling the vacant portion; and repeating the forming of the cut surfaces and the filling of the vacant portion for all of the cut sections, and all of the above is conducted before blowing-out of the blast furnace.

For horizontally cutting each of the sections, use of a wire saw is preferable. Prior to cutting the sections with a wire saw, through-holes are preferably opened in boundary portion(s) of the sections of the base. The load support for filling the vacant portion is preferably capable of transmitting a load applied from the upper side on the relevant section(s) to the lower side after filling the vacant portion. Such a material can be suitably selected from HPA (High Pack Anchor, a fibrous sack filled with mortar), α -material (a combination of garnets, spherical particles of small diameter, and one or more types of mortar) and a combination thereof.

[0027] According to the aspect of the invention, by using the vacant portions formed between the horizontal top and bottom cut surfaces, the slide members can be easily and reliably installed. Because the vacant portions are filled with the load support after the slide members are installed, the vacant portions can recover supportability of the load of the base top portion and the hearth block located above the cut portions. In particular, because the above-described cutting and filling are conducted for each of the cut sections, the height of the base top portion and the hearth block located above the cut portions can be kept constant. Thus, the cutting, the installation of the slide members and the filling of load supporters can be conducted under stable conditions for all of the sections.

With respect to the cutting of the sections with a wire saw and the installation of the slide members and the load support, International Patent Application No. PCT/JP2007/060043 and Japanese Patent Application

No. 2006-138733, which are commonly owned by the present applicant, make proposals in detail.

According to the aspect of the present application, by making preparations for the cutting of the base portion and the carrying-out of the hearth block before the blast furnace is blown-out (i.e., before suspension of the operation), the hearth block can be carried-out immediately after the blast furnace is blown-out, thereby minimizing the time period required for relining the blast furnace.

[0028] The method of relining according to the aspect of the invention, which includes the dismantling process group described above, may further include a construction process group for constructing the furnace body at the installation site, in which the construction process group includes: preparing: a transport route extending from the work site to the installation site; and a transportation platform being slidable on the transport route and having a placement surface on its top surface; manufacturing a hearth block on the placement surface with the transportation platform being placed at the work site; transporting the transportation platform upon which the hearth block is placed to the installation site along the transport route; transferring the hearth block horizontally from the placement surface onto a base of the installation site; and sequentially linking the ring blocks together to construct the furnace body.

[0029] A still further aspect of the invention provides a method of relining a furnace body of a blast furnace including a construction process group that includes: manufacturing a plurality of ring blocks at a work site; transporting the ring blocks from the work site to an installation site; and linking the ring blocks together at the installation site to construct a blast furnace, in which the construction process group further including: preparing: a transport route extending from the work site to the installation site; and a transportation platform being slidable on the transport route and having a placement surface on its top surface; manufacturing a hearth block on the placement surface with the transportation platform being placed at the work site; transporting the transportation platform upon which the hearth block is placed to the installation site along the transport route; transferring the hearth block horizontally from the placement surface onto a base of the installation site; and sequentially linking the ring blocks together to construct a furnace body.

[0030] According to the aspect of the invention, in constructing a furnace body, a hearth block is manufactured on the transportation platform at the work site and transported to the installation site by moving the transportation platform along the transport route. Then, by fixing the hearth block onto the base at the installation site and sequentially linking ring blocks together on the hearth block, the furnace body can be constructed.

At this time, by arranging the transportation platform and the transport route to be slidable against each other, the transportation platform can be moved with suitable use of the later-described tractors or the like. Thus, use of dollies is not required. In addition, the transport route is

installed continuously from the installation site to the work site, so that desired slidability between the transport route and the transportation platform can be ensured along the entire length of the transport route.

In order to ensure desired slidability between the transport route and the transportation platform, known friction reduction techniques can be used as appropriate. Examples of such friction reduction techniques include a method of using a slide member made of a predetermined material for each member and a method of using a roller mechanism.

[0031] Preferably in the method of relining a furnace body of a blast furnace according to the aspect of the invention, the preparing of the transport route and the transportation platform includes: linearly arranging the transport route; and providing a tractor on an extension of the transport route at a position remotely away from the base, and the transporting of the transportation platform includes: pulling the transportation platform with the tractor; and moving the transportation platform along the transport route.

According to the aspect of the invention, the transportation platform can be moved on the transport route with use of the tractors. At this time, by linearly arranging the transport route, the transportation platform can be reliably moved merely with the pulling by the tractors without using guides or similar for changing direction.

According to the aspect of the invention, the tractors may be provided by traction mechanisms in which known wires and known winches are combined.

[0032] The method of relining a furnace body of a blast furnace according to the aspect of the invention may employ such configurations as follows.

It is preferable that the preparing of the transport route and the transportation platform further includes: providing the transport route by linking a plurality of linear sectional transport routes together; and providing the tractor on an extension of each of the sectional transport routes, and the transporting of the transportation platform further includes: sequentially connecting the hearth blocks to be transported to a downstream tractor in a switching manner.

According to the aspect of the invention, the route can be bent at each section. Thus, a degree of freedom with respect to the location of the installation site and the work site and to the arrangement of the transport route can be ensured while still benefiting from utilization of the above-described linear pulling.

[0033] It is preferable that the tractor uses: a plurality of traction mechanisms juxtaposed in a width direction of each of the sectional transport routes; and a traction controller that synchronizes pulling operations of the traction mechanisms, and the transition controller controls the pulling operations of the traction mechanisms to be synchronized and controls movement amounts of pulled portions of the transportation platform pulled by the traction mechanisms to become constant.

Such traction control can prevent the transportation plat-

form pulled on the transport route from obliquely moving (i.e., inclining with respect to the movement direction) and from meandering (i.e., being repeatedly displaced in a width direction with respect to the movement direction).

[0034] It is preferable that the traction controller: detects the movement amounts of the pulled portions of the transportation platform in a pulling direction, the pulled portions corresponding to the traction mechanisms; determines an inclination of the transportation platform with respect to the pulling direction based on each of the detected movement amounts; and corrects operations of the traction mechanisms so that the inclination is reduced.

By using such detection and calculation from each of the traction mechanism systems, the movement amounts of the traction mechanisms can be easily and reliably controlled and synchronized. Specific control thereof, to which known machine control techniques are suitably applicable, can be suitably realized by using a programmable controller and software.

[0035] It is preferable that, in determining the inclination, the traction controller calculates an average value of the movement amounts and calculates deviations between the average value and the movement amounts, and performs corrections to the traction mechanisms, correction amounts of the corrections corresponding to the deviations.

As described above, by adjusting each of the traction mechanisms based on the deviations from the average value, the pulled portions can be applied with corrections by suitable correction amounts even when the transportation platform is deformed due to the pulling such that linearity is no longer maintained in a difference (foregoing or lagging) between widthwise movement amounts of the pulled positions. Thus, the pulled portions can be adjusted in such a direction that can correct the deformation. Prevention of meandering of the transportation platform with respect to the transport route is not necessarily conducted by preventing oblique movements through the above-described traction control but may be conducted by a mechanical engagement structure provided between the transport route and the transportation platform or by a mechanical meander-prevention mechanism using cross-sectional shapes of the transport route and the transportation platform in a direction intersecting with the transporting direction. Such a meander-prevention method and meander-prevention mechanism can also be employed in combination.

[0036] Preferably in the method of relining a furnace body of a blast furnace according to the aspect of the invention, the transport route extends into an interior of the work site, and works for the ring block are conducted on the transportation platform located on the transport route in the interior of the work site.

By extending the transport route into the interior of the work site, the ring block can be dismantled or manufactured on the transportation platform placed on a portion of the transport route located in the interior of the work

site. With this arrangement, it is no longer necessary to transfer the ring block to or from the transportation platform, thereby further shortening the work period.

[0037] Preferably in the method of relining a furnace body of a blast furnace according to the aspect of the invention, the bottom slider includes: a slide member laid on the transport route; and a slide member attached on the underside of the transportation platform, the pair of slide members being slidably in contact with each other, and the pair of slide members includes any one of: a combination where both are panel members; a combination where one of the pair is a panel member while the other is a long member; and a combination where both are long members, the slide members being made from steel material, stainless material or a low-friction layered panel.

[0038] Preferably in the method of relining a furnace body of a blast furnace according to the aspect of the invention, the top slider includes: a slide member laid on the underside of the hearth block, the pair of slide members being slidably in contact with each other, and the pair of slide members includes any one of: a combination where both are panel members; a combination where one of the pair is a panel member while the other is a long member; and a combination where both are long members, the slide members being made from steel material, stainless material or a low-friction layered panel.

[0039] According to the aspect of the invention, by using typical panel members and mold materials, implementation can be facilitated and cost can be reduced. A lubricant or similar may be applied to between the pairs of slide members.

Use of panel members as the slide members can minimize an increase in thickness caused by the installation of the slide members. With use of long members, the slide members can be installed at intervals instead of being installed over the entire surface of the transport route. Thus, ground leveling and the like can be simplified. When long members are used, the length-wise direction of the long members preferably coincides with the transporting direction. When long members are used exemplarily for the transport route, the long members may be buried in the ground by an amount corresponding to their height after the ground is leveled.

[0040] By using steel or stainless material as the basic material of the slide members, implementation can be facilitated and cost can be reduced.

Examples of the low-friction layered panel usable for the slide members include a material containing PTFE (polytetrafluoroethylene) or similar so as to secure low friction coefficient such as PILLAR FLUOROGOLD manufactured by Nippon Pillar Packing Co., Ltd. In particular, use of self-lubricating materials is preferable.

Such a low-friction layered panel is a thin panel member, but can still considerably enhance the slidability in use. However, because such a low-friction layered panel is more costly than steel and stainless materials, such a

low-friction layered panel is preferably limitedly used for the underside of the hearth block. It is also preferable that low-cost materials are used for the lengthy transport route or the placement surface.

[0041] Preferably in the method of relining a furnace body of a blast furnace according to the aspect of the invention, the bottom slider includes: a combination of a roller rail laid on the transport route and a roller mechanism attached on the underside of the transportation platform; or a combination of a roller mechanism laid on the transport route and a roller rail attached on the underside of the transportation platform, the roller mechanism rollably contacting the roller rail.

[0042] Preferably in the method of relining a furnace body of a blast furnace according to the aspect of the invention, the top slider includes: a combination of a roller rail laid on the placement surface and a roller mechanism attached on the underside of the hearth block; or a combination of a roller mechanism laid on the placement surface and a roller rail attached on the underside of the hearth block, the roller mechanism rollably contacting the roller rail.

[0043] According to the invention, by using the roller mechanism and the roller rail, the sliders can dramatically reduce the friction.

As the roller mechanisms, it is possible to use a known machine component having a roller mechanism such as TIRTANK or TIRROLLER manufactured by TIR Corporation. For the roller rails, steel or stainless panel members or metal molds can be used. Because the roller mechanisms are more expensive than the roller rails, the less-costly roller rails are preferably used for the lengthy transport route or the placement surface.

[0044] In the method of relining a furnace body of a blast furnace according to the aspect of the invention, the top slider may include a flotation transporter mounted between the underside of the ring block and the placement surface, the flotation transporter floating and moving above the placement surface by ejecting fluid.

As the flotation transporter, it is possible to use a known device, such as an air caster, that reduces friction by downwardly ejecting compressed air to form a thin layer of pressurized air between itself and a flat floor surface. According to the aspect of the invention, by using the flotation transporter, the installation of the continuous slide members or roller rails is no longer necessary.

[0045] The method of relining a furnace body of a blast furnace and the ring block transporter according to the aspect(s) of the invention can dispense with a conventional weight reduction process for the hearth. Such a conventional weight reduction process has required a series of work such as: (1) opening of the hearth mantle (furnace shell); (2) removal of coke, residual iron, pig iron and slag, stave coolers, refractory bricks and the like from the furnace interior; and (3) any temporary construction work required for such works (construction/removal of slopes for construction machinery, removal of obstacles such as pipes and decks of the furnace body). However,

according to the invention, such a series of work can be dispensed with. Thus, a relining period that has been required by a transporting process using the dollies can be shortened by at least 7 days.

Brief Description of Drawings

[0046]

Fig. 1 is a side view showing a blast furnace and a transporter according to a first exemplary embodiment of the invention.

Fig. 2 is a plan view showing the blast furnace and the transporter according to the first embodiment.

Fig. 3 is a cross-sectional view showing a bottom slider and a top slider according to the first embodiment.

Fig. 4 is a schematic view showing a preparation step according to the first embodiment.

Fig. 5 is a schematic view showing a separation step according to the first embodiment.

Fig. 6 is a schematic view showing a transfer step according to the first embodiment.

Fig. 7 is a schematic view showing a transportation step according to the first embodiment.

Fig. 8 is a cross-sectional view showing another embodiment of a bottom slider according to the invention.

Fig. 9 is a cross-sectional view showing another embodiment of a bottom slider according to the invention.

Fig. 10 is a plan view showing a meander-prevention system according to the invention.

Fig. 11 is a diagram showing a control block for the meander-prevention system according to the invention.

Fig. 12 is a diagram showing a control flow for the meander-prevention system according to the invention.

Fig. 13 is a diagram showing another control flow for the meander-prevention system according to the invention.

Fig. 14 is a cross-sectional view showing another embodiment of a bottom slider according to the invention.

Fig. 15 is a cross-sectional view showing another embodiment of a bottom slider according to the invention.

Fig. 16 is a plan view showing another embodiment of a meander-prevention mechanism according to the invention.

Fig. 17 is a cross-sectional view showing an embodiment of a primary portion of the meander-prevention mechanism according to the invention.

Fig. 18 is a cross-sectional view showing another embodiment of a primary portion of the meander-prevention mechanism according to the invention.

Fig. 19 is a cross-sectional view showing another

embodiment of the meander-prevention mechanism according to the invention.

Fig. 20 is a plan view showing another embodiment of the meander-prevention mechanism according to the invention.

Fig. 21 is a plan view showing another embodiment of the meander-prevention mechanism according to the invention.

Fig. 22 is a cross-sectional view showing another embodiment of a bottom slider according to the invention.

Fig. 23 is a cross-sectional view showing another embodiment of a bottom slider according to the invention.

Fig. 24 is a cross-sectional view showing another embodiment of a bottom slider according to the invention.

Fig. 25 is a cross-sectional view showing a bottom slider according to another embodiment of the invention.

Fig. 26 is a cross-sectional view showing a bottom slider according to another embodiment of the invention.

Fig. 27 is a side view showing a state when relining is started according to a second embodiment of the invention.

Fig. 28 is a side view showing a state during a dismantling process according to the second embodiment of the invention.

Fig. 29 is a side view showing a transition stage to a construction process according to the second embodiment of the invention.

Fig. 30 is a side view showing a state during a construction process according to the second embodiment of the invention.

Fig. 31 is a side view showing a state during a final relining stage according to the second embodiment of the invention.

Fig. 32 is a side view showing a transporter according to the second embodiment of the invention.

Explanation of Codes

[0047]

1	blast furnace
2	installation site
3	furnace body
4	base
4A	cut portion
4B	base top portion
4C	base bottom portion
4D	vacant portion
4E	bottom cut surface
4F	top cut surface
4G	cut section
5	furnace-body supporting column
6A	furnace shell

6B	refractory brick
6C	residual iron
6D	pig iron and slag
6E	bracket
5 6,6N,6P	hearth block
7,7N,7P	ring block
8	work site
8N	manufacturing work site
8P	dismantling work site
10 10	transporter
20	transport route
20A,20B	sectional transport route
20C	main transport route
20D	secondary transport route
15 21,22	base rail
23	long member
28,38,28A,28B	wire
29,39,29A,29	tractor
30,30N,30P	transportation platform
20 31	placement surface
32	underside
35	concave portion
40	bottom slider
41,42	slide plate
25 43	roller
44	TIRTANK
50	top slider
51,52	slide plate
53	load support
30 60	intermediate platform
292	traction distance controller

Best Mode for Carrying Out the Invention

35 [0048] An exemplary embodiment of the invention will be described below based on the drawings.

First Exemplary Embodiment

40 [0049] In Figs. 1 and 2, a blast furnace 1 is installed at an installation site 2, a furnace body 3 of the blast furnace 1 is constructed onto a base 4, and furnace-body supporting columns 5 are installed surrounding the furnace body 3. During dismantling, the furnace body 3 is split into a hearth block 6 and upper ring block(s) 7 and carried-out.

45 During the carrying-out, the ring block 7 is supportably suspended from jacks (not shown) installed at the furnace-body supporting columns 5. The carried-out hearth block 6 and ring block 7 are transported to a separately-located work site 8, and individually dismantled.

50 [0050] The hearth block 6 has a furnace shell 6A on its exterior, and has refractory bricks 6B installed on its inner circumference and underside. Residual iron 6C and pig iron and slag 6D cooled and solidified after the blast furnace 1 is blown-out is deposited on the bottom of the hearth interior.

55 The base 4 is made by layering refractory bricks at the

installation site.

The dismantling method for a furnace body of a blast furnace according to the aspect of the invention is employed in the dismantling of the furnace body 3 of the blast furnace 1 described above. In order to use this method, a transporter 10 according to the aspect of the invention is installed in an area from the installation site 2 to the work site 8.

[0051] The transporter 10 includes: a transport route 20 extending from the installation site 2 to the work site 8; a transportation platform 30 slidable on the transport route 20 and having a placement surface 31 on its top surface; a bottom slider 40 formed between the transport route 20 and the underside 32 of the transportation platform 30; and a top slider 50 formed between the placement surface 31 of the transportation platform 30 and the hearth block 6.

[0052] The transport route 20 includes a plurality of base rails 21 arranged in parallel with the lengthwise direction of the transport route 20 and a large number of slide plates 41 paved over their top surface(s).

As shown in Fig. 3, the base rails 21, which are each long and steel H-frame members, are buried so that their top surfaces will be the same height as the surface of the ground. As a hearth block 6 can reach weights of up to 5000 to 8000 tons, it is preferable that appropriate reinforcement is conducted with respect to the ground where the base rails 21 are to be buried. Suitable existing civil engineering techniques may be applied in the reinforcement of the ground or the burying of the base rails 21.

The slide plates 41, which are short and plate-like panels, are tightly attached to the top surface of the base rails 21 and sequentially linked so that there is no difference in height between their surfaces. The slide plates 41 provide the bottom slider 40.

[0053] The transport route 20 includes two sectional transport routes 20A and 20B.

The sectional transport routes 20A and 20B, which are each linearly shaped, are placed such that the sectional transport route 20B is orthogonally linked to the downstream end of the sectional transport route 20A (at the end remotely away from the installation site 2) with the entire arrangement having an L shape.

This configuration is employed when a linear route cannot be used to connect the installation site 2 with the work site 8. When a linear route can be used to connect the installation site 2 with the work site 8, a single and linear transport route may be installed without using the sectional transport routes.

[0054] Tractors 29 (29A and 29B) are provided at the downstream extensions of the sectional transport routes 20A and 20B. The tractors 29A and 29B include one or a plurality of traction mechanisms. According to the present embodiment, the traction mechanisms are winches or the like, with each being connected to the transportation platform 30 via wires 28 (28A and 28B). According to the present embodiment, the traction mechanisms are arranged in pairs on both sides with respect

to the width direction of the transport routes 20A and 20B (the width direction of the transportation platform 30).

As described above, the transportation platform 30 is transported over the transport route 20 by pulling the transportation platform 30 with the tractors 29 (each of the winches and wires 28). Specifically, by pulling the transportation platform 30 with the tractor 29A on the sectional transport route 20A, and by pulling the transportation platform 30 with the tractor 29B on the sectional transport route 20B, the transportation platform 30 can be transported from the installation site 2 to the work site 8.

[0055] An end of the transport route 20 (sectional transport route 20B) is extended into the interior of the work site 8.

With this arrangement, the transportation platform 30 with the ring block carried on top can be brought into the interior of the work site 8, and the work site 8 is able to house the transportation platform 30 with the ring block carried on its top.

It is also possible to construct a new ring block on the top of the transportation platform 30 while the transportation platform 30 remains on the transport route 20 extended into the interior of the work site 8.

[0056] For the tractors 29, aside from winches, a suitable drive-type traction mechanism such as hydraulic jacks can be used. As the tractors 29, any tractor is usable as long as such a tractor can produce enough drive force to overcome the resistance (friction or similar applied on the bottom slider 40 described later) applied between the transportation platform 30 and the transport route 20. As described above, one or a plurality of traction mechanisms, which may be winches, hydraulic jacks or the like, can be arranged as the tractors 29. When a plurality of traction mechanisms are used, their total drive force should be enough to overcome the resistance applied between the transportation platform 30 and the transport route 20.

While the main function of the tractors 29 is to provide the transportation platform 30 with drive force, the tractors 29 are preferably arranged with prevention of meandering of the transportation platform 30 also taken into account.

For example, when the transportation platform 30 is meandered (i.e., deviated with respect to the direction of movement), the tractors preferably adjust the drive force of a plurality of winches depending on the circumstances and return the direction of movement of the transportation platform 30 to a normal route. For the detection of meandering of the transportation platform 30, known measurement techniques are suitably usable. For instance, a linear encoder or similar may be provided on both sides of the transportation platform 30 for detecting displacement from the transport route 20, or a rotary encoder may be provided for measuring the amount of wire 28 wound on the winches on each side.

A detailed description of such meander prevention by adjusting the tractors will be given later.

[0057] The transportation platform 30 is a box-shaped structure made from a steel framework or similar, with its top surface being a placement surface 31 upon which a hearth block 6 and ring block 7 can be placed. The underside 32 of the transportation platform 30 is supported on the transport route 20 via the bottom slider 40.

The underside 32 is covered with a plurality of slide plates 42. The slide plates 42, together with the slide plates 41 on the transport route 20, provide the bottom slider 40.

[0058] On the placement surface 31 of the transportation platform 30, a large number of slide plates 51 are arranged in rows, and tractors 39 are provided at a position remotely away from the blast furnace 1.

The slide plates 51, which are short and plate-like panels, are tightly attached to the placement surface 31 and sequentially linked so that there is no difference in height between their surfaces. The slide plates 51, which provides the top sliders 50, are provided continuously into the interior of a later-described cut portion 4A of the base 4.

[0059] The tractors 39 are a pair of winches or the like arranged on both sides of the placement surface 31, and are connected to the hearth block 6 via each of the wires 38. Brackets 6E are mounted on both sides of the hearth block 6, and the wires 38 are connected to these brackets 6E. Accordingly, the hearth block 6 is designed to be transferred from the base 4 to the placement surface 31 by pulling the hearth block 6 with the tractors 39 via the wires 38.

Where appropriate, the tractors 39 can employ the same configuration as the tractors 29 described above.

[0060] The bottom slider 40 includes the above-described slide plates 41 on the transportation platform 30 and the slide plates 42 covering the underside 32 of the transportation platform 30.

As is shown in Fig. 3, the facing surfaces of the slide plates 41 and 42 slide against each other when the transportation platform 30 is moved over the transport route 20. Materials for the slide plates 41 and 42 are suitably selected in order to reduce friction resistance during this sliding.

According to the present embodiment, the slide plates 41 (longer plates) adjacent to the transport route 20 are made of steel while the slide plates 42 (comparatively shorter plates) adjacent to the transportation platform 30 are made of stainless material.

[0061] According to the present embodiment, the cut portion 4A is formed in the base 4 at a height corresponding to the height of the placement surface 31. When the hearth block 6 is to be carried-out, this cut portion 4A separates the base 4 into a base top portion 4B that is carried-out integrally with the hearth block 6 and a base bottom portion 4C that remains at the installation site 2, and ensures a vacant portion 4D in which top the sliders 50 are provided.

[0062] An intermediate platform 60 is installed between the base 4 and the transportation platform 30, and the top surface of the base bottom portion 4C and the

placement surface 31 of the transportation platform 30 are designed to form a single continuous surface via the top surface of this intermediate platform 60.

The top surface of the base bottom portion 4C, the top surface of the intermediate platform 60 and the placement surface 31 of the transportation platform 30 are covered with panel members that serve as the slide plates 51. By connecting the ends of these surfaces together, a single continuous slide plate 51 is formed.

Before the movement of the transportation platform 30, the continuous slide plate 51 is cut at the boundary portion with the intermediate platform 60. The use of a burner or any other suitable method can be employed for the cutting.

[0063] The top sliders 50 include: slide plates 51 reaching from the top surface of the base bottom portion 4C to the top surface of the placement surface 31 and located adjacent to the transportation platform 20; and slide plates 52 adjacent to the underside of the base top portion 4B, i.e., adjacent to the hearth block 6.

As is shown in Fig. 3, the facing surfaces of the slide plates 51 and 52 slide against each other when the hearth block 6 is transferred to the transportation platform 30. Materials for the slide plates 51 and 52 are suitably selected in order to reduce friction resistance during this sliding.

According to the present embodiment, the slide plates 51 (longer plates) adjacent to the transportation platform 20 are made of steel while the slide plates 52 (comparatively shorter plates) adjacent to the hearth block 6 are made of stainless material.

[0064] Panel members used for the slide plates 41,42,51 and 52 preferably have a panel thickness of 6 to 36mm. The hearth block 6 can reach weights of, for instance, 5000 to 8000 tons, and the pressure on the slide surfaces of the slide plates is extremely high. Thus, the panel members preferably have a panel thickness of 6 mm or more. However, a panel thickness of more than 36 mm is not preferable in terms of cost, and makes it difficult to handle the panel members because of weight. Accordingly, the above-described panel thickness of 6 to 36 mm is preferable.

There are no particular limitations on fixing methods for fixing the slide plates 41,42,51 and 52 to each of their installation positions. Such fixing methods may be suitably selected from, for instance, fastening with a bolt and nut or similar and fixation by welding, with the materials of portions to be joined taken into account.

For transportation, a lubricant such as carbon powder or grease is preferably applied to the slide surfaces of the slide plates 41,42,51 and 52.

[0065] For providing the cut portion 4A to the base 4, the following procedure is employed.

First, a plurality of cut sections 4G (see Fig. 2) parallel to each other in plan view are prepared, and the below work is conducted with respect to each of the cut sections. In Fig. 1, the base 4 is horizontally cut at a position corresponding to the height of the placement surface 31 to

provide a bottom cut surface 4E, and the base 4 is horizontally cut at a position higher than the placement surface 31 by a predetermined height to provide a top cut surface 4F. The section between these top and bottom cut surfaces is removed to provide a vacant portion 4D, and the slide plates 51 and 52 are arranged in a pile on the top surface of the bottom cut surface 4E. Then, a load support(s) 53 is arranged on the top surface of the slide plates 51 and 52 to fill in the vacant portion 4D. By repeating the above work for all of the cut sections 4G, the slide plates 51 and 52 and the load support(s) 53 can be arranged over the entire surface of the cut portion 4A.

[0066] A wire sawing is preferably used for horizontally cutting each of the sections 4G. It is preferable that, when a wire saw is used for cutting, horizontal through-holes are first opened in the boundary portion(s) (the dotted lines in Fig. 2) of each of the sections 4G for the base. For the load support 53, for example, a combination arrangement (see Fig. 3) of HPA 54 (High Pack Anchor, a fibrous sack filled with mortar) and α material 55 (a combination of garnets, spherical particles of small diameter, and one or more types of mortar), can be used, but an arrangement using either HPA 54 or α material 55 alone can also be used.

Japanese Patent No. 384201, JP-A-2006-183105, JP-A-2006-283183 and International Publication No. WO2007/135916, which are commonly owned by the present applicant, refer to structures including load supports or a slide member usable as the top sliders 50 or bottom sliders 40. The techniques therein can also be utilized in the invention where necessary.

However, the invention is not limited to these, but may adopt any other configuration as long as such a configuration can provide sufficient load supportability and slidability.

[0067] Using the above-described transporter 1, a furnace body is dismantled by following the below procedure in the present embodiment.

In the preparation step shown in Fig. 4, the transport route 20 is installed in the area from the installation site 2 where the furnace body 3 and the base 4 are installed to the work site 8, and the transportation platform 30 having the placement surface 31 on its top surface is slidably installed on the transport route 20. The bottom slider 40 is provided between the transportation platform 30 and the transport route 20.

In the separation step shown in Fig. 5, the cut portion 4A is formed by cutting the base 4 in a horizontal direction at the height of the placement surface 31, and a hearth block 6 is cut out by cutting (ensuring a gap 7A in Fig. 1) the portion between a ring block 7 (the upper portion of the furnace body 3) and the hearth block 6 in the horizontal direction. The top slider 50 that leads from the cut portion 4A is provided continuously on the top surface of the intermediate platform 60 and the placement surface 31.

[0068] In the transfer step shown in Fig. 6, the hearth

block 6 and the base top portion 4B are moved via the top slider 50 in the horizontal direction and placed on top of the placement surface 31.

In the transportation step shown in Fig. 7, the transportation platform 30 mounted with the hearth block 6 and the base top portion 4B is moved along the transport route 20 to the work site 8. At this time, friction between the transportation platform 30 and the transport route 20 is reduced by the bottom slider 40, so that the transportation platform 30 is stably and reliably moved while driven by the tractors 29 (see Figs. 1 and 2).

The transport route 20 according to the present embodiment is provided by linking the sectional transport routes 20A and 20B together. At the section where the sectional transport routes are linked, switching between tractors 29A and 29B is conducted.

[0069] In other words, in Fig. 2, the transportation platform 30 is connected to the tractor 29A by a wire 28A at the upstream side of the sectional transport route 20A (the left side in the figure, side adjoining to the installation site 2), and is pulled from that location to the downstream end of the sectional transport route 20A. When the transportation platform 30 reaches the downstream end of the sectional transport route 20A, the wire 28A is detached, and the transportation platform 30 is connected by another wire 28B to the tractors 29B. The transportation platform 30 is then pulled by the tractors 29B to be transported from the upstream end of the sectional transport route 20B (on the right in the figure) to the work site 8 located at the downstream end of the sectional transport route 20B (on the bottom in the figure).

[0070] According to the present embodiment, the hearth block 6 is placed on top of the transportation platform 30 and the transportation platform 30 is moved along the transport route 20 for the transportation of the hearth block 6. At this time, with the arrangement where the transportation platform 30 and the transport route 20 are slidable against each other via the bottom slider 40, the transportation platform 30 can be easily moved using the tractors 29. Thus, according to the present embodiment, there is no need to use dollies at all, and prior weight adjustment can be omitted.

Also, the transport route 20 is installed continuously from the installation site 2 to the work site 8, a desired slidability between the transport route 20 and the transportation platform 30 can be ensured along the entire length of the transport route 20.

[0071] According to the present embodiment, by linearly arranging the transport route, the transportation platform 30 can be reliably moved by simply pulling the platform 30 with the tractors 29, without using guides or similar for changing direction. Furthermore, use of the combination of an existing wire and winch for the tractors 29 can simplify a structure for pulling the transportation platform 30.

Because the transport route 20 is provided by linking the sectional transport routes 20A and 20B together, by arranging each of the sectional transport routes 20A and

20B in intersecting directions, the route as a whole can have a bending shape. Thus, a degree of freedom with respect to the location of the installation site 2 and the work site 8 and to the arrangement of the transport route can be ensured while still benefiting from the linear pulling.

[0072] According to the present embodiment, because the slide plates 41 and 42 made of steel and stainless material are used as the bottom slider 40 between the transport route 20 and the transportation platform 30, a desired slidability can be ensured with a simplified structure, and facility costs can be reduced.

According to the present embodiment, because the slide plates 51 and 52 made of steel and stainless material are used in the top slider 50 between the transportation platform 30 and the hearth block 6, a desired slidability can be ensured with a simplified structure, and facility costs can be reduced.

According to the present embodiment, in the separation step, the top slider 50 for the base 4 is provided. In addition, at the time of providing the top slider 50, the work on each of the cut portions 4A is conducted and the load support 53 is used. Thus, the operations can be conducted stably and reliably.

Other Embodiments Related to First Exemplary Embodiment

[0073] The invention is not limited to the above embodiment but includes other embodiments or modifications or the like such as those described below.

For example, while the bottom slider 40 is provided by the slide plates 41 covering the top surface of the base rails 21 of the transport route 20 and the slide plates 42 covering the underside 32 of the transportation platform 30 (see Fig. 3) in the above embodiment, the invention is not limited to this but may be of any other configuration. For example, while the slide plates 41 adjacent to the transport route 20 are steel panel members and the slide plates 42 adjacent to the transportation platform 30 are panel members made of stainless material in the above embodiment, the slide plates 41 and the slide plates 42 may be reversely configured. In other words, the slide plates 41 may be made from stainless material while the slide plates 42 may be made from steel. Alternatively, both may be made from steel.

[0074] The transport route 20 side and the transportation platform 30 side of the bottom slider 40 do not each have to be panel-shaped members, and either can be a long member.

In Fig. 8, topside flanges of the base rails 21 buried in the ground protrude above ground, and these flanges serve as the slide plates 41 against which the slide plates 42 slide, thereby providing the bottom slider 40. In this configuration, it is preferable that the base rails 21 are made of steel while the slide plates 42 are made of stainless material.

The materials buried in the ground as the transport route

20 are not limited to the steel H-frame base rails 21 (see Figs. 3 and 8), but may be a steel frame of another shape. In Fig. 9, the base rails 22 are cylindrical steel members having a square cross-section, of which top surfaces are exposed above ground to function as the slide plates 41. This kind of bottom slider 40 can also be employed.

[0075] The transportation platform 30 preferably employs a meander preventer for preventing meandering of the transportation platform 30 (deviation with respect to the direction of movement). The meander preventer may be a software-based meander-prevention system that uses the control of the tractors 29, or a mechanical meander-prevention mechanism provided between the transport route 10 and the transportation platform 30.

[0076] First, a meander-prevention system that uses the control of the tractors 29 will be explained.

When the transportation platform 30 is pulled, a plurality of systems of traction mechanisms provided as tractors 29 may pull the transportation platform 30 with unbalanced pulling force or at unbalanced pulling speed, thereby causing either one of the leading right side and the leading left side of the transportation platform 30 to precede the other (i.e., oblique movement of the transportation platform 30). When such an oblique movement has occurred, the transportation platform 30 is moved along the line of the obliquely-shifted axis and displaced in a direction intersecting with the pulling direction (the lengthwise direction of the transport route 20), i.e., laterally deviated in the width direction of the transport route 20. Then, when the amount of displacement becomes large, the transportation platform 30 is brought back by the pulling force of the traction mechanisms on the opposite side, repetition of which leads to meandering of the transportation platform 30.

The meander-prevention system prevents oblique movement of the transportation platform 30 by striking the pulling balance among the systems of the traction mechanisms of the tractors 29, and prevents the meandering resultantly caused by such oblique movement.

[0077] Figs. 10 to 12 show an example in which a meander-prevention system using pulling control is employed in the transporter 10 of the above-described first embodiment.

The transport route 20 and the transportation platform 30 in Fig. 10 have the same configurations as those in Figs. 1 and 2. The tractors 29 include four systems of traction mechanisms juxtaposed in the width direction of the transport route 20. The traction mechanisms respectively include winches 291 to 294, and the winches 291 to 294 pulls the transportation platform 30 by respectively winding up wires 281 to 284.

As also shown in Fig. 11, the tractors 29 include: position detectors 295 to 298 for detecting movement amounts of the positions on the transportation platform 30 pulled by the wires 281 to 284; and a traction controller 300 for controlling pulling operations of the winches 291 to 294 with reference to the detected positions.

[0078] As the position detectors 295 to 298, for exam-

ple, a rotary encoder for detecting a rotation angle of a wire-winding shaft may be provided in the winches 291 to 294. The wounded amount(s) of the wires 281 to 284 can be calculated from the amount of the rotation of the winding shaft. Based on the wounded amount(s) of the wires, the movement amounts of the pulled positions on the transportation platform 30, to which the wires 281 - 284 are connected, can be detected.

The position detectors 295 to 298 may directly detect the wounded amounts of the wires 281 to 284 in the winches 291 to 294 with use of an optical displacement detector or the like. Alternatively, the position detectors 295 to 298 may directly detect relative displacement of the transportation platform 30 with respect to the transport route 20 with use of optical, magnetic or other displacement detectors provided in each of the pulled positions on the transportation platform 30.

[0079] The traction controller 300 includes an operation commander 301, an oblique-movement detector 302, and an oblique-movement corrector 303.

The operation commander 301 gives commands for the activation and pulling operations of the winches 291 to 294 in accordance with a previously-recorded operation program. Calculation process, standard values and the like in the oblique-movement detector 302 and oblique-movement corrector 303 are also stored in the operation commander 301 in advance, and referenced when necessary.

The oblique-movement detector 302 detects the oblique movement of the transportation platform 30 based on movement distances D1 to D4 of the transportation platform 30 detected by the position detectors 291 to 294 (the movement distances D1 to D4 respectively correspond to the systems of the traction mechanisms). Specifically, an average value: $DM = (D1 + D2 + D3 + D4) / 4$ is calculated from the movement distances D1 to D4, and then a deviation: $dDn = Dn - DM (n=1-4)$ with respect to the obtained average value DM is calculated for each.

[0080] As shown with the dotted line in Fig. 10, when the transportation platform 30 is in a regular posture that follows the direction of transportation, the movement distances D1 to D4 are all equal, and the deviations dD1 to dD4 are all zero.

As shown with the full line in Fig. 10, when the transportation platform 30 is tilted and its movement axis is inclined, the movement distances D1 to D4 are all different values, and the deviations dD1 to dD4 with respect to the average value DM are all different values other than zero.

When the transportation platform 30 is simply tilted, the deviations dD1 to dD4 are values in proportion to their distance from the central region, which provides the average value DM.

However, when, for instance, large friction is locally applied between the transportation platform 30 and the transport route 20, the pulling force and the resistance in the width direction of the transportation platform 30 may be unbalanced, thereby causing a deformation (for

example, an arc deformation) in the width direction of the transportation platform 30. Then, some of the movement distances Dn and deviations dDn may have unique values that are no longer in proportionate relationships.

[0081] The oblique-movement corrector 303 calculates a correction value for correcting the oblique movement of the transportation platform 30 detected by the oblique-movement detector 302, and corrects the pulling operations of the winches 291 to 294 via the operation commander 301 with use of the same correction value. Specifically, correction values respectively for the systems are calculated using a function $f(dDn)$ based on the deviations dDn detected by the oblique-movement detector 302, and the rotation speeds V1 to V4 of the winches 291 to 294 of the systems are corrected based on the correction values.

[0082] Fig. 12 shows the controlling steps of the winches 291 to 294 with the traction controller 300, and also the correcting steps for that control.

Upon commencement of the pulling operations, the operation commander 301 sets the preset initial values of the pulling speed as the speeds V1 to V4 for the systems (Step S01), and then commences the pulling operation by activating the winches 291 to 294 (Process S02).

When the pulling is commenced, the oblique-movement detector 302 detects the movement distances D1 to D4 for the systems from the position detectors 295 to 298 (Process S03), calculates the average value DM for the pulled distance (Process S04), and then calculates deviations dD1 to dD4 for the systems (Process S05).

The oblique movement is detected by following the above steps S03 to S05.

[0083] The oblique-movement corrector 303 determines the deviations dD1 to dD4 for use in correction by the systems.

The oblique-movement corrector 303 compares the deviations dD1 to dD4 for the systems with a preset standard value dS. Then, if even one of the absolute values of any system deviation dDn exceeds the standard value dS, the oblique-movement corrector 303 determines that correction is necessary (Step S06). When correction is necessary, the oblique-movement corrector 303 corrects the speed Vn of each system by increasing or reducing the speed Vn by the amount obtained by the function $f(dDn)$ based on the deviation dDn of the system (Step S07).

The function f used in the correction can be set appropriately in practice. For instance, the function f may simply multiply the value by a factor, or may perform a calculation based on a preset calculation formula.

The oblique movement is corrected by following the above steps S06 - S07.

[0084] After the oblique-movement detection and the oblique-movement correction, the operation commander 301 continues the pulling operations (Step S08). The pulling operations are conducted at a new speed Vn when correction has been performed by the oblique-movement corrector 303, or at the original speed Vn when no cor-

rection has been performed. The operation commander 301 monitors the progress of the pulling, and the oblique-movement detection, oblique-movement correction and the pulling operations are continuously repeated unless the transportation platform 30 reaches the end point of the transport route 20. On the other hand, when the transportation platform 30 reaches the end point, the pulling operations are ended (Step S09).

[0085] By repeating the above operations (repetition of the oblique-movement detection, the oblique-movement correction and the pulling operations), the oblique-movement of the transportation platform 30 pulled over the transport route 20 can be prevented, thereby also preventing any meandering of the transportation platform 30 following the oblique movement.

At this time, the correction value $f(dN)$ is calculated based on the deviation dN of each of the systems for the speed correction for each of the systems. Thus, even when the transportation platform 30 is deformed and the system deviations dN are not proportionate, an optimum correction value can be used, and a correction that also compensates for the deformation of the transportation platform 30 can be performed.

[0086] According to the aspect of the invention, the steps for the correction by the tractors 29 are not limited to the steps in Fig. 12 but may be steps as in Fig. 13 that do not calculate an average value or deviations.

Upon commencement of the pulling operations, the operation commander 301 sets the preset initial values for the pulling speed as the speeds $V1$ to $V4$ for the systems respectively (Step S11), and then commences the pulling operations by activating the winches 291 to 294 (Process S12).

When the pulling operations are commenced, the oblique-movement detector 302 detects the movement distances $D1$ to $D4$ for the systems respectively from the position detectors 295 to 298 (Process S13). The above steps are the same as in Fig. 12.

In Fig. 13, the oblique-movement detector 302 uses the movement distances $D1$ and $D4$ for the systems on both outer sides of the transportation platform 30, and determines that the transportation platform 30 is obliquely moved when the absolute value of the difference between the distances $|D1-D4|$ is larger than the standard value dS (Step S14).

[0087] When the transportation platform 30 is determined as obliquely moving, the foregoing side of the tilted transportation platform 30 is detected by the oblique-movement corrector 303 (Step S15). This detection of the foregoing side can be performed by, for example, a comparison of the movement distances $D1$ - $D4$ of the systems on both outer sides. Specifically, if $D1-D4 > 0$, it means that the first system side is foregoing, and that the fourth system side is lagging.

The oblique-movement corrector 303 corrects the speed of each of the systems based on the determination of the foregoing side. For example, if the first system side is foregoing, correction is performed so that the winch 291

on the first system side is decelerated while the winch 294 on the fourth system side is accelerated (Step S16). Alternatively, if the fourth system side is foregoing, correction is performed so that the winch 291 on the first system side is accelerated while the winch 294 on the fourth system side is decelerated (Step S17).

The correction values for the second system and the third system can be set by proportionally allocating the correction values for the first system and the fourth system in accordance with the distances between each of the systems in their arrangement.

After the above the oblique-movement detection and oblique-movement correction, the operation commander 301 continues the pulling operations (Step S18). When the transportation platform 30 has reached the end point of the transport route 20, the pulling operations are ended (Step S19).

[0088] According to such meander-prevention system as in Figs. 10 to 12 or Fig. 13, by using a controller normally used for control of the winches of the tractors 29 and simply arranging the controller to additionally perform software-based processing for conducting the oblique-movement detection and the oblique-movement correction, the oblique movement and the meandering can be prevented.

Accordingly, compared to a configuration where mechanical meander-prevention mechanisms are additionally provided, installation facilitation and cost reduction can be anticipated.

[0089] On the other hand, an exemplary mechanical meander-prevention mechanism may adopt the below configuration.

When long members are used for the bottom slider 40, a mechanical meander-prevention mechanism can be provided by changing the height of some of the long members compared to others or by irregularly disposing the long members when viewed in cross-section. With this arrangement, the meander-prevention function of the transportation platform 30 can be ensured.

For example, while three base rails 21 are installed at the same height in the configuration in Fig. 8, the height of the middle rail may be altered either up or down for use as a meander-prevention mechanism.

[0090] In Fig. 14, just as in Fig. 8, three base rails 21 are buried in the ground. However, in this example, while both of the two side base rails 21 are at the normal ground level (GL), the middle base rail 21 is buried in the underside of a groove 24 formed in the ground.

A spacer 33 having such a width and thickness as to be accommodatable inside the groove 24 is installed on the underside 32 of the transportation platform 30 at the part corresponding to the groove 24. The slide plates 41 and 42 are arranged between the base rail 21 in the groove 24 and the underside of the spacer 33 and between the base rails 21 outside the groove 24 and the underside 32.

[0091] The thickness of the spacer 33 is equivalent to the depth of the groove 24 minus the thickness of the slide plates 41 and 42, and each pair of slide plates 41

and 42 (both pairs located inside and outside the groove 24) is adjusted to be in equal contact and to receive an equal amount of load.

Contact plates 33A are attached to both side surfaces of the spacer 33, and contact plates 24A are attached to the side surfaces of the groove 24 opposed to the side surfaces of the spacer 33. The combination of steel panels and stainless panels described above in relation to the bottom slide member can be used for the slide plates 41 and 42 and the contact plates 24A and 33A.

[0092] With this configuration, the slide plates 41 and 42 can provide the sliding required for transportation while supporting the load of the transportation platform 30. Furthermore, the groove 24 and the spacer 33 define an irregular shape continuous in the direction of transportation of the transportation platform 30, thereby providing a meander-prevention function to the transportation platform 30. Particularly, when large meander is about to take place, the contact plates 24A and 33A come into contact with each other, thereby preventing any further development of such a meander.

The depth of the groove 24 and the thickness of the spacer 33 may be determined in a range of, for instance, 30 to 200 mm. Furthermore, the groove 24 may be formed in the underside of the transportation platform 30 instead of the ground while the base rail buried in the ground is supported at a higher position. With this arrangement, an irregular profile that is reverse to that in Fig. 14 can provide a meander-prevention mechanism.

[0093] The meander-prevention mechanism for the transportation platform 30 may be of another configuration.

In Fig. 15, a large number of base rails 21 configured as in Figs. 8 and 14 are buried in the ground. However, while some of the base rails 21 are buried at the normal ground level (GL), the middle three base rails 21 are buried in the underside of a concave portion 24B formed in the ground.

[0094] The concave portion 24B has an arc-shaped cross-section. Of the three base rails 21 buried in the relevant section, the middle one is arranged with its top surface horizontal while the two side base rails 21 are arranged with their top surfaces inclined (i.e., the inclination conforms to the inclination of the underside of the concave portion 24B).

A convex portion 33B conforming to the cross-sectional shape of the concave portion 24B is provided on the underside 32 of the transportation platform 30 at a portion corresponding to the concave portion 24B. The arc shape of the underside of the concave portion 24B and the arc shape of the underside of the convex portion 33B are concentric with respect to each other. The distance between the concave portion 24B and the convex portion 33B is maintained constant at all positions.

[0095] The slide plates 41 and 42 are arranged between the base rail 21 in the concave portion 24B and the underside of the convex portion 33B, and between the base rails 21 outside the concave portion 24B and

the underside 32. The combination of steel panels and stainless panels described above in relation to the bottom slide member is usable for the slide plates 41 and 42.

[0096] With this configuration, the slide plates 41 and 42 are slidable with respect to each other while supporting a load. Furthermore, the concave portion 24B and the convex portion 33B can provide an uneven shape continuous in the direction of transportation of the transportation platform 30, thereby providing a meander-prevention mechanism to the transportation platform 30. Particularly, when a large meander is about to take place, an increased contact pressure is applied to the slide plates 41 attached to the inclined base rails 21 and the slide plates 42 that slide against them, thereby preventing any further development of such a meander.

The concave portion 24B and the convex portion 33B may be sized to have, for example, a height of 30 to 200 mm and a width of 100 to 300 mm. The concave portion 24B and the convex portion 33B may also be arranged in the reverse vertical arrangement.

[0097] In the configuration in Fig. 15, some of the base rails 21 are buried at normal ground level (GL), and the middle three base rails 21 are buried in the arc-shaped concave portion 24B. Alternatively, all of the base rails 21 may be buried in the arc-shaped concave portion and the entire underside 32 of the transportation platform 30 may be formed to define a convex portion.

In Fig. 16, the entire underside 32 of the transportation platform 30 is formed to define a convex portion 33C. On the other hand, a concave portion 24C is formed by digging into the ground from the normal ground level (GL). The convex portion 33C and the concave portion 24C, which have concentric cylindrical surfaces, can maintain a predetermined distance between each other.

A plurality of base rails 21 is buried in the concave portion 24C, and the slide plates 41 and 42 are arranged between these base rails 21 and the underside 32. The combination of steel panels and stainless panels described above in relation to the bottom slide member is usable for the slide plates 41 and 42.

[0098] With this configuration, like in the configuration in Fig. 15, the concave portion 24C and the convex portion 33C can provide an uneven shape continuous in the direction of transportation of the transportation platform 30, thereby providing a meander-prevention mechanism to the transportation platform 30. In particular, with a large arc using the entire underside 32 of the transportation platform 30, an even stronger meander-prevention function can be obtained.

The concave portion 24C and the convex portion 33C may be sized to have, for example, a height of 30 to 200 mm, and a width of 100 to 300 mm. The concave portion 24C and the convex portion 33C may also be arranged in the reverse vertical arrangement.

[0099] When a meander-prevention mechanism is arranged as in Figs. 14, 15 and 16, it is difficult to change direction of the transportation platform as compared to the arrangement in which the slide plates 41 and 42 are

all in sliding contact on the same plane. Thus, it is preferable that a separate interchanger is parallelly used for changing between the sectional transport routes 20A and 20B.

On the other hand, as mechanical meander-prevention mechanisms capable of coping with changing direction, the configurations described below can be employed.

[0100] In Fig. 17, a guide pin 321 is provided on the underside 32 of the transportation platform 30. On the transport route 20, a guide groove 322 (guide groove 322A on the sectional transport route 20A and guide groove 322B on the sectional transport route 20B) is formed in a space 411 between the slide plates 41 (space 411A on the sectional transport route 20A and space 411B on the sectional transport route 20B).

As shown in Fig. 18, the guide grooves 322 (322A and 322B) are formed as recesses in the ground in the spaces 411 (411A and 411B), and both interior side surfaces are covered in contact plates 322C that use steel panels or similar.

The guide pin 321 is a rod-shaped pin body 321A formed from steel and fitted at its lower end with a cylindrical or ring-shaped contact member 321C via a bearing 321B such as an oil-less metal bearing or ball-bearing. The upper end of the pin body 321A is fixed to a part of the structural frame of the transportation platform 30 by fastening with a bolt 321D or the like, or welding or similar.

[0101] By using the guide pin 321 and the guide groove 322, the movement direction of the transportation platform 30 pulled or driven over the transport route 20 is restricted to being along the groove 322, which mechanically prevents meandering.

Specifically, when the transportation platform 30 meanders to be displaced from the continuous direction of the guide groove 322, the contact member 321C of the guide pin 321 inside the guide groove 322 comes into contact with the contact plates 322C on the interior sides of the guide groove 322, thereby suppressing any further displacement.

At this time, because the contact member 321C of the guide pin 321 is rotatably attached via the bearing 321B, wear or heat generation or similar due to excessive friction or the like can be prevented even when the contact member 321C comes into contact with the contact plates 322C while the transportation platform 30 is still in motion.

[0102] The guide groove 322 (322A and 322B) for guiding the guide pin 321 is formed on each of the sectional transport routes 20A and 20B, and meander can be prevented throughout the entire length of the transport route 20.

Furthermore, as shown in Fig. 17, notches 411C are formed in the slide plates 41 of the sectional transport route 20A at sections meeting an extension of the guide groove 322B, and the guide groove 322B is extended into the notches 411C. With this arrangement, when the transportation platform 30 that has moved over the sectional transport route 20A is transferred to the sectional transport route 20B, the guide pin 321 can move smoothly

into the guide groove 322B through the notches 411C. Accordingly, with the configurations in Figs. 17 and 18, a mechanical meander-prevention structure can be provided. In addition, the transportation platform 30 can smoothly be transferred between transport routes when sectional transport routes 20A and 20B are used.

[0103] In the configuration in Fig. 18, the upper side of the guide pin 321 is fixed to the transportation platform 30, but may be supported in a rotatable manner via a bearing.

In Fig. 19, the upper side of the pin body 321A of the guide pin 321 is rotatably supported by two bearings 321E, so that the pin body 321A itself is rotatable. Accordingly, the contact member 321C on the lower side may be directly fixed to the pin body 321A.

Furthermore, in order to avoid wear and heat generation due to the contact with the contact plates 322C, the guide pin 321 is preferably installed in such a manner that at least the contact member 321C is rotatable. However, when a lubrication unit capable of providing sufficient lubricity can be additionally used, the guide pin may be fixed in a non-rotatable manner.

[0104] In the configuration in Fig. 17, one guide pin 321 is guided in the guide groove 322, but a plurality of guide pins and a plurality of guide grooves may be used. In Fig. 20, three guide pins 32 are provided on the underside of the transportation platform 30 at linearly-aligned positions.

On the sectional transport route 20A, one guide groove 322A is formed in a clearance 411A between the slide plates 41, so that each of the guide pins 321 is guided along the guide groove 322A.

On the sectional transport route 20B, three guide grooves 322B are formed in clearances 411A between the slide plates 41, so that the guide pins 321 are respectively guided along their corresponding guide groove 322B.

In the sectional transport route 20A, three notches 411C are formed at three positions corresponding to the three guide grooves 322B respectively.

In the configuration shown in Fig. 20, the plurality of guide pins 321 lined up in the movement direction are guided by the one guide groove 322A on the sectional transport route 20A, thereby further enhancing the suppression of meander.

On the other hand, the guide pins 321 are aligned parallel to the direction of movement on the sectional transport route 20B, so that the guide pins 321 and the guide grooves 322B thereon cannot be expected to provide as much guiding performance as the guide pins 321 and the guide grooves 322A do on the sectional transport route 20A. Nevertheless, with the sectional transport route 20B being shorter than the sectional transport route 20A, the guide pins 321 can still effectively prevent meandering.

[0105] In Fig. 21, three guide pins 32 are provided on the underside of the transportation platform 30 at such positions as to correspond to the points of a right-angled triangle.

On the sectional transport route 20A, two guide grooves

322A are formed in clearances 411A between the slide plates 41, so that one of the guide pins 321 is guided along one of the guide grooves 322A while the other two pins are guided along the other guide groove 322A.

On the sectional transport route 20B, two guide grooves 322B are formed in clearances 411A between the slide plates 41, so that one of the guide pins 321 is guided along one of the guide grooves 322B while the other two pins are guided along the other guide groove 322B.

In the sectional transport route 20A, notches 411C are formed at two positions corresponding to the two guide grooves 322B respectively.

In the configuration shown in Fig. 21, the two guide pins 321 lined up in the movement direction are guided by the one guide groove 322A on the sectional transport route 20A, thereby further enhancing the suppression of meandering.

Furthermore, the two guide pins 321 lined up in the movement direction are also guided by the one guide groove 322B on the sectional transport route 20B as well, thereby further enhancing the suppression of meandering.

Accordingly, meandering can be excellently prevented on either of the sectional transport routes 20A and 20B.

[0106] Each of the above embodiments uses the base rails 21 and the slide plates 41 and 42 as the bottom slider 40.

However, the bottom slider 40 is not necessarily of a configuration in which one surface and another surface actually slide against each other, but may be of a rolling configuration. The bottom slider 40 may be of any other configuration as long as friction can be reduced.

For example, as shown in Fig. 22, a slide plate 41 may be attached over the top surface of the base rails 21 of the transport route 20, and a plurality of round steel rods or cylinders may be arranged on the top of the slide plate 41 for use as rollers 43. The surface of the underside of the transportation platform 30 may roll directly on the rollers 43, or may be attached with a separate steel panel or the like. When such rollers 43 are used, the friction can be further reduced, compared to the configuration using the sliding. However, because the rollers are sequentially ejected from the rear side of the transportation platform 30 as a result of rolling, the ejected rollers are required to be cycled to the front side of the transportation platform 30.

[0107] Equipment dedicated for receiving a large load and providing rolling movement such as the TIRTANK manufactured by TIR Corporation may be used as the bottom slider 40.

As shown in Figs. 23 and 24, the TIRTANK 44 has a plurality of rollers 44B surrounding a core 44A. The rollers 44B, of which rotation axes are linked together by an endless component, are cycled while rolling around the core 44A. The core 44A is connected to a load member 44D via support members 44C provided on both sides.

In the bottom slider 40 shown in Figs. 23 and 24, the slide plate 41 is attached over the top surface of the base rails 21, and the TIRTANK 44 are arranged on the slide plate

41 so as to support the underside of the transportation platform 30. Accordingly, while the transportation platform 30 rolls on the transport route 20 with the rollers 44B of the TIRTANK 44, no special work is required as the transportation platform 30 progresses because the rollers 44B in the TIRTANK 44 are cycled by themselves.

[0108] Such TIRTANK 44 considerably increases the height as compared to panels. As a remedy, it is preferable that a concave portion is formed in the transport route 20 or the transportation platform 30 so as to accommodate the TIRTANK 44 therein.

In Fig. 25, a long member 23 having an open square shaped cross-section is buried in the transport route 20 with its opening facing upwards, thereby providing a concave groove. The concave groove, which has a width sufficient for accommodating the TIRTANK 44, is somewhat shallower than the height of the TIRTANK 44, so that the underside of the transportation platform 30 can be supported by the TIRTANK 44. According to such a configuration, the height dimension of the TIRTANK 44 can be absorbed on the transport route 20 side.

In Fig. 26, a concave portion 35 may be formed in the underside of the transportation platform 30, so that the TIRTANK 44 can be accommodated therein. The base rails 21 are installed on the transport route 20, such that the TIRTANK 44 can roll over the top surfaces of the base rails 21. According to such a configuration, only a specific portion of the transportation platform 30 is required to be spared for the concave portion for housing the TIRTANK 44. Thus, the structure of the transport route 20, which covers a long distance, can be simplified.

[0109] Furthermore, the same configurations as those described above for the bottom slider 40 can be employed in the top slider 50 between the transportation platform 30 and the hearth block 6 or base top portion 4B. When such a configuration is employed, the load support 53 is preferably provided on the top surface of the top slider 50 so as to bear the load of the hearth body at the time of the horizontal cutting for cutting out the hearth block 6 in the separation step. However, it is difficult to use thick (tall) steel materials therefor due to the installation space limitation. Thus, it is preferable to use panels as much as possible.

Additionally, the driving of the transportation platform 30 and the movement of the hearth block 6 may not necessarily be conducted by winding up the wires 28 and 38 with the tractors 29 and 39 but may be conducted with use of any other suitable drive mechanism. For instance, the transportation platform 30 may be laterally driven by a hydraulic cylinder.

Furthermore, the transportation platform 30 is not limitedly used for transporting the hearth block 6 but may be used for transporting other ring blocks 7. In addition, the transportation platform 30 is not limitedly used when the furnace body 3 is dismantled but may be used for transporting ring blocks from a work site to an installation site during construction of a blast furnace.

Second Exemplary Embodiment

[0110] Figs. 27 to 32 show a second embodiment of the invention.

In the first exemplary embodiment described above, carrying-out of the hearth block 6 according to the aspect of the invention is conducted in the dismantling process for the furnace body 3 in the dismantling of the furnace body 3. In the second exemplary embodiment described below, carrying-in of the hearth block 6 according to the aspect of the invention is conducted in the constructing of the furnace body 3 along with the carrying-out in the dismantling of the furnace body 3.

The second exemplary embodiment described below uses the same transporter as in the above-described first exemplary embodiment, so that the same reference numerals are used for the same configurations, for which no redundant description will be made.

[0111] As shown in Fig. 27, the furnace body 3 is constructed on the base 4 at the installation site 2 of the blast furnace 1. The furnace body 3 is provided by linking another ring block 7 (furnace top mantle and furnace belly mantle) onto the hearth block 6. In the below description: a new hearth block 6 will be referred to as a hearth block 6N while old hearth block 6 will be referred to as hearth block 6P; and a new ring block(s) 7 will be referred to as ring block(s) 7N while old ring block(s) 7 will be referred to as ring block(s) 7P, for distinction.

According to the present embodiment, a work site (dismantling work site 8P) is used for dismantling an old hearth block 6P carried-out from the blast furnace 1 while a work site (manufacturing work site 8N) is used for preliminarily manufacturing a hearth block 6N to be newly installed in the furnace body.

[0112] A ring block transporter 10 according to aspect of the invention is installed between the manufacturing work site 8N, the dismantling work site 8P and the installation site 2.

The transporter 10, which is substantially the same as the one in the first exemplary embodiment described above, includes the transporter 20, the transportation platforms 30 (30N and 30P) and the intermediate platform 60.

According to the present embodiment, the transport route 20 includes a main transport route 20C extending from the installation site 2 and secondary transport routes 20D branched from the main transport route 20C.

According to the present embodiment, the dismantling work site 8P and the manufacturing work site 8N are arranged on one side of the main transport route 20C, and the secondary transport routes 20D for each are branched from the same side (the upper side in the figure) of the main transport route 20C. In another embodiment, the work sites 8P and 8N can be arranged on the opposite side of the main transport route 20C, and the secondary transport routes 20D for each may be branched from the opposite side of the main transport route 20C.

According to the present embodiment, other ring blocks

7 are transported to and from other work sites with use of existing furnace body transportation vehicles (dollies). The locations of other work sites can be selected as appropriate, taking into account the state of use of the surrounding land. The configurations and the like for the dollies used for transportation as transporters may be selected as appropriate. The invention is not limited by either of these.

[0113] Explained below is a relining work for a furnace body of a blast furnace according to the second embodiment, which includes the dismantling and reconstruction of the furnace body.

The relining work for the furnace body of the blast furnace is started while the blast furnace 1 is in operation.

In Fig. 27, the manufacturing work site 8N, the dismantling work site 8P and the transporter 10 are installed in the vicinity of the installation site 2 (the preparation step in the dismantling process group and the preparation step in the construction process group). Then, at the manufacturing work site 8N, manufacturing of a new hearth block 6N is commenced on the transportation platform 30N (the manufacturing step in the construction process group). Concurrently, manufacturing of a new ring block 7N is also commenced at a work site (not shown).

A timing at which the manufacturing of the blocks is started is preferably determined by taking into account manufacturing periods for the blocks and calculating backwards from a timing when the blast furnace 1 in operation is to be blown-out. More precisely, the above-described cutting of the base 4 and bottom part of the hearth block 6 of the blast furnace 1 is conducted before the blast furnace 1 is blown-out. Then, as will be described below, the furnace body 3 (the part above the hearth block 6) is dismantled after the blast furnace 1 is blown-out, and each of the blocks is subsequently carried-in to the installation site 2 for reconstruction. Accordingly, the timing at which the manufacturing of the blocks is started can be determined such that the timing at which the manufacturing of the blocks are ended coincides with the above-described timing at which the rings are to be carried-in to the installation site 2 for the reconstruction.

[0114] As shown in Fig. 32, the construction of the new hearth block 6 is proceeded on the transportation platform 30N arranged inside the manufacturing work site 8N until refractory bricks 6B are stacked on the inside of a furnace shell 6A and the interior is filled with bed coke 6E, sleepers 6F and raw materials (coke or ore).

The new hearth block 6 manufactured at the manufacturing work site 8N is only required to include such components that are necessary for providing the furnace body 3 when the new hearth block 6 is carried-in to the installation site 2 and mutually linked. How many components are to be incorporated at the manufacturing work site 8N can be decided as appropriate in practice. Typically, components such as the furnace shell, internal refractory material and staves are incorporated there.

[0115] Referring back to Fig. 27, when the manufacturing of the blocks has reached a certain stage, the sep-

aration of the furnace body 3 is commenced (the separation step in the dismantling process group).

Here, the certain stage at which the separation is commenced may be a stage at which the estimated time until completion of the manufacturing of the ring blocks at the work sites becomes approximately equal to the estimated time for the dismantling of the furnace body 3 and the carrying-out of the ring blocks described later.

Prior to the separation of the furnace body 3, the blowing-out (cessation of operation) of the blast furnace 1 is commenced. Even if the blowing-out of the blast furnace 1 has been commenced, a considerable period of time is required for the furnace 1 to be cooled enough for separation. Accordingly, it is preferable that the preparation for the blowing-out is conducted a certain period of time earlier than the commencement time for the separation of the furnace body 3.

[0116] After the furnace body 3 is separated, the old hearth block 6P is carried-out.

In Fig. 28, the separated old ring block 7P is suspended from above, and the transportation platform 30P is brought as close as possible to the installation site 2. Then, in this state, the hearth block 6P is pulled out from the furnace and transferred onto the transportation platform 30P (the transfer step in the dismantling process group). The transportation platform 30P is subsequently moved to transport the hearth block to the work site 8P (the transportation step in the dismantling process group).

The explanation of the first exemplary embodiment with reference to Figs. 4 to 7 and their corresponding descriptions are also true of the separation step and the transportation step.

[0117] After the hearth block 6 is transported to the dismantling work site 8P, replacement of the other ring blocks 7 is conducted.

In Fig. 29, the ring blocks 7P having been suspended from above are sequentially brought down and transported by dollies 61 to work sites (not shown). At this time, the intermediate platform 60 is evacuated, so that the dollies 61 can be brought as close as possible to the installation site 2. A direction for removing the ring blocks 7P preferably coincides with the direction for removing the hearth block 6P.

When the last (highest) ring block 7P has been carried-out, new ring blocks 7N that have been manufactured at another work site (not shown) are sequentially carried-in. The new ring blocks 7N are carried-in with use of the above-described dollies 61 by following a route that is reverse to a route for the carrying-out of the old ring blocks 7P.

[0118] After the new ring blocks 7N are carried-in to the installation site, a new hearth block 6N is carried-in to be located under the ring blocks 7N.

In Fig. 30, the transport route 10 for use in dismantling has been already prepared (the preparation step in the construction process group). The new hearth block 6N, which has been manufactured on the transportation plat-

form 30N at the manufacturing work site 8N, is transported to the installation site 2 by moving the transportation platform 30N along the transport route 10 (the transportation step in the construction process group).

[0119] In Fig. 31, the new hearth block 6N is transferred from the transportation platform 30N onto the base 4 (the transfer step in the construction process group), and the ring blocks 7N, which are previously carried-in and suspended above the base 4, are brought down and sequentially linked to the hearth block 6N (the linking step in the construction process group).

Through these steps, a new furnace body 3 is constructed at the installation site 2 from the set of the hearth block 6 and ring blocks 7. Then, after the necessary piping and the like are conducted, a test run and operation of the blast furnace 1 is commenced.

The old hearth block 6P that has been already transported to the dismantling work site 8P and the old ring blocks 7P that have been transported to another work site are each dismantled and placed of as waste.

[0120] According to the present embodiment, since the dismantling process group (the preparation step, the separation step, the transfer step and the transportation step) according to the first embodiment is included, the same advantages as in the first embodiment can be obtained. Furthermore, since the construction process group (the manufacturing step, the preparation step, the transportation step, the transfer step and the linking step) is included, the manufacturing of the new hearth block 6N and ring blocks 7N can be conducted at the manufacturing work site 8N separate from the installation site 2. Thus, because blowing-out can be delayed by the amount of time spent for the manufacturing work, the operation period of the blast furnace 1 can be maximized while the non-operation period for relining can be minimized.

In addition, by conducting the construction process group in the order according to the invention, the work period for the construction of the furnace body can be shortened.

[0121] Specifically, with respect to the hearth block used for the construction of the furnace body, work such as the installation of the in-furnace refractory bricks are preferably conducted in advance at the work site. In order to shorten the period for work at the installation site, as much work as possible is preferably conducted in advance at the work site.

However, as described above, conventional ring block dollies are subject to a restriction on their maximum loading weight. When such dollies are used for transporting the hearth block manufactured at the work site to the installation site, the weight restrictions on the dollies may be a hurdle in increasing the number of work tasks completed in advance. Specifically, when dollies are used for transportation of the hearth block, the refractory bricks are installed in the hearth block up to the level under the taphole.

In contrast, when the hearth block is transported according to the aspect of the present invention, all refractory

bricks can be installed in the hearth block in advance because there is no weight restriction (thereby shortening a work period by 3 to 5 days). In addition, the interior of the hearth block can be filled in advance (during a period after the manufacturing of the hearth block and before transportation) with in-furnace materials (sleepers, coke and iron ore) required for start-up of the blast furnace (thereby shortening a work period by 1 to 2 days). Thus, by employing the construction process group according to the aspect of the invention, the work period for relining can be shortened by 4 to 7 days.

[0122] Fig. 32 shows the hearth block 6 being carried-in onto the base 4 in the construction step according to the present embodiment.

In the construction process according to the present embodiment, the hearth block 6 is carried-in onto the base 4 with use of substantially the same transporter 10 as the one used for carrying-out the hearth block 6 from the base 4 and shown in Figs. 1 and 2 (the same is true of the other ring blocks 7). However, the carrying-in shown in Fig. 31 and the carrying-out shown in Fig. 1 are different in the transporting direction.

[0123] In Fig. 32, a tractor 29C is provided on the installation site 2 while adjoining to the base 4. Because the hearth block 6 is to be pulled over the base 4, a tractor 39C is preferably located higher than the top surface of the base 4, and fixed to a column of the furnace-body supporting column 5 located opposite to the transportation platform 30.

Where necessary, the tractors 29C and 39C may be of the same configuration as the tractors 29 and 39 according to the first embodiment. Wires 28C and 38C can be suitably provided to connect the tractors 29C and 39C with the transportation platform 30 or the hearth block 6. In this way, by suitably switching a tractor unit, the transporter 10 can be used in both the dismantling process and the construction process.

[0124] According to the aspect of the invention, because the hearth block 6 or ring blocks 7 are horizontally pulled from the top surface of the transportation platform 30 to the top surface of the base 4 of the installation site 2 or vice versa, it is necessary that the top surface of the transportation platform 30 and the top surface of the base 4 be at the same height. As described in the first embodiment, the top surfaces of the transportation platform 30 and the base 4 is provided with the continuous top sliders 50 in order to facilitate the transportation of the hearth block 6 or the like.

According to the above-described second embodiment, it is preferable that the height of the top surface of the base 4 is the same both when the hearth block 6 is carried-out from the installation site 2 (dismantling process) and when the hearth block 6 is carried-in to the installation site 2 (construction process).

[0125] In the dismantling process, the height of the top surface of the base 4 is decided by horizontally cutting the bottom portion of the furnace body 3 to divide the hearth block 6 from the base 4. Accordingly, it is neces-

sary for the height of the base 4 (i.e., the height at which the furnace body 3 is horizontally cut) to be set to match the height of the top surface of the transportation platform 30.

5 In the construction process, when the base 4 dismantled earlier is to be directly reused, the height of the top surface of the base 4 is already at the height of the top surface of the transportation platform 30. On the other hand, when the base 4 is to be remade, such a base 4 is preferably constructed so that the height of its top surface matches the height of the top surface of the transportation platform 30.

[0126] While the invention is applied to the dismantling of the furnace body 3 in the above-described first embodiment and to both the dismantling and reconstruction of the furnace body 3 in the above-described second embodiment, the invention may be applied only to reconstruction with another technique being employed for the dismantling of the furnace body 3.

20 Any modifications and the like are included in the invention, as long as such modifications and the like are directed to attain an object of the invention.

Industrial Applicability

25 **[0127]** The invention, which relates to a transporter for ring block(s) and a relining method for a furnace body of a blast furnace, is applicable to carrying-in and carrying-out of the ring block(s) in renewing or dismantling the blast furnace, and particularly applicable to effective carrying-in and carrying-out of a hearth block of great weight.

Claims

35 1. A ring block transporter that transports a plurality of ring blocks between an installation site for a blast furnace and a work site that is separate from the installation site, the ring blocks being comprised in a furnace body of the blast furnace, the ring block transporter comprising:

40 a transport route installed between the installation site and the work site;
a transportation platform being slidable on the transport route and having a placement surface on its top surface, the placement surface being at a height of a base of the furnace body;
45 a bottom slider provided between the transport route and an underside of the transportation platform; and
a top slider provided between the placement surface and an underside of the ring block.

50 2. The ring block transporter according to claim 1, wherein the transport route comprises: one linear sectional transport route or a plurality of linear sectional transport routes linked together; and a tractor

provided on an extension of each of the one or plurality of sectional transport routes.

3. The ring block transporter according to claim 2, wherein the tractor comprises: a plurality of traction mechanisms juxtaposed in a width direction of each of the one or plurality of sectional transport routes; and a traction controller that synchronizes pulling operations of the traction mechanisms. 5
4. The ring block transporter according to claim 3, wherein the traction controller comprises: a position detector that detects movement amounts of pulled portions of the transportation platform in a pulling direction, the pulled portions corresponding to the traction mechanisms; an oblique-movement detector that determines an inclination of the transportation platform with respect to the pulling direction based on each of the detected movement amounts; and an oblique-movement corrector that corrects operations of the traction mechanisms so that the inclination is reduced. 10 15 20
5. The ring block transporter according to claim 3, wherein the oblique-movement detector calculates an average value of the movement amounts and calculates deviations between the average value and the movement amounts, and the oblique-movement corrector performs corrections to the traction mechanisms, correction amounts of the corrections corresponding to the deviations. 25 30
6. The ring block transporter according to any one of claims 1 to 5, wherein the transport route extends into an interior of the work site, and the transportation platform is accommodatable in the interior of the work site with the ring block being placed on the transportation platform. 35
7. The ring block transporter according to any one of claims 1 to 6, wherein 40

the bottom slider comprises: a slide member laid on the transport route; and a slide member attached on the underside of the transportation platform, the pair of slide members being slidably in contact with each other, and 45

the pair of slide members comprises any one of: a combination where both are panel members; a combination where one of the pair is a panel member while the other is a long member; and a combination where both are long members, the slide members being made from steel material, stainless material or a low-friction layered panel. 50
8. The ring block transporter according to any one of claims 1 to 6, wherein the bottom slider comprises: a combination of a roller rail laid on the transport route and a roller mechanism attached on the underside of the transportation platform; or a combination of a roller mechanism laid on the transport route and a roller rail attached on the underside of the transportation platform, the roller mechanism rollably contacting the roller rail. 55
9. The ring block transporter according to any one of claims 1 to 8, wherein 60

the top slider comprises: a slide member laid on the placement surface; and a slide member attached on the underside of the ring block, the pair of slide members being slidably in contact with each other, and the pair of slide members comprises any one of: a combination where both are panel members; a combination where one of the pair is a panel member while the other is a long member; and a combination where both are long members, the slide members being made from steel material, stainless material or a low-friction layered panel. 65
10. The ring block transporter according to any one of claims 1 to 8, wherein the top slider comprises: a combination of a roller rail laid on the placement surface and a roller mechanism attached on the underside of the ring block; or a combination of a roller mechanism laid on the placement surface and a roller rail attached on the underside of the ring block, the roller mechanism rollably contacting the roller rail. 70
11. The ring block transporter according to claim 9 or 10, wherein the top slider extends from the placement surface to the base. 75
12. The ring block transporter according to any one of claims 1 to 8, wherein the top slider comprises a flotation transporter mounted between the underside of the ring block and the placement surface, the flotation transporter floating and moving above the placement surface by ejecting fluid. 80
13. The ring block transporter according to any one of claims 1 to 12, further comprising an intermediate platform installed between the base and the transport route, a top surface of the intermediate platform being flat and at a same height as the placement surface. 85
14. A method of relining a furnace body of a blast furnace, comprising a dismantling process group that comprises: horizontally cutting the furnace body installed at an installation site to divide the furnace body into a plurality of ring blocks; transporting the ring blocks from the installation site to a work site; and further dismantling the ring blocks at the work site, wherein 90

the dismantling process group further comprises: 95

- preparing: a transport route extending from the installation site to the work site; and a transportation platform being slidable on the transport route and having a placement surface on its top surface;
- separating a hearth block by horizontally cutting a base portion of the furnace body at a height of the placement surface and horizontally cutting a portion of the furnace body between an upper portion of the furnace body and the hearth block; transferring the hearth block onto the placement surface by horizontally moving the hearth block; and
- transporting the transportation platform upon which the hearth block is placed to the work site along the transport route.
15. The method of relining a furnace body of a blast furnace according to claim 14, wherein the separating of the hearth block comprises:
- setting a plurality of cut sections when the base portion of the furnace body is horizontally cut, the plurality of cut sections being parallel to a transporting direction of the transferring of the hearth block in a plan view;
- horizontally cutting each of the cut sections at a position corresponding to a height of the placement surface and at a position higher than the placement surface by a predetermine height to form a bottom cut surface and a top cut surface; removing portions between the top and bottom cut surfaces to form a vacant portion;
- arranging a slide member on a top surface of the bottom cut surface, the slide member extending in a movement direction of the transferring of the hearth block and arranging a load support on a top surface of the slide member to filling the vacant portion; and
- repeating the forming of the cut surfaces and the filling of the vacant portion for all of the cut sections, and
- all of the above is conducted before blowing-out of the blast furnace.
16. The method of relining a furnace body of a blast furnace according to claim 14 or 15, further comprising a construction process group for constructing the furnace body at the installation site, wherein the construction process group comprises:
- preparing: a transport route extending from the work site to the installation site; and a transportation platform being slidable on the transport route and having a placement surface on its top surface;
- manufacturing a hearth block on the placement surface with the transportation platform being placed at the work site;
- transporting the transportation platform upon which the hearth block is placed to the installation site along the transport route;
- transferring the hearth block horizontally from the placement surface onto a base of the installation site; and
- sequentially linking the ring blocks together to construct the furnace body.
17. A method of relining a furnace body of a blast furnace, comprising a construction process group that comprises: manufacturing a plurality of ring blocks at a work site; transporting the ring blocks from the work site to an installation site; and linking the ring blocks together at the installation site to construct a blast furnace, wherein the construction process group further comprising:
- preparing: a transport route extending from the work site to the installation site; and a transportation platform being slidable on the transport route and having a placement surface on its top surface;
- manufacturing a hearth block on the placement surface with the transportation platform being placed at the work site;
- transporting the transportation platform upon which the hearth block is placed to the installation site along the transport route;
- transferring the hearth block horizontally from the placement surface onto a base of the installation site; and
- sequentially linking the ring blocks together to construct a furnace body.
18. The method of relining a furnace body of a blast furnace according to any one of claims 14 to 17, wherein the preparing of the transport route and the transportation platform comprises: linearly arranging the transport route; and providing a tractor on an extension of the transport route at a position remotely away from the base, and the transporting of the transportation platform comprises: pulling the transportation platform with the tractor; and moving the transportation platform along the transport route.
19. The method of relining a furnace body of a blast furnace according to claim 18, wherein the preparing of the transport route and the transportation platform further comprises: providing the transport route by linking a plurality of linear sectional transport routes together; and providing the tractor on an extension of each of the sectional transport routes, and the transporting of the transportation platform further comprises: sequentially connecting the hearth

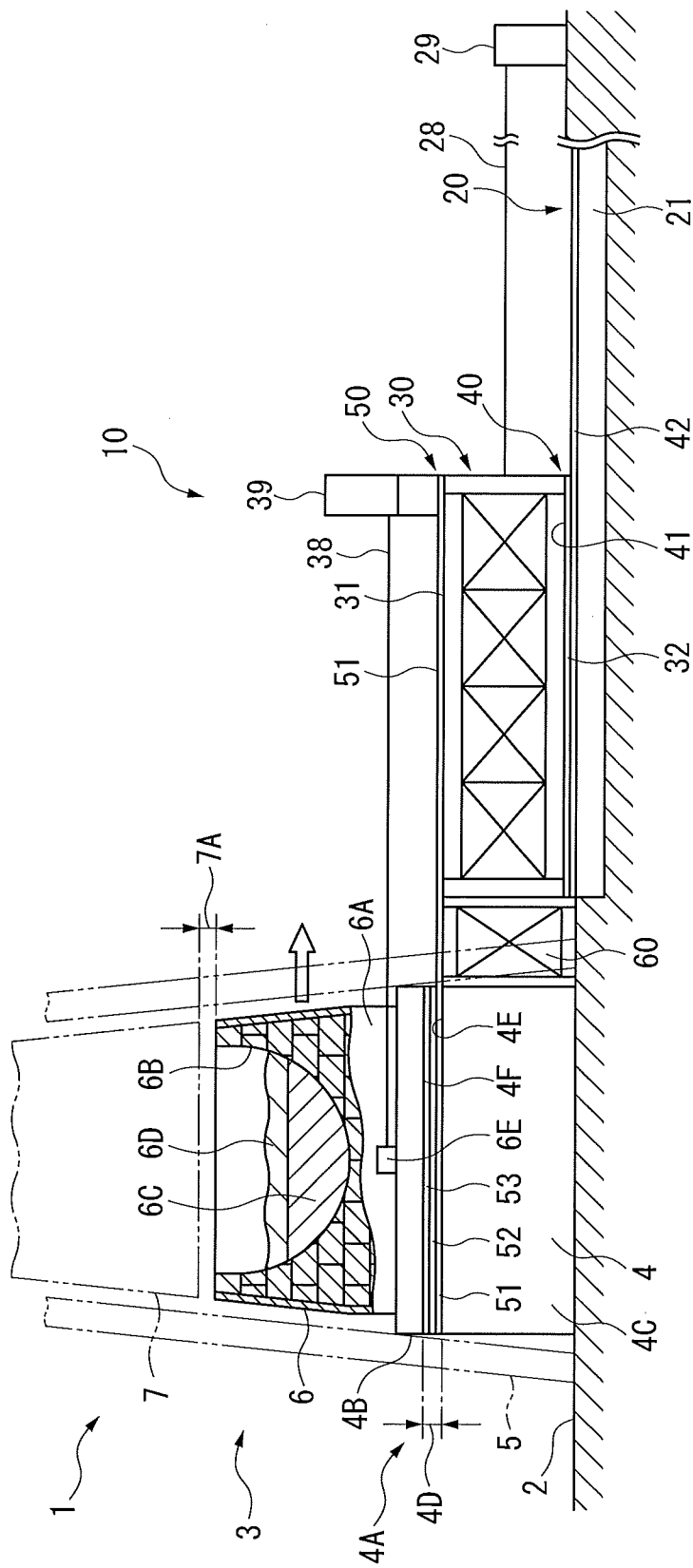
blocks to be transported to a downstream tractor in a switching manner.

20. The method of relining a furnace body of a blast furnace according to claim 18 or 19, wherein the tractor uses: a plurality of traction mechanisms juxtaposed in a width direction of each of the sectional transport routes; and a traction controller that synchronizes pulling operations of the traction mechanisms, and the transition controller controls the pulling operations of the traction mechanisms to be synchronized and controls movement amounts of pulled portions of the transportation platform pulled by the traction mechanisms to become constant.
21. The method of relining a furnace body of a blast furnace according to claim 20, wherein the traction controller: detects the movement amounts of the pulled portions of the transportation platform in a pulling direction, the pulled portions corresponding to the traction mechanisms; determines an inclination of the transportation platform with respect to the pulling direction based on each of the detected movement amounts; and corrects operations of the traction mechanisms so that the inclination is reduced.
22. The method of relining a furnace body of a blast furnace according to claim 21, wherein in determining the inclination, the traction controller calculates an average value of the movement amounts and calculates deviations between the average value and the movement amounts, and performs corrections to the traction mechanisms, correction amounts of the corrections corresponding to the deviations.
23. The method of relining a furnace body of a blast furnace according to any one of claims 14 to 22, wherein the transport route extends into an interior of the work site, and works for the ring block are conducted on the transportation platform located on the transport route in the interior of the work site.
24. The method of relining a furnace body of a blast furnace according to any one of claims 14 to 23, wherein a bottom slider is provided between the transport route and an underside of the transportation platform, the bottom slider comprises: a slide member laid on the transport route; and a slide member attached on the underside of the transportation platform, the pair of slide members being slidably in contact with each other, and the pair of slide members comprises any one of: a combination where both are panel members; a combination where one of the pair is a panel member while the other is a long member; and a combination where both are long members, the slide members

being made from steel material, stainless material or a low-friction layered panel.

25. The method of relining a furnace body of a blast furnace according to any one of claims 14 to 23, wherein a bottom slider provided between the transport route and an underside of the transportation platform, and the bottom slider comprises: a combination of a roller rail laid on the transport route and a roller mechanism attached on the underside of the transportation platform; or a combination of a roller mechanism laid on the transport route and a roller rail attached on the underside of the transportation platform, the roller mechanism rollably contacting the roller rail.
26. The method of relining a furnace body of a blast furnace according to any one of claims 14 to 25, wherein a top slider is provided between the placement surface and the underside of the hearth block, the top slider comprises: a slide member laid on the placement surface; and a slide member attached on the underside of the hearth block, the pair of slide members being slidably in contact with each other, and the pair of slide members comprises any one of: a combination where both are panel members; a combination where one of the pair is a panel member while the other is a long member; and a combination where both are long members, the slide members being made from steel material, stainless material or a low-friction layered panel.
27. The method of relining a furnace body of a blast furnace according to any one of claims 14 to 25, wherein a top slider is provided between the placement surface and the underside of the hearth block, and the top slider comprises: a combination of a roller rail laid on the placement surface and a roller mechanism attached on the underside of the hearth block; or a combination of a roller mechanism laid on the placement surface and a roller rail attached on the underside of the hearth block, the roller mechanism rollably contacting the roller rail.
28. The method of relining a furnace body of a blast furnace according to any one of claims 14 to 25, wherein a top slider is provided between the placement surface and the underside of the hearth block, and the top slider comprises a flotation transporter mounted between the underside of the ring block and the placement surface, the flotation transporter floating and moving above the placement surface by ejecting fluid.

FIG. 1



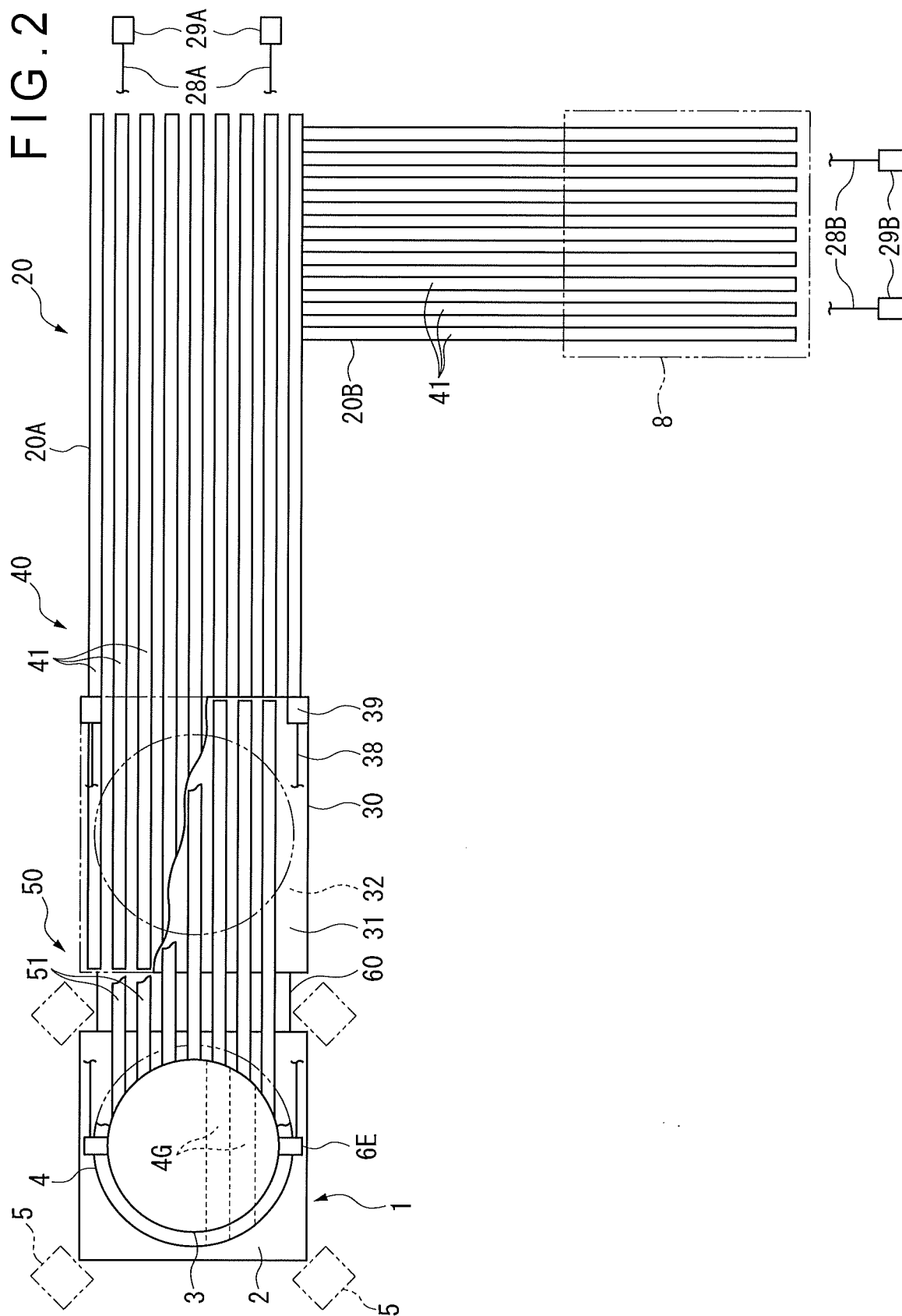


FIG. 3

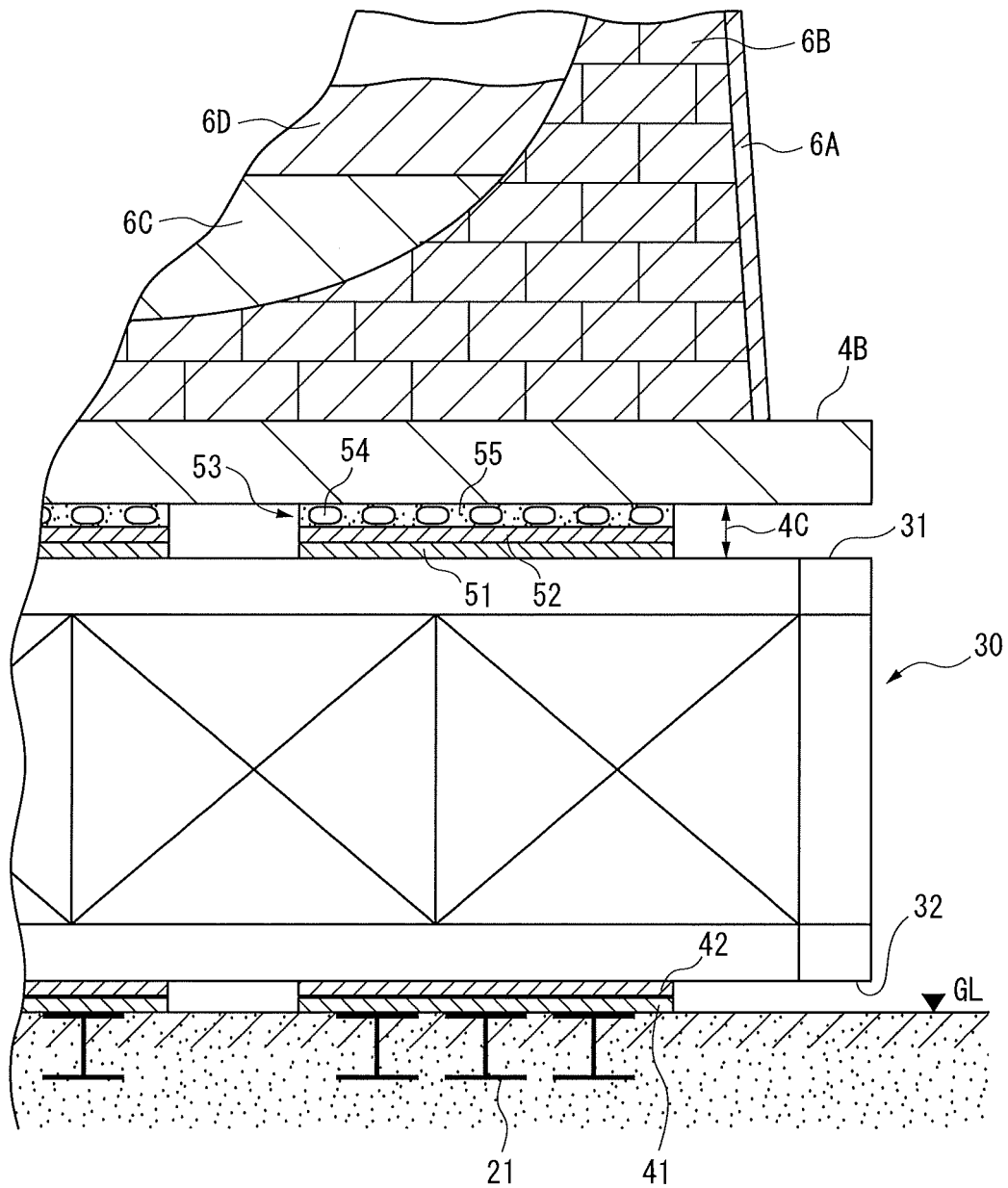


FIG. 4

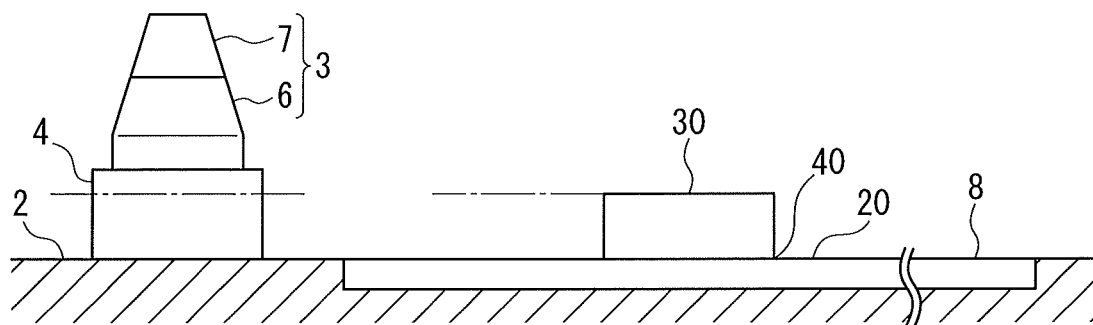


FIG. 5

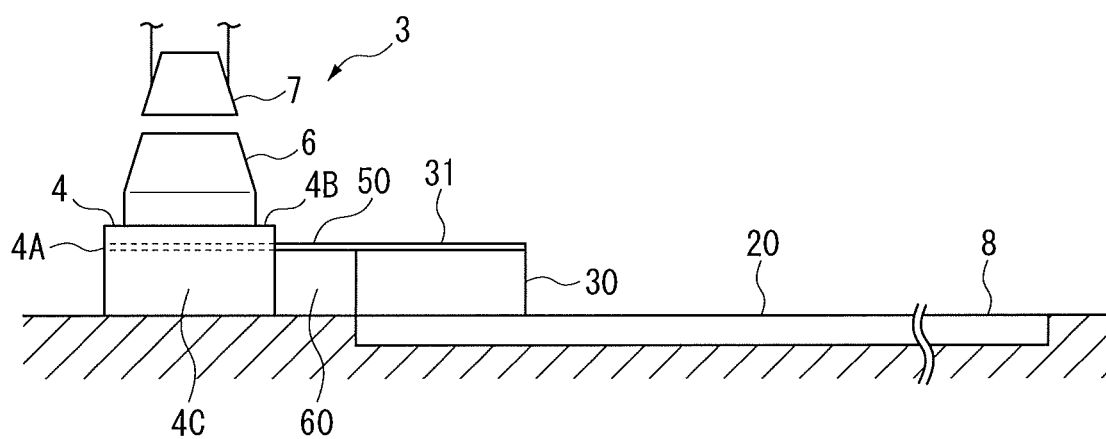


FIG. 6

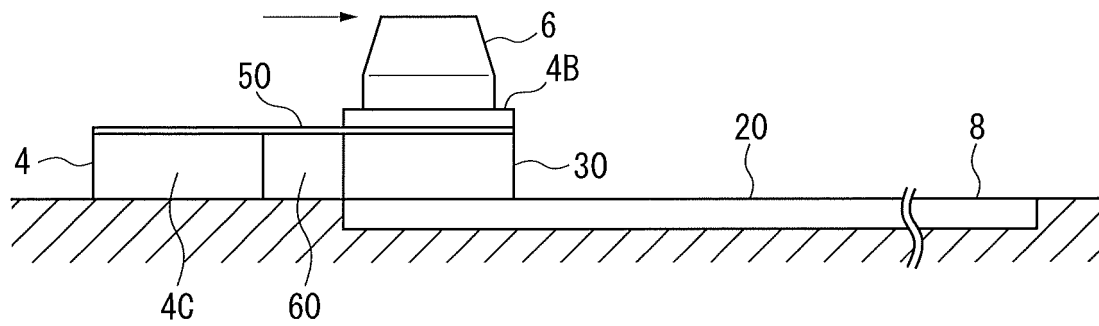


FIG. 7

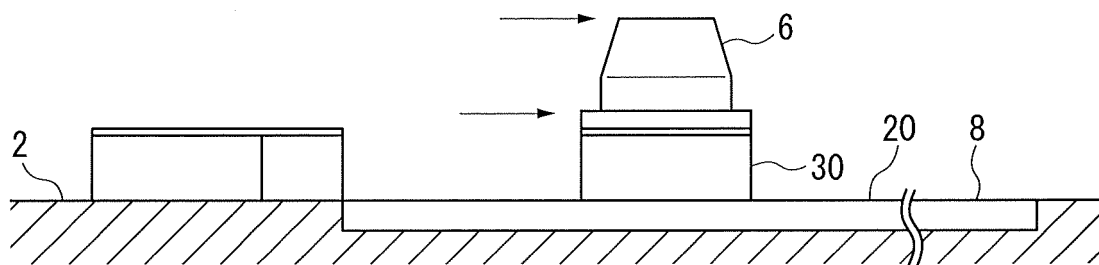


FIG. 8

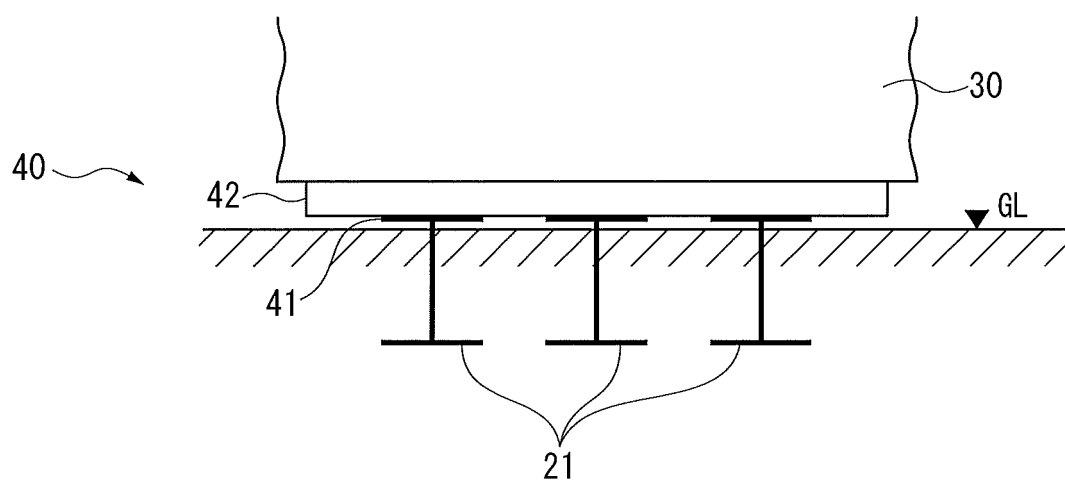


FIG. 9

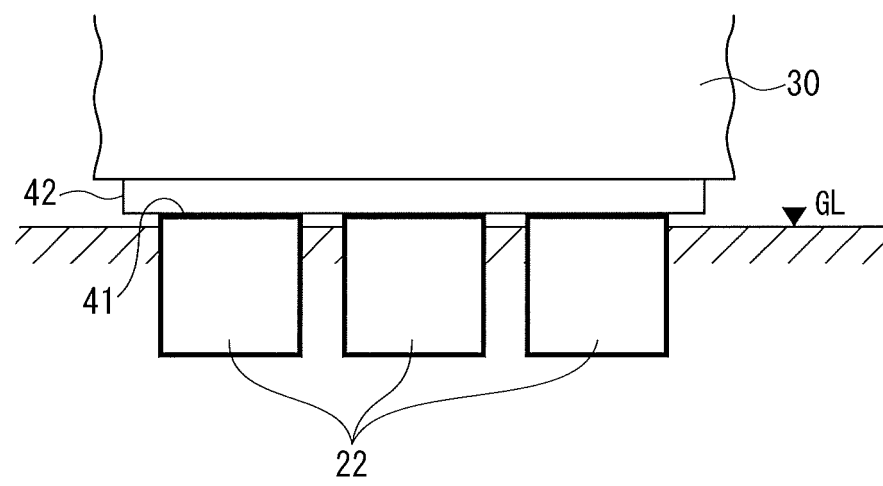


FIG. 10

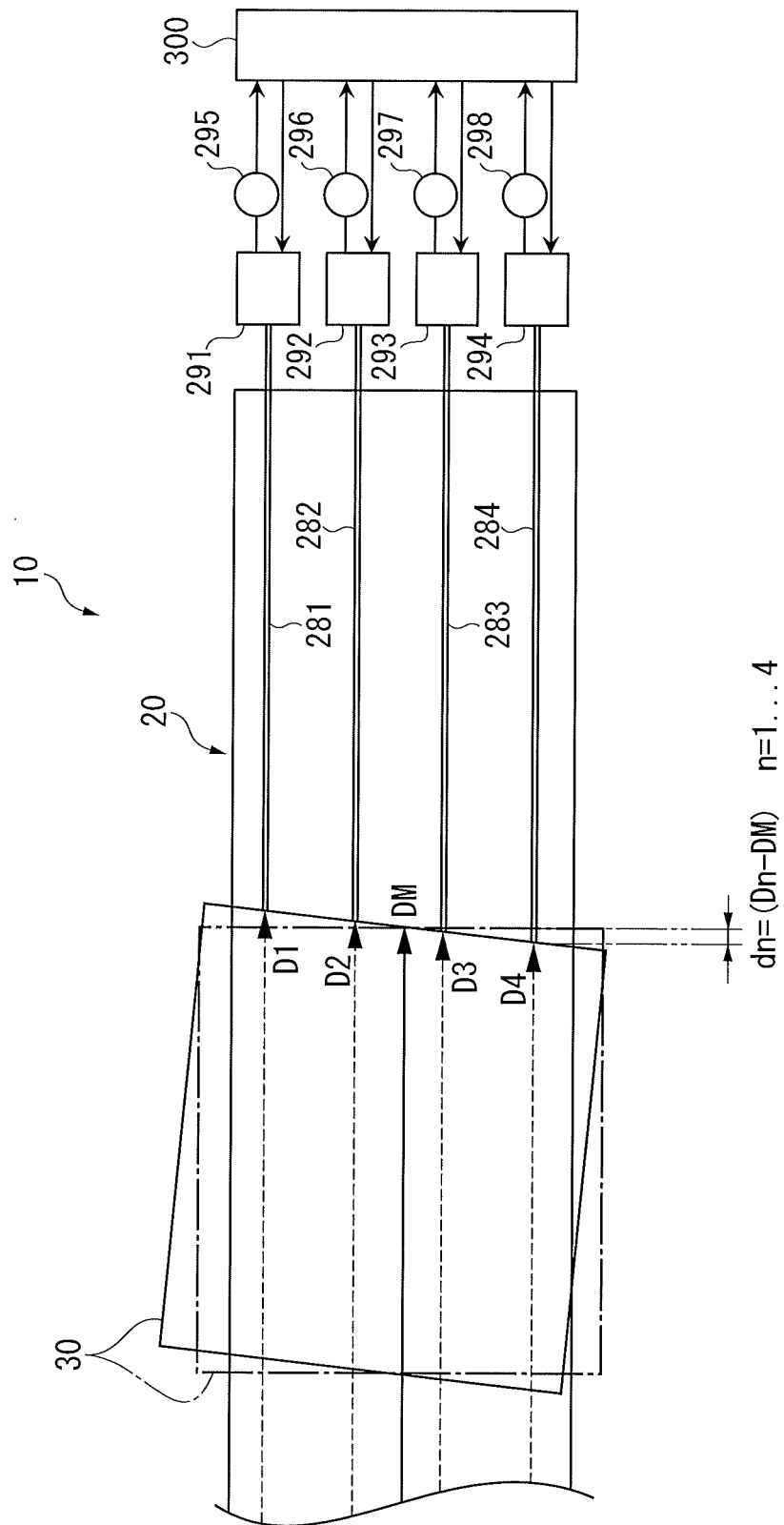


FIG. 11

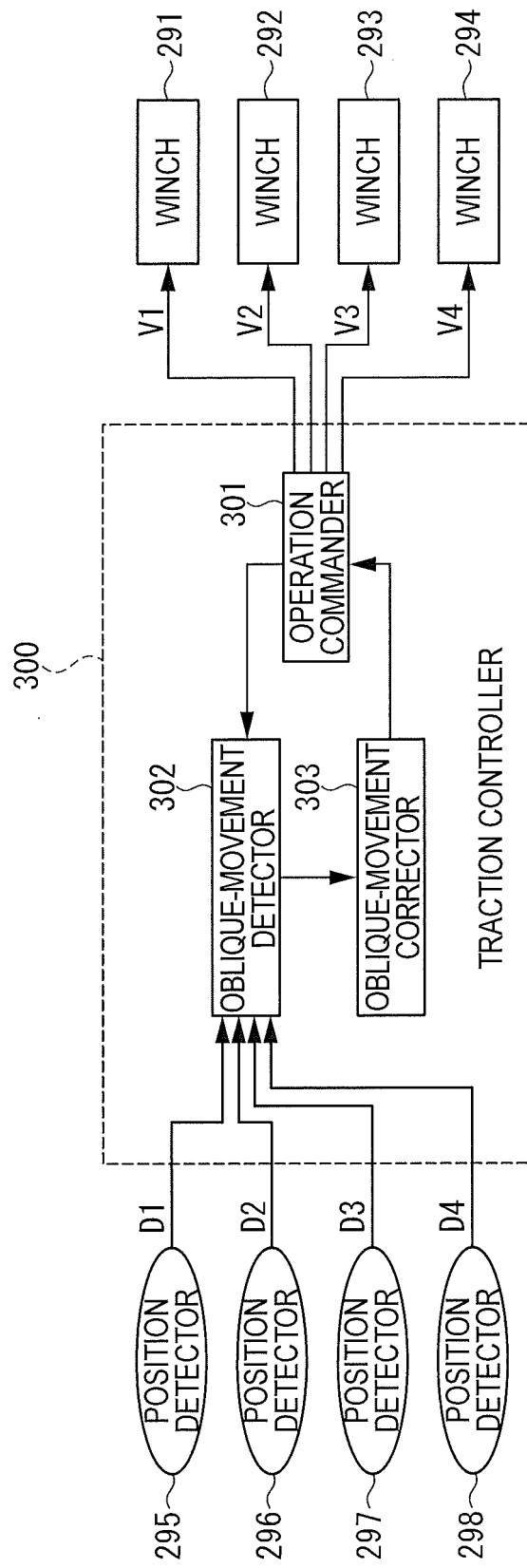


FIG. 12

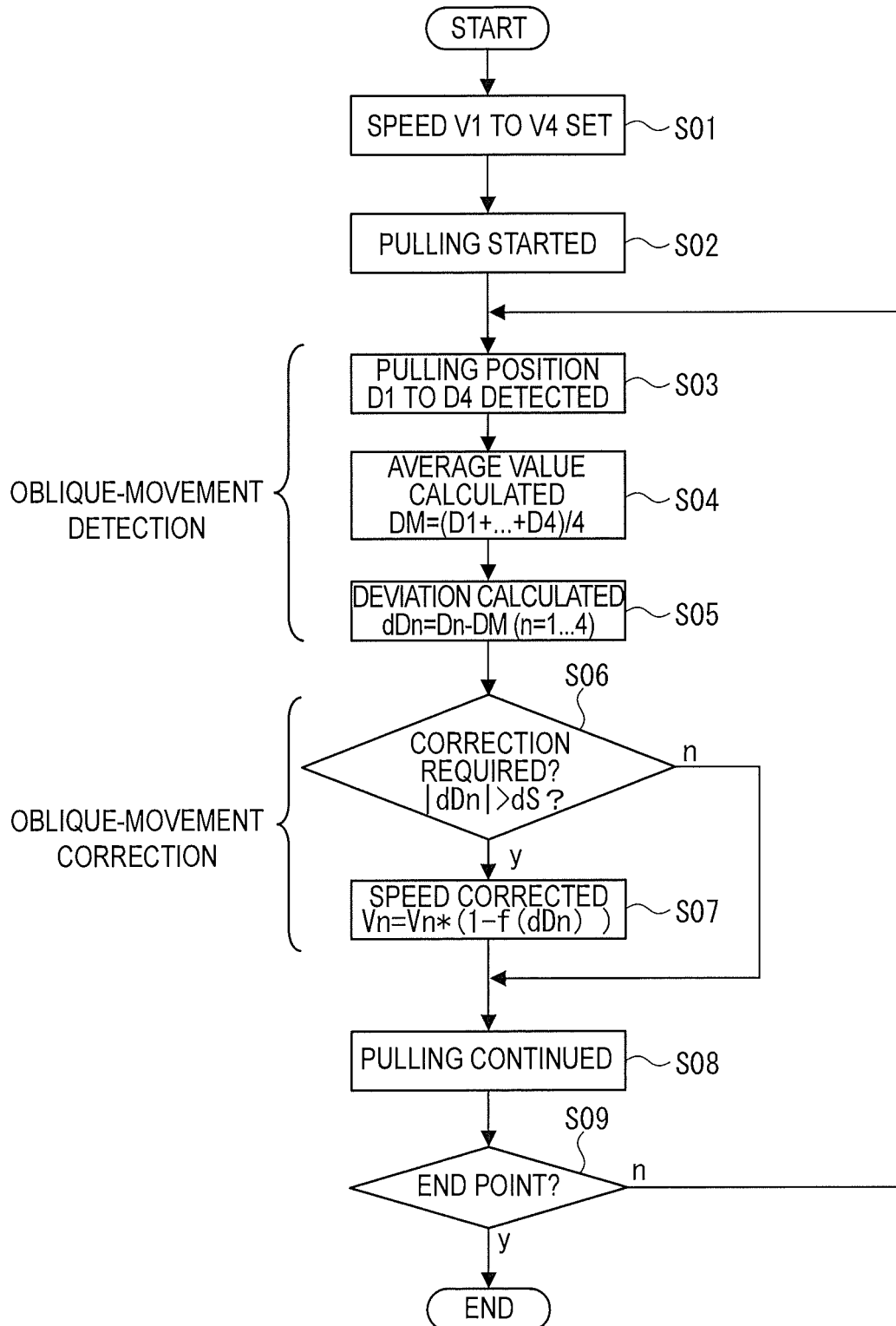


FIG. 13

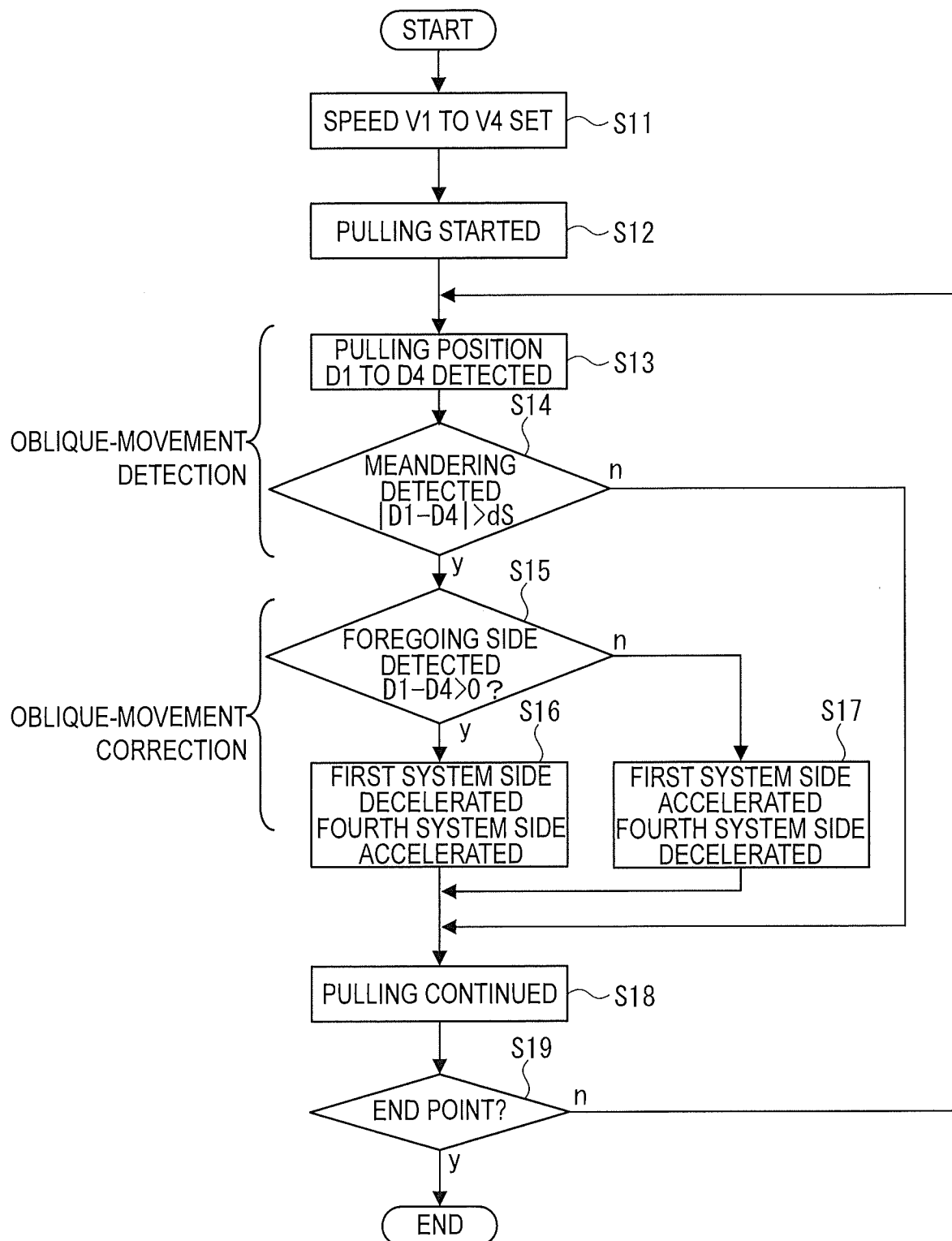


FIG. 14

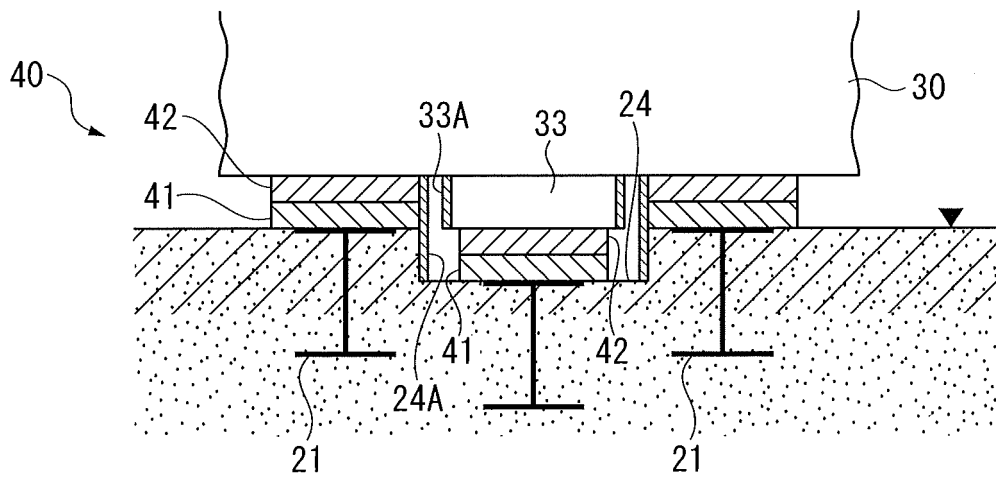


FIG. 15

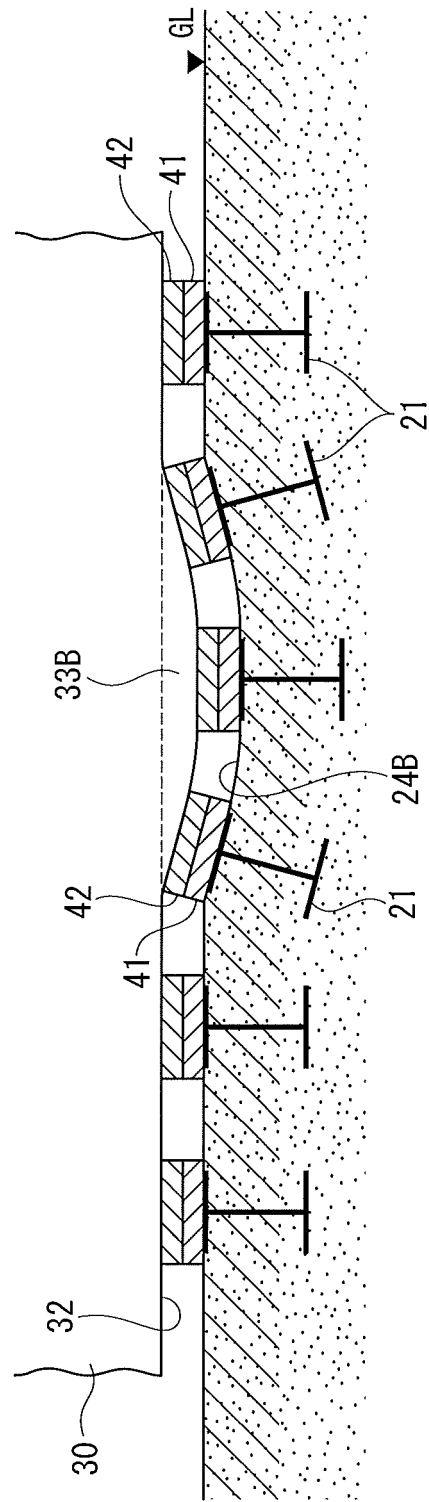
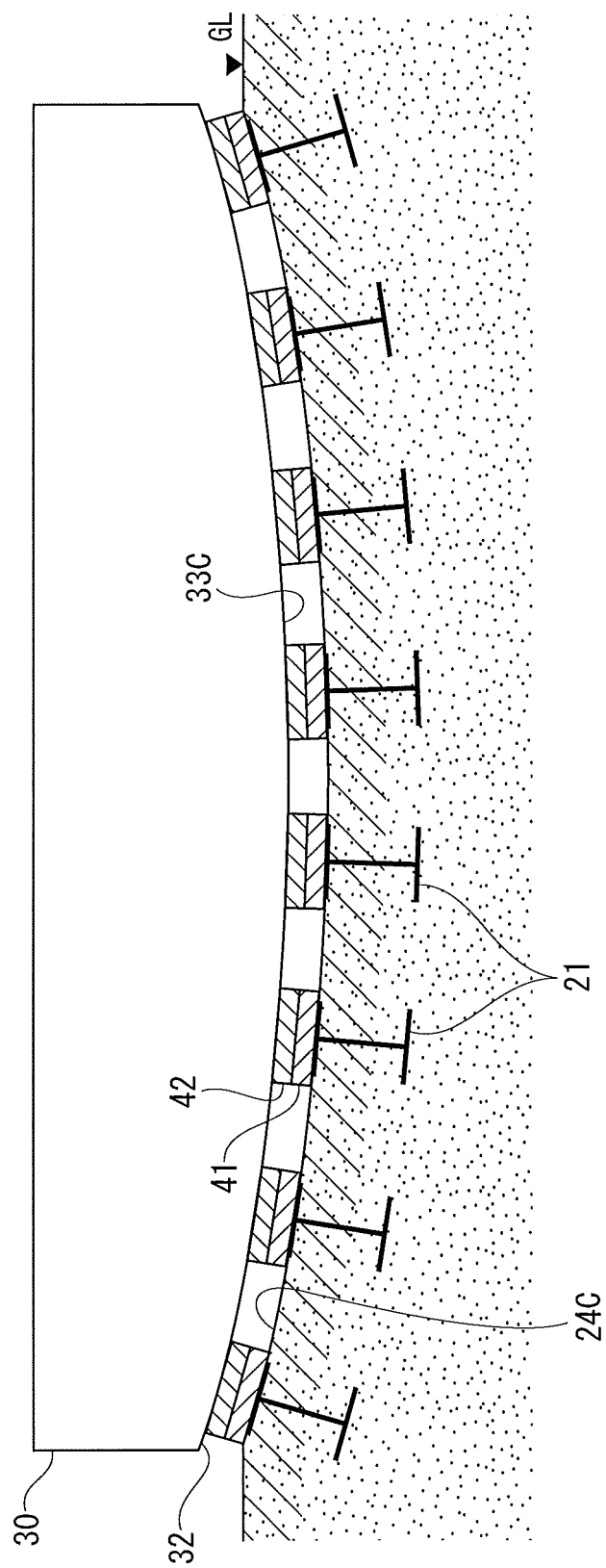


FIG. 16



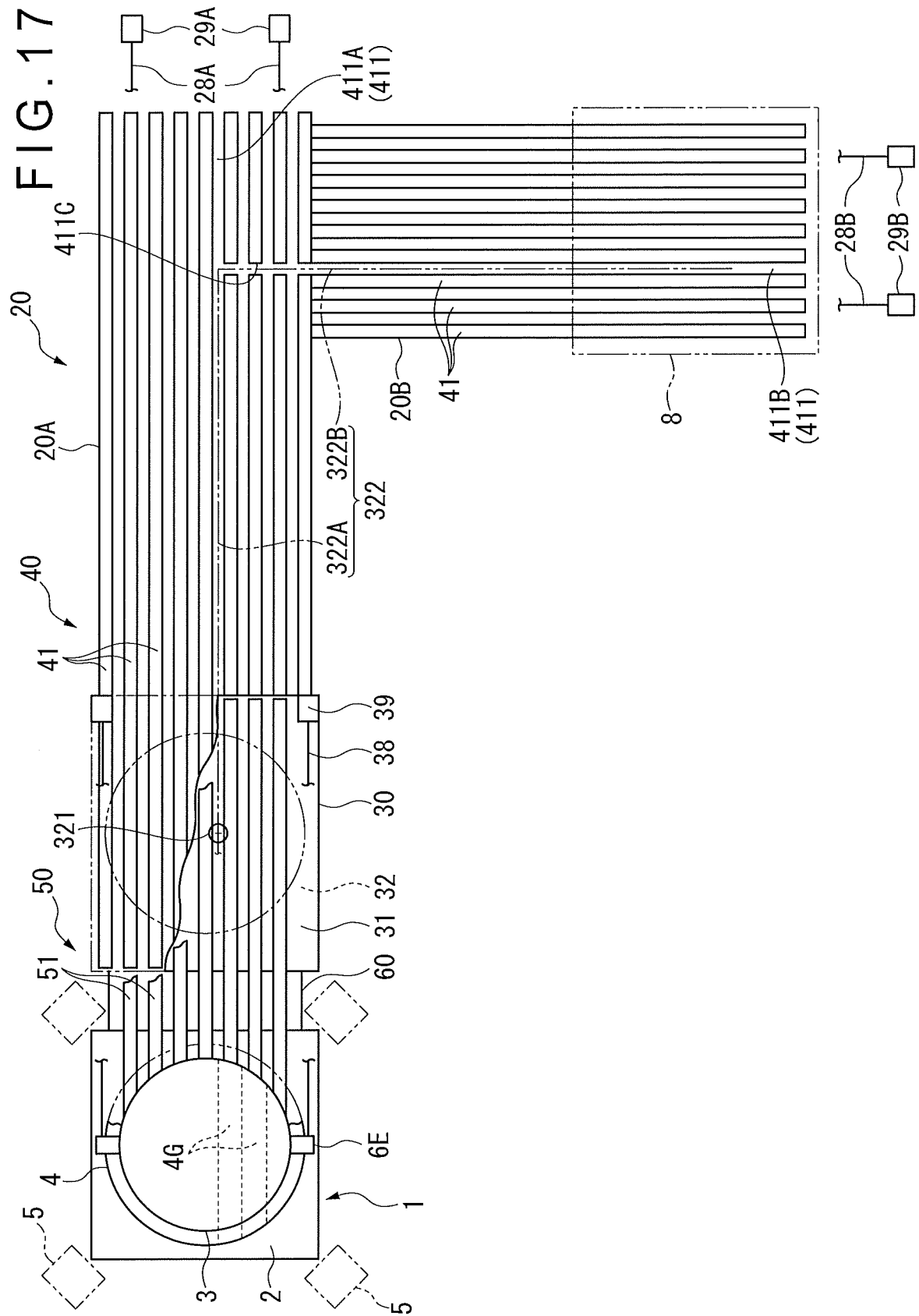


FIG. 18

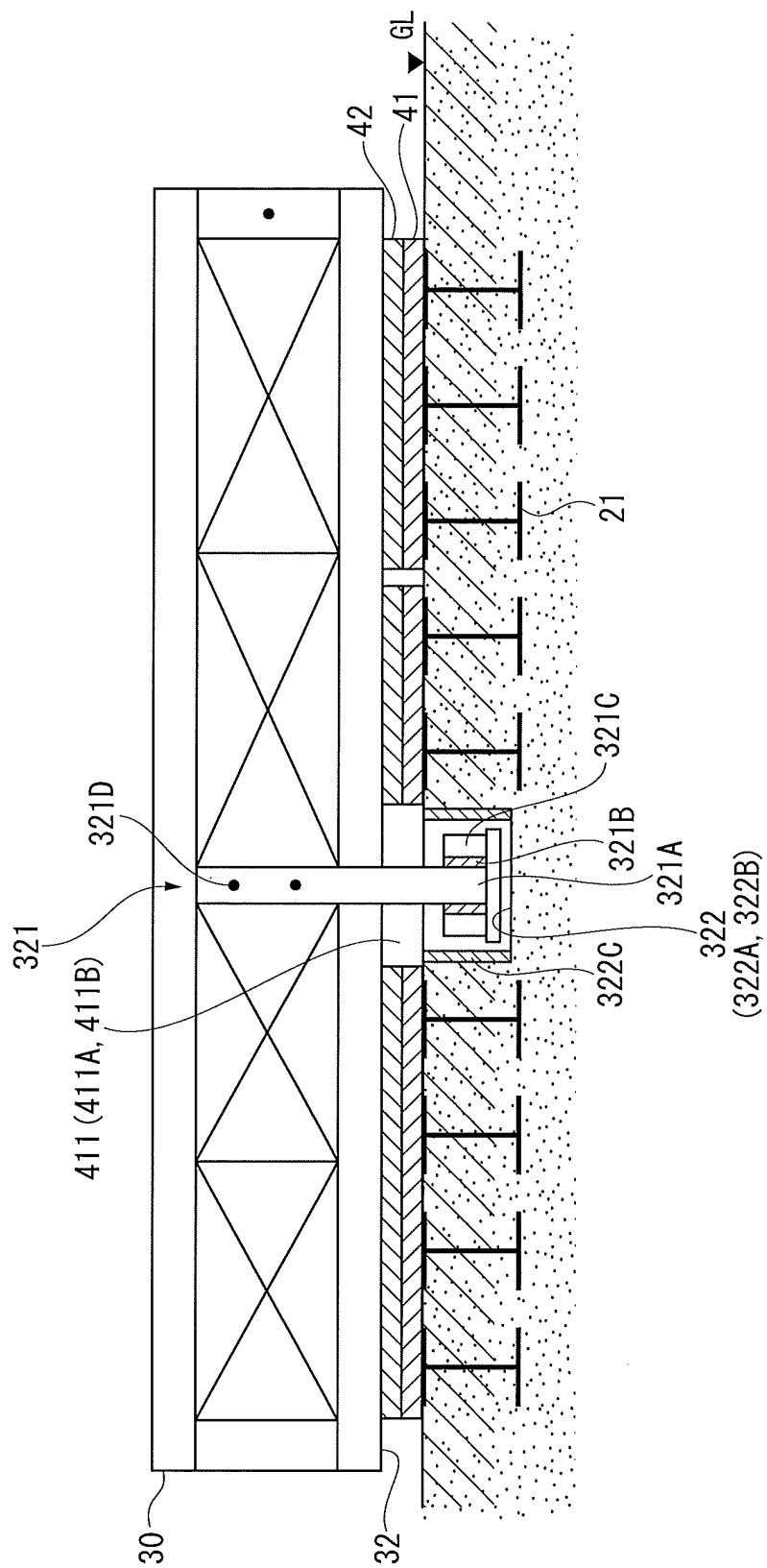
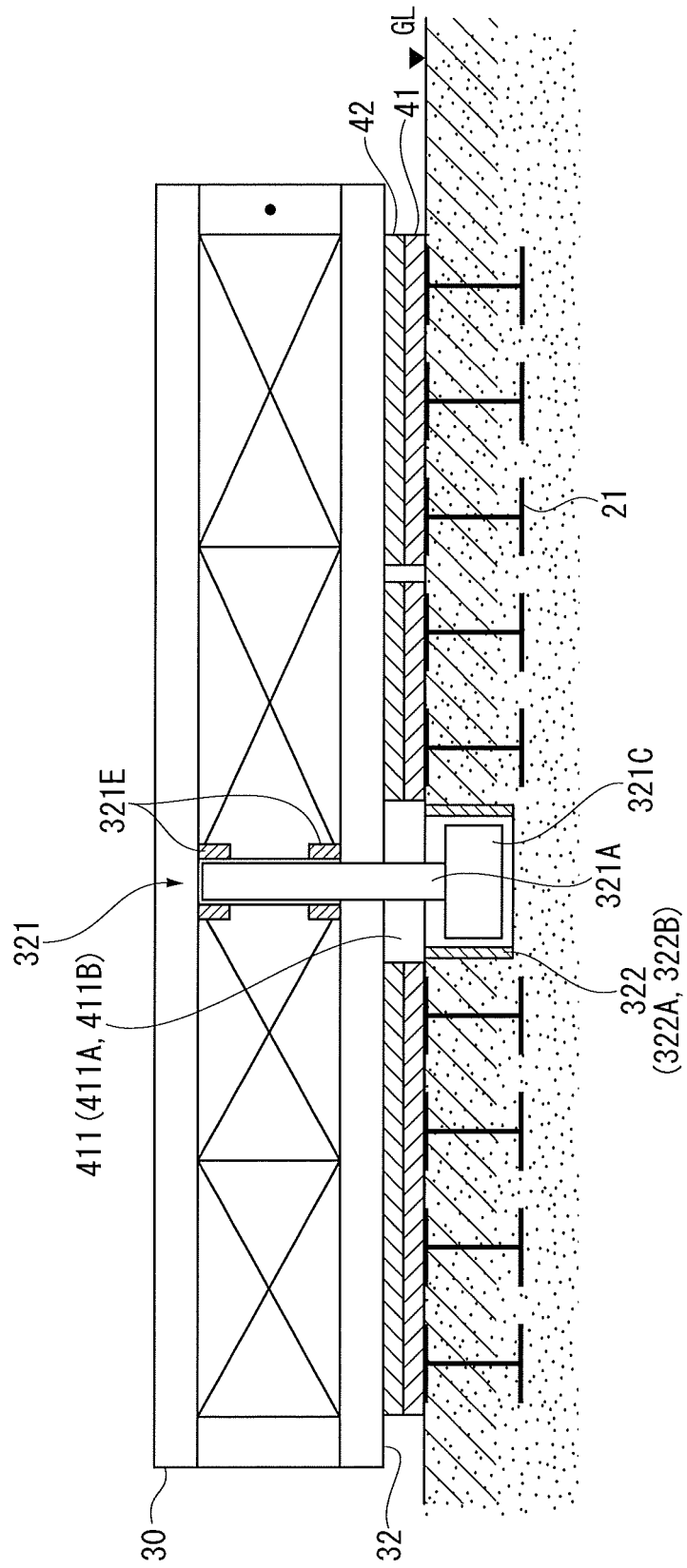
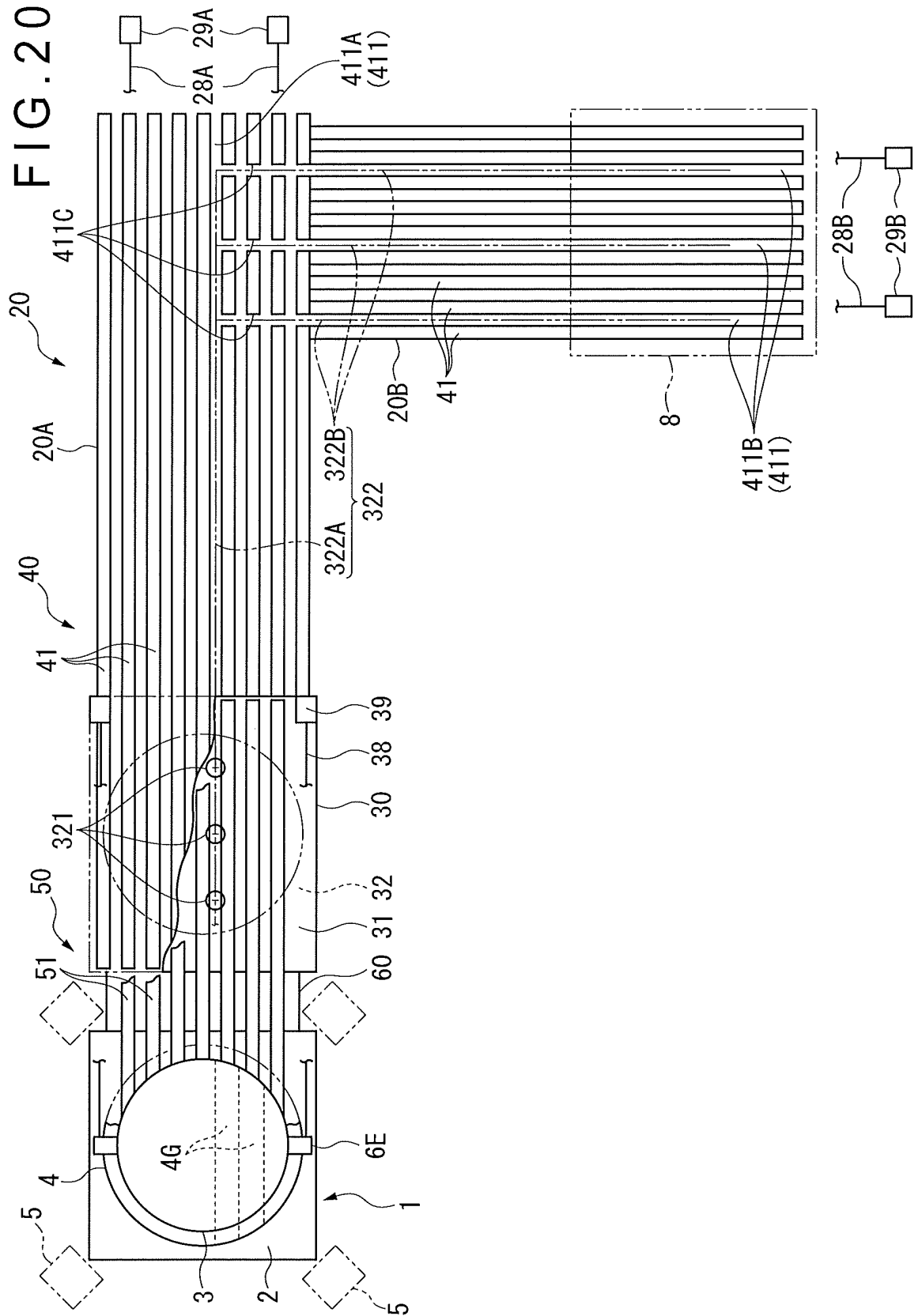


FIG. 19





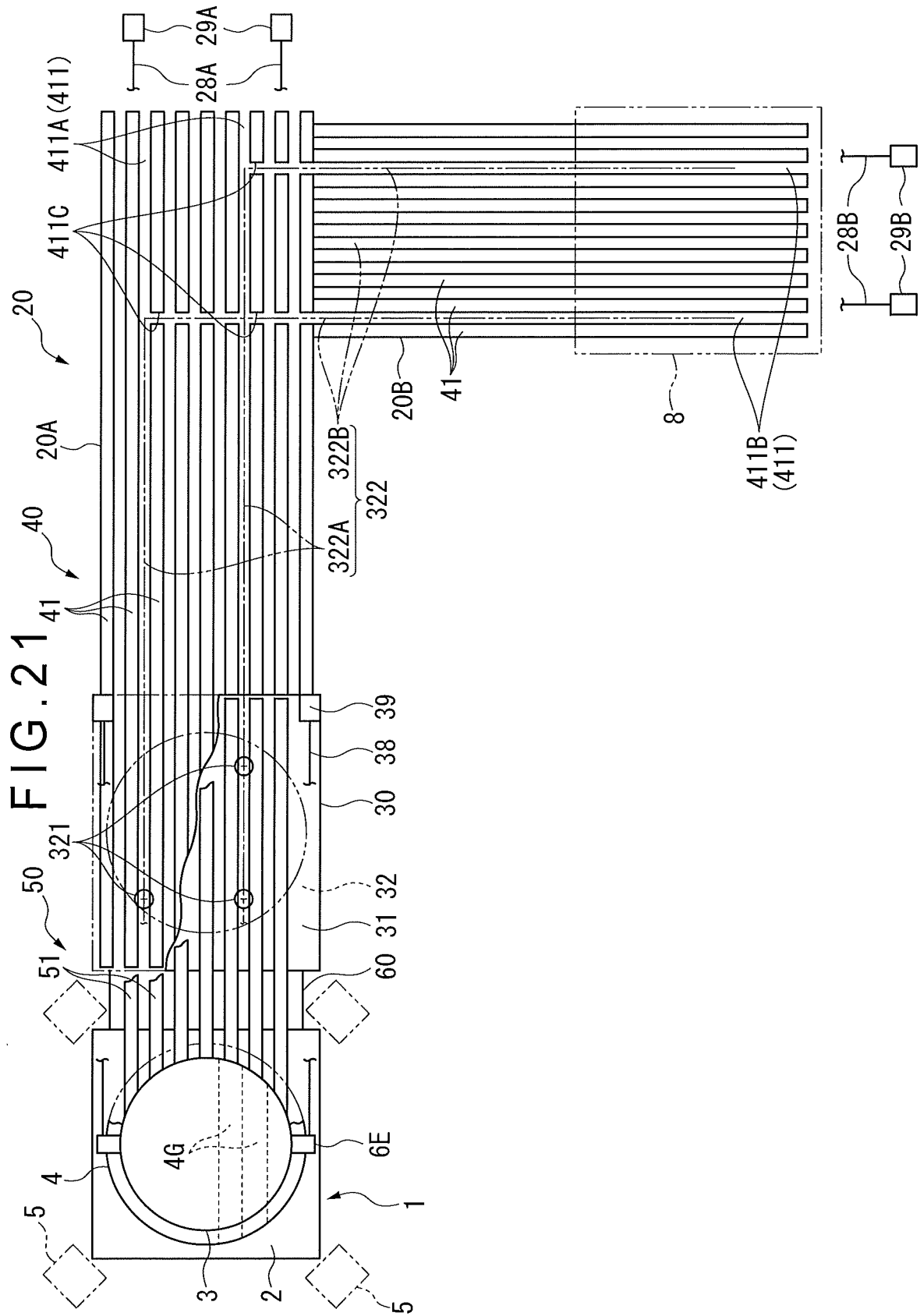


FIG. 22

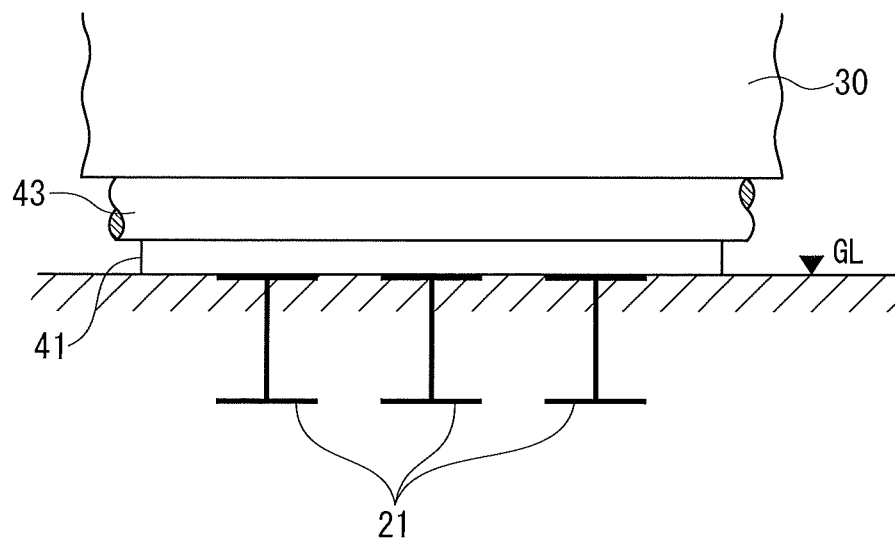


FIG. 23

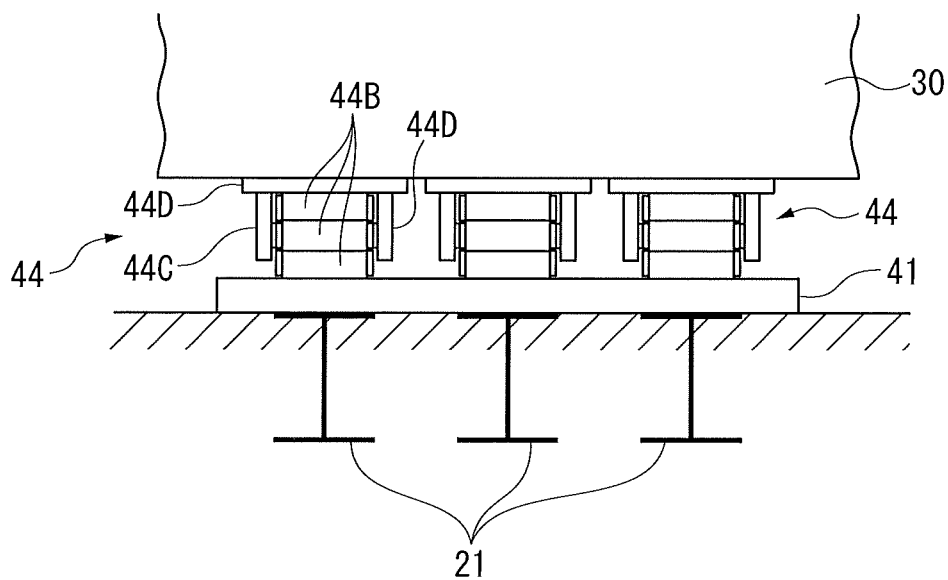


FIG. 24

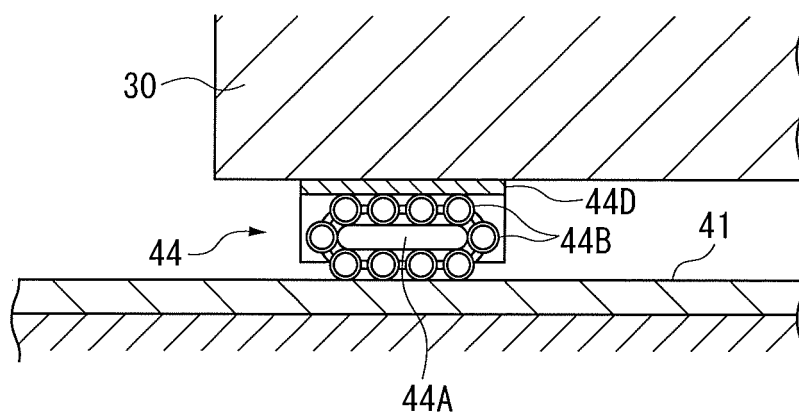


FIG. 25

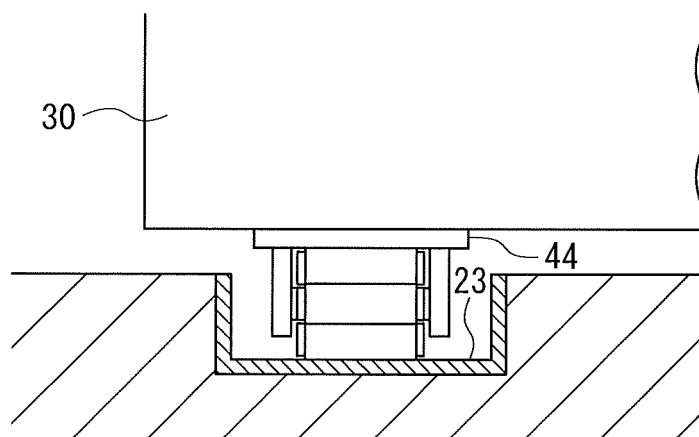


FIG. 26

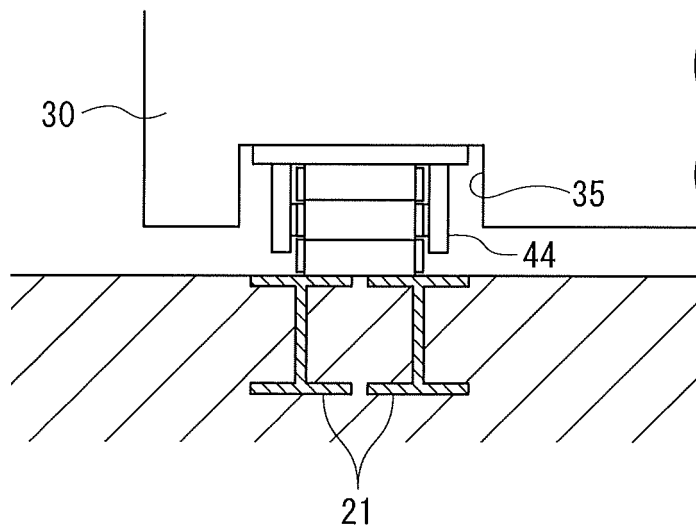


FIG. 27

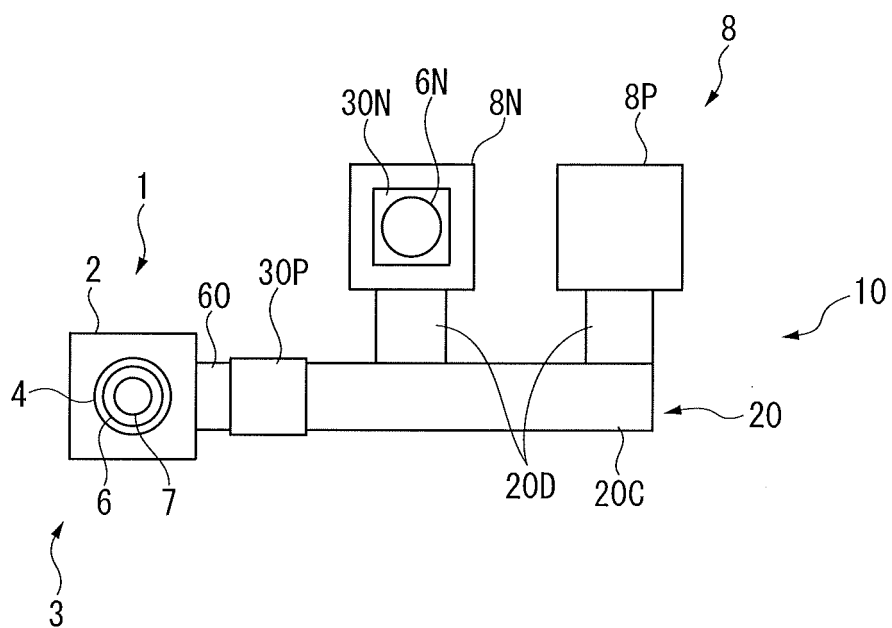


FIG. 28

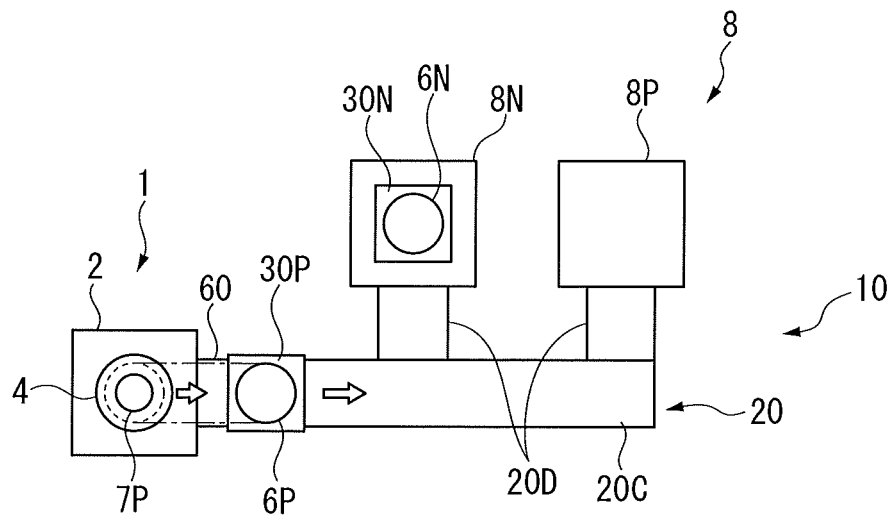


FIG. 29

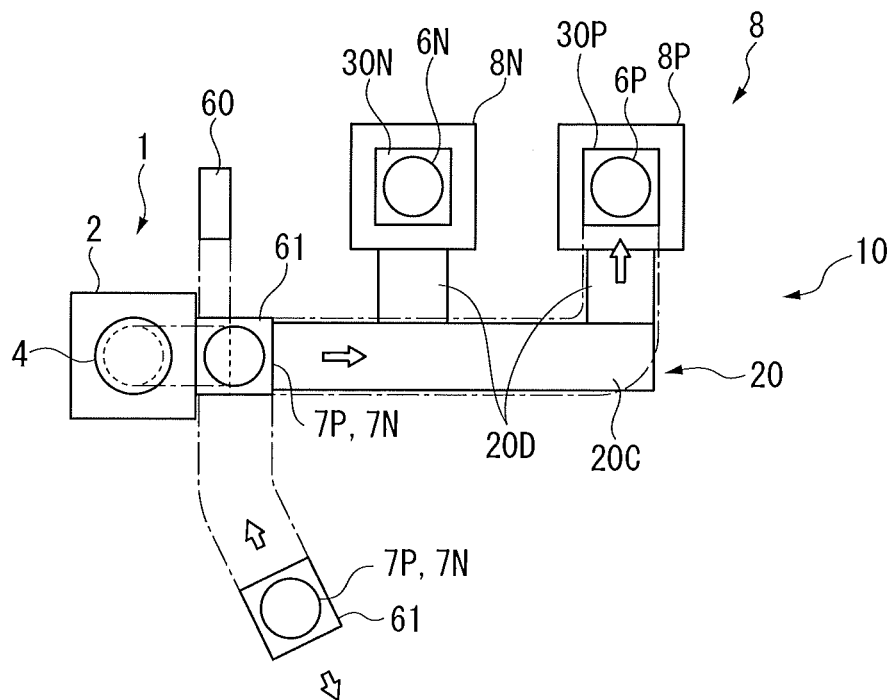


FIG. 30

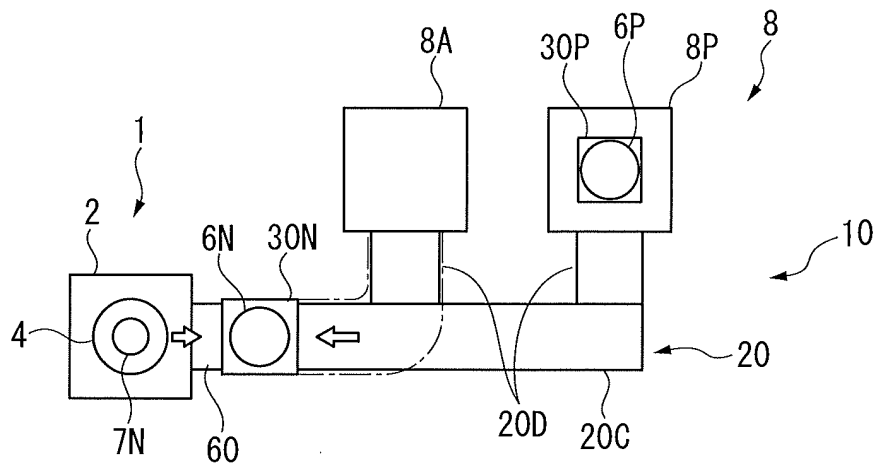


FIG. 31

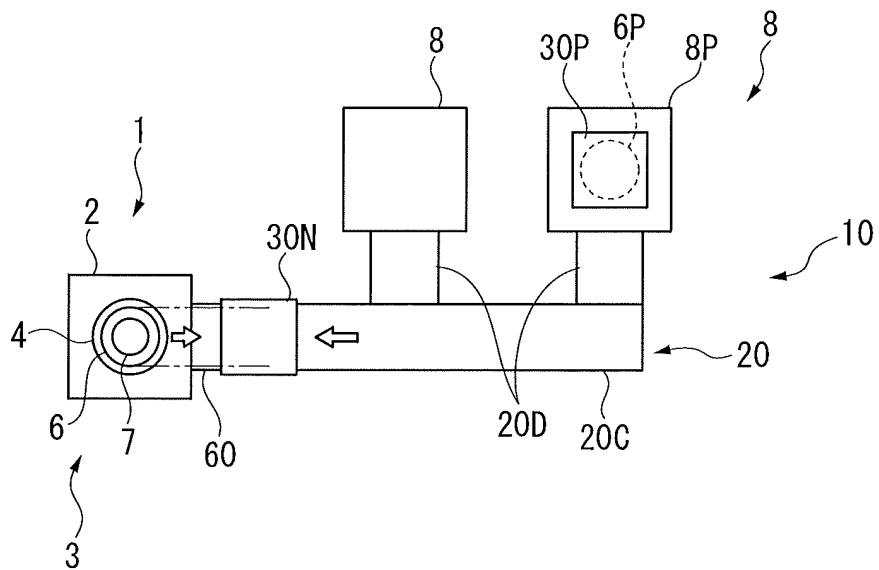
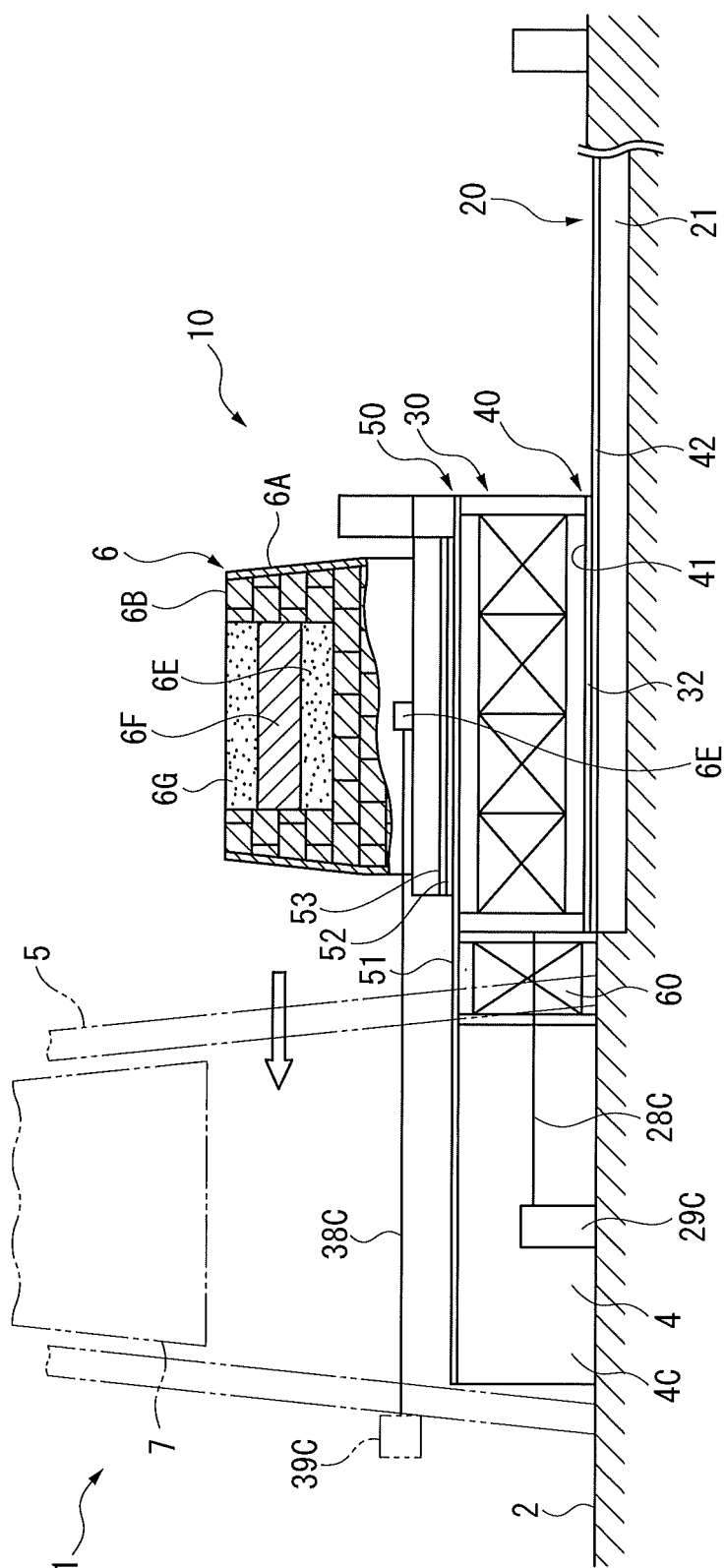


FIG. 32



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/064001

A. CLASSIFICATION OF SUBJECT MATTER C21B7/00 (2006.01) i		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) C21B7/00-7/24		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2008 Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006-283183 A (Nippon Steel Engineering Co., Ltd.), 19 October, 2006 (19.10.06), Full text (Family: none)	1-28
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 06 October, 2008 (06.10.08)		Date of mailing of the international search report 14 October, 2008 (14.10.08)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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