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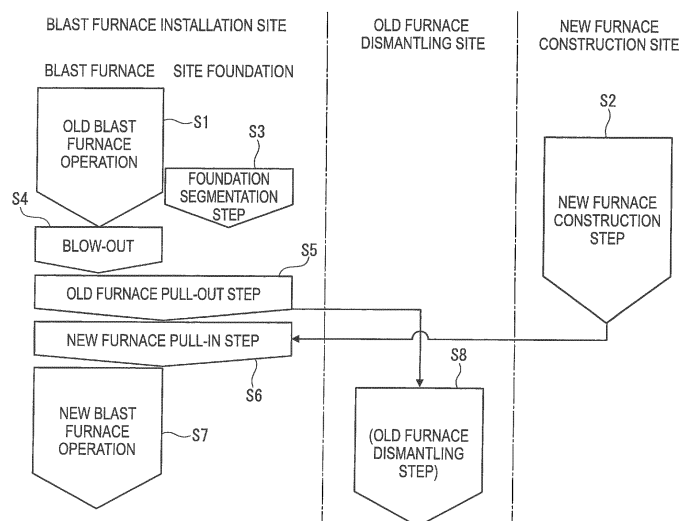
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(54) **BLAST FURNACE REPAIR METHOD**

(57) A method for revamping a blast furnace that has a furnace body and a furnace body tower installed on a site foundation includes: while an old blast furnace is in operation (S1), a new furnace construction step (S2) of constructing a new furnace tower structure and a new furnace proper on the new foundation at a site different from the site foundation; and a foundation segmentation step (S3) of vertically cutting the site foundation to segment the site foundation into a foundation top on which

the old furnace proper and the old furnace tower structure are mounted and a foundation bottom; blowing out the blast furnace (S4); an old furnace pull-out step (S5) of carrying out the foundation top integrally with the old furnace proper and the old furnace tower structure; and a new furnace pull-in step (S6) of introducing the new foundation on the foundation bottom integrally with the new furnace tower structure and the new furnace proper.

FIG. 1



Description

TECHNICAL FIELD

[0001] The present invention relates to a method for revamping a blast furnace, and more particularly, to a method for revamping a blast furnace capable of performing removal of an old furnace proper and an old furnace tower structure and construction of a new furnace proper and a new furnace tower structure in a short period of time.

BACKGROUND ART

[0002] In an iron-making blast furnace, there is a need for a repair, that is, a renewal of a furnace body every ten years or so.

[0003] The renewal of the furnace body is performed by removing the old furnace proper constructed on a foundation of a blast furnace installation site and by constructing a new furnace proper on the foundation.

[0004] At the time of renewal of the furnace body, when dismantling the old furnace proper on the foundation and then constructing a new furnace proper, a blow-out period of the blast furnace is extended causing a large amount of economic loss per day.

[0005] For such problems, a so-called ring block construction method for revamping a blast furnace has been adopted, in which the furnace body is sliced into a cross section of a ring and is removed from the foundation as a ring block and the ring block is assembled in a different site to be carried into the foundation.

[0006] Among them, a large block construction method of increasing the size of the ring block and segmenting the blast furnace into four huge ring blocks or so has been developed (see Patent Literature 1).

[0007] In the method of Patent Literature 1, the old furnace proper to be removed and the ring block of the carried-in new furnace proper are sequentially suspended on a jack installed in the blast furnace body tower and are removed by carrying out the block at the furnace bottom side to the lateral side.

[0008] However, in the furnace bottom portion of the old furnace proper, the weight of the furnace bottom residue cooled and solidified after the blowing out the blast furnace is great, and in some cases, the total weight is, for example, 8,000 tons. Thus, it is difficult to suspend them.

[0009] A method for dismantling the blast furnace bottom portion that removes the heavy furnace bottom portion without suspension has been suggested (see Patent Literature 2).

[0010] In the method of Patent Literature 2, a foundation is divided into a plurality of elongate compartments extending in a carry-out direction, a work of horizontally cutting the foundation and repacking a sliding plate and a filler is successively performed on each compartment, and after the repacking of all the compartments is per-

formed, the compartments are moved to slide using the sliding plate and are carried out only in a horizontal direction. According to this method, it is also possible to remove and carry in a huge furnace bottom portion having a weight exceeding 8,000 tons as the ring block. With the above techniques, the revamping construction period of the blast furnace is shortened.

[0011] Meanwhile, as a technique prior to the above-described large block construction method, a technique of collectively removing the old furnace proper of the blast furnace and installing a new furnace proper constructed at a different site by carrying in the new furnace proper on the foundation has been also suggested (see Patent Literature 3).

[0012] However, in the technique of Patent Literature 3, although the furnace body is handled collectively, as it is apparent in the drawings, the furnace body tower is left without change, and there is no description of dismantling or construction of the furnace body tower.

[0013] The reason for this is that, in the technical level of the revamping method of the blast furnace of the day, a countermeasure for the life expectancy of the furnace main body (wear of refractory or the like) is mainly performed, and a slight expansion or the like is simply considered to a change in a furnace volume. Thus, only the furnace main body is dismantled and reconstructed upon revamping, there is no need for dismantling and reconstructing of the furnace body tower that supports the furnace body, and the furnace body tower is usually reused from the construction period and economic viewpoints.

[0014] Further, as a construction method for tall structures of plant equipment, a technique of collectively carrying in an apparatus body and its peripheral framework onto the foundation is suggested (see Patent Literature 4).

[0015] In this technique, since the bottom of the apparatus is provided as a separate body, the dimension of the apparatus body and the framework is shortened by the size of the separate lower apparatus so as to be conveyed. After installing the foundation, the shortened apparatus body and the framework are suspended and extended, and the separately conveyed lower apparatus is installed to complete the apparatus main body. Thus, the technique of Patent Literature 4 is similar to a large block construction method in the blast furnace. However, as is also described in Patent Literature 4, the technique assumes the conveyance using ships and vehicles, but does not assume a huge structure such as a blast furnace. Furthermore, in Patent Literature 4, although there is a description of installation using a special foldable framework, there is no description of removal of the old structure.

CITATION LIST

PATENT LITERATURE(S)

[0016]

Patent Literature 1: JP-A-2006-283183
 Patent Literature 2: JP-B2-4300249
 Patent Literature 3: JP-A-52-13406
 Patent Literature 4: JP-A-58-106036

SUMMARY OF THE INVENTION

PROBLEM(S) TO BE SOLVED BY THE INVENTION

[0017] As described above, since the extension of the blow-out period of the blast furnace causes significant economic losses, there is a demand for further shortening the construction period to suppress the blow-out period as short as possible.

[0018] However, in the large block construction method as described in Patent Literature 1 or 2 mentioned above, since there is a need for operations of removal and carrying-in for each ring block, and there is also a need for an operation of suspending the ring block in the furnace body tower each time the ring block is removed and carried in, it is difficult to shorten the revamping construction period.

[0019] Further, in the large block construction method as described in Patent Literature 1 or 2 mentioned above, in order to suspend the respective ring blocks in the furnace body tower, the furnace body tower is required to have been set up at the time of removal and carrying-in of the furnace body, and there is a need to disassemble and reconstruct the furnace body tower separately from the furnace body, which is a problem in shortening the construction period.

[0020] It is conceivable to reuse the furnace body tower of the old furnace proper for that of a new furnace proper without any change. However, in this case, furnace volume expansion of the new furnace proper is limited in order to avoid interference with the old furnace tower structure.

[0021] Here, in the above-described Patent Literature 3, by collectively replacing the furnace body, it is possible to eliminate the suspending work to the furnace body tower in the ring block construction method including the large block construction method. However, in Patent Literature 3, the furnace body tower is not renewed, and the technique cannot be applied to the renewal of a blast furnace involving the expansion of the furnace body volume.

[0022] Moreover, in the above-described Patent Literature 4, since the assumed apparatus is small enough to be conveyed by ships and vehicles, the method disclosed therein cannot be directly applied to the renewal of the blast furnace, there is a need for a work in expansion and contraction of the framework and attachment and detachment of the lower apparatus, and this technique is not suitable for shortening construction period.

[0023] Thus, in the large block construction method as described in the above Patent Literature 1 or 2, it is difficult to further shorten the construction period. Even with reference to Patent Literatures 3 and 4 disclosing tech-

niques before Patent Literatures 1 and 2, it is difficult to perform the removal of an old furnace proper and an old furnace tower structure, and the construction of a new furnace proper and a new furnace tower structure at the time of revamping of the blast furnace in a short period of time.

[0024] An object of the invention is to provide a method for revamping a blast furnace capable of performing the removal of the old furnace proper and the old furnace tower structure and the construction of the new furnace proper and the new furnace tower structure in a short period of time.

MEANS FOR SOLVING THE PROBLEM(S)

[0025] A method according to an aspect of the invention is for revamping a blast furnace that has a furnace body and a furnace body tower installed on a site foundation, the method including: a new furnace construction step of constructing new foundation and constructing a new furnace tower structure and a new furnace proper on the new foundation in a new furnace construction site different from the site foundation; and a foundation segmentation step of vertically cutting the site foundation to segment the site foundation into a foundation top on which the old furnace proper and the old furnace tower structure are mounted and a foundation bottom, the new furnace construction step and the foundation segmentation step being performed while the blast furnace is in operation; blowing out the blast furnace; an old furnace proper carry-out process of carrying out the foundation top from the top of the foundation bottom integrally with the old furnace proper and the old furnace tower structure; and a new furnace pull-in step of carrying in the new foundation on the foundation bottom integrally with the new furnace tower structure and the new furnace proper.

[0026] In the above aspect of the invention, in the new furnace construction step, while the old blast furnace is in operation, the new furnace proper and the new furnace tower structure are constructed on the top of a new foundation in a new furnace construction site different from the blast furnace installation site. Further, after the old blast furnace is blown out, by performing the old furnace pull-out step and the new furnace pull-in step, it is possible to remove the old furnace proper and the old furnace tower structure from the site foundation, and to collectively replace the new furnace proper and the new furnace tower structure constructed in advance. The removed old furnace proper and the old furnace tower structure can be suitably dismantled in a state of re-operating the new blast furnace in still another old furnace dismantling site.

[0027] Therefore, in the invention, the revamping construction period of the blast furnace can be shortened to about 50 to 70 days.

[0028] Although depending on the furnace volume, it

requires about 120 to 150 days in the conventional method for performing all the works from the dismantling of the old furnace proper to the construction of a new furnace proper on the same foundation.

[0029] Moreover, even in the large block construction method or the ring block construction method described above, although production and dismantling for each ring block can be performed at a site different from the foundation, there is a need to segment the ring block, suspend and carry out the old furnace proper and carry in the ring block, and to suspend and connect a new furnace proper on the foundation. In this case, it requires about 80 to 120 days for revamping construction period.

[0030] As described above, in the invention, since the main work on the foundation of the blast furnace installation site is limited to the old furnace pull-out step and the new furnace pull-in step, it is possible to significantly shorten the revamping construction period of the blast furnace.

[0031] Further, in the invention, by integrally replacing the furnace body and the furnace body tower, it is also possible to collectively perform dismantling of the old furnace proper and the construction of the new furnace proper. The construction period can be also shortened in this regard.

[0032] Also, because of the collective replacement including the furnace body tower, equipment (such as various facilities and piping and wiring) installed between the old furnace proper and the old furnace tower structure can be carried out to the outside of the foundation in a mounted state. In addition, the equipment installed between the new furnace proper and the new furnace tower structure is outfitted in advance in the new furnace construction step to be collectively carried in onto the foundation. The revamping construction period can also be shortened in this regard.

[0033] In addition, a remarkable feature of the invention is that, since the old furnace tower structure is replaced with a new furnace tower structure simultaneously with the replacement of the old furnace proper with the new furnace proper, even when the furnace volume of the new furnace proper is significantly enlarged, the size of the new furnace proper is not restricted by the size of the old furnace tower structure. That is, even when a large new furnace proper which is not able to be housed in the old furnace tower structure, the large new furnace proper can be housed by constructing a new furnace tower structure matching thereto, and it is also possible to drastically enhance a freedom degree of expanding the furnace volume.

[0034] In addition, in the new furnace pull-in step, since a new furnace proper to be conveyed can be integrally conveyed in a stable state by being supported on the new furnace tower structure, it is possible to safely perform the process.

[0035] In the above aspect of the invention, in the new furnace pull-in step, it is desirable that a restoration foundation is formed on an upper surface of the foundation

bottom, and the new foundation is carried in onto an upper surface of the restoration foundation integrally with the new furnace tower structure and the new furnace proper.

[0036] In the invention, by cutting during the foundation segmentation step or by the work in the old furnace pull-out step, even when the upper surface of the foundation bottom is rough with large irregularities and the like, the upper surface can be covered with a restoration foundation, and the upper surface of the restoration foundation can be reconstructed with high smoothness. Therefore, when installing a sliding structure of the pull-in transfer device on the upper surface of the restoration foundation, it is possible for the new furnace proper to be stably carried in with high accuracy.

[0037] In the above aspect of the invention, in the new furnace construction step, an pull-in transfer device linearly extending from the new furnace construction site to the site foundation is used, and

in the old furnace proper carry-out process, an pull-out transfer device is used which extends from the site foundation toward a site where the new furnace construction step is performed, and extends from a direction change position in an intersection direction, and

each of the pull-in transfer device and the pull-out transfer device has a sliding structure using a solid lubricated low-friction lining between a pair of sliding plates.

[0038] In the invention, after construction of the new blast furnace (a new furnace proper and a new furnace tower structure) on the new foundation in the new furnace construction step, the new foundation, the new furnace proper and the new furnace tower structure are conveyed to the site foundation in the new furnace pull-in step. At this time, by linearly providing the pull-in transfer device, it is possible to perform the conveyance by minimum driving with no direction change or the like, thereby reducing a possibility of causing deformation and the like on the new furnace proper and the new furnace tower structure on the new foundation, and safely performing the conveyance.

[0039] Further, the old furnace body carry-out device can partially share, for example, a portion from the site foundation to the direction change position with the aforementioned pull-in transfer device, and it is possible to efficiently use a ground leveled and reinforced as the pull-in transfer device. Specifically, in order to receive the load of the huge new furnace proper and new furnace tower structure, sufficient reinforcement is performed on the ground on which the pull-in transfer device is installed.

In the pull-out transfer device as well, there is a need for reinforcement of the ground to receive a heavy load of the old furnace proper and the old furnace tower structure, and by partially sharing the pull-out transfer device with the pull-in transfer device, it is possible to reduce the work and cost of the ground reinforcement as a whole.

[0040] It should be noted, however, that the invention is not limited to the configuration of partially sharing the mutual conveying path in the pull-out transfer device and

the pull-in transfer device. The invention may be configured so that the pull-out transfer device and the pull-in transfer device are independent of each other.

[0041] In addition, since the pull-out transfer device changes in direction at a halfway of the pull-in transfer device and extends in the intersection direction, it is possible to set the old furnace dismantling site at a site different from the new furnace construction site, and it is possible to avoid an interference of the working site.

[0042] Further, since the old furnace proper and the old furnace tower structure are dismantled after being carried out, there is no problem even when deformation or the like occurs, and there is no problem for the pull-out transfer device to experience the direction change. In view of these circumstances, in the invention, it is the most desirable to linearly set the pull-in transfer device and to change the direction of the pull-out transfer device in the intersection direction.

[0043] However, the invention is not limited to the configuration in which the pull-in transfer device is linearly set and the pull-out transfer device experiences the direction change in the intersection direction in the middle (i.e. at a halfway). The invention may be configured so that the pull-out transfer device is linearly set, and the pull-in transfer device experiences the direction change in the intersection direction in the middle.

[0044] In the above aspect of invention, each of the pull-out transfer device and the pull-in transfer device may experience the direction change. For example, the pull-in transfer device may experience the direction change in the intersection direction at a halfway of the conveying path and the pull-out transfer device may experience the direction change in the intersection direction from a halfway of the pull-in transfer device may be provided. For example, a shared portion of the conveying path may extend from the blast furnace installation site, the pull-in transfer device may extend from its end portion toward the new furnace construction site in the intersection direction, and the pull-out transfer device may extend toward the old furnace dismantling site from the end portion to the opposite side.

[0045] In the above aspect of the invention, each of the pull-out transfer device and the pull-in transfer device may be linearly configured. In this case, the pull-out transfer device and the pull-in transfer device need to be independent from each other, and for example, it is possible to use a configuration in which the pull-out transfer device linearly extends to one side of the site foundation and the pull-in transfer device extends in the other direction. At this time, an angle formed between the pull-out transfer device and the pull-in transfer device is not limited to the configuration that forms 180 degrees (the devices are arranged on the same line) or 90 degrees, but a configuration that forms an angle such as 45 degrees or 60 degrees may be adopted. The reason is that, since the furnace body tower is also integrally conveyed in the invention, there is no restriction such as an angle that allows the passage of the furnace body tower.

[0046] Further, in the invention, it is possible to perform the conveyance of the new foundation, the new furnace proper and the new furnace tower structure in the new furnace pull-in step by sliding operation between the sliding plates in a sliding plate type sliding structure that causes a pair of sliding plates to slide each other.

[0047] Specifically, when a mechanical structure (e.g. vehicle wheels or rollers) is used and a heavy load is applied due to the huge new furnace proper and new furnace tower structure, a portion of the mechanical structure that receives the concentrated load is deformed or damaged to impair the function, and the conveyance may become difficult. However, in the conveyance using such a pair of sliding plates, it is possible to receive a heavy load by dispersing the load on the wide sliding surface, and since a local deformation is hard to occur by the continuous sliding surface, it is possible to reliably perform the conveyance even in a huge new furnace proper and the new furnace tower structure.

[0048] Further, by installing a solid lubricated low-friction lining between the pair of sliding plates, it is possible to further reduce the mutual friction and to perform smooth and high-accurate conveyance, and thus, even when an integrally constructed new blast furnace is conveyed, the function of the new blast furnace is not impaired.

[0049] It should be noted that, in regard to the sliding plate type sliding structure which allows the pair of sliding plates to slide each other and a the furnace body conveyance of the heavy load using the same, it is desirable to refer to Patent Literature 2 described above. As the solid lubricated low-friction lining, it is preferable to use a lining on which a solid lubricant, for example, fine powdery solid lubricant such as polytetrafluoroethylene resin (PTFE), molybdenum disulfide and graphite are rigidly attached on the surface of a substrate.

[0050] The sliding structure may be utilized not only in the pull-in transfer device utilized in the new furnace pull-in step, but also in a pull-out transfer device that is used in the old furnace pull-out step.

[0051] In the above aspect of the invention, the aforementioned pull-in transfer device and pull-out transfer device specifically preferably are installed with a platform(s) as described below and a sliding structure(s) along the conveying path in order to perform the conveying operation using the platform(s) and the sliding structure(s).

[0052] First, in the above aspect of the invention, it is possible that in which the pull-out transfer device includes a first movement path extending from the site foundation toward the site where the new furnace construction step is performed, a second movement path extending in the intersection direction from a halfway of the first movement path, an pull-out transfer base that is movable on the first movement path, a branch transfer base that is movable in the second movement path, and a recess that is formed in the ground along the second movement path and houses the branch transfer base,

the first movement path includes a sliding structure that is continued from an upper surface of the pull-out transfer base to the upper surface of the foundation bottom and includes a sliding surface having a height set at a level L1, a sliding structure that is formed between a lower surface of the pull-out transfer base and the ground and includes a sliding surface having a height set at a level L2, and a sliding structure that is formed on an upper surface of the branch transfer base and includes a sliding surface having a height set at the level L2,

the second movement path includes a sliding structure that is formed between a lower surface of the branch transfer base and a bottom surface of the recess and includes a sliding surface having a height set at a level L3, the pull-in transfer device includes a third movement path extending from the new foundation toward the site foundation, an pull-in transfer base that is movable on the third movement path and supports the new foundation, and a support member disposed in the recess at a half-way of the third movement path,

the third movement path includes a sliding structure that is formed between a lower surface of the pull-in transfer base and the ground, is continued to the vicinity of the foundation bottom via an upper surface of the support member and includes a sliding surface having a height set at the level L2, a sliding structure that is formed between an upper surface of the pull-in transfer base and a lower surface of the new foundation and includes a sliding surface having a height set at a level L4, and a sliding structure that is formed between the upper surface of the restoration foundation and the lower surface of the new foundation and includes a sliding surface having a height set at the level L4, and

the heights of the sliding surfaces of the sliding structures have a relation of level L4 > level L1 > level L2 > level L3.

[0053] In the invention, by carrying out the old furnace proper and the foundation top from the site foundation using a sliding structure of a level L1, and by conveying the old furnace proper and the foundation top using an pull-out transfer base by a sliding structure of a level L2 to the subsequent direction change, it is possible to suppress the movement of only the old furnace proper or the foundation top to a short distance, it is possible to use an pull-out transfer base in the movement of the longer distance, and it is possible to perform the smooth and stable conveyance. Further, since a branch transfer base is moved by a sliding structure of a level L3 lower than the level L2, it is possible to mount the old furnace proper or the foundation top on the upper surface of the branch transfer base with the pull-out transfer base, and it is possible to smoothly perform the direction change.

[0054] Furthermore, when a new blast furnace and a new foundation are carried in, by using the pull-in transfer base that slides at the same level L2 as the movement of the pull-out transfer base, the smooth and stable conveyance can be performed, and it is possible to share the reinforcement or the like of the ground. Furthermore, by using a sliding structure of a level L4 higher than the

level L1 in carrying in a new blast furnace and a new foundation from the pull-in transfer base, it is possible to carry in the new blast furnace and the new foundation onto the upper surface of the restoration foundation.

[0055] Second, in the above aspect of the invention, it is possible that the pull-out transfer device includes a first movement path extending from the site foundation toward a site where the new furnace construction step is performed, a second movement path extending in the intersection direction from a halfway of the first movement path, and an pull-out transfer base that is movable from the first movement path to the second movement path,

the first movement path includes a sliding structure that is continued from an upper surface of the pull-out transfer base to the upper surface of the foundation bottom and includes a sliding surface having a height set at a level L1, and a sliding structure that is formed between a lower surface of the pull-out transfer base and the ground and includes a sliding surface having a height set at a level L2, the second movement path includes a sliding structure that is formed between the lower surface of the pull-out transfer base and the ground, is continued with the sliding structure of the level 2 of the first movement path in the intersection direction, and includes a sliding surface having a height set at the level L2,

the pull-in transfer device includes a third movement path extending from the new foundation toward the site foundation, and an pull-in transfer base that is movable on the third movement path and supports the new foundation,

the third movement path includes a sliding structure that is formed between the lower surface of the pull-in transfer base and the ground, is continued to the vicinity of the foundation bottom, and includes a sliding surface having a height set at the level L2, a sliding structure that is formed between the upper surface of the pull-in transfer base and the lower surface of the new foundation and includes a sliding surface having a height set at a level L4, and a sliding structure that is formed between the upper surface of the restoration foundation and the lower surface of the new foundation and includes a sliding surface having a height set at the level L4, and the heights of the sliding surfaces of the sliding structures have relation of level L4 > level L1 > level L2.

[0056] In the invention, an effect described above can be basically obtained, and the old furnace proper and the foundation top can be carried out only by the pull-out transfer base that slides by the sliding structure of the level L2. Thus, it is possible to omit the construction of the branch transfer base and the recess described above.

[0057] Third, in the above aspect of the invention, it is possible that the pull-out transfer device includes a first movement path extending from the site foundation toward a site where the new furnace construction step is performed, a second movement path extending in the intersection direction from a halfway of the first move-

ment path, a branch base installed on the ground along the second movement path, a branch transfer base that is movable along the branch base, and an intermediate base that is connected to the site foundation and the branch base along the first movement path, the first movement path includes a sliding structure that is continued from an upper surface of the branch transfer base to the upper surface of the foundation bottom via the upper surface of the intermediate base and includes a sliding surface having a height set at a level L1, the second movement path includes a sliding structure that is formed between a lower surface of the branch transfer base and an upper surface of the branch base and includes a sliding surface having a height set at a level L3', the pull-in transfer device includes a third movement path extending from the new foundation toward the site foundation, a construction base that supports the new foundation, and an auxiliary base that is installed on the branch base and the intermediate base at a halfway of the third movement path, the third movement path includes a sliding structure that is formed between a lower surface of the new foundation and an upper surface of the construction base, is continued to an upper surface of the restoration foundation via an upper surface of the auxiliary base, and includes a sliding surface having a height set at the level L4, and the heights of the sliding surfaces of the sliding structures have a relation of level L4 > Level L1 > level L3'.

[0058] In the invention, at the time of being carried out, since the old furnace proper or the foundation top directly slides by the sliding mechanism of the level L1 and is directly moved to a direction change position, it is possible to omit the pull-out transfer base. In the direction change, since the branch transfer base using a sliding structure of a level L3' lower than the level L1 is used, it is possible to mount the old furnace proper or the foundation top on the upper surface of the branch transfer base, and it is possible to smoothly perform the direction change. On the other hand, at the time of being carried in, the new furnace proper or the new foundation is controllably slid by the sliding structure of the level L4 and can be directly carried in onto the site foundation. At this time, by using a sliding structure of the level L4 higher than the level L1, the new blast furnace and the new foundation can be carried in onto the upper surface of the restoration foundation. At this time, by using a sliding structure of the level L4 higher than the level L1, the new blast furnace and the new foundation can be carried in onto the upper surface of the restoration foundation.

[0059] In the above aspect of the invention, it is desirable that the pull-in transfer device includes: a guide groove which is continued in a conveying direction on a fixed side of the sliding structure; and a guide block engaged with the guide groove on a movement side, the guide block being installed at two front and rear positions in a traveling direction of the movement side.

[0060] In the invention, by the engagement of the guide

groove with the guide block, even when the movement side of the pull-in transfer device somehow tends to move in a direction other than a predetermined conveying direction, since the vertical load applied to the movement side is heavy enough (i.e. the weight of the entire blast furnace), the guide block cannot go out beyond the step of the guide groove. Therefore, since the guide block is maintained in the guide groove and the guide is continued, the movement side is movable only in a predetermined conveying direction, thus ensuring stability and high accuracy of the conveyance.

[0061] In the above aspect of the invention, it is desirable the pull-in transfer device includes an accuracy of a horizontal error of 3 mm or less per 1 m of movement.

[0062] In the invention, since the conveyance of a new foundation, a new furnace proper and a new furnace tower structure in the new furnace pull-in step as described above has high accuracy and stability, it is possible to sufficiently suppress the deformation or the like that occurs in the new furnace proper and the new furnace tower structure on the new foundation, and it is possible to perform the safe conveyance with high accuracy.

[0063] According to the invention, by limiting the work on the foundation to the old furnace pull-out step and the new furnace pull-in step, it is possible to limit the revamping construction period of the blast furnace mainly to the construction periods of the old furnace pull-out step and the new furnace pull-in step. Thus, it is possible to significantly shorten the revamping construction period.

[0064] Therefore, the invention can provides a method for revamping a blast furnace capable of performing the removal of the old furnace proper and the old furnace tower structure, and the construction of the new furnace proper and the new furnace tower structure in a short period of time.

BRIEF DESCRIPTION OF DRAWING(S)

[0065]

Fig. 1 is a flowchart illustrating an outline of a blast furnace revamping process according to a first exemplary embodiment of the invention.

Fig. 2 is a plan view illustrating an arrangement of a working place used in the revamp of the first exemplary embodiment.

Fig. 3 is a plan view illustrating an old furnace pull-out step of the first exemplary embodiment.

Fig. 4 is a plan view illustrating a new furnace pull-in step of the first exemplary embodiment.

Fig. 5 is an elevational view illustrating cutting of a foundation segmentation step of the first exemplary embodiment.

Fig. 6 is an enlarged elevational view illustrating a cutting work of the foundation segmentation step of the first exemplary embodiment.

Fig. 7 is an enlarged perspective view illustrating the cutting work of the foundation segmentation step of

the first exemplary embodiment.

Fig. 8 is an elevational view illustrating a conveying device used in the old furnace pull-out step of the first exemplary embodiment.

Fig. 9 is a plan view illustrating a sliding structure of a level L1 used in the old furnace pull-out step of the first exemplary embodiment.

Fig. 10 is a plan view illustrating a sliding structure of a level L2 used in the old furnace pull-out step of the first exemplary embodiment.

Fig. 11 is a plan view illustrating a sliding structure of a level L3 used in the old furnace pull-out step of the first exemplary embodiment.

Fig. 12 is an enlarged perspective view illustrating a relevant part of the conveying device used in the old furnace pull-out step of the first exemplary embodiment.

Fig. 13 is a cross-sectional view illustrating the relevant part of the conveying device used in the old furnace pull-out step of the first exemplary embodiment.

Fig. 14 is an enlarged cross-sectional view illustrating the relevant part of the conveying device used in the old furnace pull-out step of the first exemplary embodiment.

Fig. 15 is a plan view illustrating the relevant part of the conveying device used in the old furnace pull-out step of the first exemplary embodiment.

Fig. 16 is an elevational view of a first conveying operation of the old furnace pull-out step of the first exemplary embodiment.

Fig. 17 is an elevational view of a second conveying operation of the old furnace pull-out step of the first exemplary embodiment.

Fig. 18 is an elevational view illustrating a traction device used in the conveying device of the first exemplary embodiment.

Fig. 19 is a plan view illustrating the traction device used in the conveying device of the first exemplary embodiment.

Fig. 20 is an elevational view illustrating a preparatory step in the new furnace pull-in step of the first exemplary embodiment.

Fig. 21 is an elevational view illustrating a conveying device used in the new furnace pull-in step of the first exemplary embodiment.

Fig. 22 is an enlarged perspective view illustrating a relevant part of the conveying device used in the new furnace pull-in step of the first exemplary embodiment.

Fig. 23 is an elevational view of a first conveying operation of the new furnace pull-in step of the first exemplary embodiment.

Fig. 24 is an elevational view of a second conveying operation in the new furnace pull-in step of the first exemplary embodiment.

Fig. 25 is an elevational view illustrating a conveying device used in an old furnace pull-out step according

to a second exemplary embodiment of the invention.

Fig. 26 is a plan view illustrating the conveying device used in the old furnace pull-out step of the second exemplary embodiment.

Fig. 27 is an elevational view illustrating a conveying device used in an old furnace pull-out step according to a third exemplary embodiment of the invention.

Fig. 28 is a plan view illustrating a sliding structure of a level L1 used in the old furnace pull-out step of the third exemplary embodiment.

Fig. 29 is a plan view illustrating a sliding structure of a level L3' used in the old furnace pull-out step of the third exemplary embodiment.

Fig. 30 is an elevational view illustrating the conveying device used in a new furnace pull-in step of the third exemplary embodiment.

Fig. 31 is a plan view illustrating a sliding structure of a level L4 used in the new furnace pull-in step of the third exemplary embodiment.

Fig. 32 is a plan view illustrating an old furnace pull-out step according to a fourth exemplary embodiment of the invention.

Fig. 33 is a plan view illustrating a new furnace pull-in step of the fourth exemplary embodiment.

Fig. 34 is a plan view illustrating an old furnace pull-out step according to a fifth exemplary embodiment of the invention.

Fig. 35 is a plan view illustrating a new furnace pull-in step of the fifth exemplary embodiment.

Fig. 36 is a plan view illustrating an old furnace pull-out step according to a sixth exemplary embodiment of the invention.

Fig. 37 is a plan view illustrating a new furnace pull-in step of the sixth exemplary embodiment.

Fig. 38 is a plan view illustrating an old furnace pull-out step according to a seventh exemplary embodiment of the invention.

Fig. 39 is a plan view illustrating a new furnace pull-in step of the seventh exemplary embodiment.

Fig. 40 is a cross-sectional view illustrating a pull-in transfer device that is usable in the fourth and fifth exemplary embodiments.

DESCRIPTION OF EMBODIMENT(S)

[0066] Exemplary embodiment(s) of the invention will be described below with reference to the attached drawings.

First Exemplary Embodiment

[0067] Each drawing of Figs. 1 to 4 illustrates an outline of a blast furnace revamping process performed in this exemplary embodiment (Fig. 1), a plane arrangement of a working site used in the revamp (Fig. 2), an old furnace pull-out step (Fig. 3), and a new furnace pull-in step (Fig. 4).

[0068] As shown in Fig. 2, a blast furnace revamped

in this exemplary embodiment (an old blast furnace 10) is installed on a blast furnace installation site P1. In a blast furnace installation site P1, an old furnace proper 11 and an old furnace tower structure 12 are constructed on a site foundation 13. The site foundation 13 is rectangular in a plan view, and a new furnace construction site P2 is set on an axis A1 perpendicular to a middle point of its one side.

[0069] In the new furnace construction step S2, in a new furnace construction step S2 (see Fig. 1) which will be described later, a new blast furnace 20 including a new furnace proper 21 and a new furnace tower structure 22 is constructed on an upper surface of a new foundation 23. An old furnace dismantling site P3 is set on an axis A2 extending in an orthogonal direction from an intermediate position of the axis A1 that connects the new furnace construction site P2 and the blast furnace installation site P1.

[0070] In this exemplary embodiment, as illustrated in Fig. 1, while the operation (an old blast furnace operation S1) of the old blast furnace 10 installed on the blast furnace installation site P1 is continued, a new furnace construction step S2 starts in the new furnace construction site P2, and the new furnace proper 21 and the new furnace tower structure 22 to be the new blast furnace 20 are constructed on the new foundation 23.

[0071] In this exemplary embodiment, a furnace volume of the new furnace proper 21 is enlarged to be larger than a furnace volume of the old furnace proper 11. Therefore, a span of the new furnace tower structure 22 is wider than the span of the old furnace tower structure 12.

[0072] In the new furnace construction step S2, in addition to basic structures, i.e. the new furnace proper 21 and the new furnace tower structure 22, auxiliary facilities such as control equipment and wiring and piping are out-fitted in the new blast furnace 20 on the new foundation 23. By enhancing an outfit rate in this process, it is possible to reduce the work required for preparation of a new furnace pull-in step S6 or a new blast furnace operation S7 performed in the blast furnace installation site P1 later and to shorten the construction period.

[0073] On the other hand, in the blast furnace installation site P1, while the old blast furnace operation S1 is continued, a foundation segmentation step S3 of segmenting the site foundation 13 of the old blast furnace 10 in operation into a foundation top 14 and a foundation bottom 15 (see Fig. 5) is performed.

[0074] After the foundation is segmented, a blow-out S4 is performed in the old blast furnace 10, thereafter, an old furnace pull-out step S5 is performed, and the foundation top 14, on which the old blast furnace 10 including the old furnace proper 11 and the old furnace tower structure 12 is carried, is conveyed to the old furnace dismantling site P3.

[0075] As illustrated in Fig. 3, in the old furnace pull-out step S5, the foundation top 14 carrying the old blast furnace 10 is carried out in a direction of the axis A1

(sometimes referred to as axis A1 (A2, A3...) direction hereinafter), is moved along the axis A2 by changing the direction, and is conveyed to the old furnace dismantling site P3. At this time, the new furnace construction step S2 is continued.

[0076] A new furnace pull-in step S6 is performed subsequent to the old furnace pull-out step S5. A new foundation 23 carrying the new blast furnace 20 in the new furnace construction step S2 is moved in an axis A1 direction and is carried in on the foundation bottom 15 after removal of the foundation top 14 and the old blast furnace 10.

[0077] When the new blast furnace 20 is carried in onto the foundation bottom 15, the connection of piping and wiring to the new furnace proper 21 and the new furnace tower structure 22 is performed to complete the new blast furnace 20. Further, the blast furnace is blown in to start a new blast furnace operation S7 using the new blast furnace 20.

[0078] The foundation top 14 and the old blast furnace 10 carried out in the old furnace pull-out step S5 are sequentially dismantled by performing the old furnace dismantling step S8 in the old furnace dismantling site P3. At this time, the new blast furnace operation S7 is separately initiated in the blast furnace installation site P1, and the old furnace dismantling step S8 can be performed independently of the operation of the blast furnace and can be gradually progressed depending on a desired schedule.

[0079] Hereinafter, the foundation segmentation step S3, the old furnace pull-out step S5 and the new furnace pull-in step S6 in this exemplary embodiment will be described in detail.

Foundation Segmentation Step S3

[0080] Figs. 5 to 8 illustrate details of the foundation segmentation step S3 in this exemplary embodiment.

[0081] In the foundation segmentation step S3, as illustrated in Fig. 5, the site foundation 13 installed on the blast furnace installation site P1 is horizontally cut at a level L1 and is segmented into a foundation top 14 and a foundation bottom 15.

[0082] The old blast furnace 10 (having the old furnace proper 11 and the old furnace tower structure 12) is constructed on the site foundation 13. The segmented foundation top 14 is horizontally movable integrally with the old blast furnace 10 constructed on the upper surface. The foundation bottom 15 is left while being fixed on the blast furnace installation site P1.

[0083] As the cutting in the foundation segmentation step S3, a plurality of strip-shaped cut compartments (in a plan view) along the axis A1 described above may be initially set on the site foundation 13 and the horizontal cutting using a wire saw is sequentially performed for each cut compartment. It is possible to use the procedure described in Patent Literature 2 described above.

[0084] As illustrated in Fig. 6, each cut compartment

(T1, T2, T3,...) of a side surface (a side surface facing the new furnace construction site P2 or an opposite side surface) of the site foundation 13 is bored with a drill at positions of each boundary (B1, B2,...) to form a through-hole 91 which passes through the site foundation 13 in the axis A1 direction. Further, a guide member 92 such as an H-beam is installed in the through-hole 91, and wire saws 93 are held at heights of an upper flange and a lower flange of the guide member.

[0085] The wire saws 93 can horizontally cut a material (a brick forming the site foundation 13) of the cut compartment T2 interposed between the boundaries B1 and B2, for example, by being mounted to move through and around the two through-holes 91 of the positions of the boundaries B1 and B2.

[0086] By performing such a horizontal cut at the two upper and lower positions inside the through-hole 91, the site foundation 13 is segmented into the foundation top 14 and the foundation bottom 15 in the cut compartment T2. Further, between the foundation top 14 and the foundation bottom 15, a cavity 94 is formed after removal of the cut material having a predetermined thickness.

[0087] It should be noted that, even when the cavity 94 is generated in the cut compartment T2, since the adjacent cut compartments T1 and T3 are uncut, the foundation top 14 is maintained at a predetermined interval with respect to the foundation bottom 15.

[0088] As illustrated in Fig. 7, when the cavity 94 is formed, a fixed side sliding plate 81, a movement side sliding plate 82 and a high pack anchor 95 are installed in the cavity 94.

[0089] The fixed side sliding plate 81 is laid on the bottom surface of the cavity 94, that is, the upper surface of the foundation bottom 15. A stainless alloy or the like having a low friction coefficient is used as the fixed side sliding plate 81.

[0090] The movement side sliding plate 82 is installed on the upper surface of the fixed side sliding plate 81. A low-friction lining 83 containing a solid lubricant is provided on a surface, which faces the fixed side sliding plate 81, of the movement side sliding plate 82.

[0091] As the low-friction lining 83, it is possible to use a lining in which a solid lubricant, for example, fine powders of polytetrafluoroethylene resin (PTFE), molybdenum disulfide, graphite and the like are rigidly adhered on the surface of the substrate.

[0092] Among them, a lining (coefficient of friction μ = approximately 0.06) provided by rigidly adhering polytetrafluoroethylene resin onto the surface of the metal plate, with an epoxy resin or a polyimide resin is the most suitable. For example, a lining commercially available as a "PILLAR FLUOROGOLD PILLAR No. 4801 produced by NIPPON PILLAR PACKING Co., Ltd." is usable.

[0093] The high pack anchor 95 is an elongated tough flexible bag having a length corresponding to the movement side sliding plates 82 and obtained by weaving aramid resin fibers or the like. The high pack anchor 95 is disposed on the upper surface of the movement side slid-

ing plate 82. Further, by filling a grout such as cement slurry therein, an upper surface of the high pack anchor 95 is pressed against a ceiling surface of the cavity 94, i.e., the lower surface of the foundation top 14.

[0094] When the grout solidifies in this state, the foundation top 14 is supported by the high pack anchor 95. In other words, the load of the foundation top 14 can be transferred to the foundation bottom 15 via the high pack anchor 95, the movement side sliding plate 82 and the fixed side sliding plate 81.

[0095] Returning to Fig. 6, when the foundation top 14 is in the state of being supported on the foundation bottom 15 via the high pack anchor 95 and the like in the cut compartment T2, the adjacent cut compartments T3 and T1 are subsequently cut.

[0096] In the foundation segmentation step S3, by sequentially performing the work as described above for each cut compartment, all the cut compartments, that is, the entire site foundation 13 is finally segmented into the foundation top 14 and the foundation bottom 15.

[0097] The movement side sliding plates 82 and the fixed side sliding plates 81 installed between the foundation top 14 and the foundation bottom 15 constitute a part of a conveying device that is used in an old furnace pull-out step S5, which will be described later.

Pull-out transfer device 30 Used in Old furnace pull-out step S5

[0098] In the foundation segmentation step S3, installation of the pull-out transfer device 30 used in the next old furnace pull-out step S5 is also performed.

[0099] As shown in Fig. 8, to perform the extraction work (see Fig. 3) in the old furnace pull-out step S5, the pull-out transfer device 30 is provided with an pull-out transfer base 31 that is movable along the axis A1 from the vicinity of the site foundation 13 (see Fig. 3), and a branch transfer base 32 that is movable along the axis A2 from a halfway of a movement path of the pull-out transfer base 31 (see Fig. 3).

[0100] The pull-out transfer base 31 is a flat platform formed by a steel frame shaft assembly or the like, and a sliding structure 42 is provided between its lower surface and the ground. The upper surface of the pull-out transfer base 31 is set at the same height as the upper surface of the foundation bottom 15, and a sliding structure 41 which is continued from the upper surface of the pull-out transfer base 31 to the upper surface of the foundation bottom 15 is provided. A sliding surface height of the sliding structure 41 is set at a level L1, and a sliding surface height of the sliding structure 42 is set at a level L2.

[0101] The branch transfer base 32 is a flat platform formed by a steel frame shaft assembly or the like, and is installed in a recess 33 in the axis A2 direction formed in the ground. One end of the recess 33 is disposed in a path that connects the blast furnace installation site P1 and the new furnace construction site P2, and the other

end thereof is disposed in the old furnace dismantling site P3.

[0102] A sliding structure 43 is installed between the bottom surface of the recess 33 and the lower surface of the branch transfer base 32. The sliding surface height of the sliding structure 43 is set at a level L3.

[0103] The upper surface of the branch transfer base 32 is set at the same height as the ground. Although the majority of above-mentioned sliding structure 42 is installed on the ground, a part thereof is installed on the upper surface of the branch transfer base 32.

[0104] As shown in Fig. 9, the sliding structure 41 provided on the upper surface of the pull-out transfer base 31 is configured by utilizing the fixed side sliding plate 81 described in Fig. 7 and the movement side sliding plate 82 with the low-friction lining 83 provided thereon.

[0105] The fixed side sliding plate 81 of the sliding structure 41 is continuously installed from the upper surface of the foundation bottom 15 to the upper surface of the pull-out transfer base 31. The movement side sliding plate 82 of the sliding structure 41 is installed on the lower surface of the foundation top 14 to slide with respect to the fixed side sliding plate 81 of the sliding structure 41.

[0106] With such a sliding structure 41, the foundation top 14 can be horizontally carried out along the sliding surface of the level L1 and can be placed on the upper surface of the pull-out transfer base 31.

[0107] As shown in Figs. 10 and 12, similarly to the above-described sliding structure 41, the sliding structure 42 on which the pull-out transfer base 31 (see Fig. 8) slides includes the fixed side sliding plate 81 described in Fig. 7, and a movement side sliding plate 82 with the low-friction lining 83 provided thereon.

[0108] The fixed side sliding plate 81 of the sliding structure 42 is continuously installed from the vicinity of the foundation bottom 15 to the upper surface of the branch transfer base 32. The movement side sliding plate 82 of the sliding structure 42 is installed on the lower surface of the pull-out transfer base 31 to slide with respect to the fixed side sliding plate 81 of the sliding structure 42.

[0109] With such a sliding structure 42, the pull-out transfer base 31 with the foundation top 14 placed thereon can be horizontally carried out along the sliding surface of the level L2 and can be placed on the upper surface of the branch transfer base 32.

[0110] As shown in Figs. 11 and 12, similarly to the sliding structure 41 described above, the sliding structure 43 on which the branch transfer base 32 slides includes the fixed side sliding plate 81 described in Fig. 7, and the movement side sliding plate 82 with the low-friction lining 83 provided thereon.

[0111] The fixed side sliding plate 81 of the sliding structure 43 is continuously disposed from one end to the other end of the recess 33. The movement side sliding plate 82 of the sliding structure 43 is installed on the lower surface of the branch transfer base 32 to slide with respect to the fixed side sliding plate 81 of the sliding struc-

ture 43.

[0112] With such a sliding structure 43, the branch transfer base 32 on which the foundation top 14 and the pull-out transfer base 31 are mounted can be horizontally carried out along the sliding surface of the level L2 and can be conveyed to the old furnace dismantling site P3.

Ground Reinforcement of Pull-out transfer device 30

[0113] In the pull-out transfer device 30 (see Fig. 8), the sliding structure 42 is placed on the ground, and the sliding structure 43 is installed on the bottom surface of the recess 33. The ground and the bottom surface, on which the sliding structures 42 and 43 are installed, are subjected to ground improvement or the like so that sufficient rigidity is obtained to withstand the heavy load such as a furnace body of a blast furnace. Further, the reinforcing steel material 34 (see Fig. 12) that receives the sliding structures 42 and 43 is provided on the ground and the bottom surface.

[0114] As shown in Fig. 12, a reinforcing steel material 34 such as an H-shaped steel having a flat upper surface is embedded on the ground on which the sliding structure 42 is installed. A level adjustment rail 96 using a long steel plate is installed on the upper surface of the reinforcing steel material 34. The fixed side sliding plate 81 of the sliding structure 42 is supported on the upper surface of the rail 96 at the level L2. By appropriately interposing a shim between the rail 96 and the upper surface of the reinforcing steel material 34, the linearity in the longitudinal direction of the rail 96 is ensured, and the upper surfaces of all the rails 96 arranged in parallel are adjusted to be aligned at the level L2.

[0115] Also, the similar reinforcing steel material 34 and the rail 96 are also installed on the bottom surface of the recess 33, on which the sliding structure 43 is installed, and the fixed side sliding plate 81 of the sliding structure 43 is supported at the level L3 by the reinforcing steel material 34 and the rails 96.

[0116] The sliding structure 42 is continuously disposed from the ground being in contact with the side surface of the foundation bottom 15 to the upper surface of the branch transfer base 32. However, when moving the branch transfer base 32 using the sliding structure 43, the fixed side sliding plate 81 of the sliding structure 42 is cut at an edge portion of the branch transfer base 32 (a dotted line portion in Fig. 12), and is separated from the sliding structure 42 outside the recess 33 remaining in the ground.

Guide Structure 50 of Pull-out transfer device 30

[0117] In the pull-out transfer base 31 and the branch transfer base 32 of the pull-out transfer device 30 (see Fig. 8), a guide structure 50 is installed in each of the sliding structures 42 and 43.

[0118] As illustrated in Fig. 13, the above-described reinforcing steel material 34 is embedded in the ground,

and the pull-out transfer base 31 is supported thereon. The sliding structure 42 is provided between the upper surface of the reinforcing steel material 34 and the lower surface of the pull-out transfer base 31.

[0119] As illustrated in Fig. 14, a guide groove 51 which is linearly continued along the longitudinal direction (the axis A1 direction of Fig. 2) of the sliding structure 42 is formed in the central one of the sliding structures 42 described above.

[0120] The guide groove 51 is deep enough to reach the reinforcing steel material 34 from the sliding structure 42. On the other hand, a guide block 52 made of a steel capable of being housed in the guide groove 51 is provided on the lower surface of the pull-out transfer base 31.

[0121] The cross-sectional shapes of the guide block 52 and the guide grooves 51 are such that the respective tops have a rectangular shape and bottoms have a semi-circular shape, and a predetermined gap required for sliding is ensured between the respective contour shapes. The cross-sectional shapes may be other shapes.

[0122] As illustrated in Fig. 15, the guide block 52 is fixed to the two positions of the front side and the rear side in the movement direction, on the lower surface of the pull-out transfer base 31.

[0123] By the two guide blocks 52 engaged with the guide grooves 51 that are continuous in a straight line, the guide structure 50 accurately maintains the orientation of the pull-out transfer base 31 in the continuous direction of the guide groove 51 (i.e. the axis A1 that is a conveying direction of the sliding structure 42). Further, since the engagement between the guide block 52 and the guide groove 51 is maintained even during movement when driving the pull-out transfer base 31 is driven in the conveying direction, the pull-out transfer base 31 can be accurately conveyed to an expected target position while the conveying direction is correctly regulated.

[0124] For example, even when the pull-out transfer base 31 attempts to move in a direction other than the predetermined conveying direction for some reasons, since the vertical load applied to the pull-out transfer base 31 is a heavy weight of the entire blast furnace, the guide block 52 cannot go out beyond the step of the guide groove 51. Therefore, the guide block 52 is maintained in the guide groove 51 and the continuous guidance is provided, and the pull-out transfer base 31 is only movable in a predetermined conveying direction without meandering.

Conveyance in Old furnace pull-out step S5

[0125] In the old furnace pull-out step S5, by sequentially performing a first conveying operation, a second conveying operation and a third conveying operation described below using the pull-out transfer device 30 described above, the old blast furnace 10 located in the blast furnace installation site P1 is conveyed to the old furnace dismantling site P3.

[0126] In the first conveying operation, as illustrated in

Fig. 16, by driving the foundation top 14 in the axis A1 direction (see Fig. 3) to cause the sliding structure 41 at the level L1 to slide, the foundation top 14 and the old blast furnace 10 constructed on the top of the foundation top 14 are integrally carried out from the upper surface of the foundation bottom 15 and are moved to the upper surface of the pull-out transfer base 31.

[0127] In the second conveying operation, as illustrated in Fig. 17, by driving the pull-out transfer base 31 in the axis A1 direction (see Fig. 3) to cause the sliding structure 42 at the level L2 to slide, the pull-out transfer base 31, and the foundation top 14 and the old blast furnace 10 placed on the extraction platform 31 are integrally moved to the upper surface of the branch transfer base 32.

[0128] In the third conveying operation, by driving the branch transfer base 32 in the axis A2 direction (see Fig. 3) to cause the sliding structure 43 at the level L3 to slide, the branch transfer base 32, and the pull-out transfer base 31, the foundation top 14 and the old blast furnace 10 placed thereon are integrally moved to the old furnace dismantling site P3 (see Fig. 3).

[0129] By sequentially performing the first conveying operation, the second conveying operation and the third conveying operation described above, it is possible to convey the old blast furnace 10 located in the blast furnace installation site P1 to the old furnace dismantling site P3, thereby completing the old furnace pull-out step S5 illustrated in Fig. 3.

[0130] In the driving of the foundation top 14, the pull-out transfer base 31 and the branch transfer base 32 in the first to third conveying operations described above, any of traction from the front side in the traveling direction or propulsion from the rear side may be adopted, but it is preferred to perform, for example, the following traction.

[0131] As an example, in the first conveyance, when integrally moving the foundation top 14 and the old blast furnace 10, a wire may be connected to the foundation top 14 and the foundation top may be pulled by a winch from the side of the new furnace construction site P2 side. It is possible to use a hydraulic jack such as a center hole jack or other driving sources in the traction.

[0132] At this time, since the new foundation 23 and the new blast furnace 20 constructed thereon are located in the new furnace construction site P2 which is in the traction direction, the traction wire is inserted into a gap of the framework of the new foundation 23 or is pulled out of both sides of the new furnace construction site P2 so as to circumvent the new foundation 23.

[0133] Figs. 18 and 19 illustrate an example of a specific traction device.

[0134] A traction device 70 has four center hole jacks 71 installed in parallel on the ground near the new furnace construction site P2, and the respective pulled wires 72 extend to the site foundation 13 along the axis A1 which is in the carry-out conveying direction.

[0135] In the foundation top 14 of the site foundation

13, through-holes penetrating through both side surfaces of the foundation top in the axis A1 direction are formed, and the wires 72 are exposed to the side surface of the opposite side of the new furnace construction site P2 of the foundation top 14 through the through-holes. A reaction force receiving member 73 is inserted and is firmly fixed to a front end of each of the exposed wires 72.

[0136] In such a traction device 70, by pulling the respective wires 72 with synchronized operations of the four center hole jacks 71, the horizontal traction force is applied to the foundation top 14. Thus, the foundation top 14 is displaced relative to the foundation bottom 15 by the support member 35, and the above-mentioned first conveyance is performed by the displacement.

[0137] It should be noted that, since the weights of the foundation top 14, and the old furnace proper 11 and the old furnace tower structure 12 located thereon are large, a huge traction force is applied to the wires 72, but since the wires are pressed against the side surface of the foundation top 14 in a large area using the reaction force receiving member 73, cracking or the like does not occur around the through-hole of the foundation top 14 by a load concentration.

[0138] Such a traction device 70 is also used in the second and third conveying operations.

[0139] In the second conveying operation, as illustrated in Fig. 18, the center hole jack(s) 71 similar to the traction device 70 in the first conveying operation is installed on the ground near the new furnace construction site P2, the wires 72 extending in the axis A1 direction are connected to the pull-out transfer base 31 via the reaction force receiving member 73 and the pull-out transfer base is pulled.

[0140] In the third conveying operation, although it is not illustrated in the drawings, the center hole jack(s) 71 similar to the traction device 70 in the first conveying operation is installed on the old furnace dismantling site P3, the wires 72 extending in the axis A2 direction are connected to the branch transfer base 32 via the reaction force receiving member 73 and the branch transfer base is pulled.

Preparation in New Furnace Pull-in Step S6

[0141] As shown in Fig. 4, the old blast furnace 10 is conveyed from the blast furnace installation site P1 to the old furnace dismantling site P3 by the old furnace pull-out step S5 described above. Next, by the new furnace pull-in step S6, the new blast furnace 20 constructed in the new furnace construction site P2 is transferred to the top of the foundation bottom 15 of the site foundation 13 after removal of the old blast furnace 10.

[0142] As shown in Fig. 20, when the old furnace pull-out step S5 is completed, as a residue of the pull-out transfer device 30, a part (a fixed side sliding plate 81 of Fig. 7) of the sliding structure 41 is left on the upper surface of the foundation bottom 15, and a part (the fixed side sliding plate 81 in Fig. 7) of the sliding structure 42

is left on the ground between the foundation bottom 15 and the recess 33. Further, a part (the fixed side sliding plate 81 in Fig. 12) of the sliding structure 43 is left in the recess 33 of the trace in which the branch transfer base 32 moves.

[0143] Thus, as preparation for performing the new furnace pull-in step S6, the residue of the pull-out transfer device 30 described above is removed, and the pull-in transfer device 39 used for conveyance in the new furnace pull-in step S6 is installed.

[0144] As illustrated in Fig. 21, the pull-in transfer device 39 has an pull-in transfer base 38 that supports the new foundation 23, a sliding structure 44 that is continued from the bottom of the pull-in transfer base 38 to the front of the foundation bottom 15, a sliding structure 45 that is installed between the upper surface of the pull-in transfer base 38 and the lower surface of the new foundation 23, and a sliding structure 46 that is installed on the upper surface of the foundation bottom 15.

[0145] It should be noted that each of the sliding structures 44, 45 and 46 includes the same components (i.e. the fixed side sliding plate 81, the movement side sliding plates 82 and the low-friction lining 83 illustrated in Fig. 7) as the sliding structures 41 to 43 mentioned above, and the sliding structures 44, 45 and 46 continuously extend in the axis A1 direction (see Fig. 4).

[0146] The sliding structure 44 is formed between the lower surface of the pull-in transfer base 38 and the ground, and the fixed side formed on the ground is installed in succession to the front of the foundation bottom 15.

[0147] The recess 33 as described above is left at a halfway of the sliding structure 44. Thus, the support member 35 is installed on the recess 33 to support the sliding structure 45 across the recess 33 over the entire surface.

[0148] The sliding structure 44 may use a part of the sliding structure 42 that is left on the ground between the foundation bottom 15 and the recess 33.

[0149] The sliding structure 44 below the pull-in transfer base 38 is constructed in advance when installing the pull-in transfer base 38.

[0150] By such a sliding structure 44, the pull-in transfer base 38 is horizontally movable with the new foundation 23 and the new blast furnace 20 placed on the upper surface thereof from the new furnace construction site P2 to the front of the blast furnace installation site P1.

[0151] The height of the sliding surface of the sliding structure 44 is at the same level L2 as the sliding structure 42. However, when not using a part of the sliding structure 42, the height of the sliding surface may be at a different level.

[0152] In a portion of the sliding structure 44 installed on the ground, similarly to the sliding structure 42 described above, the ground reinforcement using the reinforcing steel material 34 (see Fig. 12) is performed. However, when a part of the sliding structure 42 is used for the purpose of reinforcement, it is possible to use the

ground reinforcement using the reinforcing steel material 34 can be directly used.

[0153] The sliding structure 45 is installed between the lower surface of the new foundation 23 and the upper surface of the pull-in transfer base 38 in advance when installing the new foundation 23 on the pull-in transfer base 38.

[0154] By such a sliding structure 45, the new foundation 23 is horizontally movable with respect to the pull-in transfer base 38.

[0155] The height of the sliding surface of the sliding structure 45 is at a level L4. The level L4 is set higher than the level L1 of the sliding structure 41 described above.

[0156] The sliding structure 46 includes a fixed side installed on the upper surface of the foundation bottom 15, and a movement side (new foundation 23 side) of the sliding structure 45 described above.

[0157] Although the details will be described later, while the pull-in transfer base 38 is in contact with the foundation bottom 15, the new foundation 23 is horizontally moved with respect to the pull-in transfer base 38 using the sliding structures 45 and 46, and is transferred to the upper surface of the foundation bottom 15.

[0158] In order to perform such a transfer, the height of the sliding surface of the sliding structure 46 is at the same level L4 as the sliding structure 45.

[0159] Further, in order to ensure the level L4 in the sliding structure 46, a restoration foundation 26 that supports the sliding structure 46 is installed on the upper surface of the foundation bottom 15.

[0160] As shown in Fig. 22, when the old furnace pull-out step S5 is completed, the fixed side sliding plate 81 (see Fig. 7) of the sliding structure 41 installed in the foundation segmentation step S3 is left on the upper surface of the foundation bottom 15 of the site foundation 13 old furnace pull-out step. Thus, the fixed side sliding plate 81 of the sliding structure 41 is removed. Furthermore, the upper surface of the foundation bottom 15 exposed after removing the fixed side sliding plate 81 of the sliding structure 41 is a surface formed by a horizontal cutting with a wire saw in the foundation segmentation step S3, and the residual irregularities are inevitable. Therefore, the upper surface of the foundation bottom 15 is cut and removed over a predetermined thickness to smoothen and the upper surface of the foundation bottom 15.

[0161] The restoration foundation 26 is installed on the upper surface of the smoothened foundation bottom 15.

[0162] The restoration foundation 26 has a pad 84 installed on the upper surface of the foundation bottom 15, a pad liner 85 placed on the pad 84, and a base grout 86 that is filled around the pad 84 and is solidified. On the upper surface of the pad liner 85, the same level adjustment rail 96 as the rail installed on the upper surface of the reinforcing steel material 34 for ground reinforcement as described above is installed, and the sliding structure 46 is installed on an upper surface of the rail 96.

[0163] The pad 84 is intended to support the fixed side

sliding plate 81 of the sliding structure 46 via the pad liner 85 and the rail 96, and is arranged on the upper surface the foundation bottom 15 at a predetermined interval along the continuous direction of the fixed side sliding plate 81. Although the pad 84 is capable of supporting the weight of the fixed side sliding plate 81, by applying the deformation to the pad 84 by an operator, the sliding surface of the fixed side sliding plate 81 is adjusted to be a level L4.

[0164] As such a pad 84, anything can be used as long as a pad can support the weight of the fixed side sliding plate 81, is deformable in the installation stage and is cured by the passage of time from the installation or a predetermined process. For example, it is possible to use a grout with high viscosity or a thermosetting synthetic resin material.

[0165] The pad liner 85 is a shim (i.e. a back plate made of steel), the upper surface height of the rail 96 is aligned to a predetermined level by adding or subtracting a plurality of liners, and thus, the upper surface, i.e. the sliding surface of the fixed side sliding plate 81, is adjusted to the level L4.

[0166] The base grout 86 is made of a concrete or the like, and is filled around the pad 84 after the adjustment of the height of the fixed side sliding plate 81. The base grout 86 is filled from the upper surface of the foundation bottom 15 to the height to cover the side surface of the rail 96, and the upper surface side of the rail 96 and the fixed side sliding plate 81 are kept exposed.

[0167] When the base grout 86 is solidified, the restoration foundation 26 is completed. The restoration foundation 26 keeps the height of the fixed side sliding plate 81 at the adjusted height (i.e. in a state in which the sliding surface is at the level L4).

[0168] As shown in Fig. 22, as described above, the fixed side sliding plate 81 of the sliding structure 46 is supported so that the sliding structure 46 is the level L4 of the sliding surface by the restoration foundation 26. When the new foundation 23 is transferred thereon, the movement side sliding plate 82 of the lower surface of the new foundation 23 installed as the sliding structure 45 comes into sliding contact with the fixed side sliding plate 81 of the upper surface of the foundation bottom 15 via the low-friction lining 83 provided on the surface of the movement side sliding plates, and thus, the function as the sliding structure 46 is obtained.

[0169] As shown in Fig. 21, by sequentially moving the new foundation 23 and the new blast furnace 20 using the sliding structures 44, 45 and 46 described above, the new foundation 23 and the new blast furnace 20 can be conveyed to the top of the foundation bottom 15. The sliding structures 44, 45 and 46 define the pull-in transfer device 39.

[0170] It should be noted that, in the pull-in transfer device 39, each of the sliding structures 44, 45 and 46 is adjusted with high accuracy so as to exhibit a horizontal error of 3 mm or less per 1 m of movement.

[0171] Further, in the pull-in transfer device 39, the

guide structure 50 similar to that in the pull-out transfer device 30 is installed between the fixed side of the sliding structures 44, 45 and 46, and the new foundation 23 and the pull-in transfer base 38. Thus, the posture during conveyance is stabilized, and it is possible to convey the new blast furnace 20 into the correct position on the foundation bottom 15.

Conveyance in New furnace pull-in step S6

[0172] In the new furnace pull-in step S6, by sequentially performing a first conveying operation and a second conveying operation described below using the aforementioned pull-in transfer device 39, the new blast furnace 20 located at the new furnace construction site P2 is conveyed to the blast furnace installation site P1.

[0173] In the first conveying operation, as illustrated in Fig. 23, the pull-in transfer base 38 located at the new furnace construction site P2 is driven in the axis A1 direction (see Fig. 3) to cause a slide movement of the sliding structure 44 located at the level L2, thereby integrally and horizontally moving the new blast furnace 20, the new foundation 23 and the pull-in transfer base 38 and conveying the new blast furnace 20, the new foundation 23 and the introduction platform 38 from the new furnace construction site P2 to a position adjacent to the foundation bottom 15.

[0174] In the second conveying operation, as illustrated in Fig. 24, the new foundation 23 located above the pull-in transfer base 38 and being adjacent to the foundation bottom 15 is driven in the axis A1 direction (see Fig. 3) to cause the slide movement of the sliding structure 45 at the level L4 to slide, the new blast furnace 20 and the new foundation 23 are integrally and horizontally moved, are gradually transferred to the sliding structure 46 located at the same level L4, and are conveyed to the upper surface of the restoration foundation 26 formed on the foundation bottom 15 from the upper surface of the pull-in transfer base 38.

[0175] Thus, the new foundation 23 and the new blast furnace 20 are installed on the foundation bottom 15, and the new blast furnace 20 is completely carried in onto the blast furnace installation site P1.

[0176] It should be noted that, in the first and second conveying operations, the driving of the pull-in transfer base 38 and the new foundation 23 may be effected by the traction or propulsion, and it is possible to use the same structure as the traction device 70 (see Figs. 18 and 19) that is used in the above-described old furnace pull-out step S5.

[0177] Also, the carried-in new foundation 23 and restoration foundation 26 are securely fixed until the new blast furnace operation S7. For example, it is possible to perform fixing, by pouring and solidifying mortar with high fluidity between the new foundation 23 and the restoration foundation 26. Such fixation can be performed in a short period of time in parallel with the connection and the like of peripheral facilities of the new blast furnace 20.

Effect of First Exemplary Embodiment

[0178] The first exemplary embodiment provides the following effects.

[0179] In the new furnace construction step S2, the new furnace body 21 and the new furnace tower structure 22 as the new blast furnace 20 can be constructed on the new foundation 23 in a new furnace construction site P2 different from the blast furnace installation site P1 in an operating state (the old blast furnace operation S1) of the old blast furnace 10. Further, after performing the blow-out S4 of the old blast furnace 10, by performing the old furnace pull-out step S5 and the new furnace pull-in step S6, the foundation top 14 and the old blast furnace 10 (the old furnace proper 11 and the old furnace tower structure 12) can be removed from the top of the site foundation 13, and can be collectively replaced with the new foundation 23 and the new blast furnace 20 that are constructed in advance. The removed old blast furnace 10 can be appropriately disassembled in another old furnace dismantling site P3 while the new blast furnace 20 is re-operated (the new blast furnace operation S7).

[0180] Thus, in this exemplary embodiment, the re-vamping construction period of the blast furnace can be shortened to about 50 to 70 days.

[0181] In addition, since the replacement of the foundation top 14 with the new foundation 23, and the replacement of the old furnace tower structure 12 with the new furnace tower structure 22 are also collectively performed in addition to the replacement of the old furnace proper 11 with the new furnace proper 21, equipment (various facilities and piping and wiring) installed between the old furnace proper 11 and the old furnace tower structure 12 can be carried out to the outside of the foundation while the equipment is kept mounted. Furthermore, the equipment installed between the new furnace proper 21 and the new furnace tower structure 22 is out-fitted in the new furnace construction step S2 in advance and can be collectively carried in onto the foundation. It is also possible to shorten the construction period in this regard.

[0182] Further, in this exemplary embodiment, since the old furnace tower structure 12 is replaced with the new furnace tower structure 22 simultaneously with the replacement of the old furnace proper 11 with the new furnace proper 21, the furnace volume is not restricted to the dimensions of the old furnace tower structure 12 even when the furnace volume of the new furnace proper is greatly enlarged.

[0183] In other words, a large new furnace proper 21 which is not adapted to be housed in the old furnace tower structure 12, can be provided by constructing a new furnace tower structure 22 matching thereto in advance. Accordingly, it is possible to significantly increase the degree of freedom in enlarging the furnace volume.

[0184] In addition, in the new furnace pull-in step S6, since the conveyed new furnace proper 21 can be integrally conveyed in a stable state by being supported on

the new furnace tower structure 22, the process can be safely performed.

[0185] In this exemplary embodiment, by the pull-in transfer device 39, the conveyance of the new furnace pull-in step S6 can be performed. In other words, the new foundation 23 and the new blast furnace 20 located in the new furnace construction site P2 can be conveyed to the top of the foundation bottom 15 of the blast furnace installation site P1.

[0186] At this time, by linearly providing the pull-in transfer device 39, it is possible to perform the conveyance with minimum driving without a direction change or the like, thereby reducing the possibility of causing a deformation or the like on the new furnace proper 21 and the new furnace tower structure 22 on the new foundation 23 and performing the safe conveyance.

[0187] In this exemplary embodiment, in the pull-in transfer device 39, the sliding structures 44, 45 and 46 are configured so that a fixed side sliding plate 81 over a long distance is used as a fixed side (lower side), a short movement side sliding plate 82 is used as a movement side, the plates are formed of a stainless steel alloy or the like having a low coefficient of friction, and a low-friction lining 83 including a solid lubricant is provided on the movement side sliding plate 82. Thus, it is possible to significantly reduce the friction coefficient with respect to the fixed side. Therefore, even when the new foundation 23, and the new blast furnace 20 including the new furnace proper 21 and the new furnace tower structure 22 to be conveyed have a heavy weight (e.g. exceeding 8,000 tons), it is possible to perform the conveyance without hindrance.

[0188] In the pull-in transfer device 39, each of the sliding structures 44, 45 and 46 is adjusted with high accuracy so that a horizontal error is 3 mm or less per 1 m of movement. Therefore, it is possible to sufficiently suppress the deformation or the like that occurs in the new furnace proper 21 and the new furnace tower structure 22 on the new foundation 23, and it is possible to perform the safe conveyance with high accuracy.

[0189] In the pull-in transfer device 39, the guide grooves 51 are formed on the fixed sides of the sliding structures 44, 45 and 46 and the guide blocks 52 are formed and on and engaged with the lower surfaces of the new foundation 23 and the pull-in transfer base 38 as the movement side. Thus, using the simple guide structure 50, the guide is not disengaged by the large weight of new blast furnace 20, resulting in a stable attitude during conveyance, and it is possible to carry in the new blast furnace 20 to a precise position on the foundation bottom 15.

[0190] In the pull-in transfer device 39, the conveyance of the new blast furnace 20 and the new foundation 23 is effected by the horizontal movement of the pull-in transfer base 38 at the level L2 using the sliding structure 44 and the horizontal movement at the level L4 using the sliding structures 45 and 46 reaching the upper surface of the foundation bottom 15 from the upper surface of

the pull-in transfer base 38. Thus, since the new blast furnace 20 and the new foundation 23 are not raised and lowered at all, it is possible to shorten the revamping construction period accordingly.

[0191] In this exemplary embodiment, by the pull-out transfer device 30, the conveyance in the old furnace pull-out step S5 can be performed, that is, the foundation top 14 and the old blast furnace 10 located in the blast furnace installation site P1 can be conveyed to the old furnace dismantling site P3.

[0192] At this time, the pull-out transfer device 30 is conveyed along an L-shaped path in which the direction changes in the middle, and especially, a part of the path (i.e. a portion from the vicinity of the site foundation 13 to the recess 33) is superimposed with the pull-in transfer device 39. Thus, it is possible to share and effectively utilize the ground that is leveled and reinforced to withstand the large load.

[0193] Specifically, in order to receive the heavy load of the new foundation 23, the new furnace proper 21 and the new furnace tower structure 22, a sufficient reinforcement is performed on the ground on which the carry-in conveying path is provided. In the carry-out conveying path, there is a need for reinforcement of the ground to receive a heavy load of the foundation top 14, the old furnace proper 11 and the old furnace tower structure 12, and by partially sharing the carry-in conveying path with the carry-out conveying path, it is possible to reduce the work of the ground reinforcement as a whole.

[0194] Since the pull-out transfer device 30 extends from its middle to an intersection direction (the axis A2 direction), while partially sharing the path with the pull-in transfer device 39 (the axis A1 direction), it is possible to set the old furnace dismantling site P3 in a site different from the new furnace construction site P2, thereby avoiding interference of the working site.

[0195] It should be noted that, since the old furnace proper 11 and the old furnace tower structure 12 are dismantled after being carried out, there is no problem even when a deformation or the like occurs, and there is no problem even if a direction of the movement of the pull-out transfer device 30 changes at a halfway of pull-out transfer device.

[0196] In particular, the direction change from the axis A1 direction to the axis A2 direction in the pull-out transfer device 30 is achieved by placing the pull-out transfer base 31, which moves in the axis A1 direction, on the branch transfer base 32 which moves in the axis A2 direction. Thus, since a special mechanism for direction change or the like is unnecessary, it is possible to smoothly and reliably perform the work.

[0197] Further, the recess 33 is formed in the axis A1 direction in which the branch transfer base 32 is to be moved, so that the branch transfer base 32 can be moved at the level L3 lower by one level than the level L2 at which the pull-out transfer base 31 moves. Thus, it is possible to provide a device for placing the pull-out transfer base 31 on the branch transfer base 32, without using

a lifting mechanism or other special devices.

[0198] Further, the conveyance of the old blast furnace 10 and the foundation top 14 is effected by the horizontal movement at the level L1 of the sliding structure 41 from the upper surface of the foundation bottom 15 to the upper surface of the pull-out transfer base 31, the horizontal movement at the level L2 along the sliding structure 42 of the pull-out transfer base 31, and the horizontal movement at the level L3 along the sliding structure 43 of the branch transfer base 32. Thus, it is possible to perform stably the conveyance in the old furnace pull-out step S5 with high accuracy, without raising and lowering the old blast furnace 10 and the foundation top 14.

[0199] In this exemplary embodiment, in the pull-out transfer device 30, each of the sliding structures 41, 42 and 43 is configured so that a fixed side sliding plate 81 over a long distance is used as a fixed side (a lower side), a short movement side sliding plate 82 is used as a movement side, the plates are formed of a stainless steel alloy or the like having a low coefficient of friction, and a low-friction lining 83 containing a solid lubricant is provided on the movement side sliding plate 82. Thus, it is possible to significantly reduce the friction coefficient with respect to the fixed side. Therefore, even when the foundation top 14, and the old blast furnace 10 including the old furnace proper 11 and the old furnace tower structure 12 to be conveyed have a heavy weight (e.g. exceeding 8,000 tons), it is possible to perform the conveyance without hindrance.

[0200] In this exemplary embodiment, in the foundation segmentation step S3, the cutting is sequentially performed in a plurality of cut compartments such that the high pack anchor is filled in the cut portion. Thus, it is possible to vertically cut the site foundation 13, and to install the sliding structure 41 between the foundation top 14 and the foundation bottom 15 while the old blast furnace operation S1 is continued without raising or lowering the foundation top 14, the old furnace proper 11 and the old furnace tower structure 12.

Second Exemplary Embodiment

[0201] Figs. 25 and 26 illustrate a second exemplary embodiment of the invention.

[0202] As in the above-described first exemplary embodiment, this exemplary embodiment revamps a blast furnace by a general progression illustrated in Figs. 1 to 4. However, this exemplary embodiment is different from the above-described first exemplary embodiment in a configuration of a pull-out transfer device 30A that is used in the old furnace pull-out step S5. Therefore, in the following description, the repeated description of the common features is not provided, and the different portions will be described.

[0203] In the above-described first exemplary embodiment, the pull-out transfer device 30 (see Fig. 8) uses the recess 33 formed in the ground, the sliding structure 43 laid on the bottom surface thereof and the branch

transfer base 32 moving within the recess 33 in order to perform the third conveying operation (conveyance in the axis A2 direction reaching the old furnace dismantling site P3).

[0204] In the pull-out transfer device 30A of this exemplary embodiment, the recess 33 and the branch transfer base 32 are omitted, and the third conveying operation is performed at the same level L2 as the second conveying operation.

[0205] As shown in Figs. 25 and 26, the pull-out transfer device 30A is provided with the same pull-out transfer base 31 and sliding structures 41 and 42 as the above-described first exemplary embodiment. The sliding structure 41 is set at the level L1, and the sliding structure 42 is set at the level L2.

[0206] The sliding structure 42 is supported on the ground over the entire length and is reinforced with a reinforcing steel material 34 illustrated in Fig. 12.

[0207] The sliding structure 43 is installed on the ground at the level L2 similarly to the sliding structure 42.

[0208] An intersection between the sliding structure 42 and the sliding structure 43, the respective fixed side sliding plates 81 (see Fig. 7) intersect with each other in a grid shape and are welded, and thereafter, the upper surface serving as a sliding surface is smoothly polished.

[0209] In such an exemplary embodiment, by the second conveying operation, the pull-out transfer base 31 is conveyed in the axis A1 direction using the sliding structure 42 and reaches the intersection of the sliding structure 42 and the sliding structure 43. Further, in the third conveying operation, the pull-out transfer base 31 is conveyed from the intersection in the axis A2 direction using the sliding structure 43 and is sent to the old furnace dismantling site P3.

[0210] According to such an exemplary embodiment, it is also possible to obtain the same effects as the above-described first exemplary embodiment.

[0211] Moreover, in the pull-out transfer device 30A, since it is not necessary to form the recess 33 in the ground, it is possible to simplify the civil engineering works.

[0212] On the other hand, at the intersection of the sliding structure 42 and the sliding structure 43, the upper surface serving as the sliding surface needs to be smoothly polished after individually welding each of the fixed side sliding plates 81. Therefore, it is desirable to suitably select which one of the first exemplary embodiment or the present exemplary embodiment to be employed in consideration of the work load or the like depending on the site conditions and the like.

Third Exemplary Embodiment

[0213] In each drawing of Figs. 27 to 31, a third exemplary embodiment of the invention is illustrated.

[0214] As in the above-described first exemplary embodiment, this exemplary embodiment revamps the blast furnace by the general progression illustrated in Figs. 1

to 4. However, this exemplary embodiment is different from the above-described first exemplary embodiment in the configurations of an pull-out transfer device 30B used in the old furnace pull-out step S5 and an pull-in transfer device 39B used in the new furnace pull-in step S6. In the following description, the repeated description of the common features is omitted, and the different portions will be described.

[0215] First, the pull-out transfer device 30B used in the old furnace pull-out step S5 will be described.

[0216] In the above-described first exemplary embodiment, the pull-out transfer device 30 (see Fig. 8) is equipped with the sliding structure 41 in the axis A1 direction (level L1), the sliding structure 42 in the same axis A1 direction (level L2) and the sliding structure 43 in the axis A2 direction (level L3) corresponding to each of the first to third conveying operations. Further, by setting the upper and lower surfaces of the pull-out transfer base 31 at the level L1 and the level L2, respectively, and by setting the level L3 below a predetermined height of the level L2 (i.e. by forming the recess 33 and laying the sliding structure 43 on its lower surface), the pull-out transfer base 31 is placed on the branch transfer base 32 to achieve the direction change in the axis A2 direction.

[0217] In contrast, in this exemplary embodiment, the pull-out transfer base 31 and the second conveying operation are omitted, as the first conveying operation, the foundation top 14 and the old blast furnace 10 are horizontally moved to the top of the branch transfer base 32 from the foundation bottom 15 in the axis A1 direction at the level L1, and as the third conveying operation, the branch transfer base 32 on which the foundation top 14 and the old blast furnace 10 are mounted is conveyed in the axis A2 direction at the level L3' lower than the level L1.

[0218] Therefore, the pull-out transfer device 30B of this exemplary embodiment has the following features different from the above-described first exemplary embodiment.

[0219] As shown in Figs. 27, 28 and 29, an intermediate base 61 is installed on the ground toward the new furnace construction site P2 from the vicinity of the foundation bottom 15. A front end of the intermediate base 61 facing the new furnace construction site P2 extends up to the front of the position at which the direction changes.

[0220] A branch base 62 is installed on the ground from the position of direction change toward the old furnace dismantling site P3 (see Fig. 3). The branch transfer base 32 is placed on the top of the branch base 62.

[0221] The sliding structure 41 is installed between the upper surface of the foundation bottom 15 and the lower surface of the foundation top 14 as in the first exemplary embodiment, and its fixed side (the fixed side sliding plate 81 illustrated in Fig. 7) extends to the upper surface of the branch transfer base 32 from the upper surface of the foundation bottom 15 via the upper surface of the intermediate base 61. The height of the sliding surface

of the sliding structure 41 is set at the same level L1 as the first exemplary embodiment.

[0222] The same sliding structure 43 as the first exemplary embodiment is installed between the upper surface of the branch base 62 and the lower surface of the branch transfer base 32. The height of the sliding surface of the sliding structure 43 is set at a level L3' lower by the height of the branch transfer base 32 than the level L1 of the sliding structure 41.

[0223] The sliding structure 43 is disposed on the lower surface of the recess 33 (see Fig. 8), and its sliding surface is at the level L3 lower than the ground surface in the first exemplary embodiment. However, since the level L3' of this exemplary embodiment is set at the upper surface of the branch base 62 installed on the ground, the level L3' is higher than the ground. However, this exemplary embodiment is the same as the first exemplary embodiment in that the level L3' is lower than the height until then (the level L2 in the first exemplary embodiment, and the level L1 in this exemplary embodiment) by the height of the branch transfer base 32 used in the direction change.

[0224] Next, a pull-in transfer device 39B (see Figs. 30 and 31) used in the new furnace pull-in step S6 will be described.

[0225] In the above-described first exemplary embodiment, the pull-in transfer device 39 (see Fig. 21) is equipped with a sliding structure 44 that allows slide movement of the bottom surface side of the pull-in transfer base 38 in order to perform the first conveying operation, and sliding structures 45 and 46 that allows the slide movement of the new foundation 23 with respect to upper surface of the pull-in transfer base 38 and the upper surface of the restoration foundation 26 in order to perform the second conveyance.

[0226] In contrast, in this exemplary embodiment, the first conveying operation that horizontally moves the pull-in transfer base 38 is omitted, and the second conveying operation is performed, in which the new foundation 23 and the new blast furnace 20 are horizontally moved directly from the top of the stand installed on the new furnace construction site P2 and are conveyed to the upper surface of the restoration foundation 26 in a single operation.

[0227] Therefore, the pull-in transfer device 39B of this exemplary embodiment includes the following configurations different from the above-described first exemplary embodiment.

[0228] As illustrated in Figs. 30 and 31, in the new furnace construction site P2, a construction base 63 is installed on the ground, and the new foundation 23 for constructing the new blast furnace 20 is supported on the upper surface of the construction base 63. A sliding structure 45 having a height of a sliding surface at a level L4 is installed between the lower surface of the new foundation 23 and the upper surface of the construction base 63.

[0229] In this exemplary embodiment, the intermediate

base 61 and the branch base 62 of the pull-out transfer device 30B (see Fig. 27) used in the old furnace pull-out step S5, and the sliding structures 41 and 43 of each upper surface remain between the new furnace construction site P2 and the foundation bottom 15. After removing each of the sliding structures 41 and 43, auxiliary bases 64 and 65 are placed on the intermediate base 61 and the branch base 62, respectively, so that the upper surface heights of the stands are the same as that of the construction base 63.

[0230] In this exemplary embodiment, the restoration foundation 26 is also formed on the upper surface of the foundation bottom 15, and the height of the upper surface of the restoration foundation 26 is the same as that of the construction base 63. Also, the fixed side of the sliding structure 46 is laid from the upper surface of the restoration foundation 26 over the upper surfaces of the auxiliary bases 65 and 64. As in the first exemplary embodiment, the sliding structure 46 shares the movement side of the sliding structure 45 formed on the lower surface of the new foundation 23 (see Fig. 23). The sliding surface of the sliding structure 46 is set at the level L4 and is connected to the end portion of the fixed side of the sliding structure 45 of the upper surface of the construction base 63 after installation, and it's the upper surface of the sliding structure 46 is smoothly finished.

[0231] In such an exemplary embodiment, in the old furnace pull-out step S5, the foundation top 14 and the old blast furnace 10 are conveyed from the top of the foundation bottom 15 to the top of the branch transfer base 32 using the sliding structure 41. Subsequently, the branch transfer base 32 is conveyed to the old furnace dismantling site P3 (see Fig. 3) by using the sliding structure 43.

[0232] On the other hand, in the new furnace pull-in step S6, after installation of the restoration foundation 26, the auxiliary bases 64 and 65 and the sliding structure 46, the new foundation 23 and the new blast furnace 20 are conveyed to the blast furnace installation site P1 at once.

[0233] According to the third exemplary embodiment, it is also possible to obtain the same effect as the above-described first exemplary embodiment.

[0234] Moreover, in the pull-out transfer device 30B used in the old furnace pull-out step S5, there is no need for a second conveying operation in the old furnace pull-out step S5 of the above-described first exemplary embodiment, but only two conveying operations of the first conveying operation in the axis A1 direction at the level L1 and the third conveying operation in the axis A2 direction at the level L3' are necessary. Accordingly, it is possible to reduce the operations including installation and removal of equipment such as the traction device 70 (see Figs. 18 and 19) for driving in each conveyance operation, and thus the construction period is further shortened.

[0235] Also, as in the first exemplary embodiment, since it is not necessary to form the recess 33 in the

ground, it is possible to simplify the civil engineering works.

[0236] Further, since the branch base 62 and the branch transfer base 32 are used in the conveyance in the axis A2 direction, there is no need to perform the connection and polishing of a plurality of intersections between the sliding structure 42 and the sliding structure 43 as in the second exemplary embodiment.

[0237] On the other hand, in the pull-in transfer device 39B (see Figs. 30 and 31) used in the new furnace pull-in step S6, after installation of the restoration foundation 26, the auxiliary bases 64 and 65, and the sliding structure 46, it is possible to convey the new foundation 23 and the new blast furnace 20 to the blast furnace installation site P1 at once.

[0238] Therefore, as compared to the case of performing the first and second conveying operations as in the first exemplary embodiment or the second exemplary embodiment, it is possible to reduce the operations including installation and removal of the equipment relating to the driving of the traction device 70 (see Figs. 18 and 19) or the like, and it is possible to further shorten the construction period.

[0239] Further, since the new foundation 23 and the new blast furnace 20 are conveyed to the blast furnace installation site P1 at once and do not stop in the middle, stability of the conveyance and the conveyance accuracy can be enhanced.

Fourth Exemplary Embodiment

[0240] Figs. 32 and 33 illustrate a fourth exemplary embodiment of the invention.

[0241] As in the first to third exemplary embodiments described above, this exemplary embodiment revamps the blast furnace by each process described in Fig. 1. However, this exemplary embodiment is different from the above-described first to third exemplary embodiments in a planar arrangement of the blast furnace installation site P1, the new furnace construction site P2 and the old furnace dismantling site P3, and is also different in the arrangements of the carry-out conveying path used in the old furnace pull-out step S5 and the carry-in conveying path used in the new furnace pull-in step S6.

[0242] In the above-described first to third exemplary embodiments, as illustrated in Fig. 2, the new furnace construction site P2 is placed in the axis A1 direction with respect to the blast furnace installation site P1, and the old furnace dismantling site P3 is installed on the axis A2 extending in the intersection direction from the middle between the blast furnace installation site P1 and the new furnace construction site P2.

[0243] As illustrated in Figs. 32 and 33, in this exemplary embodiment, the new furnace construction site P2 and the old furnace dismantling site P3 are disposed opposite to each other with respect to the arrangement of Fig. 2 described above. Therefore, in this exemplary em-

bodiment, the carry-out conveying path 30' from the blast furnace installation site P1 to the old furnace dismantling site P3 is linearly configured, and the carry-in conveying path 39' ranging from the new furnace construction site P2 to the blast furnace installation site P1 is configured in an L-shape that branches from a halfway of the carry-out conveying path 30' in the intersection direction.

[0244] In such an exemplary embodiment, the conveyance is performed as follows.

[0245] In the old furnace pull-out step S5, as illustrated in Fig. 32, the site foundation 13 is segmented in the blast furnace installation site P1, and is linearly moved to the old furnace dismantling site P3 along the carry-out conveying path 30' integrally with the foundation top 14 and the old blast furnace 10 (the old furnace proper 11 and the old furnace tower structure 12) disposed thereon.

[0246] In the new furnace pull-in step S6, as illustrated in Fig. 33, the new blast furnace 20 (the new furnace proper 21 and the new furnace tower structure 22) constructed in the new furnace construction site P2 is moved integrally with the new foundation 23 to the blast furnace installation site P1 along the carry-in conveying path 39'. In the carry-in conveying path 39', first, the new blast furnace 20 is moved along the axis A2 and along the axis A1 after the direction change.

[0247] It should be noted that the specific mechanism of the conveying device in the carry-out conveying path 30' and the carry-in conveying path 39' may be the same as the pull-out transfer devices 30, 30A and 30B and the pull-in transfer devices 39, 39A and 39B of each of the above-described exemplary embodiments, and the specific mechanism may be suitably designed in accordance with the configuration of the above-described first exemplary embodiment (using the levels L1 to L4), second exemplary embodiment (using the levels L1, L2 and L4) or third exemplary embodiment (using the levels L1, L3' and L4).

[0248] According to the fourth exemplary embodiment, it is also possible to obtain the same effects as the first to third exemplary embodiments described above. However, the effect by the linear carry-in conveying path in the respective exemplary embodiments cannot be obtained.

Fifth Exemplary Embodiment

[0249] Figs. 34 and 35 illustrate a fifth exemplary embodiment of the invention.

[0250] As in the above-described first to third exemplary embodiments, this exemplary embodiment revamps the blast furnace by each process described in Fig. 1. However, this exemplary embodiment is different from the above-described first to third exemplary embodiments in the planar arrangements of the blast furnace installation site P1, the new furnace construction site P2 and the old furnace dismantling site P3, and is also different in the arrangements of the carry-out conveying path used in the old furnace pull-out step S5 and the

carry-in conveying path used in the new furnace pull-in step S6.

[0251] This exemplary embodiment is configured so that each of the carry-out conveying path 30' and the carry-in conveying path 39' performs the direction change in the middle.

[0252] As shown in Figs. 34 and 35, the carry-out conveying path 30' extends from the blast furnace installation site P1 along the axis A1, is subjected to direction change in the middle, and extends upward in the drawings along the axis A2. The old furnace dismantling site P3 is located at an end portion. The carry-in conveying path 39' extends from the blast furnace installation site P1 along the axis A1, is subjected to direction change in the middle, and extends downward in the drawings along the axis A2, and the new furnace construction site P2 is located at an end portion.

[0253] Therefore, this exemplary embodiment is configured so that each of the carry-out conveying path 30' and the carry-in conveying path 39' is subjected to the direction change in the middle, and the path extending from the blast furnace installation site P1 along the axis A1 is shared by the carry-out conveying path 30' and the carry-in conveying path 39'.

[0254] In the fifth exemplary embodiment, the conveyance is performed as follows.

[0255] In the old furnace pull-out step S5, as illustrated in Fig. 34, the site foundation 13 is segmented in the blast furnace installation site P1, and is moved to the blast furnace installation site P1 along the carry-out conveying path 30' integrally with the foundation top 14 and the old blast furnace 10 (the old furnace proper 11 and the old furnace tower structure 12) provided thereon. In the carry-out conveying path 30', the movement is initially performed along the axis A1, and the movement is performed along the axis A2 after the direction change toward the old furnace dismantling site P3.

[0256] In the new furnace pull-in step S6, as illustrated in Fig. 35, the new blast furnace 20 (the new furnace proper 21 and the new furnace tower structure 22) constructed in the new furnace construction site P2 is moved integrally with the new foundation 23 to the blast furnace installation site P1 along the carry-in conveying path 39'. In the carry-in conveying path 39', the movement is initially performed along the axis A2 (toward the old furnace dismantling site P3), and the movement is performed along the axis A1 after the direction change toward the blast furnace installation site P1.

[0257] It should be noted that the specific mechanism of the conveying device in the carry-out conveying path 30' and the carry-in conveying path 39' may be configured in the same manner as the pull-out transfer devices 30, 30A and 30B and the pull-in transfer devices 39, 39A and 39B of each of the above-described exemplary embodiments, and the specific mechanism may be suitably designed in accordance with the configuration of the above-described first exemplary embodiment (using the levels L1 to L4), second exemplary embodiment (using the lev-

els L1, L2 and L4) or third exemplary embodiment (using the levels L1, L3' and L4).

[0258] According to the fifth exemplary embodiment, it is also possible to obtain the same effects as the first to third exemplary embodiments described above.

[0259] On the other hand, since both of the carry-out conveying path 30' and the carry-in conveying path 39' experience the direction change, the degree of freedom in selection of the installation site of the new furnace construction site P2 and the old furnace dismantling site P3 is high, thus being easily applicable to the blast furnace in which the peripheral facilities are crowded.

[0260] Furthermore, it is possible to share the conveying device in the shared portion along the axis A1 by the carry-out conveying path 30' and the carry-in conveying path 39'. In addition, by disposing the portions along the axis A2 on a straight line, it is possible to share the conveying device such as a traction device 70.

[0261] It should be noted that, in the pull-out transfer devices 30, 30A and 30B and the pull-in transfer devices 39 and 39B in the above-described first to third exemplary embodiments, and in the carry-out conveying path 30' and the carry-in conveying path 39' in the fourth exemplary embodiment or the fifth exemplary embodiment, when changing the conveying direction in the middle, the angle of the direction change may be 45 degrees, 60 degrees or any other angle without being limited to 90 degrees.

[0262] Furthermore, the number of parts that perform the direction change in each conveying path such as the carry-out conveying path 30' and the carry-in conveying path 39' (i.e. the number of times of performing the direction change in one conveying path) may be two or more without being limited to one.

Sixth Exemplary Embodiment

[0263] Figs. 36 and 37 illustrate a sixth exemplary embodiment of the invention.

[0264] As in the above-described first to third exemplary embodiments, this exemplary embodiment revamps the blast furnace by each process described in Fig. 1. However, this exemplary embodiment is different from the above-described first to third exemplary embodiments in the planar arrangements of the blast furnace installation site P1, the new furnace construction site P2 and the old furnace dismantling site P3 and is also different in the carry-out conveying path used in the old furnace pull-out step S5 and the carry-in conveying path used in the new furnace pull-in step S6.

[0265] In this exemplary embodiment, the blast furnace installation site P1, the new furnace construction site P2 and the old furnace dismantling site P3 are arranged on a straight line along the axis A1. In particular, the new furnace construction site P2 and the old furnace dismantling site P3 are located on the opposite side with respect to the blast furnace installation site P1.

[0266] In this exemplary embodiment, each of the car-

ry-out conveying path 30' and the carry-in conveying path 39' is linearly configured. The carry-out conveying path 30' and the carry-in conveying path 39' are installed on the opposite sides with the blast furnace installation site P1 interposed therebetween, and have configurations independent of each other with no shared portion.

[0267] In the sixth exemplary embodiment, the conveyance is performed as follows.

[0268] In the old furnace pull-out step S5, as illustrated in Fig. 36, the site foundation 13 is segmented in the blast furnace installation site P1, and is linearly moved to the old furnace dismantling site P3 along the carry-out conveying path 30' integrally with the foundation top 14 and the old blast furnace 10 (the old furnace proper 11 and the old furnace tower structure 12) disposed thereon.

[0269] In the new furnace pull-in step S6, as illustrated in Fig. 37, the new blast furnace 20 (the new furnace proper 21 and the new furnace tower structure 22) constructed in the new furnace construction site P2 is linearly moved integrally with the new foundation 23 to the blast furnace installation site P1 along the carry-in conveying path 39'.

[0270] It should be noted that the specific mechanism of the conveying device in the carry-out conveying path 30' and the carry-in conveying path 39' may be the same as the pull-out transfer devices 30, 30A and 30B and the pull-in transfer devices 39, 39A and 39B of each of the above-described exemplary embodiments, and the specific mechanism may be suitably designed in accordance with the configuration of the above-described first exemplary embodiment (using the levels L1 to L4), second exemplary embodiment (using the levels L1, L2 and L4) or third exemplary embodiment (using the levels L1, L3' and L4).

[0271] However, in this exemplary embodiment, the carry-out conveying path 30' and the carry-in conveying path 39' are linearly situated and independent of each other. Therefore, in this exemplary embodiment, the features (levels L3 and L3') for direction change as in the above-described exemplary embodiments can be omitted.

[0272] With the sixth exemplary embodiment, it is also possible to obtain the same effects as the above-described first to third exemplary embodiments.

Seventh Exemplary Embodiment

[0273] Figs. 38 and 39 illustrate a seventh exemplary embodiment of the invention.

[0274] As in the above-described first to third exemplary embodiments, this exemplary embodiment revamps the blast furnace by each process described in Fig. 1. However, this exemplary embodiment is different from the above-described first to third exemplary embodiments in the planar arrangements of the blast furnace installation site P1, the new furnace construction site P2 and the old furnace dismantling site P3, and is also different in the arrangements of the carry-out conveying

path used in the old furnace pull-out step S5 and the carry-in conveying path used in the new furnace pull-in step S6.

[0275] In this exemplary embodiment, as in the above-described sixth exemplary embodiment, each of the carry-out conveying path 30' and the carry-in conveying path 39' is linearly configured.

[0276] However, the carry-out conveying path 30' extends along the axis A1 direction, whereas the carry-in conveying path 39' extends along an axis A3 (a diagonal direction of the rectangular site foundation 13) that forms an angle of 45 degrees with respect to the axis A1.

[0277] In such an exemplary embodiment, it is possible to perform the conveyance of the old blast furnace 10 and the new blast furnace 20 in the same procedure as the above-described sixth exemplary embodiment.

[0278] According to this exemplary embodiment, it is possible to obtain the same effect as the above-described sixth exemplary embodiment. Moreover, by defining the carry-in conveying path 39' along the axis A3 that forms an angle of 45 degrees with respect to the axis A1, the new furnace construction site P2 can be set at a position different from the above-described sixth exemplary embodiment.

[0279] Specifically, even when the arrangement as in the sixth exemplary embodiment described above cannot be performed due to the relation of the peripheral facilities of the blast furnace or the like, i.e. when it is not possible to dispose the blast furnace installation site P1, the new furnace construction site P2 and the old furnace dismantling site P3 on a straight line along the axis A1, the sites can be arranged by changing the position of the new furnace construction site P2. Further, the carry-in conveying path 39' can be diagonally (the axis A3 is 30 degrees, 60 degrees, 120 degrees, 135 degrees or the like with respect to the axis A1) installed toward the site in which the new furnace construction site P2 can be defined.

Modification(s)

[0280] The invention is not limited to the above-described exemplary embodiments, and modifications or the like within the scope capable of achieving an object of the invention are included in the invention.

[0281] An existing blast furnace foundation structure such as a reinforced concrete structure constructed on the ground of the blast furnace installation site P1 corresponds to the site foundation 13.

[0282] Although such a site foundation 13 is segmented into the foundation top 14 and the foundation bottom 15 in the foundation segmentation step S3, it is desirable to select its segmented position in consideration of the internal reinforced concrete structure of the site foundation 13 or the like.

[0283] A slab-like foundation structure that extends in a planar manner may be used as the new foundation 23, and a steel frame shaft assembly structure or a structure

partially filled with refractory filler such as castable refractory may be used.

[0284] The new foundation 23 is carried in onto the blast furnace installation site P1 to form the foundation of the new blast furnace 20, and the facility equipment and the piping and wiring such as cooling pipes required as the blast furnace function may be installed in advance.

[0285] The equipment to the new foundation 23 may be installed prior to the construction of the new furnace proper 21 and the new furnace tower structure 22 to the upper surface of the new foundation 23 or may be simultaneously installed.

[0286] It is only necessary for the pull-out transfer base 31, the branch transfer base 32, the pull-in transfer base 38, the intermediate base 61, the branch base 62 and the construction base 63 in each exemplary embodiment to be capable of supporting the load of the foundation top 14 and the old blast furnace 10 supported on the upper surface or the new foundation 23 and the new blast furnace 20, and it is possible to use a steel frame shaft assembly structure. Here, in the new furnace pull-in step S6, when conveying the new blast furnace 20 and the new foundation 23, it is required to minimize the deformation of the new furnace proper 21 and the new furnace tower structure 22 after the completion of outfitting. Therefore, in the pull-in transfer devices 39 and 39B relating to the conveyance of the new furnace proper 21 or the like, it is desirable to ensure the sufficient rigidity. On the other hand, in the old furnace pull-out step S5, since the old blast furnace 10 and the foundation top 14 are only dismantled thereafter, the pull-out transfer devices 30, 30A and 30B do not require such a high accuracy as that of the pull-in transfer devices 39 and 39B.

[0287] In the sliding structures 41 to 46 are used in the pull-out transfer devices 30, 30A and 30B and the pull-in transfer devices 39 and 39B, it is only necessary for the fixed side sliding plate 81 and the movement side sliding plate 82 of Fig. 7 described above that the fixed side sliding plate 81 is a plate-shaped member continuous in the conveying direction, but the movement side sliding plate 82 may be intermittently arranged without being limited to be continuous in the conveying direction. Further, details thereof may be suitably changed as long as an expected sliding performance can be obtained by, for example, arranging a plurality of disk-shaped pads.

[0288] In order to reduce the friction with respect to the fixed side sliding plate 81, the movement side sliding plate 82 is provided with the low-friction lining 83. However, the low-friction lining 83 may be provided on the fixed side sliding plate 81. Otherwise, the low-friction lining 83 may be omitted, the fixed side sliding plate 81 and the movement side sliding plate 82 are brought into direct sliding contact with each other, and lubricant having high lubricity under a high load may be supplied between each of the plates.

[0289] As the low-friction lining 83, a lining in which the solid lubricant itself has a sheet shape or a film shape may be adopted without being limited to a lining obtained

by rigidly adhering a solid lubricant, for example (e.g., fine powders such as polytetrafluoroethylene resin (PTFE), molybdenum disulfide and graphite) onto the surface of the substrate. Furthermore, the low-friction lining 83 may be omitted, and the solid lubricant may be dispersed in a viscous medium and may be supplied between the fixed side sliding plate 81 and the movement side sliding plate 82 in a form of grease.

[0290] The guide structure 50 is provided in each of the pull-out transfer devices 30, 30A and 30B and the pull-in transfer devices 39 and 39B to improve the accuracy of the conveyance axis. However, although such a high accuracy is essential in the pull-in transfer devices 39 and 39B, the high accuracy is not required in the pull-out transfer devices 30, 30A and 30B. However, in order to perform the safe conveyance, it is desirable to add a structure for preventing an oblique motion, and it is possible to appropriately adopt the structure such as those described in Patent Literature 1 described above.

[0291] In each of the exemplary embodiments, each of the pull-out transfer devices 30, 30A and 30B and the pull-in transfer devices 39, 39A and 39B is provided, and the height levels L1 to L4 are set in each device. Specifically, the first exemplary embodiment (using the levels L1 to L4), the second exemplary embodiment (using the levels L1, L2 and L4) and the third exemplary embodiment (using the levels L1, L3' and L4) are defined, and the same height levels L1 to L4 are also used in the carry-out conveying path 30' and the carry-in conveying path 39' of the fourth to seventh exemplary embodiments.

[0292] The specific values of the height levels L1 to L4 may be appropriately set at the time of implementation. Further, it is also possible to add other levels depending on the intersection of the conveying paths or the like.

[0293] However, it is desirable to perform setting of the level L4 (a level in which the restoration foundation 26 is installed on the upper surface of the smooth foundation bottom 15) at all times with respect to the basic level L1 (a level in which the site foundation 13 is horizontally cut and is segmented into the foundation top 14 and the foundation bottom 15), i.e. the formation of the new restoration foundation 26 by leveling the upper surface of the foundation bottom 15. By such a restoration foundation 26, it is possible to smoothly carry in the new blast furnace 20.

[0294] Further, when the carry-in conveying path 39' is set at the level L4 in the above-described fourth and fifth exemplary embodiments, it is possible to use a configuration as illustrated in Fig. 40.

[0295] As shown in Fig. 40, the branch transfer base 32 is supported via the sliding structure 43. Similarly to the structure of Fig. 12, the ground that supports the sliding structure 43 is reinforced with the reinforcing steel material 34. The pull-in transfer base 38 is supported on the upper surface of the branch transfer base 32 via the sliding structure 42. The new foundation 23 is formed on the upper surface of the pull-in transfer base 38 via the sliding structure 45, and the new blast furnace 20 including the new furnace proper 21 and the new furnace tower

structure 22 is formed on the new foundation 23. Here, the sliding surface (the sliding structure 43) of the branch transfer base 32 can be set at the level L3, the sliding surface (the sliding structure 42) of the pull-in transfer base 38 can be set at the level L2, and the sliding surface (the sliding structure 45) of the new foundation 23 can be set at the level L4.

INDUSTRIAL APPLICABILITY

[0296] The invention is applicable as a method for re-vamping a blast furnace that performs the removal of an old furnace proper and an old furnace tower structure and the construction of a new furnace proper and a new furnace tower structure in a short period of time.

EXPLANATION OF CODE(S)

[0297]

- 10...Old blast furnace
- 11...Old furnace proper
- 12...Old furnace tower structure
- 13...Site foundation
- 14...Foundation top
- 15...Foundation bottom
- 20...New blast furnace
- 21...New furnace proper
- 22...New furnace tower structure
- 23...New foundation
- 26...Restoration foundation
- 30, 30A, 30B...Pull-out transfer device
- 30' ...Carry-out conveying path
- 31...Pull-out transfer base
- 32...Branch transfer base
- 33...Recess
- 34...Reinforcing steel material
- 35...Support member
- 38...Pull-in transfer base
- 39, 39B...Pull-in transfer device
- 39' ...Carry-in conveying path
- 41, 42, 43, 44, 45, 46...Sliding structure
- 50...Guide structure
- 51...Guide groove
- 52...Guide block
- 61...Intermediate base
- 62...Branch base
- 63...Construction base
- 64, 65...Auxiliary base
- 70...Traction device
- 71...Center hole jack
- 72...Wire
- 73...Reaction force receiving member
- 81...Fixed side sliding plate
- 82...Movement side sliding plate
- 83...Low-friction lining
- 84...Pad
- 85...Pad liner

86...Base grout
 91...Through-hole
 92...Guide member
 93...Wire saw
 94...Cavity
 95...High pack anchor
 96...Rail
 A1, A2...Axis
 B1...Boundary
 L1, L2, L3, L4...Level
 P1...Blast furnace installation site
 P2...New furnace construction site
 P3...Old furnace dismantling site
 S1...Old blast furnace operation
 52...New furnace construction step
 S3...Foundation segmentation step
 S4...Blow-out
 S5...Old furnace pull-out step
 56...New furnace pull-in step
 S7...New blast furnace operation
 58...Old furnace dismantling step
 T1, T2, T3...Cut compartment

Claims

1. A method for revamping a blast furnace that has a furnace body and a furnace body tower installed on a site foundation, the method comprising:

a new furnace construction step of constructing new foundation and constructing a new furnace tower structure and a new furnace proper on the new foundation in a new furnace construction site different from the site foundation;
 a foundation segmentation step of vertically cutting the site foundation to segment the site foundation into a foundation top on which the old furnace proper and the old furnace tower structure are mounted and a foundation bottom, the new furnace construction step and the foundation segmentation step being performed while the blast furnace is in operation;
 blowing out the blast furnace;
 an old furnace pull-out step of carrying out the foundation top from the top of the foundation bottom integrally with the old furnace proper and the old furnace tower structure; and
 a new furnace pull-in step of carrying in the new foundation on the foundation bottom integrally with the new furnace tower structure and the new furnace proper.

2. The method for revamping a blast furnace according to claim 1,
 wherein, in the new furnace pull-in step, a restoration foundation is formed on an upper surface of the foundation bottom, and the new foundation is carried in

onto an upper surface of the restoration foundation integrally with the new furnace tower structure and the new furnace proper.

3. The method for revamping a blast furnace according to claim 2,
 wherein, in the new furnace construction step, an pull-in transfer device linearly extending from the new furnace construction site to the site foundation is used,
 in the old furnace pull-out step, an pull-out transfer device is used which extends from the site foundation toward a site where the new furnace construction step is performed, and extends from a direction change position in an intersection direction, and each of the pull-in transfer device and the pull-out transfer device comprises a sliding structure using a solid lubricated low-friction lining between a pair of sliding plates.
4. The method for revamping a blast furnace according to claim 3,
 wherein the pull-out transfer device comprises a first movement path extending from the site foundation toward the site where the new furnace construction step is performed, a second movement path extending in the intersection direction from a halfway of the first movement path, an pull-out transfer base that is movable on the first movement path, a branch transfer base that is movable in the second movement path, and a recess that is formed in the ground along the second movement path and houses the branch transfer base,
 the first movement path comprises a sliding structure that is continued from an upper surface of the pull-out transfer base to the upper surface of the foundation bottom and comprises a sliding surface having a height set at a level L1, a sliding structure that is formed between a lower surface of the pull-out transfer base and the ground and comprises a sliding surface having a height set at a level L2, and a sliding structure that is formed on an upper surface of the branch transfer base and comprises a sliding surface having a height set at the level L2,
 the second movement path comprises a sliding structure that is formed between a lower surface of the branch transfer base and a bottom surface of the recess and comprises a sliding surface having a height set at a level L3,
 the pull-in transfer device comprises a third movement path extending from the new foundation toward the site foundation, an pull-in transfer base that is movable on the third movement path and supports the new foundation, and a support member disposed in the recess at a halfway of the third movement path, the third movement path comprises a sliding structure that is formed between a lower surface of the pull-in transfer base and the ground, is continued to

the vicinity of the foundation bottom via an upper surface of the support member and comprises a sliding surface having a height set at the level L2, a sliding structure that is formed between an upper surface of the pull-in transfer base and a lower surface of the new foundation and comprises a sliding surface having a height set at a level L4, and a sliding structure that is formed between the upper surface of the restoration foundation and the lower surface of the new foundation and comprises a sliding surface having a height set at the level L4, and the heights of the sliding surfaces of the sliding structures have a relation of level L4 > level L1 > level L2 > level L3.

5. The method for revamping a blast furnace according to claim 3, wherein the pull-out transfer device comprises a first movement path extending from the site foundation toward a site where the new furnace construction step is performed, a second movement path extending in the intersection direction from a halfway of the first movement path, and an pull-out transfer base that is movable from the first movement path to the second movement path, the first movement path comprises a sliding structure that is continued from an upper surface of the pull-out transfer base to the upper surface of the foundation bottom and comprises a sliding surface having a height set at a level L1, and a sliding structure that is formed between a lower surface of the pull-out transfer base and the ground and comprises a sliding surface having a height set at a level L2, the second movement path comprises a sliding structure that is formed between the lower surface of the pull-out transfer base and the ground, is continued with the sliding structure of the level 2 of the first movement path in the intersection direction, and comprises a sliding surface having a height set at the level L2, the pull-in transfer device comprises a third movement path extending from the new foundation toward the site foundation, and an pull-in transfer base that is movable on the third movement path and supports the new foundation, the third movement path comprises a sliding structure that is formed between the lower surface of the pull-in transfer base and the ground, is continued to the vicinity of the foundation bottom, and comprises a sliding surface having a height set at the level L2, a sliding structure that is formed between the upper surface of the pull-in transfer base and the lower surface of the new foundation and comprises a sliding surface having a height set at a level L4, and a sliding structure that is formed between the upper surface of the restoration foundation and the lower surface of the new foundation and comprises a sliding surface having a height set at the level L4, and

the heights of the sliding surfaces of the sliding structures have relation of level L4 > level L1 > level L2.

6. The method for revamping a blast furnace according to claim 3, wherein the pull-out transfer device comprises a first movement path extending from the site foundation toward a site where the new furnace construction step is performed, a second movement path extending in the intersection direction from a halfway of the first movement path, a branch base installed on the ground along the second movement path, a branch transfer base that is movable along the branch base, and an intermediate base that is connected to the site foundation and the branch base along the first movement path, the first movement path comprises a sliding structure that is continued from an upper surface of the branch transfer base to the upper surface of the foundation bottom via the upper surface of the intermediate base and comprises a sliding surface having a height set at a level L1, the second movement path comprises a sliding structure that is formed between a lower surface of the branch transfer base and an upper surface of the branch base and comprises a sliding surface having a height set at a level L3', the pull-in transfer device comprises a third movement path extending from the new foundation toward the site foundation, a construction base that supports the new foundation, and an auxiliary base that is installed on the branch base and the intermediate base at a halfway of the third movement path, the third movement path comprises a sliding structure that is formed between a lower surface of the new foundation and an upper surface of the construction base, is continued to an upper surface of the restoration foundation via an upper surface of the auxiliary base, and comprises a sliding surface having a height set at the level L4, and the heights of the sliding surfaces of the sliding structures have a relation of level L4 > Level L1 > level L3'.
7. The method for revamping a blast furnace according to any one of claims 3 to 6, wherein the pull-in transfer device comprises: a guide groove which is continued in a conveying direction on a fixed side of the sliding structure; and a guide block engaged with the guide groove on a movement side, the guide block being installed at two front and rear positions in a traveling direction of the movement side.
8. The method for revamping a blast furnace according to any one of claims 3 to 7, wherein the pull-in transfer device has an accuracy of a horizontal error of 3 mm or less per 1 m of movement.

FIG. 1

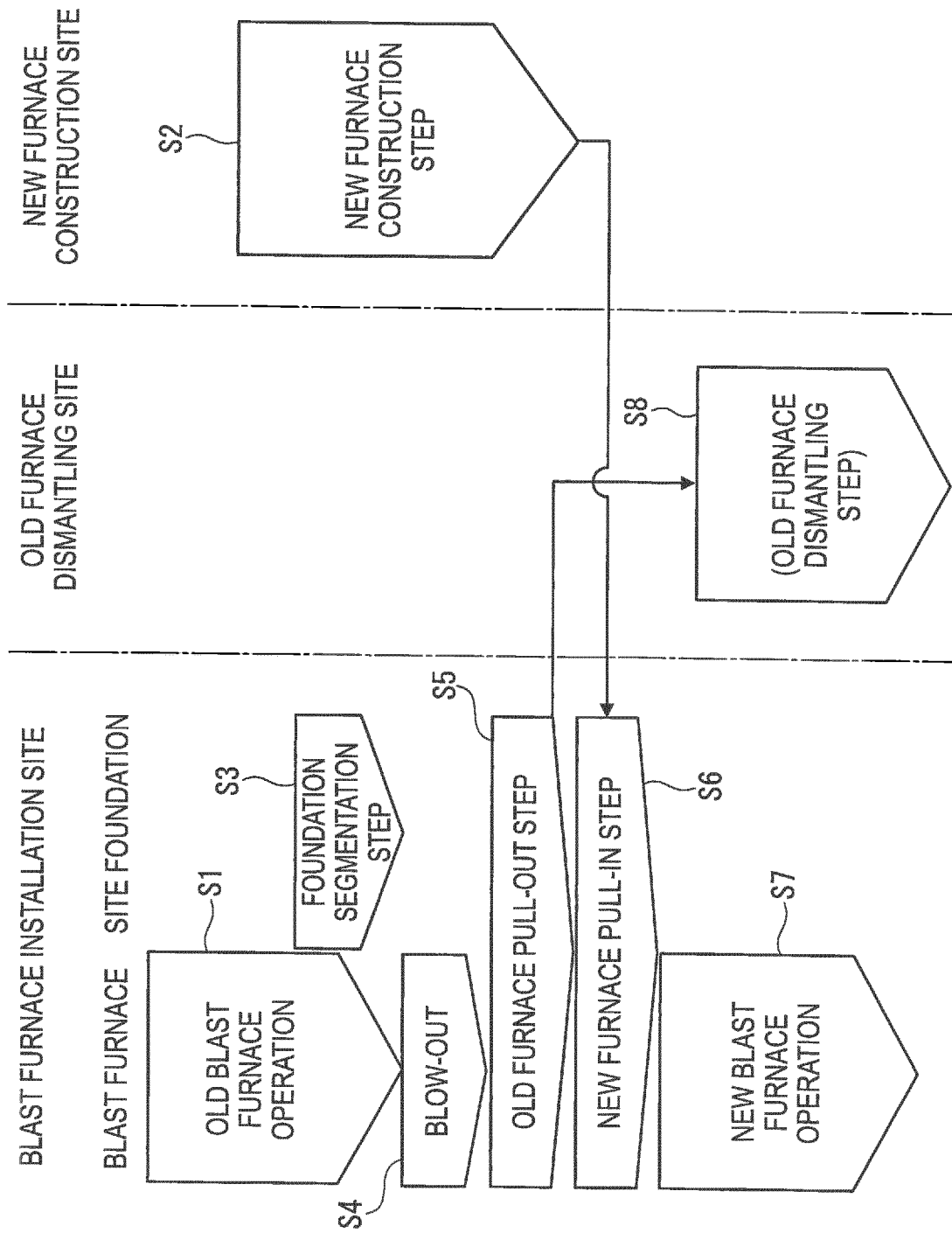


FIG. 2

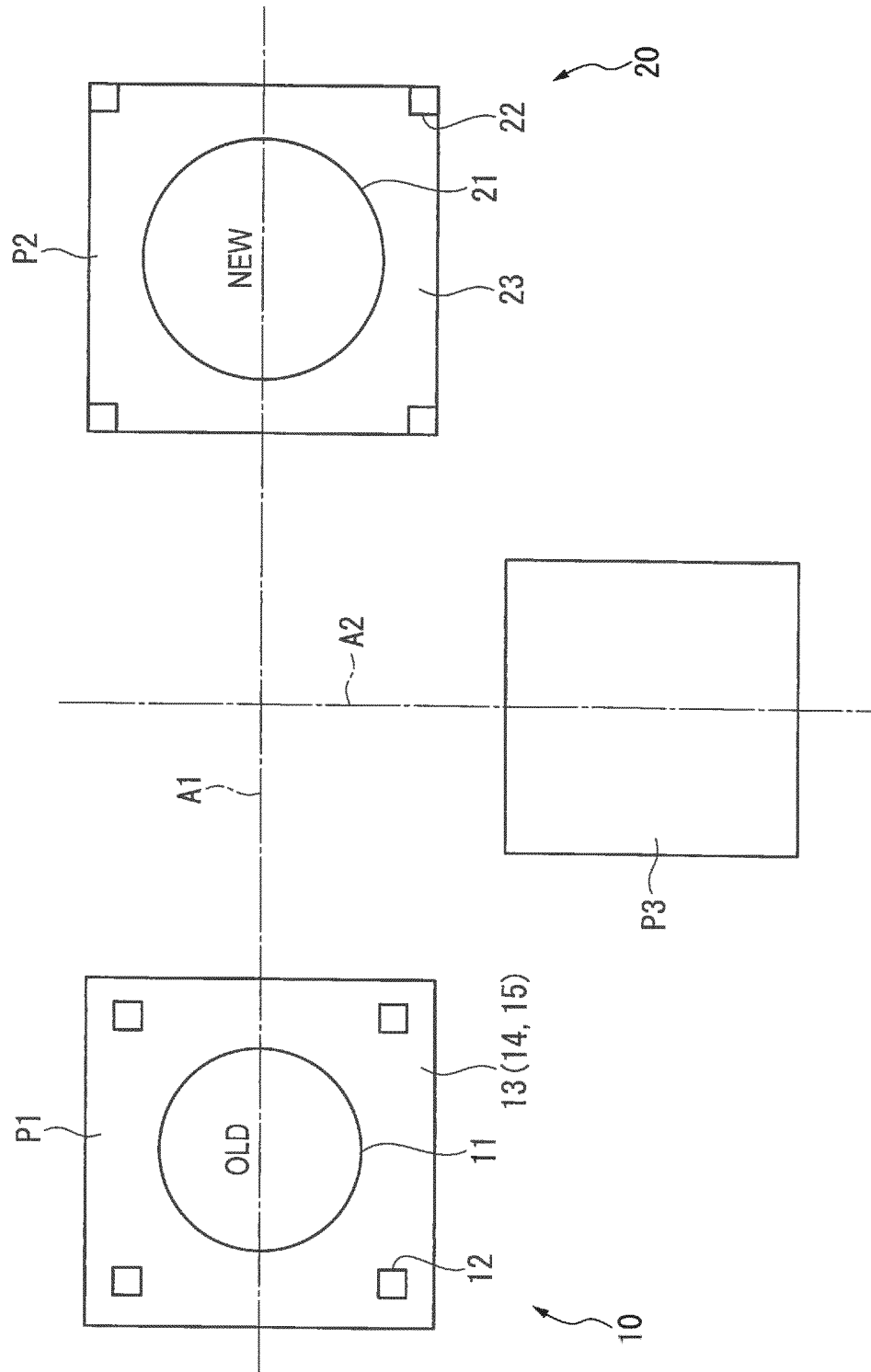


FIG. 3

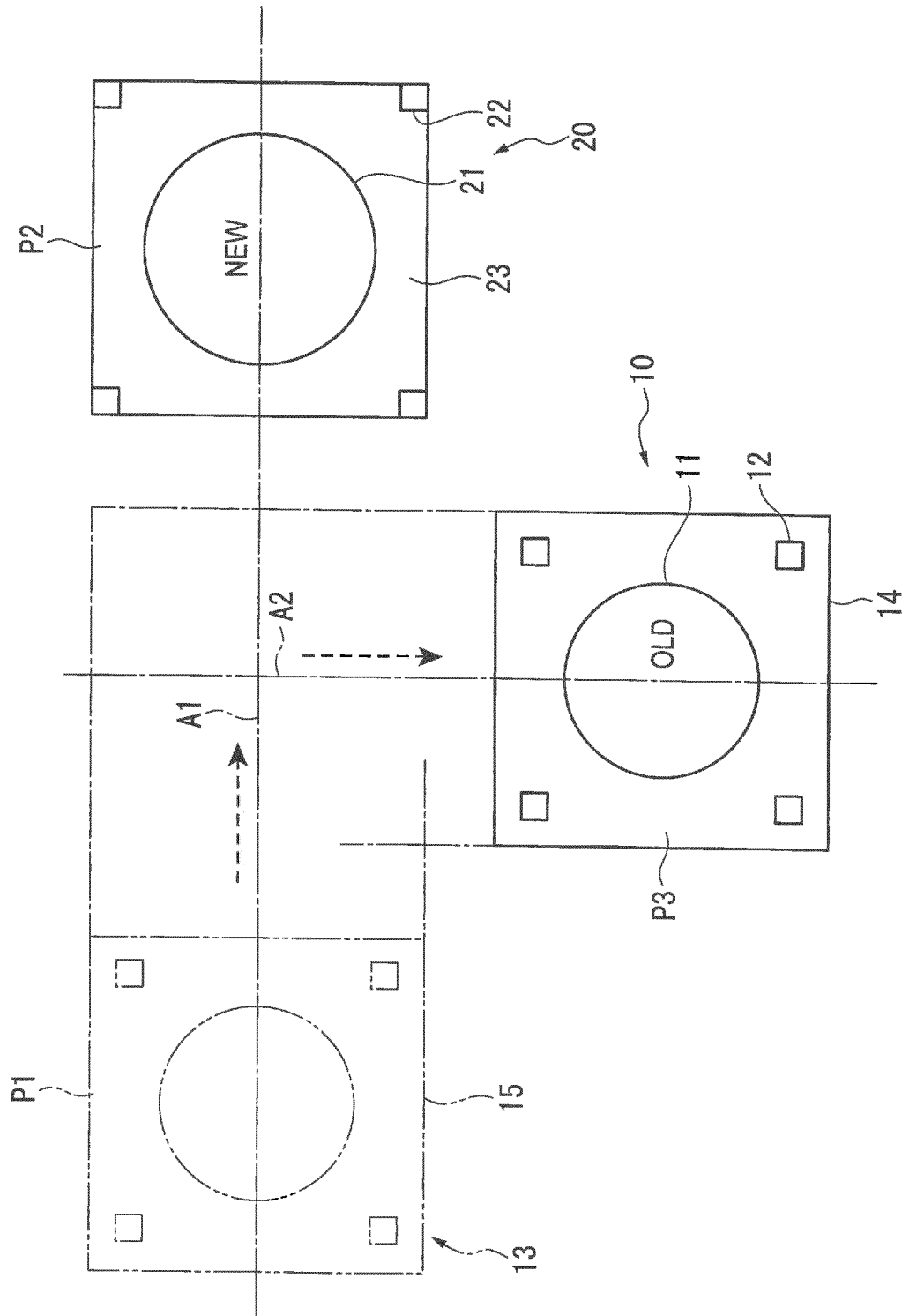


FIG. 4

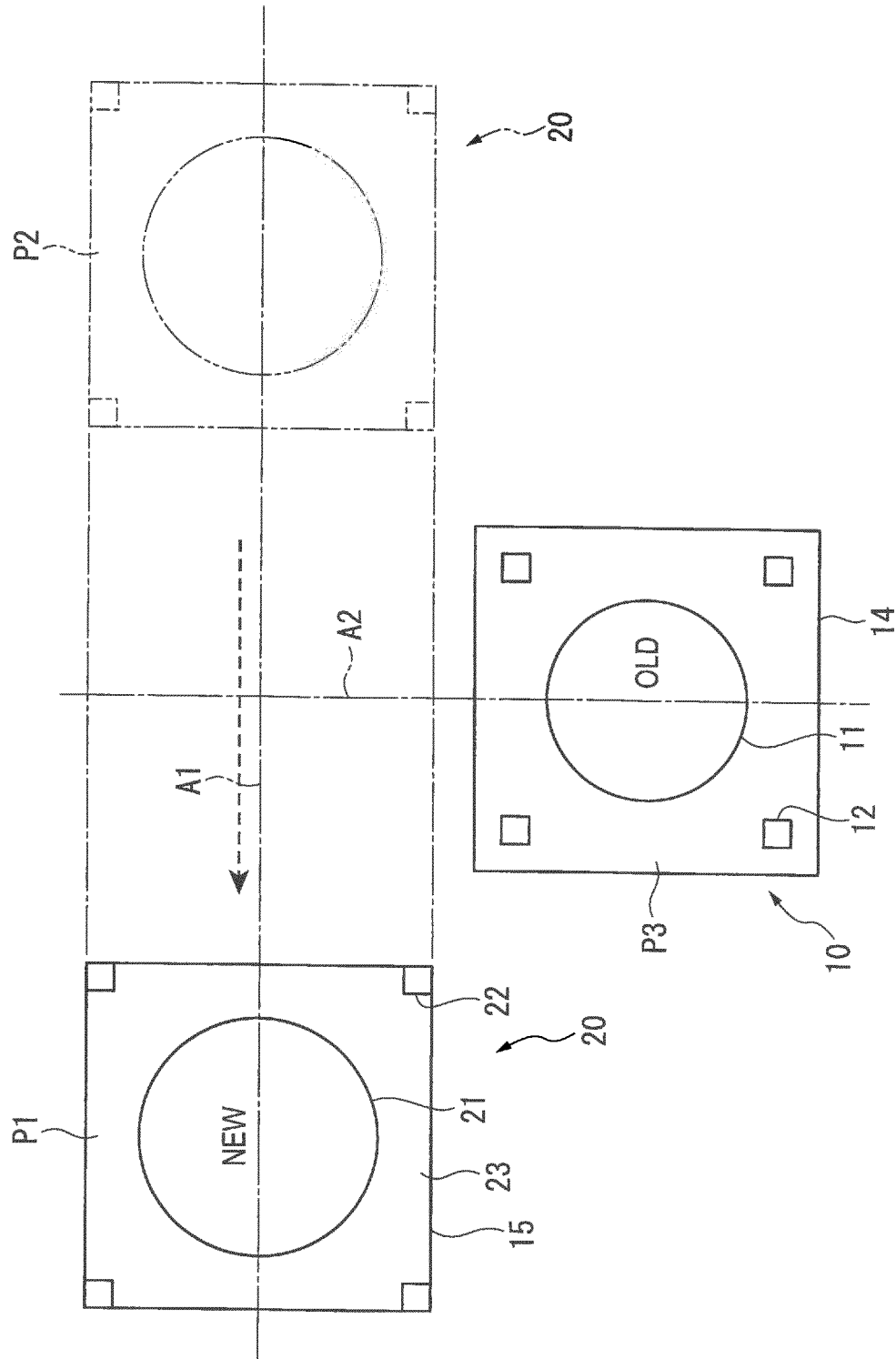


FIG. 5

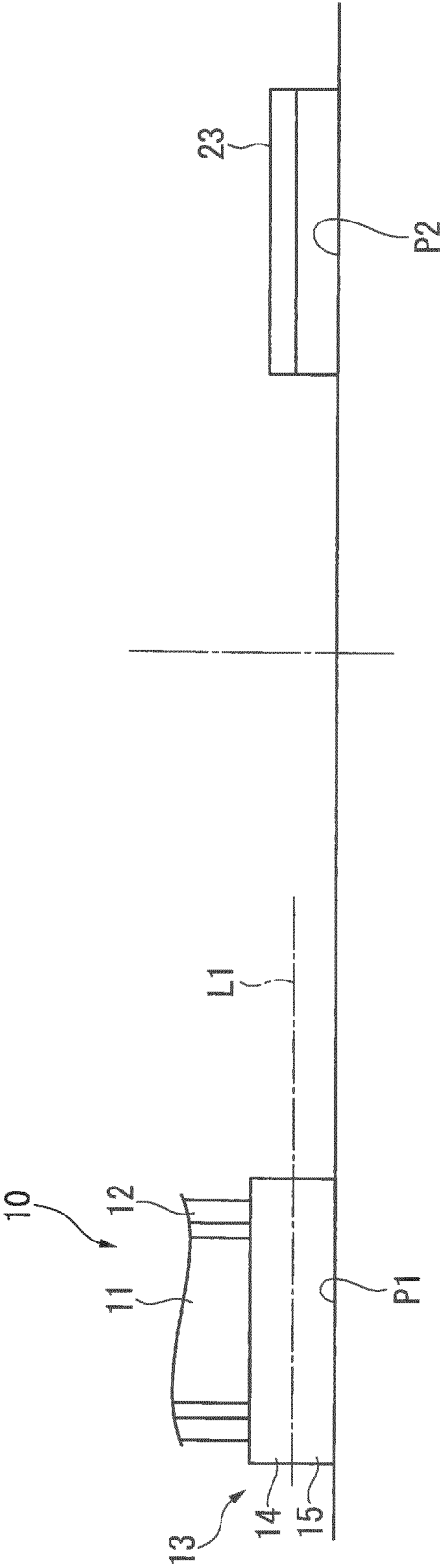


FIG. 6

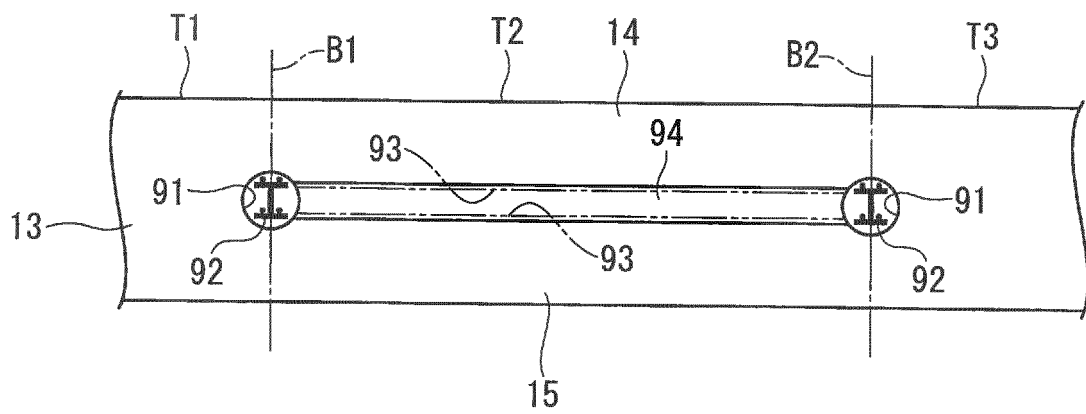


FIG. 7

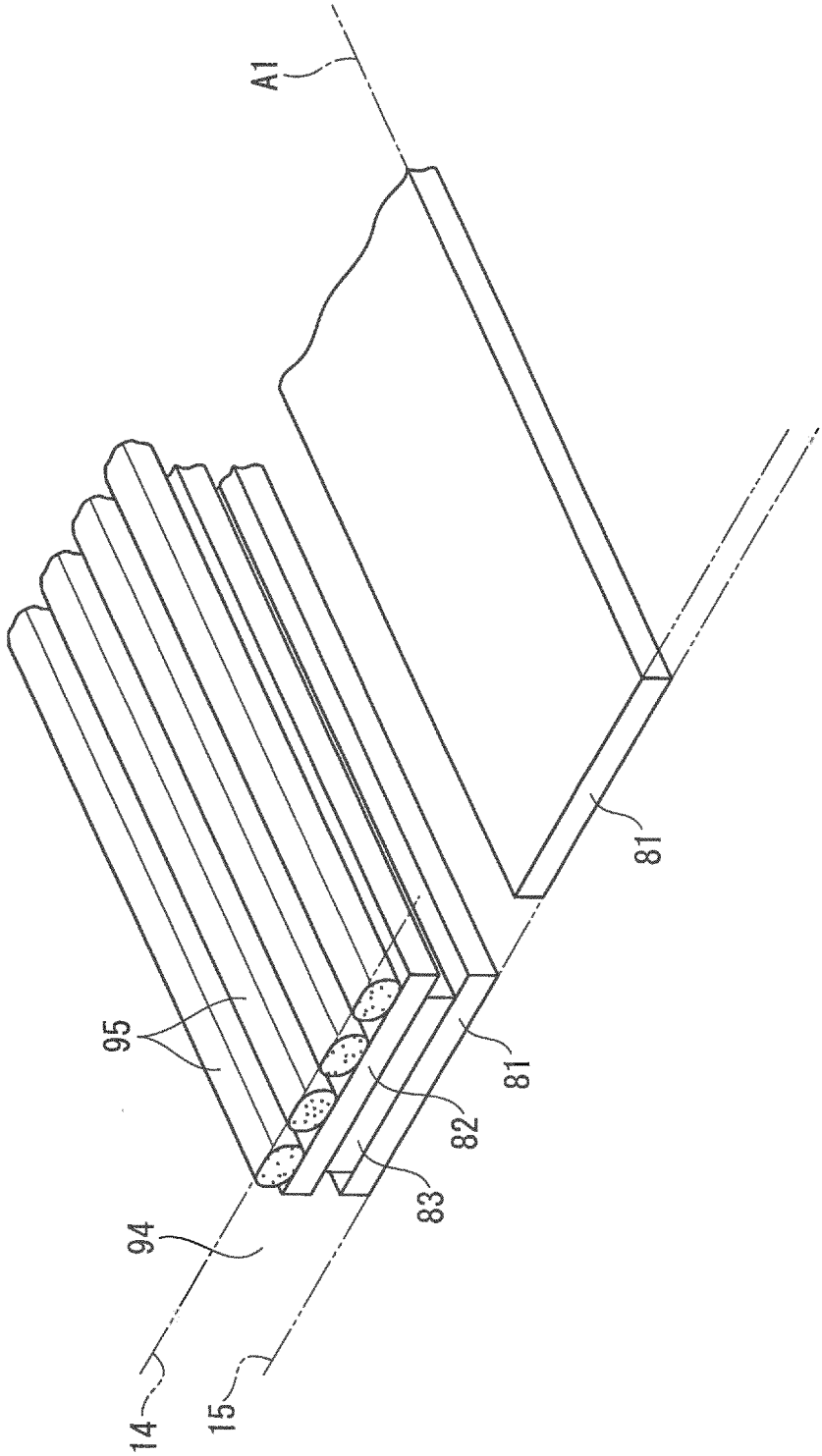


FIG. 8

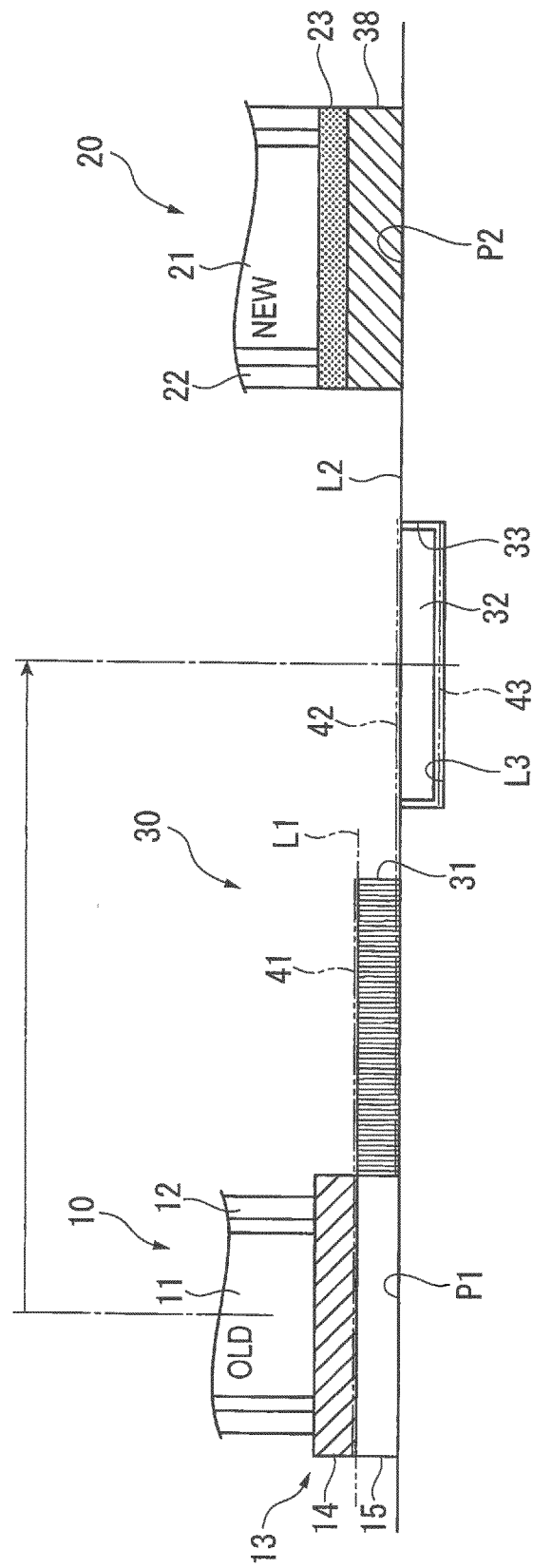


FIG. 9

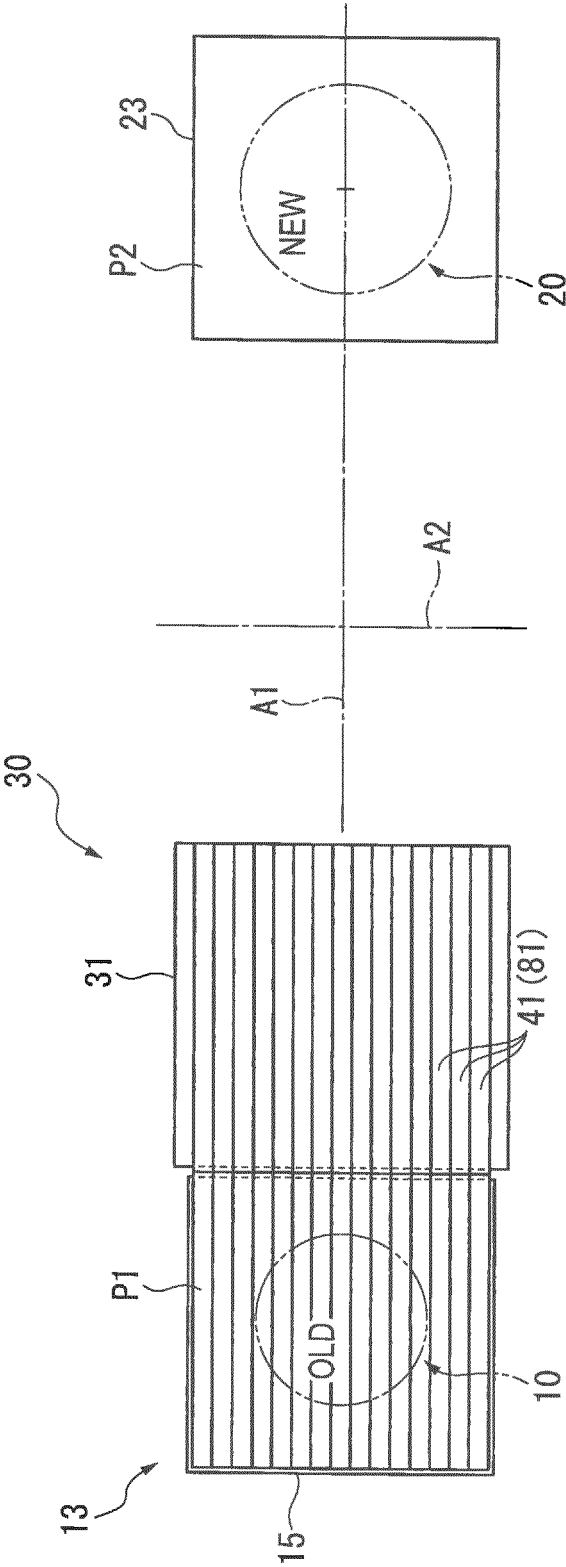


FIG. 10

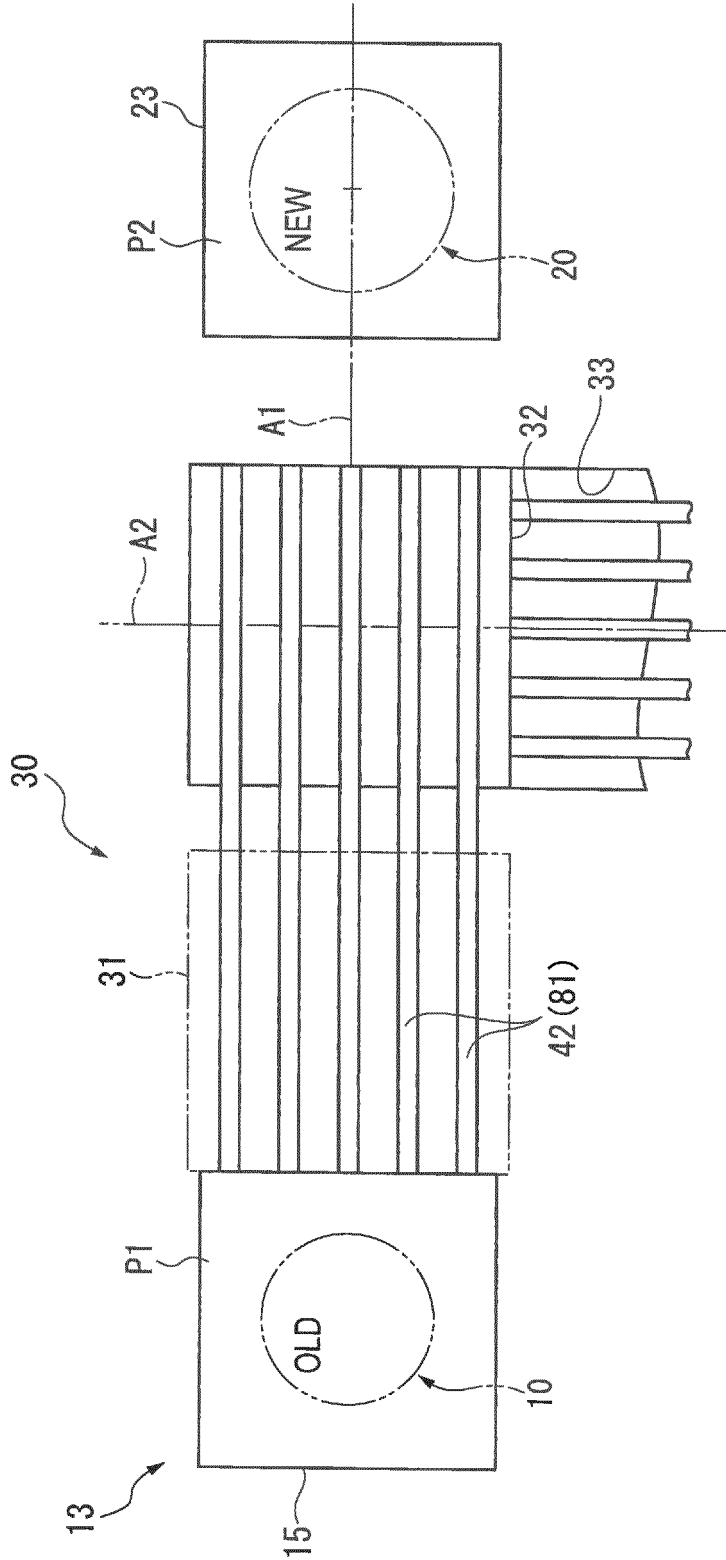
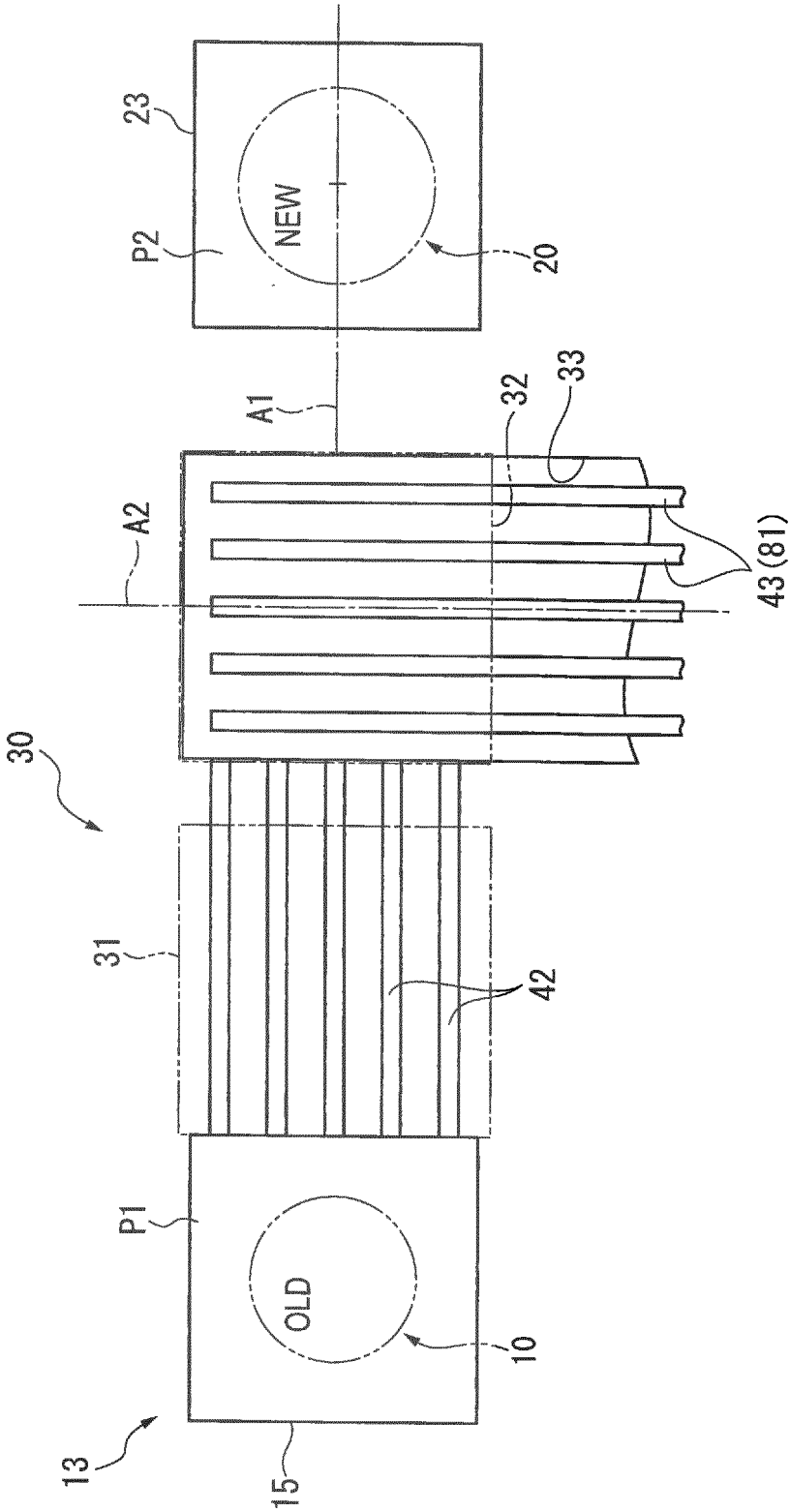


FIG. 11



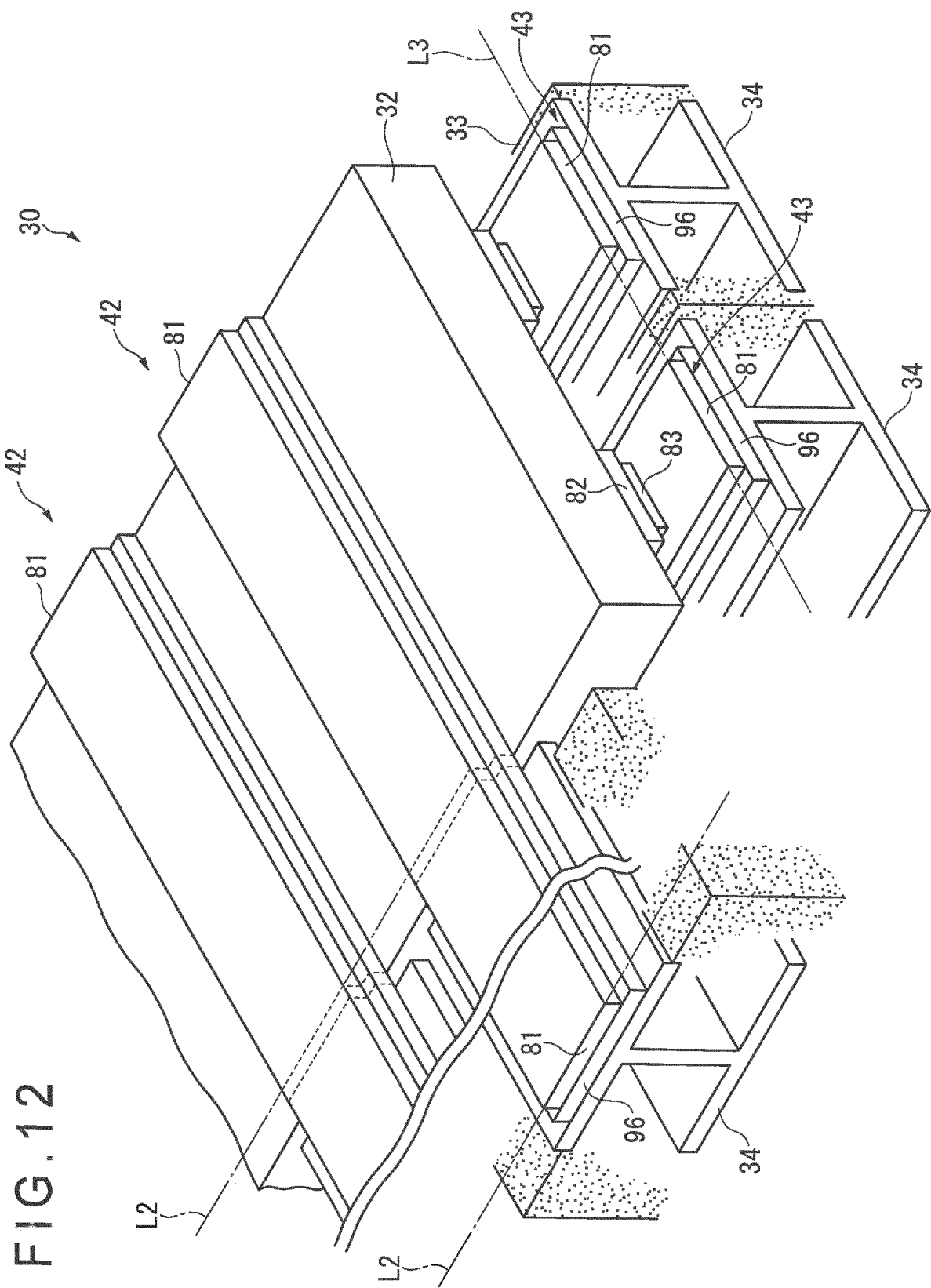


FIG. 13

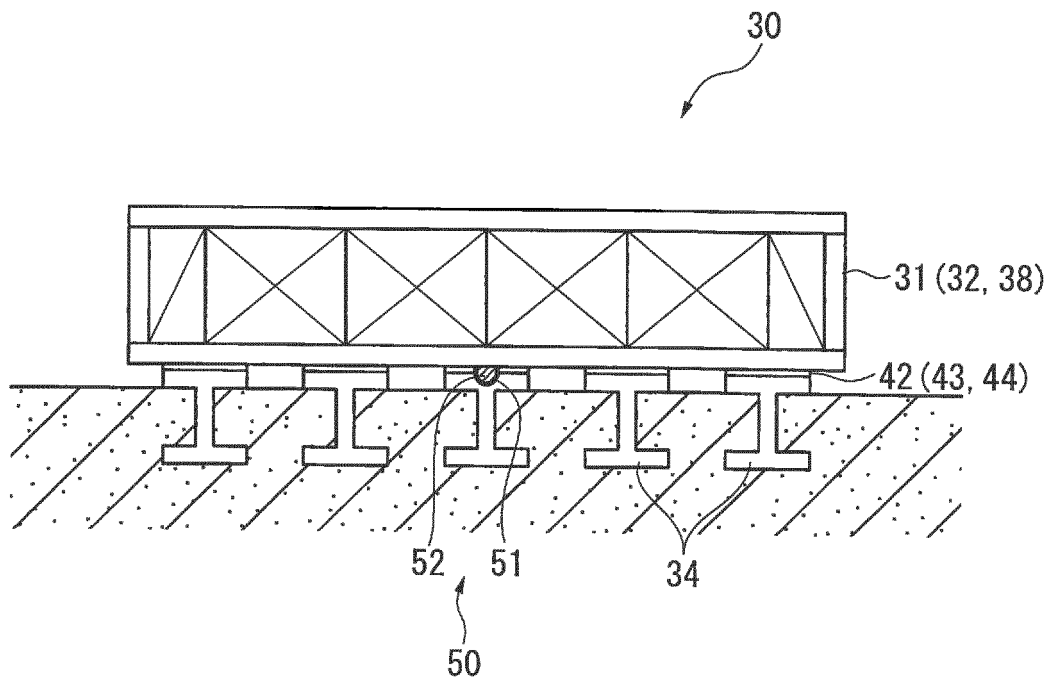


FIG. 14

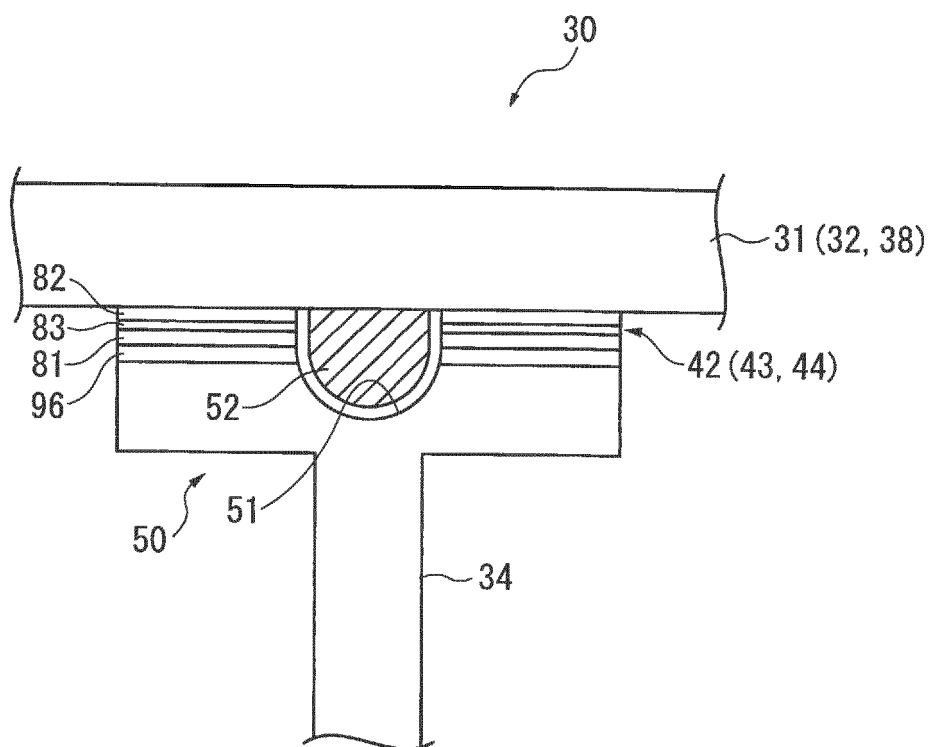


FIG. 15

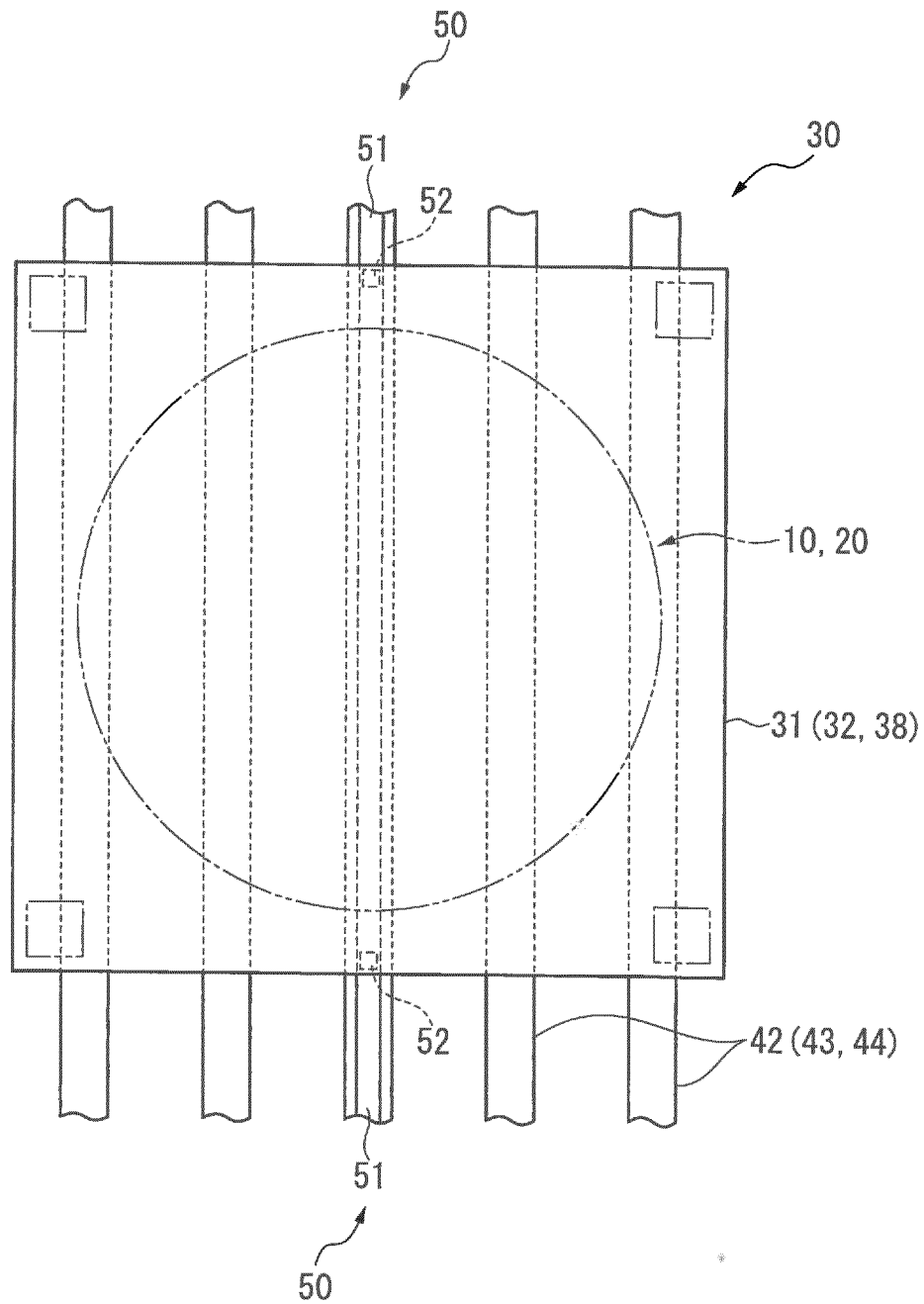


FIG. 16

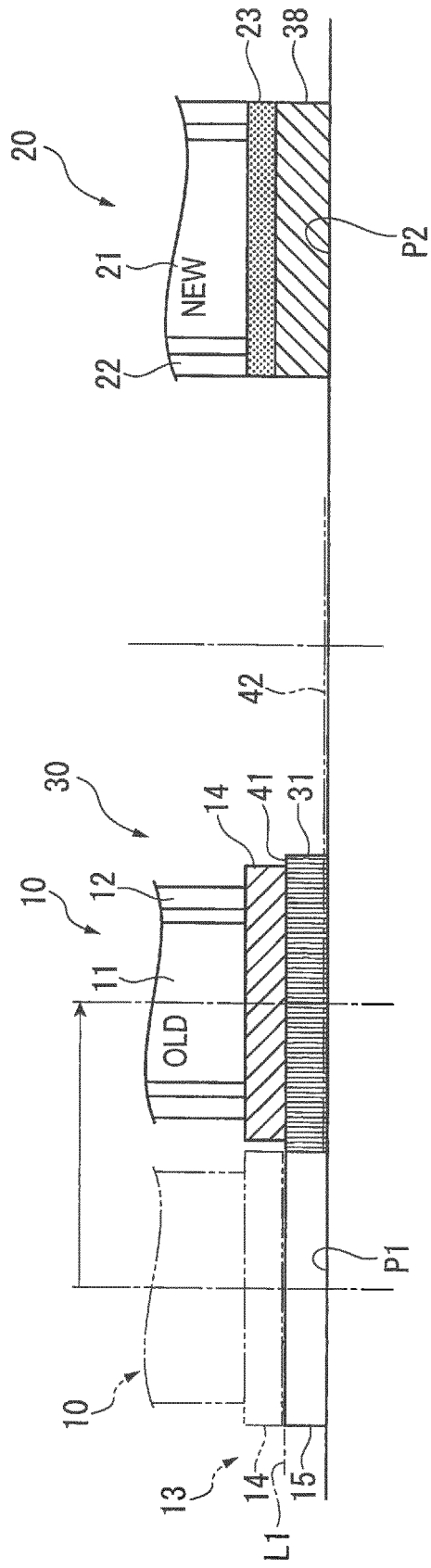
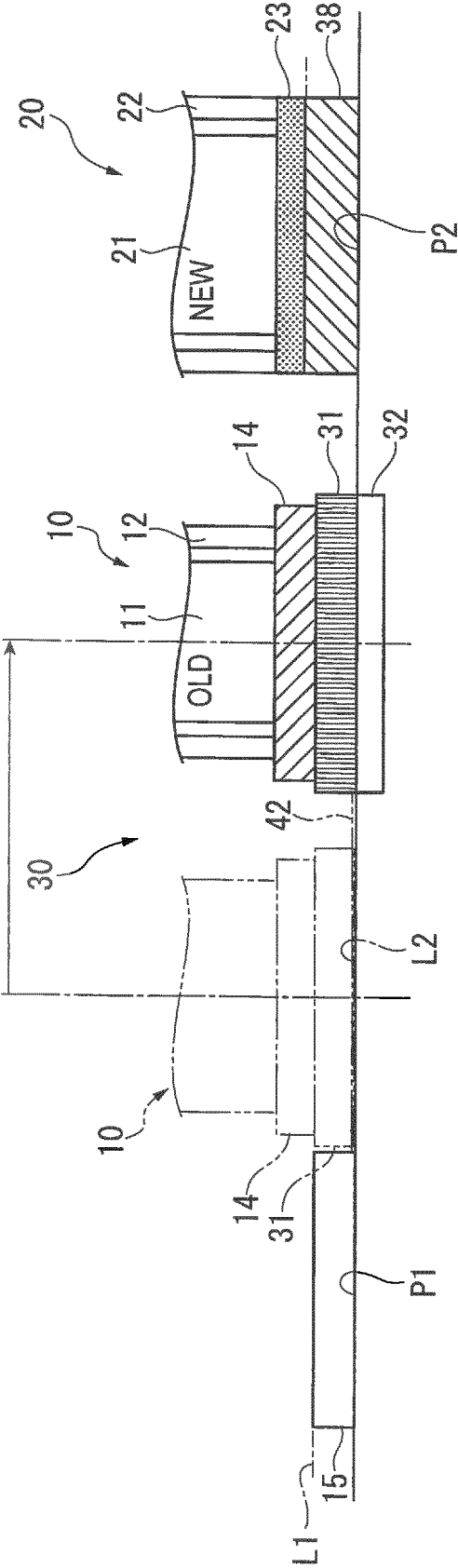


FIG.17



1. 8

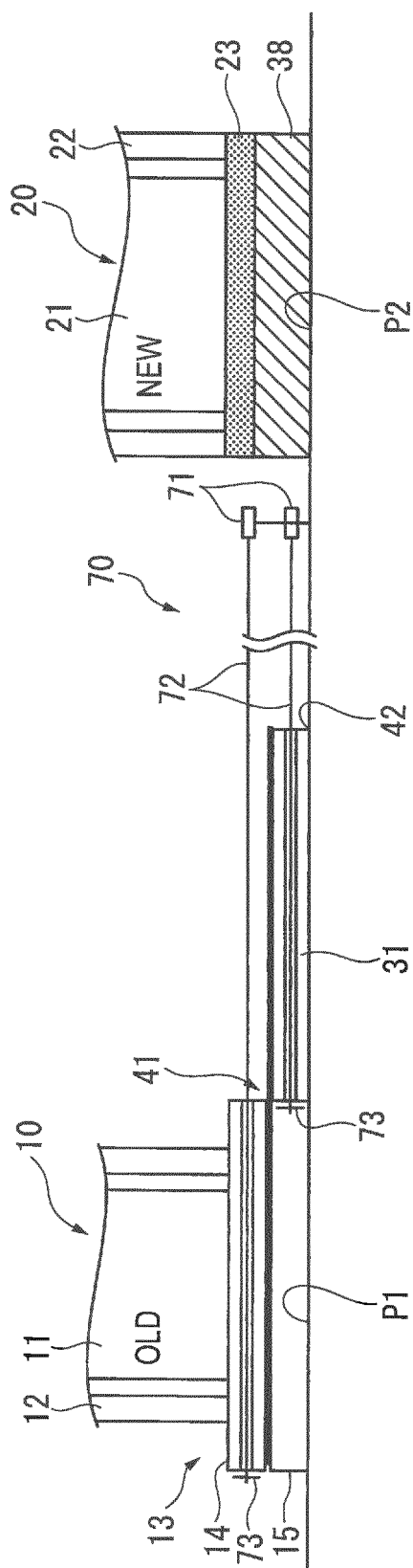


FIG. 19

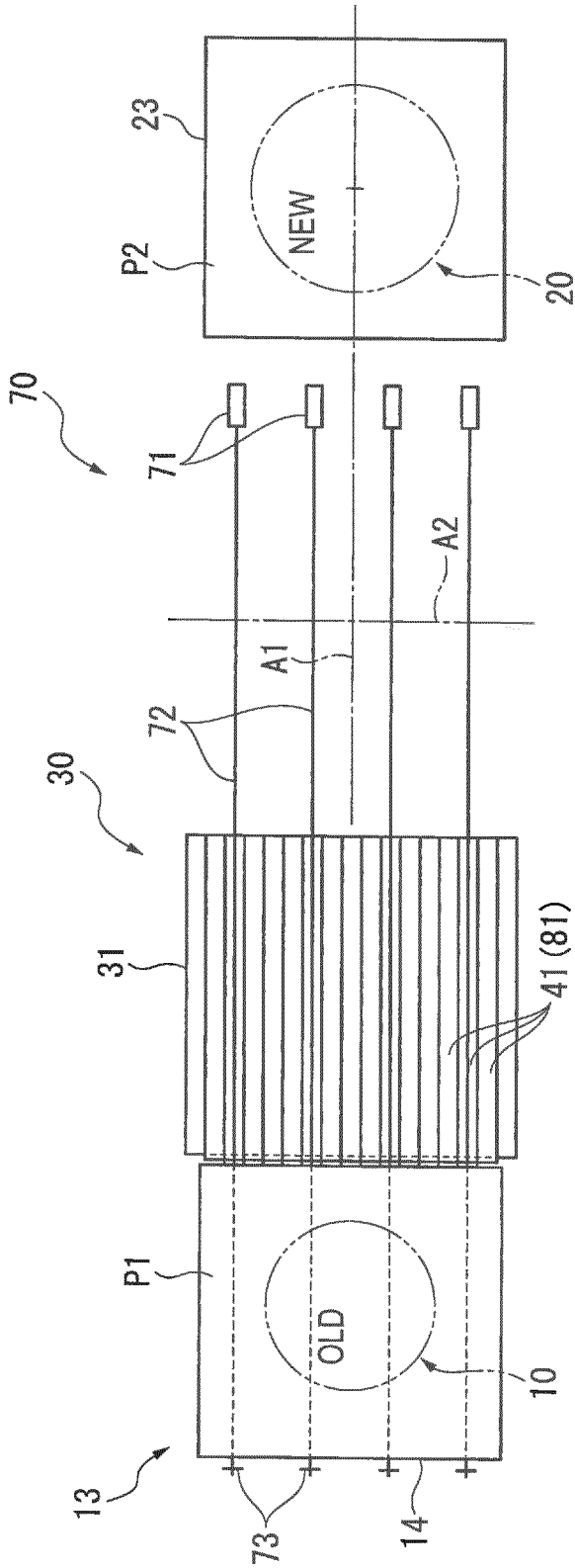


FIG. 20

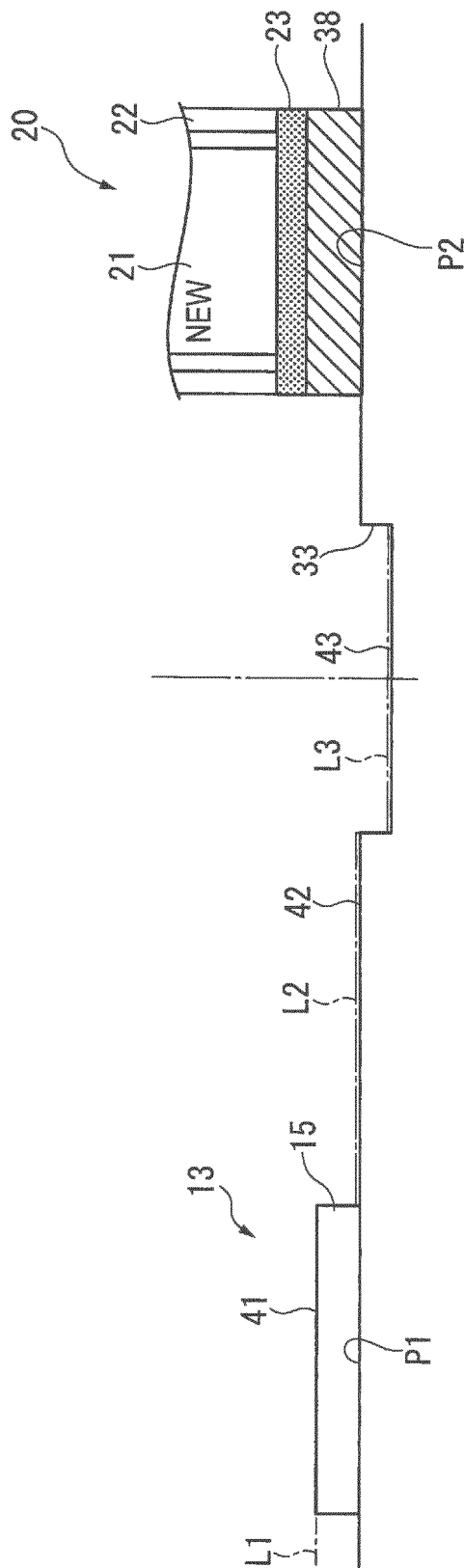
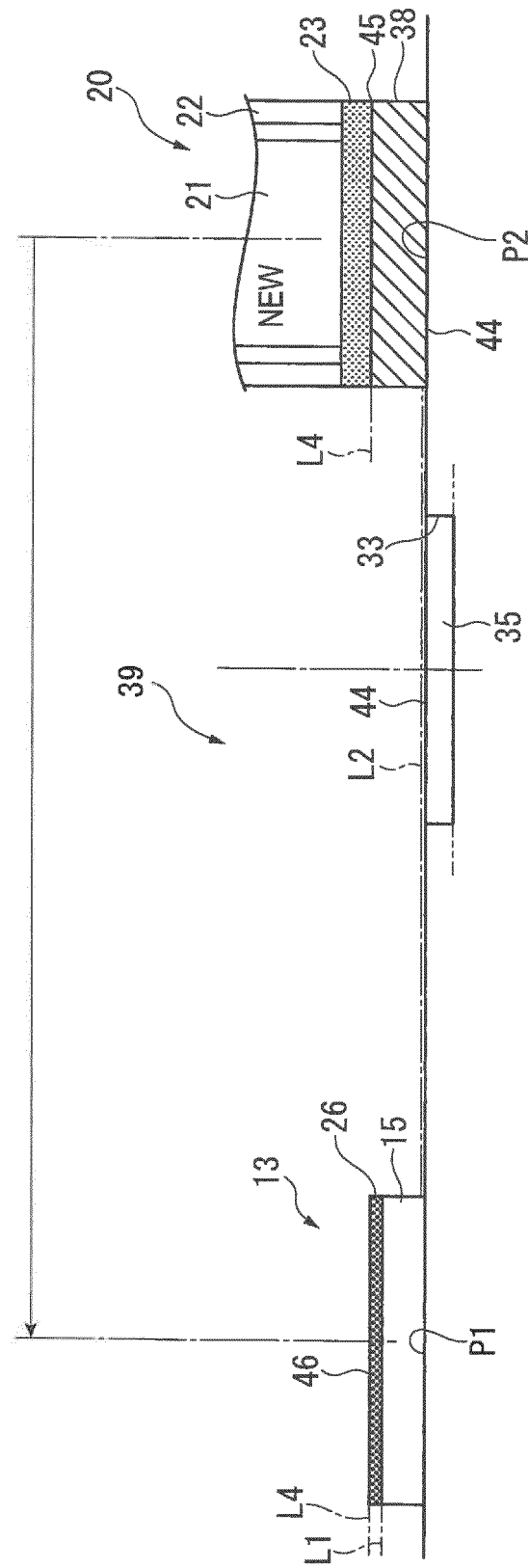


FIG. 21



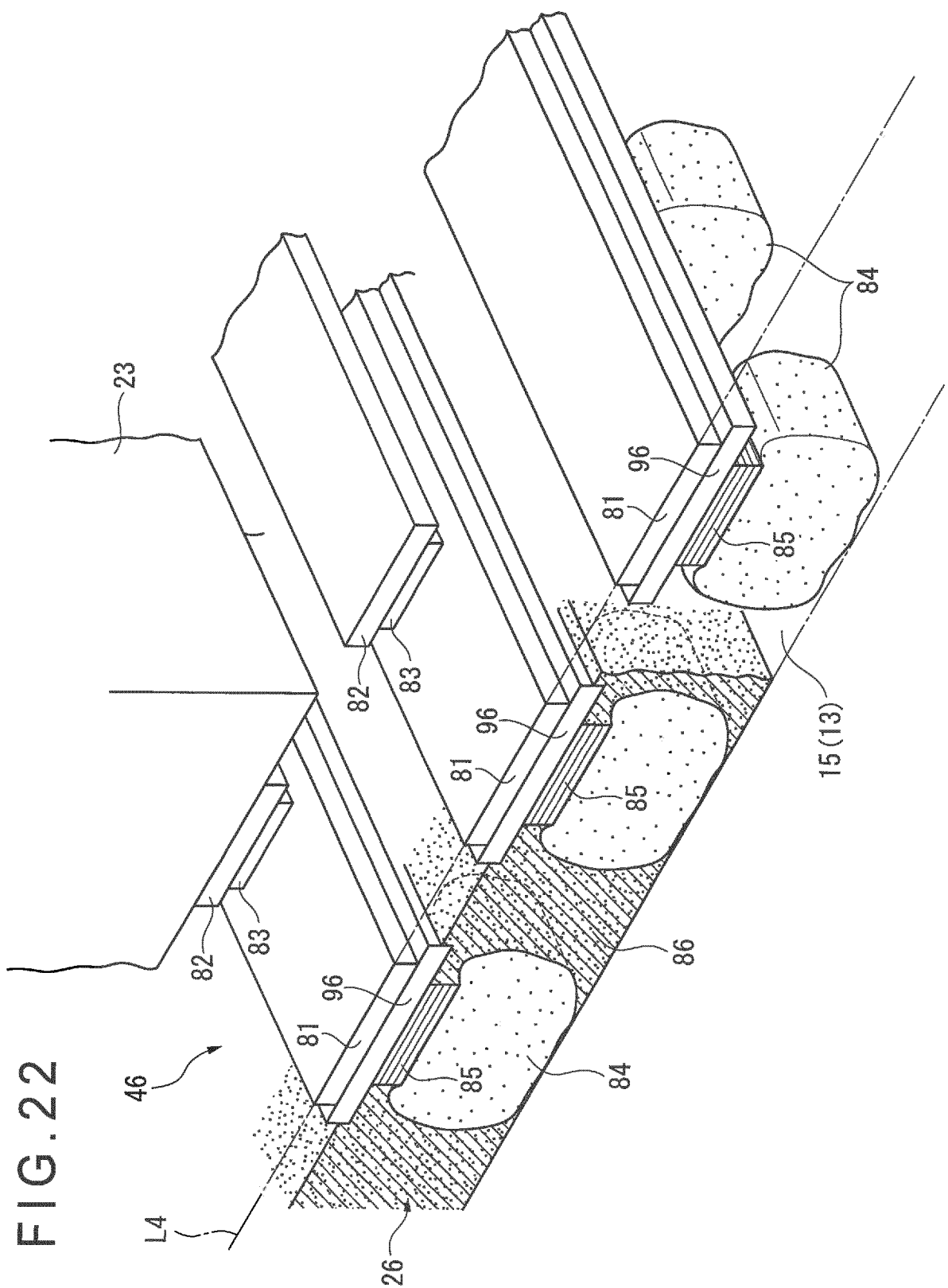


FIG. 23

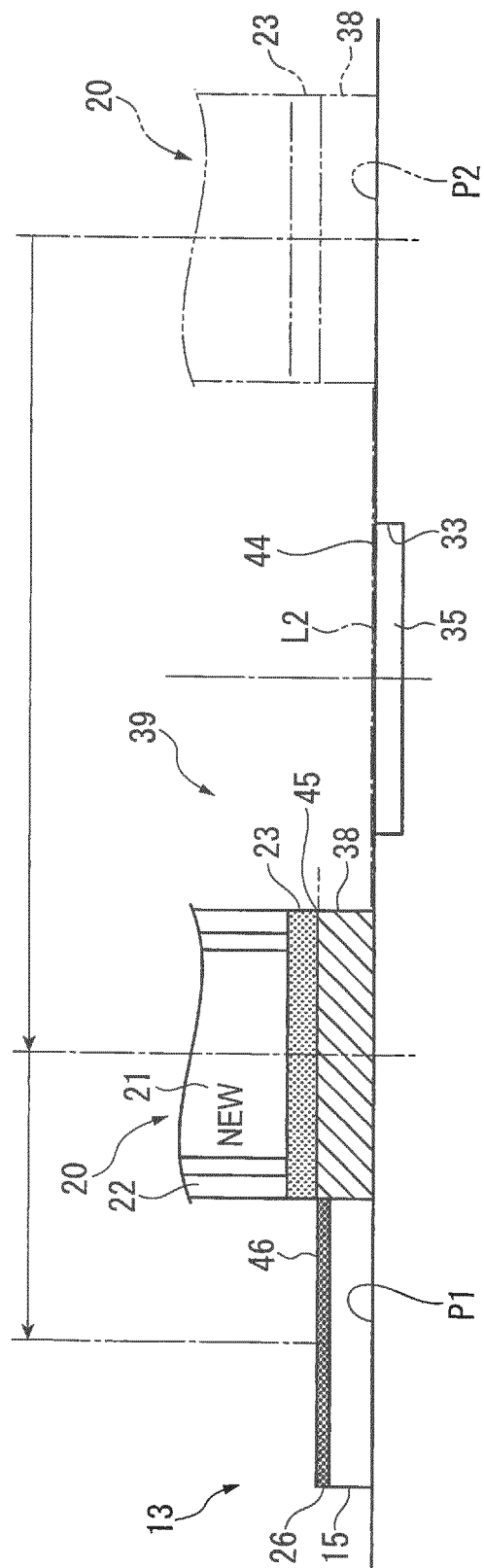


FIG. 24

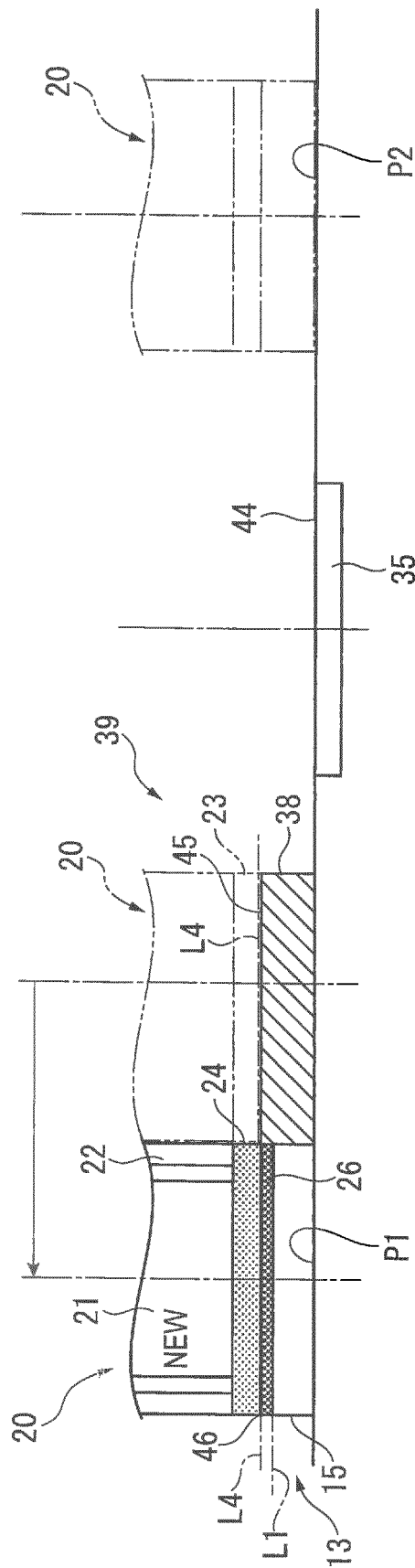


FIG. 25

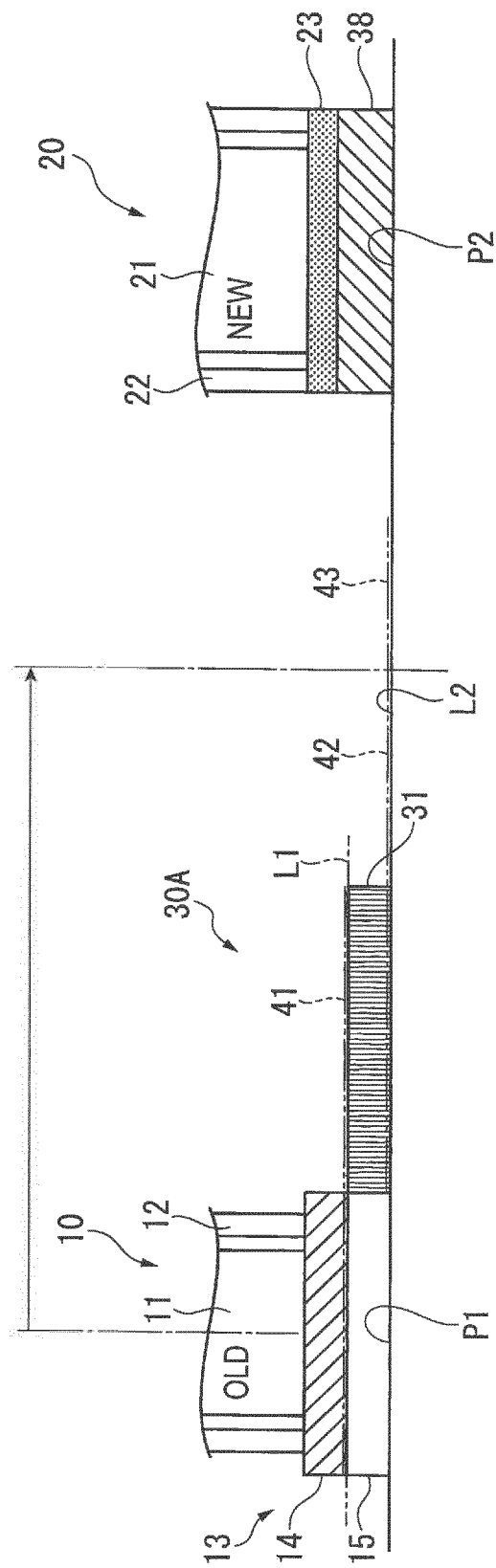


FIG. 26

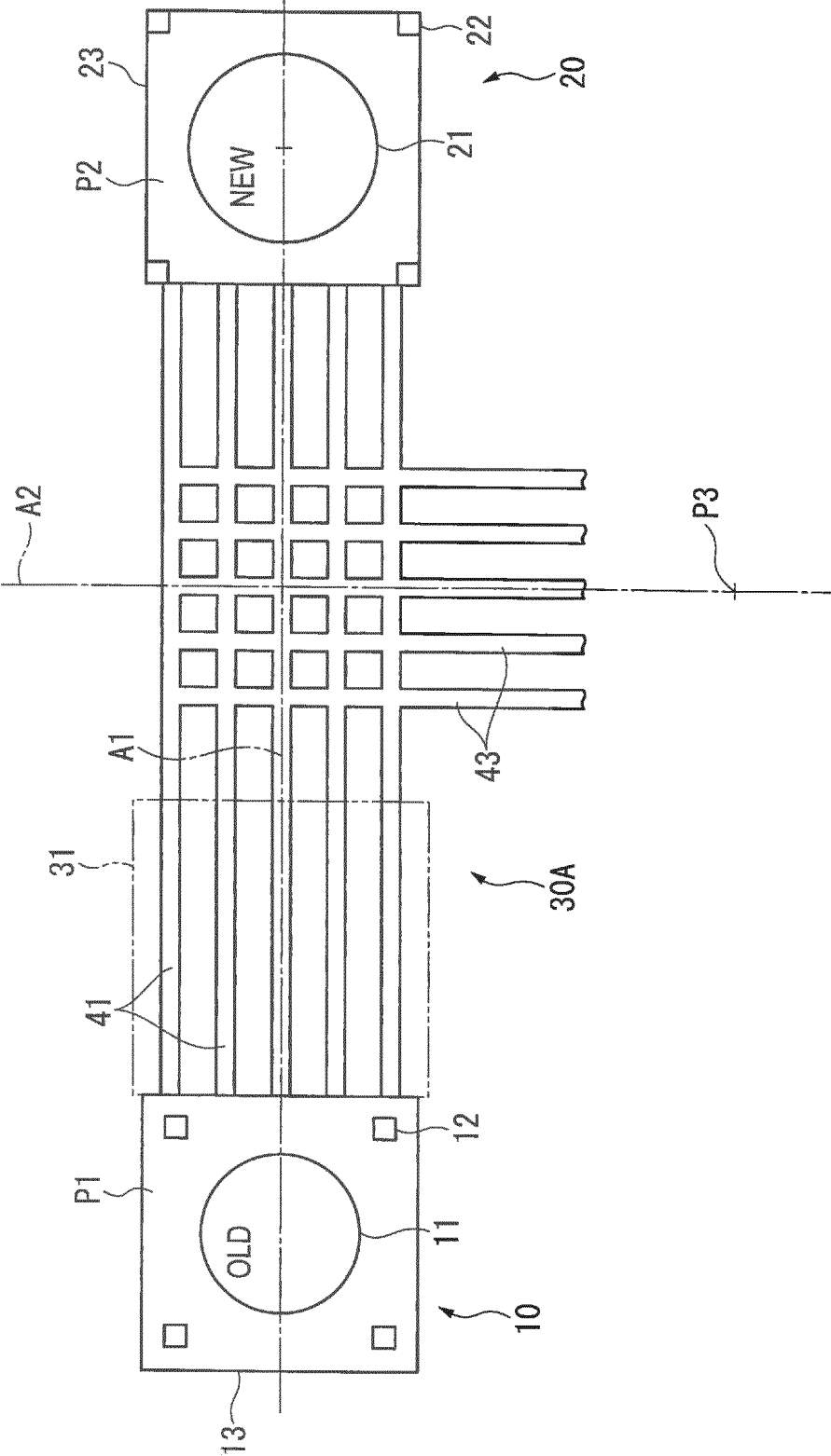


FIG. 28

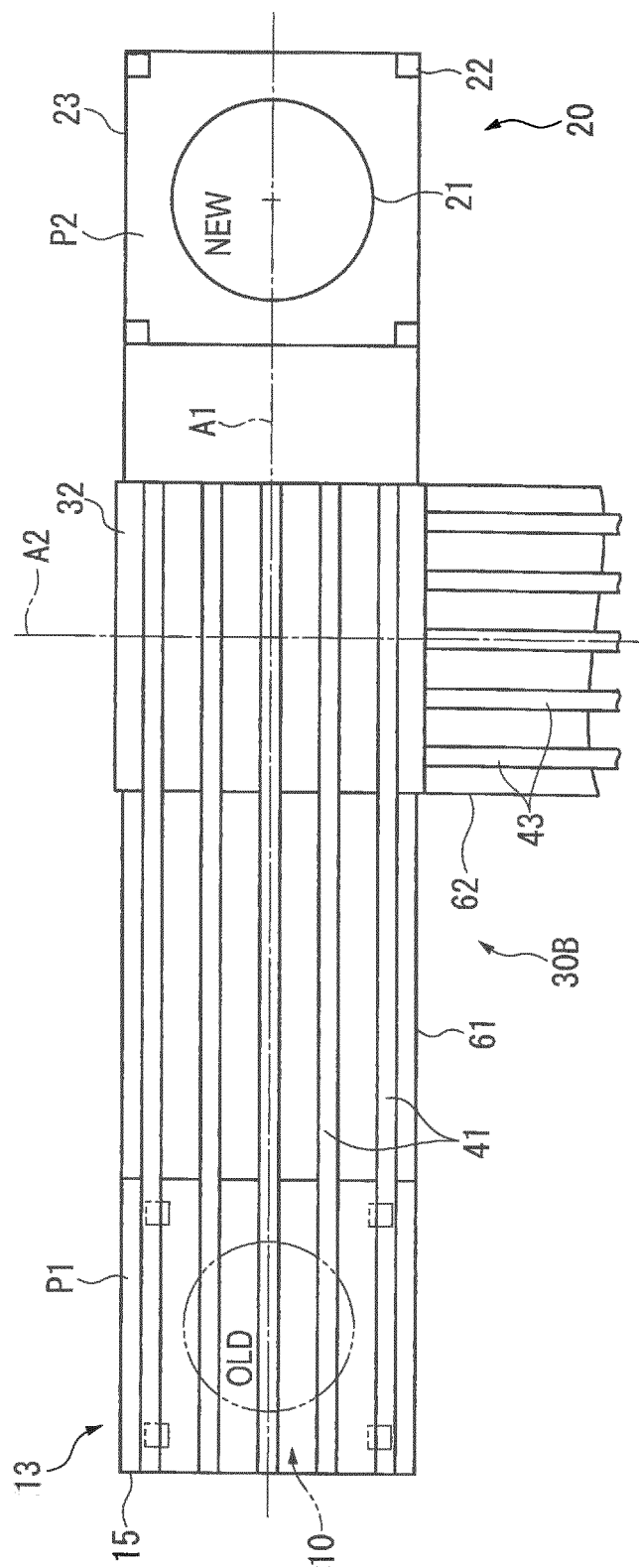
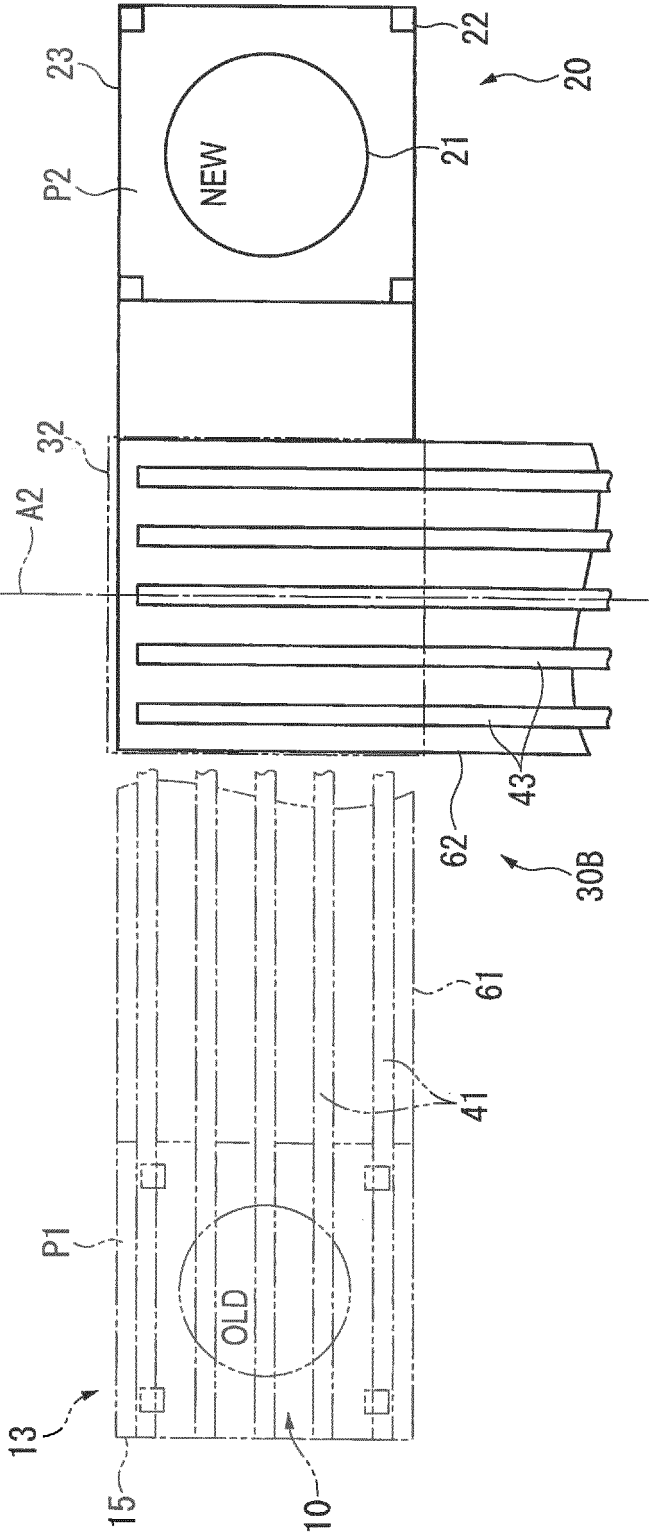


FIG. 29



FILE 30

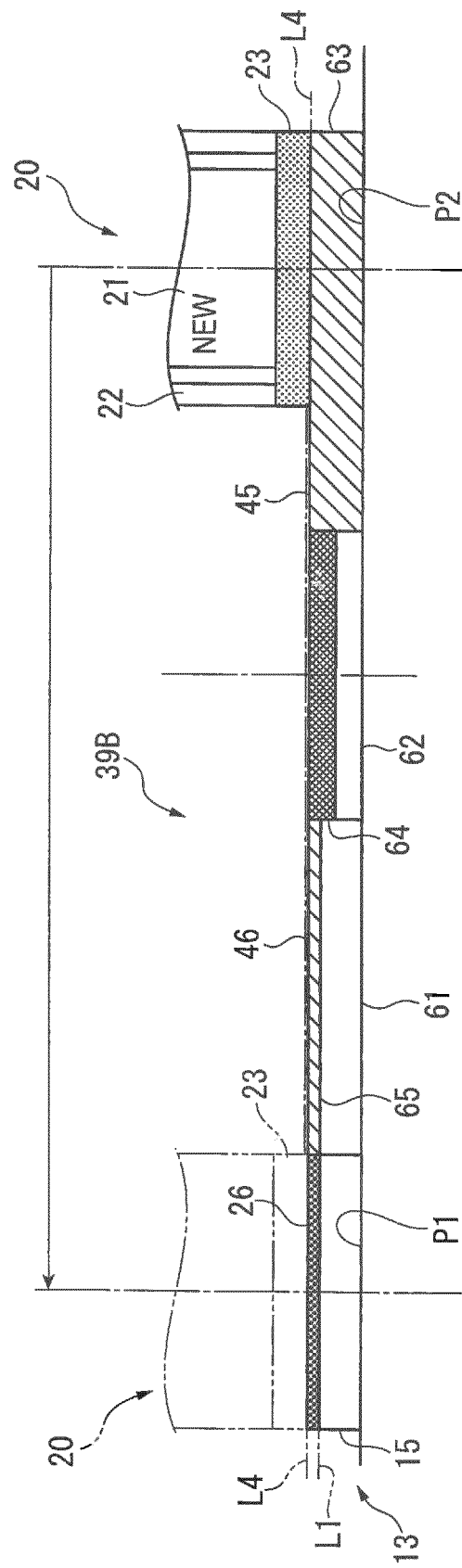


FIG. 31

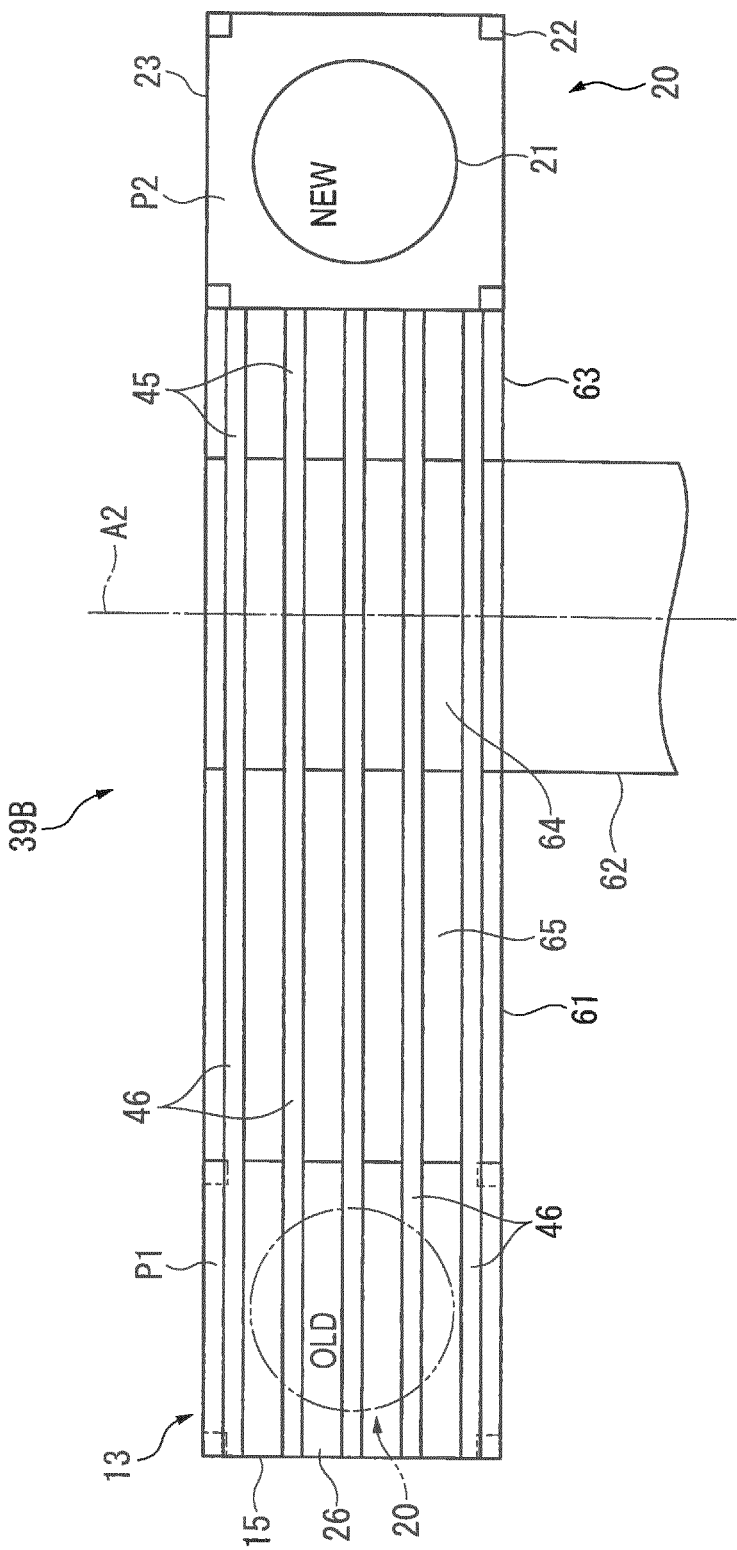
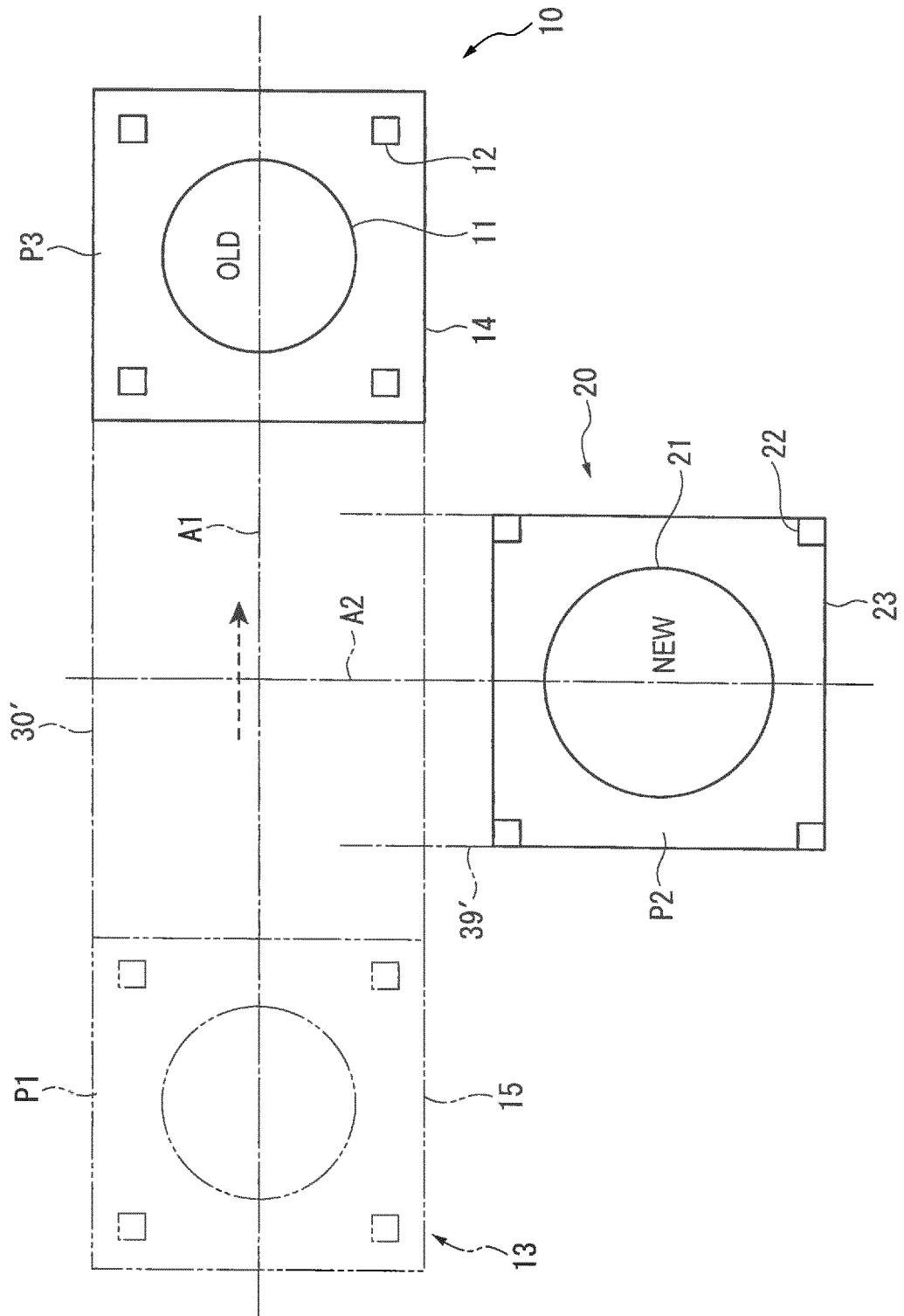


FIG. 32



F/G.3.3

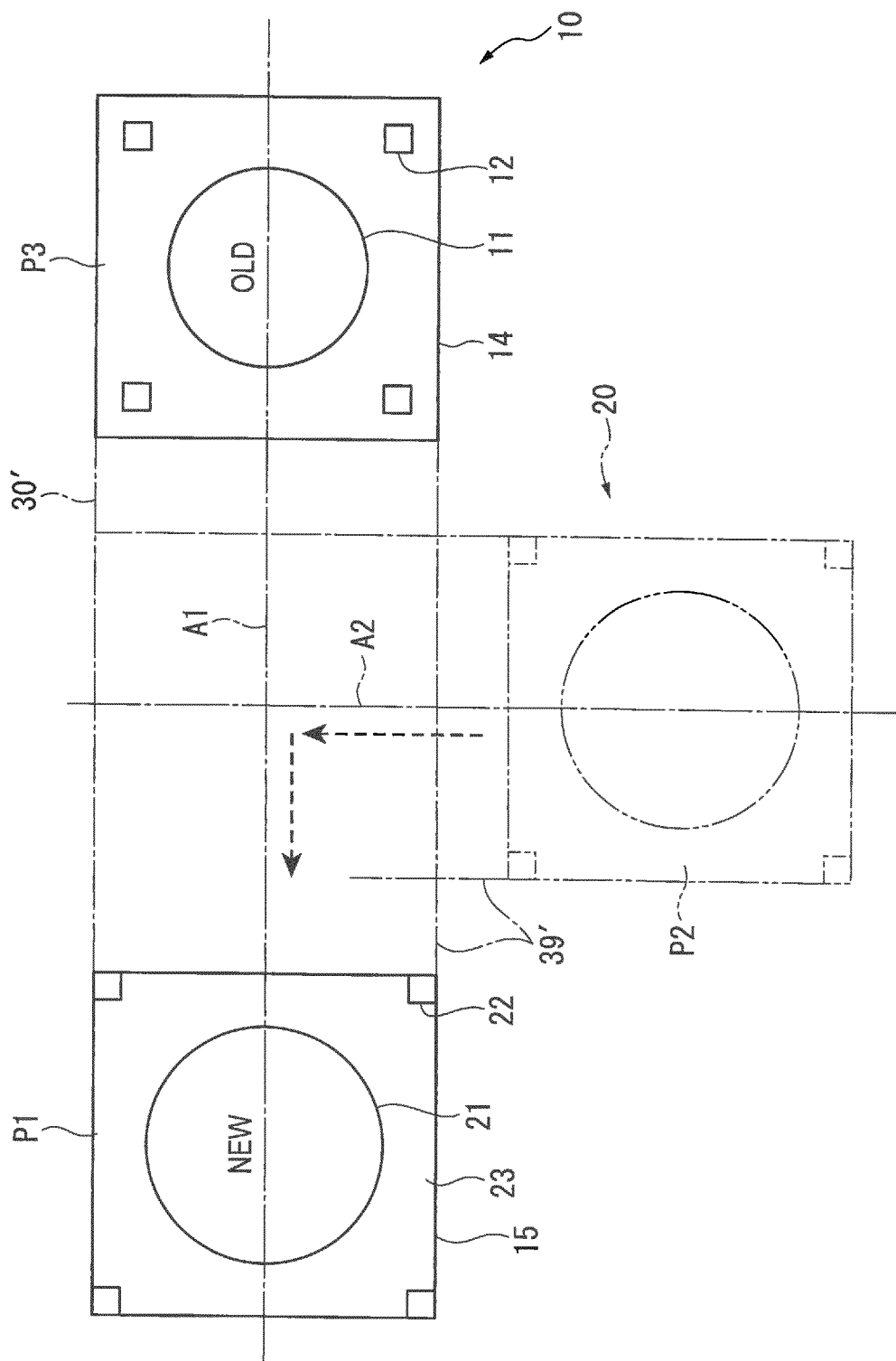


FIG. 34

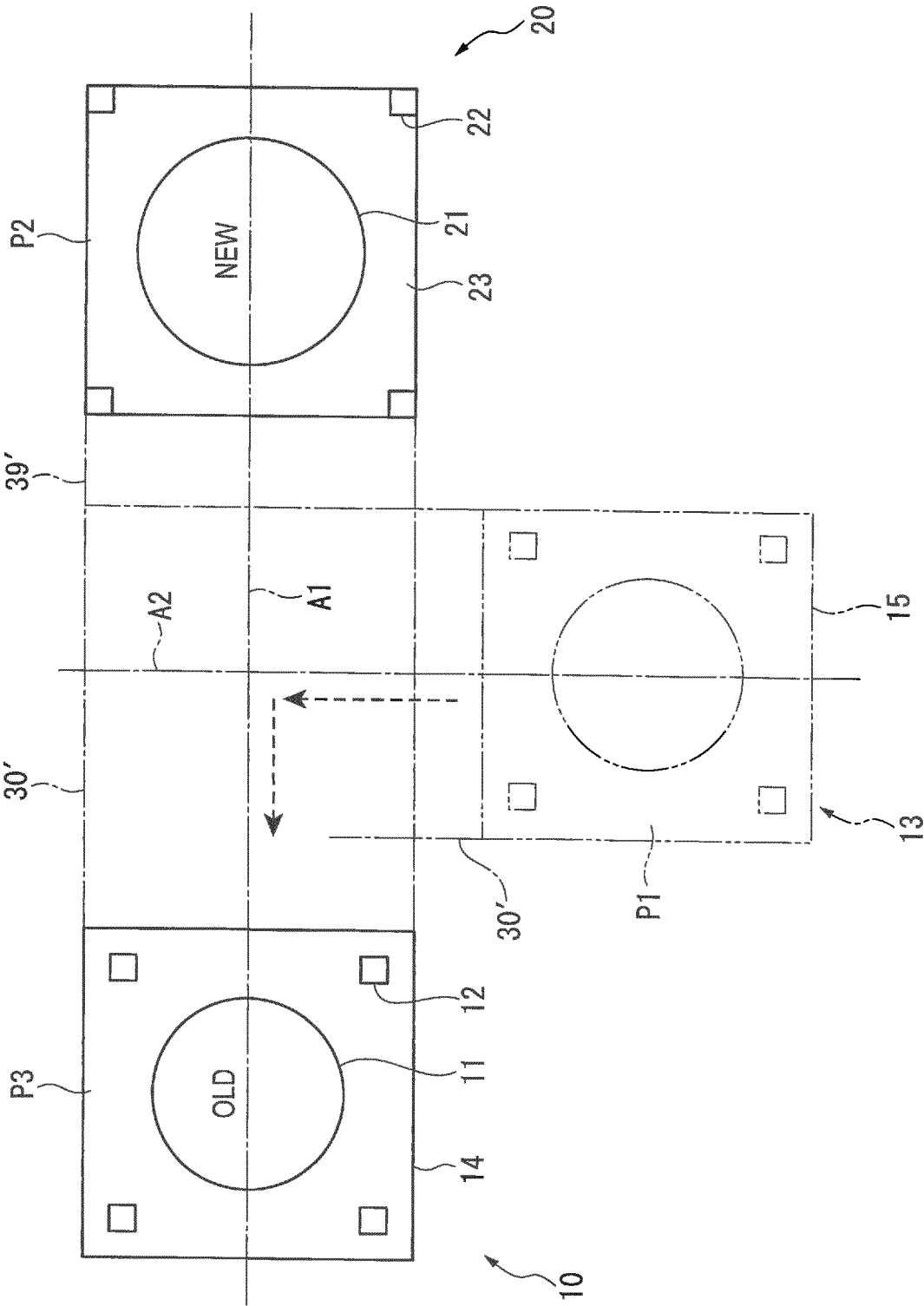


FIG. 35

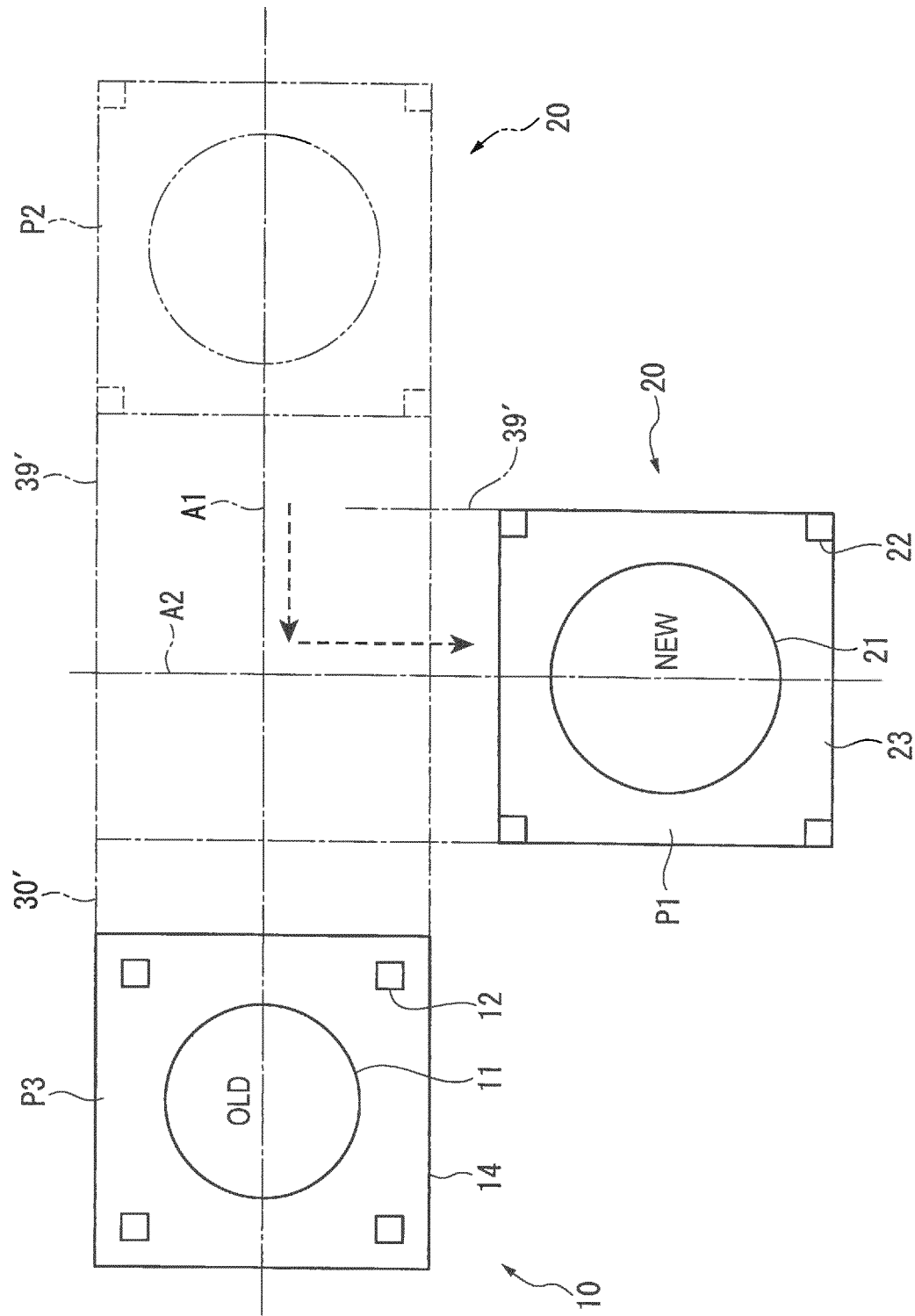


FIG. 36

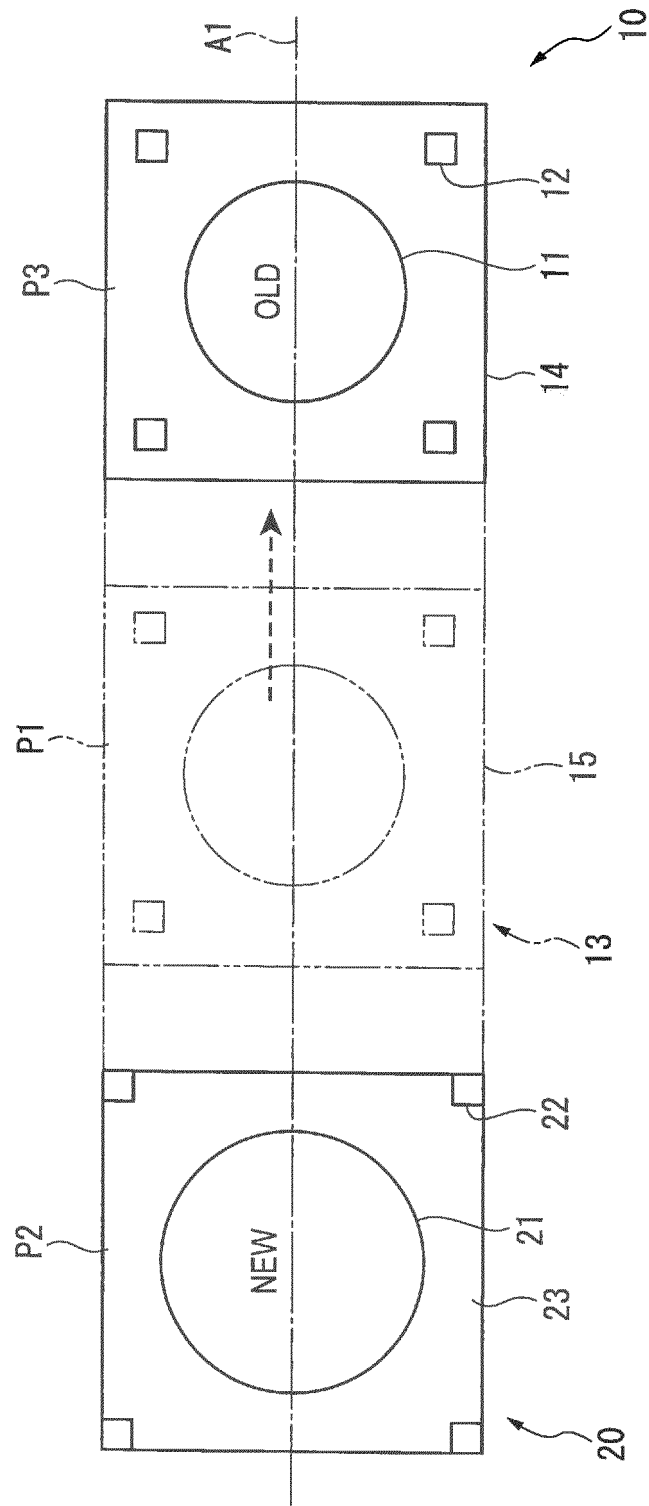


FIG. 37

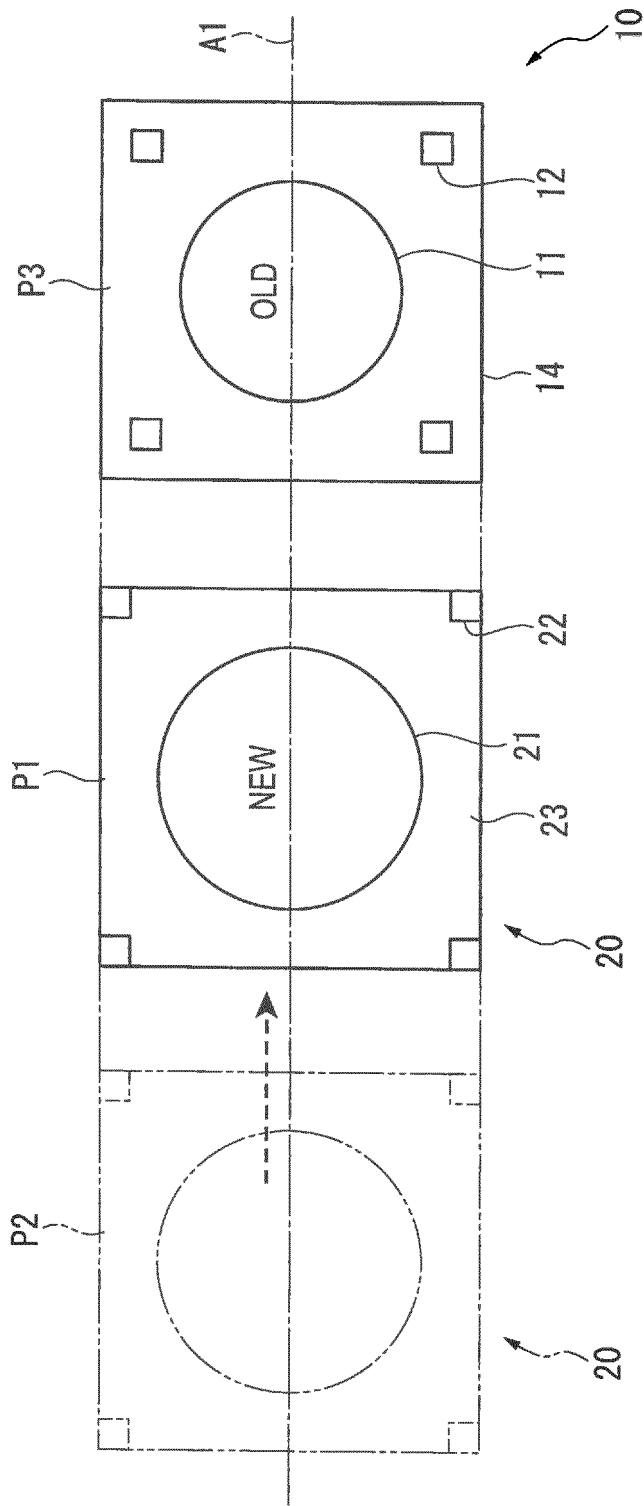
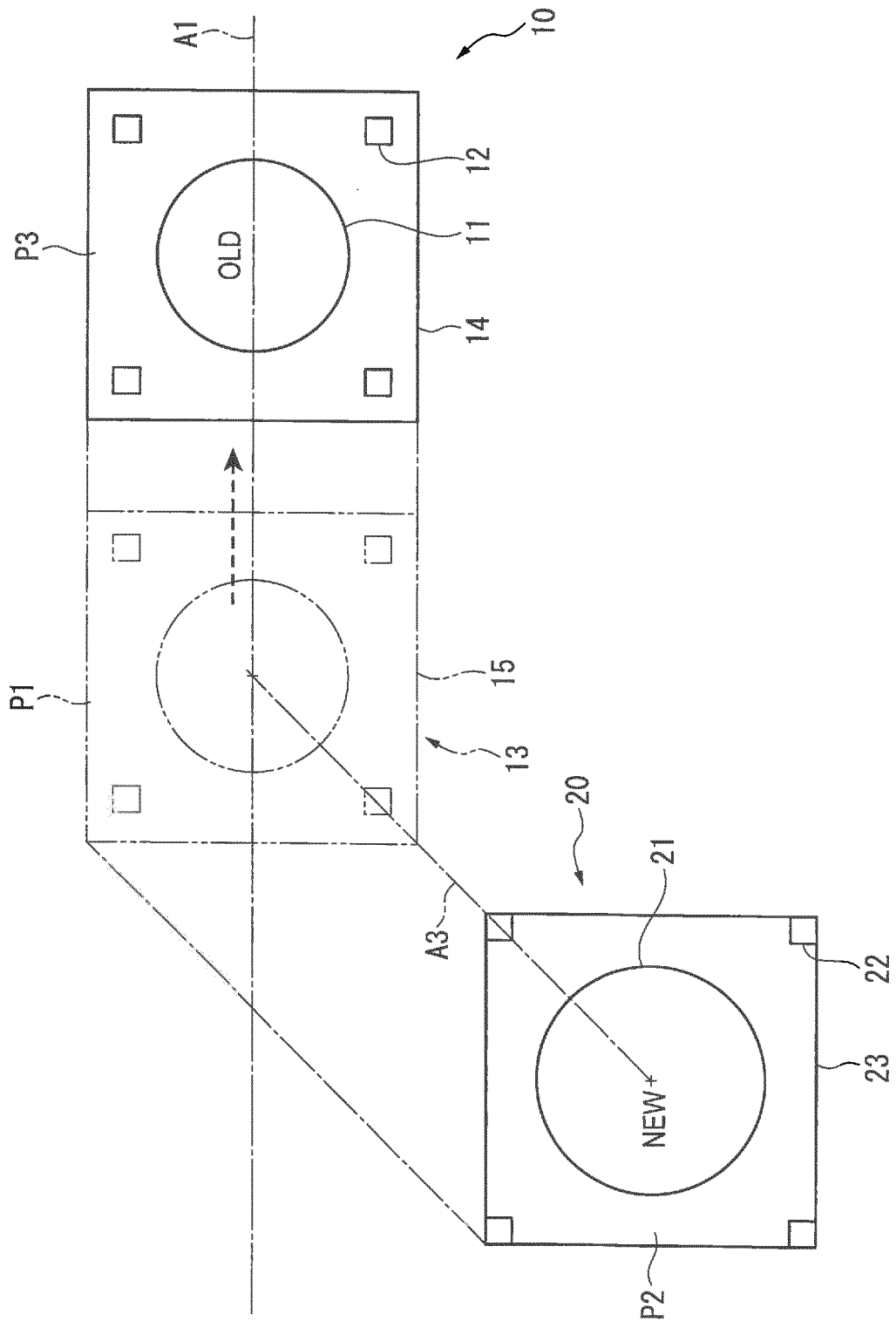


FIG. 38



93. GG. F

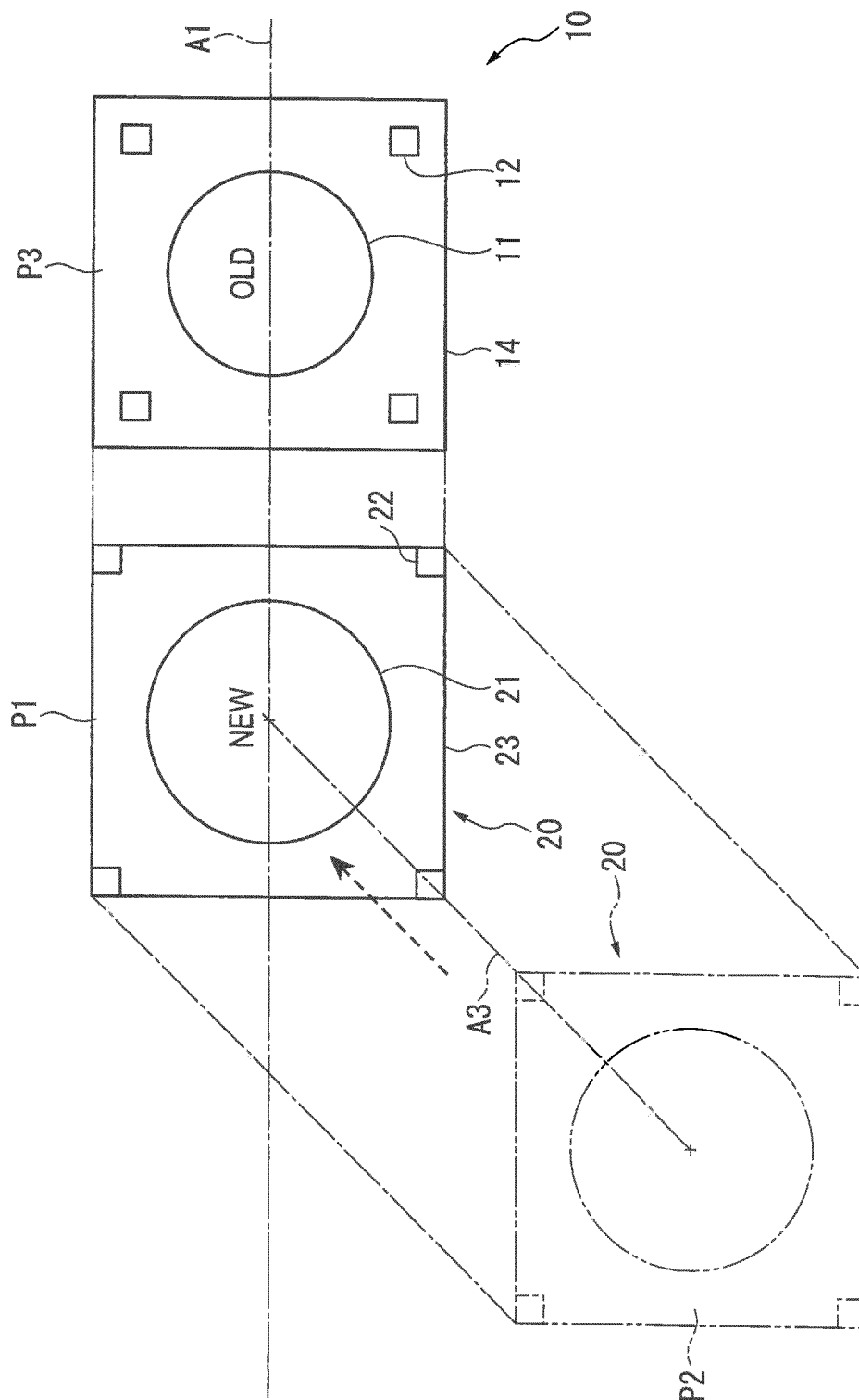
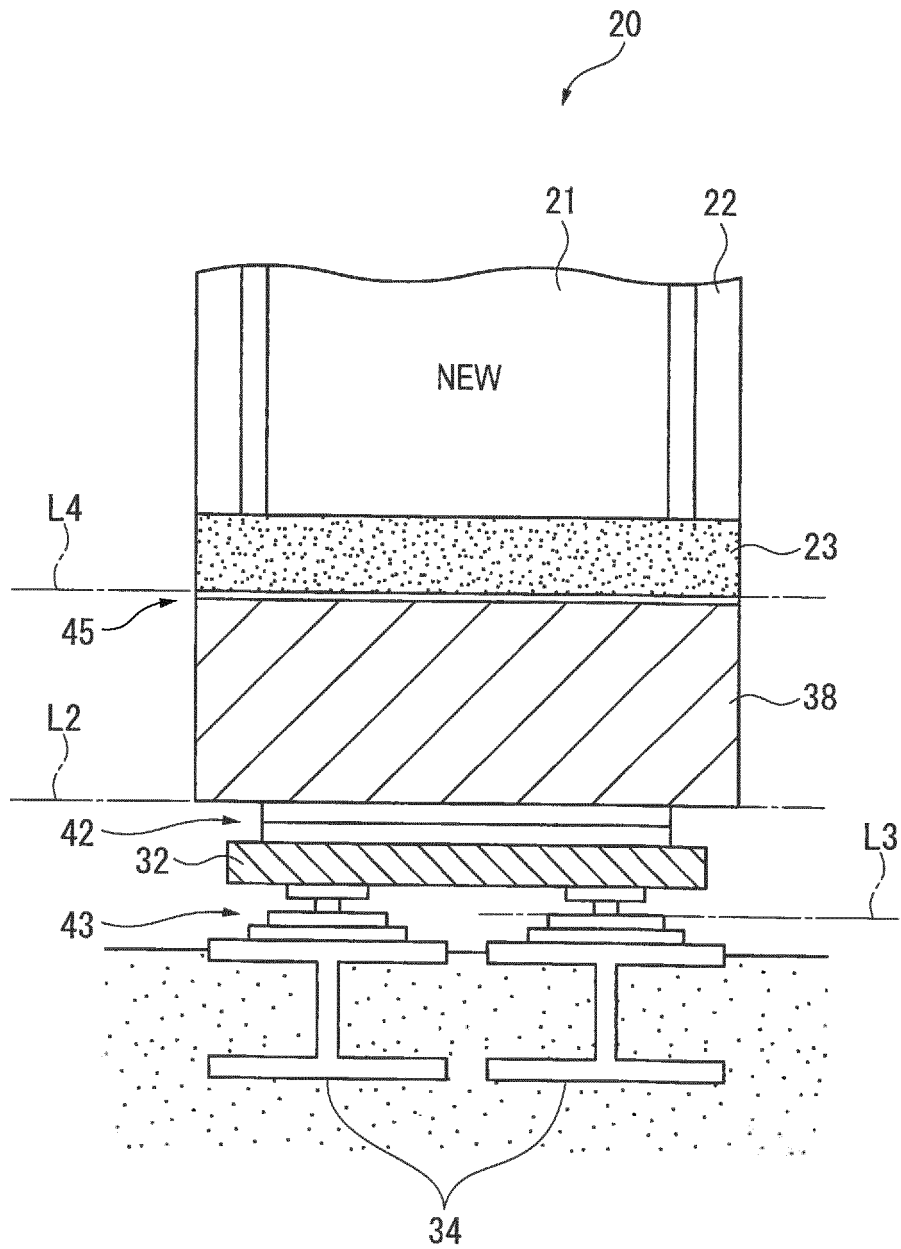


FIG. 40



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/069944

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

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	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

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 52-013406 A (Kawasaki Steel Corp.), 01 February 1977 (01.02.1977), entire text; all drawings (Family: none)	1-8
A	JP 52-043709 A (Sankyu Un'yu Kiko Kabushiki Kaisha), 06 April 1977 (06.04.1977), entire text; all drawings & US 4064616 A & GB 1518879 A & DE 2644260 A & FR 2326471 A & MX 144815 A & AU 1812176 A & BR 7606576 A & CA 1052080 A & IT 1073861 B	1-8



Further documents are listed in the continuation of Box C.



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Date of the actual completion of the international search

28 August, 2014 (28.08.14)

Date of mailing of the international search report

09 September, 2014 (09.09.14)

Name and mailing address of the ISA/
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Authorized officer

Facsimile No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/069944

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 58-106036 A (Sankyu Inc.), 24 June 1983 (24.06.1983), entire text; all drawings (Family: none)	1-8
A	JP 4351288 B2 (Nippon Steel Engineering Co., Ltd.), 28 October 2009 (28.10.2009), entire text; all drawings & WO 2009/020111 A1 & EP 2172569 A1 & KR 10-2009-0130417 A & CN 101688256 A & ES 2411130 T	1-8
A	JP 4351290 B2 (Nippon Steel Engineering Co., Ltd.), 28 October 2009 (28.10.2009), entire text; all drawings & WO 2009/054443 A1 & KR 10-2010-0083831 A & CN 101835910 A	1-8

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- JP 2006283183 A [0016]
- JP 4300249 B [0016]
- JP 52013406 A [0016]
- JP 58106036 A [0016]