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(54) AIR KNIFE SYSTEM HAVING FRONT AND REAR MOVING APPARATUS

(57) Proposed is an air knife system having a front and rear moving apparatus. The front and rear moving apparatus includes a front and rear guiding unit supporting the air knife module such that the air knife module is capable of being moved in front and rear directions with respect to the body, a front and rear driving unit configured to adjust a distance of the air knife with respect to the plated steel sheet by moving the air knife module, and interlock units connecting upper ends of gas transferring pipes to the body and rotating the gas transferring pipes with respect to centers of the gas supply pipes, thereby allowing a front and rear movement of the air knife module, the gas transferring pipes being rotatably and respectively connected to the gas supply pipes of the air knife module.

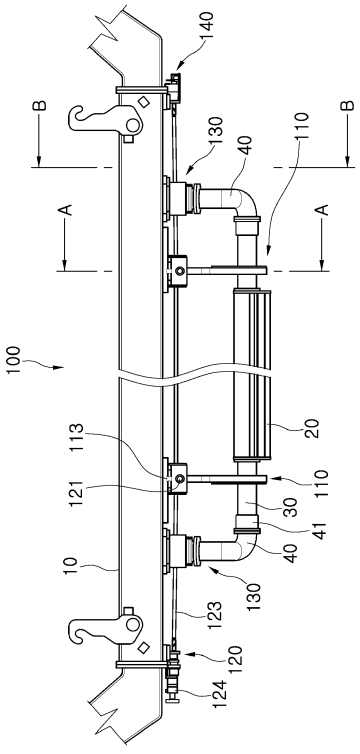


FIG. 1

EP 4 310 218 A1

Description

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority to Korean Patent Application No. 10-2022-0090547, filed July 21, 2022, the entire contents of which are incorporated herein for all purposes by this reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] An embodiment of the present disclosure relates to an air knife system including an air knife and an apparatus moving the air knife frontward and rearward.

Description of the Related Art

[0003] Generally, an air knife may control the plating amount (plating thickness) of a zinc plated steel sheet by jetting gas at a high pressure to a surface (a front surface or a rear surface) of the zinc plated steel sheet.

[0004] In a conventional technology, a positioner which has a large volume and which requires a large mounting space is required to be used for moving the air knife in front and rear directions, so that the conventional technology is disadvantageous in terms of efficiency. Particularly, since pipes connected to the air knife so as to supply gas such as air and so on interfere with each other, the air knife cannot be moved in the front and rear directions without changing a position of the air knife. Furthermore, there is a problem that the air knife cannot be rapidly moved in the front and rear directions according to a size of zinc plated steel sheet, working conditions, and so on.

[0005] Meanwhile, since a front and rear movement position of the air knife cannot be accurately measured and cannot be checked, there is a problem that production efficiency is lowered.

Document of Related Art

[0006] As related patent documents, KR 20-1992-0012105 U (1992.07.25), KR 20-0202429 Y1 (2000.11.15), JP 2001-131724 A (2001.05.15), KR 10-2003-0017111 A (2003.03.03), KR 20-0382147 Y1 (2005.04.18), KR 10-2012-0032283 A (2012.04.05), KR 10-2013-0044970 A (2013.05.03), KR 10-1746549 B1 (2017.06.14), and KR 10-1866313 B1 (2018.06.14) may be referred to.

SUMMARY OF THE INVENTION

[0007] Accordingly, the present disclosure has been made keeping in mind the above problems occurring in the related art, and an objective of an embodiment of the present disclosure is to smoothly move an air knife in front and rear directions without changing a position of the air knife.

[0008] In addition, another objective of an embodiment of the present disclosure is to accurately measure a front and rear movement distance of the air knife.

[0009] The technical problems to be solved by the present disclosure are not limited to the above-mentioned problems and other problems which are not mentioned will be clearly understood by those skilled in the art from the following description.

[0010] According to an embodiment of the present disclosure, there is provided an air knife system including: an air knife module having an air knife jetting gas to a plated steel sheet, the air knife module having gas supply pipes that respectively protrude in left and right directions from corresponding positions of both side surfaces of the air knife; a body mounted above the air knife module, the body having an inner portion provided with a flow path for transferring the gas; gas transferring pipes configured to transfer the gas from the flow path to the gas supply pipes, the gas transferring pipes having lower ends coupled to ends of the gas supply pipes through connection pipes such that the gas transferring pipes are capable of being rotated with respect to a pipe center of the gas supply pipes, respectively; a front and rear guiding unit supporting the air knife module such that the air knife module is capable of being moved in front and rear directions with respect to the body; a front and rear driving unit configured to adjust a distance of the air knife with respect to the plated steel sheet by moving the air knife module; and interlock units connecting upper ends of the gas transferring pipes to the body and rotating the gas transferring pipes with respect to the pipe center according to a front and rear movement of the air knife module, thereby allowing the front and rear movement of the air knife module.

[0011] The interlock units may respectively include: connection housings provided on the body, the connection housings having inner potions that are respectively in communication with the flow path through gas discharge ports of the body; supporting members respectively provided in the inner portions of the connection housings; rotating bodies respectively supported by the supporting members such that the rotating bodies are capable of being rotated around an axis of the left and the right directions; moving pipes having lower ends movably penetrating centers of the rotating bodies in a directions orthogonal to the axis of the left and right directions while the moving pipes are in state in which lower ends thereof are connected to the gas transferring pipes, respectively.

[0012] The front and rear guiding unit may include a plurality of front and rear guiding units. Each of the plurality of front and rear guiding units may include: a bracket having a lower end connected to the air knife module; a guide rail provided on the body along the front and rear directions; and a guide block provided on an upper end of the bracket, the guide block being capable of being

moved along each guide rail.

[0013] The front and rear driving unit may include: screw shafts provided to be capable of being rotated around an axis of the front and rear directions, the screw shafts having front side portions respectively screw coupled to each bracket; a power transmission shaft connected to rear ends of the screw shafts through gear boxes; and a driving motor configured to rotate the power transmission shaft.

[0014] The air knife system according to an embodiment of the present disclosure may further include a distance measurement unit configured to measure a front and rear movement distance of the air knife by detecting a rotation number of the power transmission shaft.

[0015] The technical solutions will be more specifically and clearly described with reference to the embodiments to be described below and the drawings. In addition to the above-mentioned technical solutions, various technical solutions will be additionally provided.

[0016] According to an embodiment of the present disclosure, since the air knife is moved in the front and rear directions while maintaining a horizontal state without changing a position of the air knife, a distance of the air knife with respect to a plated steel sheet is capable of being adjusted to a desired distance.

[0017] In addition, according to an embodiment of the present disclosure, a front and rear movement distance of the air knife may be more accurately measured, and a measured result may be provided. In addition, since the front and rear moving apparatus is capable of being easily applied, the front and rear moving apparatus is capable of being applied in an air knife system having various types.

[0018] The effects of the present disclosure are not limited to the above-mentioned effects, and other effects which are not mentioned above may be clearly understood by those skilled in the art from the present specification and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The above and other objectives, features, and other advantages of the present disclosure will be more clearly understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a front view illustrating an air knife system according to an embodiment of the present disclosure;

FIG. 2 is a cross-sectional view taken along line A-A in FIG. 1;

FIG. 3 is a cross-sectional view taken along line B-B in FIG. 1;

FIG. 4 is a partial cross-sectional view taken along line C-C in FIG. 3;

FIG. 5 is a plan view illustrating a distance measurement unit of the air knife system according to an embodiment of the present disclosure; and

FIGS. 6 and 7 are views illustrating an operation of a front and rear moving apparatus of the air knife system on the basis of FIGS. 2 and 3, the air knife system according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

[0020] Hereinafter, an embodiment of the present disclosure will be described with reference to the accompanying drawings.

[0021] A configuration, an operation, and so on of an air knife system according to an embodiment of the present disclosure is illustrated in FIGS. 1 to 7.

[0022] The air knife system 100 according to an embodiment of the present disclosure includes: an air knife module having an air knife 20 jetting gas (for example, air) to a plated steel sheet (not illustrated), the air knife module having gas supply pipes that respectively protrude in left and right directions from corresponding positions of both side surfaces of the air knife 20; a body 10 mounted above the air knife module (see reference numerals 20 and 30), the body 10 having an inner portion provided with a flow path 11 for transferring the gas; and gas transferring pipes 40 configured to transfer the gas from the flow path 11 to the gas supply pipes 30, the gas transferring pipes 40 having lower ends coupled to ends of the gas supply pipes 30 through connection pipes 41 such that the gas transferring pipes 40 are capable of being rotated with respect to a pipe center 25c of the gas supply pipes 30, respectively.

[0023] In addition, the air knife system 100 according to an embodiment of the present disclosure further includes: a front and rear guiding unit 110 supporting the air knife module such that the air knife module is capable of being moved in front and rear directions with respect to the body 10; a front and rear driving unit 120 configured to adjust a distance of the air knife 20 with respect to a surface (a front surface or a rear surface) of the plated steel sheet by moving the air knife module; and interlock units 130 connecting upper ends of the gas transferring pipes 40 to the body 10 and inducing a rotation movement with respect to the pipe center 25c according to a front and rear movement of the air knife module to the connected gas transferring pipes 40, thereby allowing a front and rear movement of the air knife module. Here, the front and rear guiding unit 110, the front and rear driving unit 120, and the interlock units 130 constitute a front and rear moving apparatus that moves the air knife module with respect to the surface of the plated steel sheet.

[0024] In a hot-dip plating process, the air knife 20 may be positioned at a rear end of a plating bath (not illustrated). When a steel sheet (not illustrated) is deposited in molten metal (for example, zinc (Zn) and so on) in the plating bath, the steel sheet may become the plated steel sheet on which the molten metal is attached to a surface thereof. The air knife 20 may adjust the amount of molten

metal (the plating amount) attached to the plated steel sheet by jetting the gas at a high pressure to the plated steel sheet that has passed through the plating bath.

[0025] The gas supply pipes 30 may have rectilinear shapes, and may be respectively coupled to the both side surfaces of the air knife 20 and may be moved in the front and rear directions together with the air knife 20. The gas supply pipes 30 at the both sides coincide with each other when the gas supply pipes 30 are viewed from a side direction thereof.

[0026] The flow path 11 may be connected to a high pressure gas providing source (not illustrated) that provides the gas. The body 10 may include a frame having a duct structure providing the flow path 11. A position of the frame having the duct structure may be fixed by a mounting frame (not illustrated).

[0027] The gas is introduced into the air knife 20 by passing through the gas transferring pipes 40 and the gas supply pipes 30 from the flow path 11, and is capable of being discharged to the plated steel sheet through the air knife 20.

[0028] At least one of the front and rear guiding unit 110 may be provided. The front and rear guiding unit 110 may be provided to support the gas supply pipes 30 at both sides thereof such that the gas supply pipes 30 at both sides thereof are capable of being moved in the front and rear directions with respect to the body 10.

[0029] Referring to FIGS. 2 and 4, the front and rear guiding unit 110 includes: a bracket 110 having a lower end connected to the air knife module; a guide rail 113 provided on the body 10 along the front and rear directions; and a guide block 112 provided on an upper end of the bracket 111 and coupled to the guide rail 113 such that the guide block 112 is capable of being moved in the front and rear directions along the guide rail 113.

[0030] The front and rear driving unit 120 may move the air knife module in the front and rear directions by moving the bracket 111. Otherwise, the front and rear driving unit 120 may move the air knife module in the front and rear directions by moving the guide block 112 instead of the bracket 111.

[0031] Referring to FIGS. 1, 2, and 4, the front and rear driving unit 120 includes: a screw shaft 121 provided to be capable of being rotated around an axis A1 of the front and rear directions, the screw shaft 121 having an outer circumference provided with an external thread, and having a front side portion thereof screw coupled to the bracket 111; and a driving motor 124 configured to provide a driving force for rotating the screw shaft 121 in frontward and rearward. When the driving motor 124 is operated, the screw shaft 121 is rotated, and the bracket 111 is moved frontward or rearward according to a rotation direction of the screw shaft 121, so that the air knife module is moved in the same direction together with the bracket 111.

[0032] When the front and rear guiding unit 110 is provided to support the gas supply pipes 30 such that the gas supply pipes 30 are capable of being moved in the front and rear directions with respect to the body 10, the screw shafts 121 may be provided to be respectively screw coupled to each bracket 111. In addition, the front and rear driving unit 120 may further include: gear boxes 122 respectively connected to rear sides of the screw shafts 121; and power transmission shafts 123 respectively connected to the gear boxes 122. In addition, the driving motor 124 may be provided to rotate the power transmission shaft 123. For example, the gear box 122 may be a spiral bevel gear box in an orthogonal shaft type or a miter gear box. Accordingly, when the front and rear guiding unit 110 is provided to support the gas supply pipes 30 such that the gas supply pipes 30 are capable of being moved in the front and rear directions with respect to the body 10, the brackets 111 are simultaneously moved in the front and rear directions by a single driving motor 124. For reference, according to a positional relationship between the gear boxes 122 and the driving motor 124, the power transmission shaft 123 may include a universal joint.

[0033] Meanwhile, as the driving motor 124, a double shaft type driving motor may be applied. In addition, the power transmission shaft 123 is connected to any one shaft of the driving motor 124, and a handle for performing a manual operation may be connected to the other shaft of the driving motor 124. Therefore, if necessary, the air knife module may be moved in the front and rear directions manually by using the handle such that the power transmission shaft 123 is rotated.

[0034] In the air knife system 100 according to an embodiment of the present disclosure, when the air knife module (see reference numerals 20 and 30) is moved in the front and rear directions by the front and rear driving unit 120, the gas transferring pipes 40 are performing a rotation movement with respect to the pipe center 25c by the interlock units 130. Therefore, the air knife module may be spaced apart from or approached to the plated steel sheet by smoothly and accurately moving the air knife module in the front and rear directions by a guidance of the front and rear guiding unit 110. In addition, when the air knife module (see reference numerals 20 and 30) is moved in the front and rear directions by the front and rear driving unit 120, the upper ends of the gas transferring pipes 40 performing the rotation movement with respect to the pipe center 25c may be connected to the body 10 by the interlock units 130.

[0035] Referring to FIG. 4, the interlock units 130 include: connection housings 131 provided on the body 10 so as to be respectively in communication with gas discharge ports 12 provided at a lower portion of the body 10; supporting members 132 provided in a state in which the supporting members 132 are respectively fixed to inner portions of the connections housings 131, the inner portions being respectively and spatially connected to the flow path 11 through the gas discharge ports 12; rotating bodies 133 respectively supported by the supporting members 132 such that the rotating bodies 133 are capable of being rotated around an axis A2 of the left and

the right directions; and moving pipes 134 having lower ends respectively connected to the gas transferring pipes 40 and respectively and movably penetrating centers of the rotating bodies 133 in a directions orthogonal to the axis of the left and right directions. Of course, the gas may be introduced into the gas transferring pipes 40 by passing through gas discharge ports 12 from the flow path 11 and passing through the inner portions of the connection housings 131 and the moving pipes 134.

[0036] The rotating bodies 133 may have a circumference formed in a spherical surface shape. For example, the rotating bodies 133 may be provided in ball shapes or shapes similar to balls. The supporting members 132 may be formed such that spherical surfaces respectively surrounding the spherical surfaces of the rotating bodies 133. Accordingly, the rotating bodies 133 may be rotated around the axis A2 in the left and right directions (in other words, centers of the supporting members 132), and room for the rotating bodies 133 to be slightly rotated in other directions with respect to the centers of the supporting members 132 may be provided so as to perform a smooth front and rear movement operation of the air knife module.

[0037] When a moving force in the front and rear directions is applied to the air knife module (see reference numerals 20 and 30) by the front and rear driving unit 120, the gas transferring pipes 40 are rotated frontward or rearward together with the connection pipes 41 with respect to the pipe center 25c, and the moving pipes 134 connected to the gas transferring pipes 40 are also rotated together in the same directions. Accordingly, as the rotating bodies 133 are rotated in the same direction together with the moving pipes 134 around the axis A2 (centers of the supporting members 132) of the left and right directions, the moving pipes 134 are relatively moved upward or downward, thereby allowing the movement of the air knife module in the front and rear directions. At this time, the upper ends of the gas transferring pipes 40 remain connected to the body 10, and the air knife module is accurately moved frontward or rearward without changing a position of the air knife module. That is, in the air knife system 100 according to an embodiment of the present disclosure, when the air knife module is moved in the front and rear directions, angles of the gas transferring pipes 40 are changed according to the front and rear movement of the air knife module and vertical positions of the gas transferring pipes 40 are changed, so that the air knife module may be accurately moved frontward and rearward without changing the position of the air knife module.

[0038] Referring to FIG. 4, one sides of the connection pipes 41 are respectively fitted and coupled to the gas supply pipes 30 such that the connection pipes 41 are capable of being rotated, so that the connection pipes 41 are capable of being rotated with respect to the pipe center 25c. The gas transferring pipes 40 are pipes having elbow structures, and have lower ends thereof respectively coupled to the one sides of the connection pipes 41, so that the gas transferring pipes 40 are capable of being rotated together with the connection pipes 41 with respect to the pipe center 25c. Sealing members for securing airtightness may be respectively interposed between the gas supply pipes 30 and the connection pipes 41 that are coupled to each other.

[0039] Positions between the gas transferring pipes 40 and the connection housings 131 are surrounded by stretchable pipes 135, so that the gas introduced into the connection housings 131 from the gas transferring pipes 40 may be prevented from being discharged to the outside or foreign substances are prevented from being introduced from the outside. For example, the stretchable pipes 135 may be bellows.

[0040] Referring to FIG. 1, the air knife system 100 according to an embodiment of the present disclosure may further include a distance measurement unit 140 configured to measure a distance where the air knife 20 is moved in the front and rear directions with respect to the plated steel sheet as the air knife module is moved by the front and rear moving apparatus.

[0041] The distance measurement unit 140 is configured to measure a front and rear movement distance of the air knife 20 by detecting the rotation number (the rotation amount) of the power transmission shaft 123.

[0042] Referring to FIG. 1, FIG. 5, and so on, the distance measurement unit 140 includes: a measurement module 141 having an input shaft and an output shaft, the measurement module 141 having the input shaft connected to the power transmission shaft 123, and the measurement module 141 being configured to detect the rotation number of the power transmission shaft 123; a measurement screw shaft 143 connected to the output shaft of the measurement module 141 through a measurement gear box 142; a moving body 144 screw coupled to an external thread of the measurement screw shaft 143, the moving body 144 being capable of moving in a length direction of the measurement screw shaft 143 according to a rotation direction of the measurement screw shaft 143; a reference member 145 provided at the moving body 144; and a sensor (see reference numerals 146A and 146B) sensing whether the reference member 145 is positioned at a position corresponding to a predetermined maximum frontward movement distance and a predetermined maximum rearward movement distance of the air knife 20.

[0043] The distance measurement unit 140 further includes a measurement unit frame 147 mounted on the body 10. In the distance measurement unit 140, the measurement module 141, the measurement gear box 142, the sensor, and so on may be mounted on the measurement unit frame 147.

[0044] In the measurement module 141, when the input shaft and the output shaft are connected to each other and the input shaft is rotated while the power transmission shaft 123 is rotated, the output shaft may be rotated. The measurement module 141 may detect the rotation number of the power transmission 123 by detecting the

rotation number of the input shaft. The measurement module 141 may be provided with an encoder for detecting the rotation number of the input shaft, and a detected value may be transmitted to an operation room in a wired manner or a wireless manner.

[0045] The measurement screw shaft 143 is rotated by receiving a rotational force of the output shaft of the measurement module 141 through the measurement gear box 142. The measurement gear box 142 may be a miter gear box and so on. The moving body 144 may be formed in a shape in which a rotation of the moving body 144 performed together with the measurement screw shaft 143 is limited by being in contact with the measurement unit frame 147 and so on.

[0046] The reference member 145 and the sensor (see reference numerals 146A and 146B) may be used to prevent the air knife 20 from being moved frontward or rearward beyond an allowable distance by front and rear moving apparatus.

[0047] The reference member 145 may be moved together with the moving body 144. The sensor may include a first sensor 146A and a second sensor 146B.

[0048] The first sensor 146A and the second sensor 146B may be disposed to be spaced apart from each other by a predetermined interval (for example, an interval corresponding to the allowable distance) along a moving direction of the reference member 145.

[0049] The first sensor 146A and the second sensor 146B may be contact type sensors such as limit switches. Otherwise, the first sensor 146A and the second sensor 146B may be non-contact type sensors such as optical sensors. For example, when the optical sensors are used, the reference member 145 may be configured such that the reference member 145 is capable of reflecting light from the first sensor 146A and the second sensor 146B.

[0050] While the present disclosure has been described above, the present disclosure is not limited to the disclosed embodiment and the accompanying drawings, and those skilled in the art may variously modify the present disclosure without departing from the technical features of the present disclosure.

Claims

1. An air knife system comprising:

   an air knife module having an air knife jetting gas to a plated steel sheet, the air knife module having gas supply pipes that respectively protrude in left and right directions from corresponding positions of both side surfaces of the air knife;
   a body mounted above the air knife module, the body having an inner portion provided with a flow path for transferring the gas;
   gas transferring pipes configured to transfer the gas from the flow path to the gas supply pipes, the gas transferring pipes having lower ends coupled to ends of the gas supply pipes through connection pipes such that the gas transferring pipes are capable of being rotated with respect to a pipe center of the gas supply pipes, respectively;
   a front and rear guiding unit supporting the air knife module such that the air knife module is capable of being moved in front and rear directions with respect to the body;
   a front and rear driving unit configured to adjust a distance of the air knife with respect to the plated steel sheet by moving the air knife module; and
   interlock units connecting upper ends of the gas transferring pipes to the body and rotating the gas transferring pipes with respect to the pipe center according to a front and rear movement of the air knife module, thereby allowing the front and rear movement of the air knife module.

2. The air knife system of claim 1, wherein the interlock units respectively comprise:

   connection housings provided on the body, the connection housings having inner potions that are respectively in communication with the flow path through gas discharge ports of the body;
   supporting members respectively provided in the inner portions of the connection housings;
   rotating bodies respectively supported by the supporting members such that the rotating bodies are capable of being rotated around an axis of the left and the right directions;
   moving pipes having lower ends movably penetrating centers of the rotating bodies in a directions orthogonal to the axis of the left and right directions while the moving pipes are in state in which lower ends thereof are connected to the gas transferring pipes, respectively.

3. The air knife system of claim 1 or claim 2, wherein the front and rear guiding unit comprises a plurality of front and rear guiding units and each of the plurality of front and rear guiding units comprises:

   a bracket having a lower end connected to the air knife module;
   a guide rail provided on the body along the front and rear directions; and
   a guide block provided on an upper end of the bracket, the guide block being capable of being moved along each guide rail.

4. The air knife system of claim 3, wherein the front and rear driving unit comprises:

   screw shafts provided to be capable of being

rotated around an axis of the front and rear directions, the screw shafts having front side portions respectively screw coupled to each bracket;

a power transmission shaft connected to rear ends of the screw shafts through gear boxes; and

a driving motor configured to rotate the power transmission shaft.

5. The air knife system of claim 4, further comprising a distance measurement unit configured to measure a front and rear movement distance of the air knife by detecting a rotation number of the power transmission shaft.

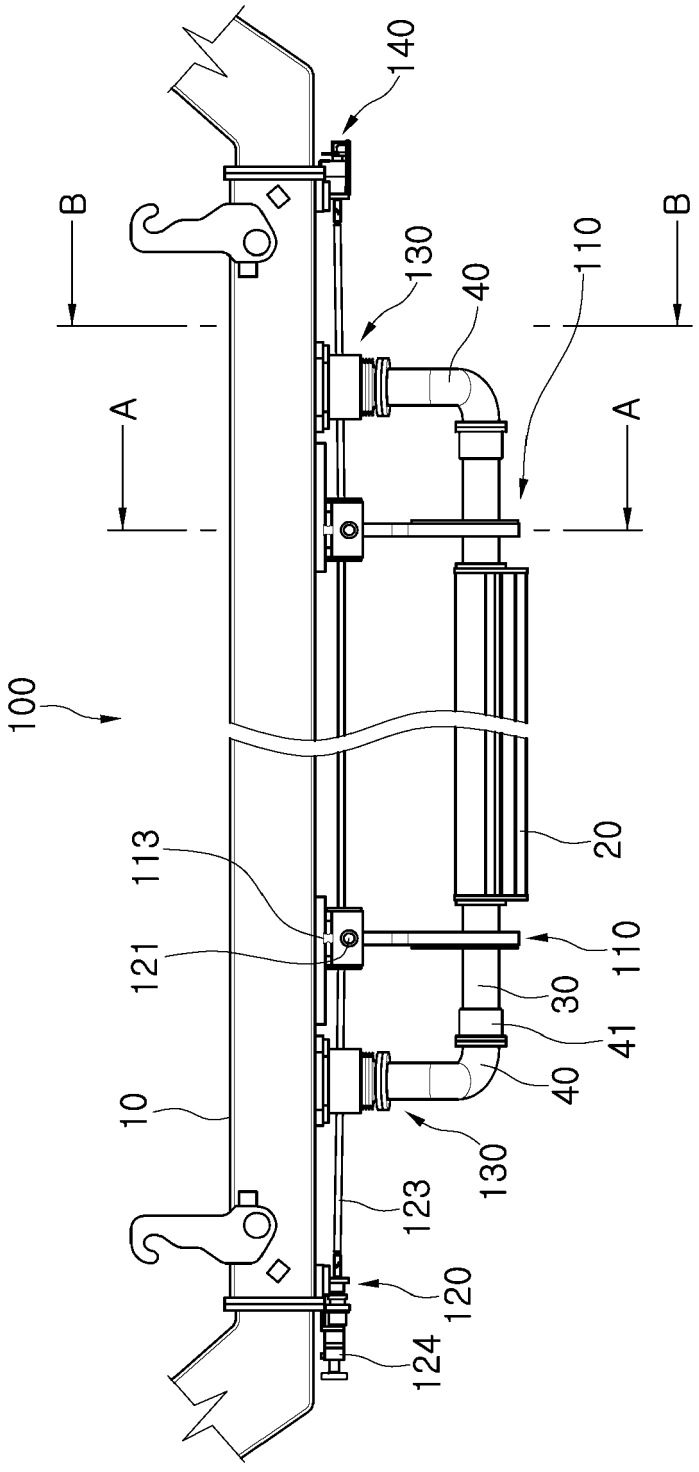


FIG. 1

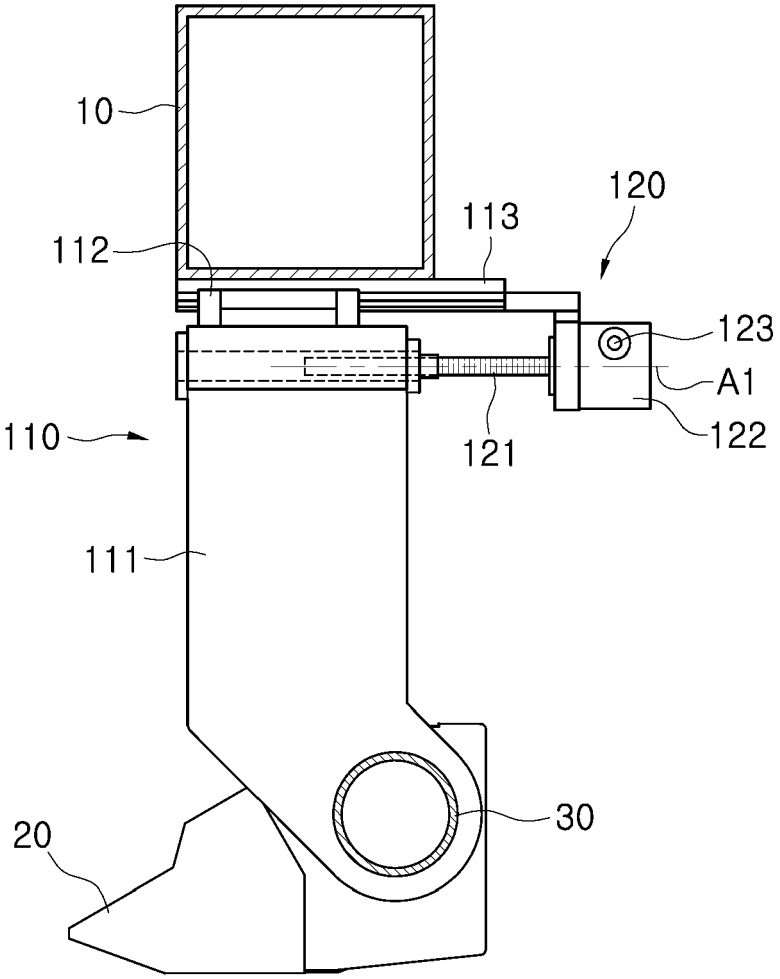


FIG. 2

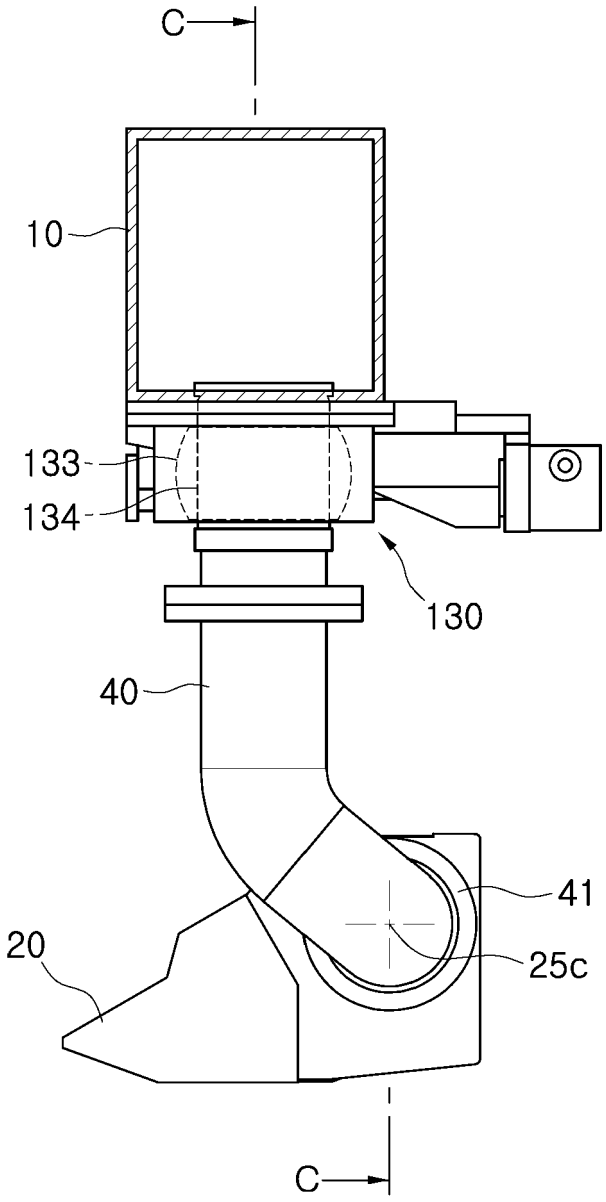
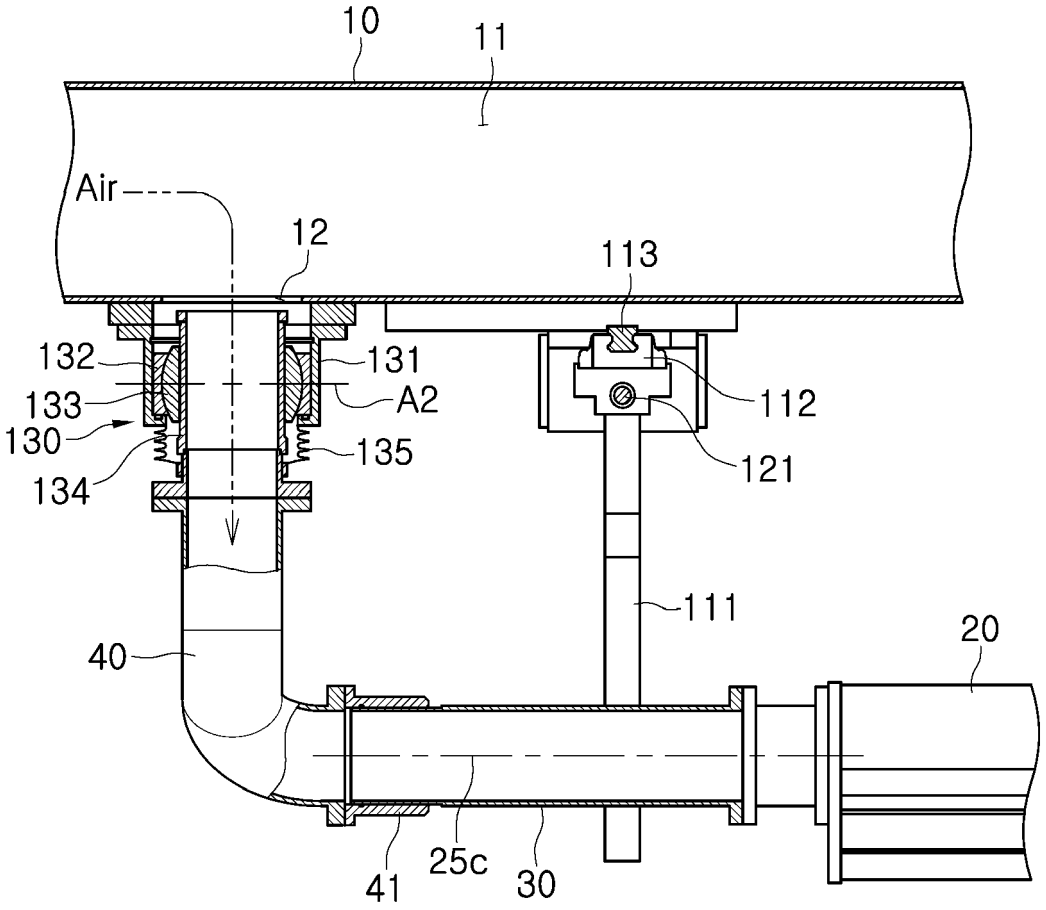


FIG. 3


10
11
Air
12
113
132
131
133
A2
130
135
134
112
121
111
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40
41
25c
30

FIG. 4

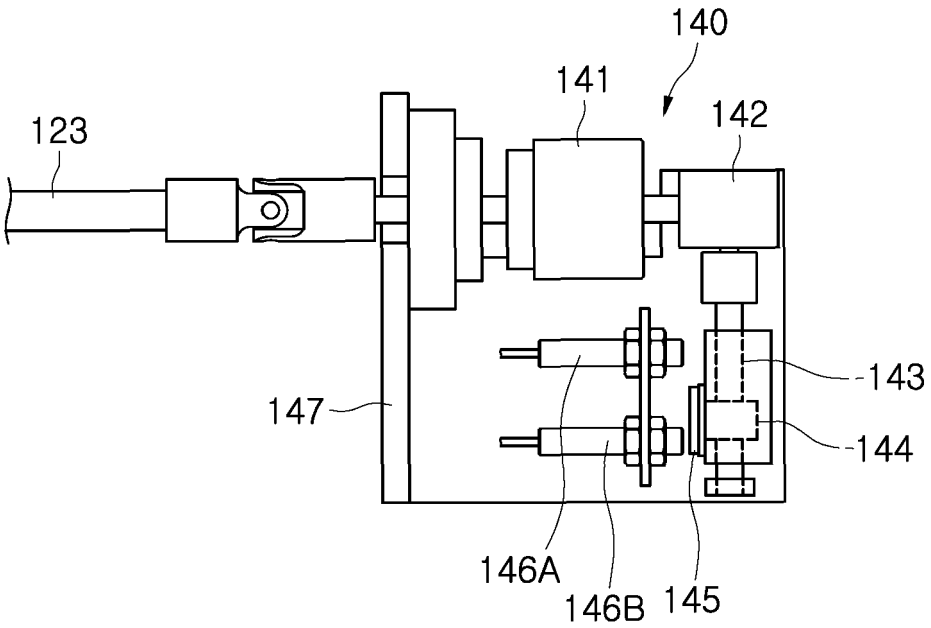

FIG. 5

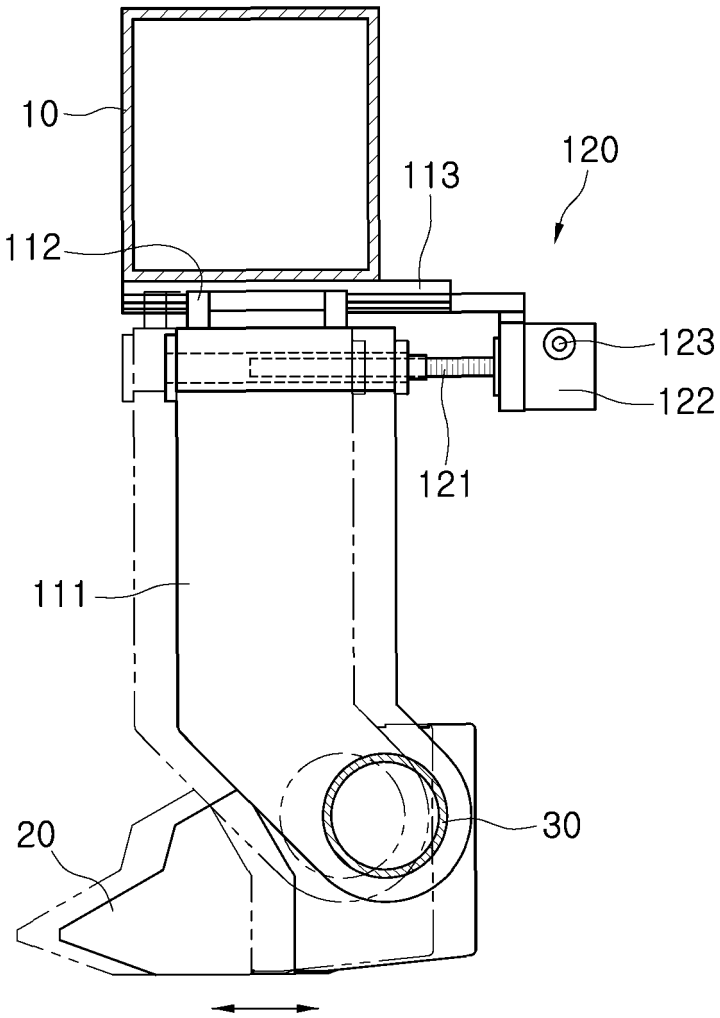

FIG. 6

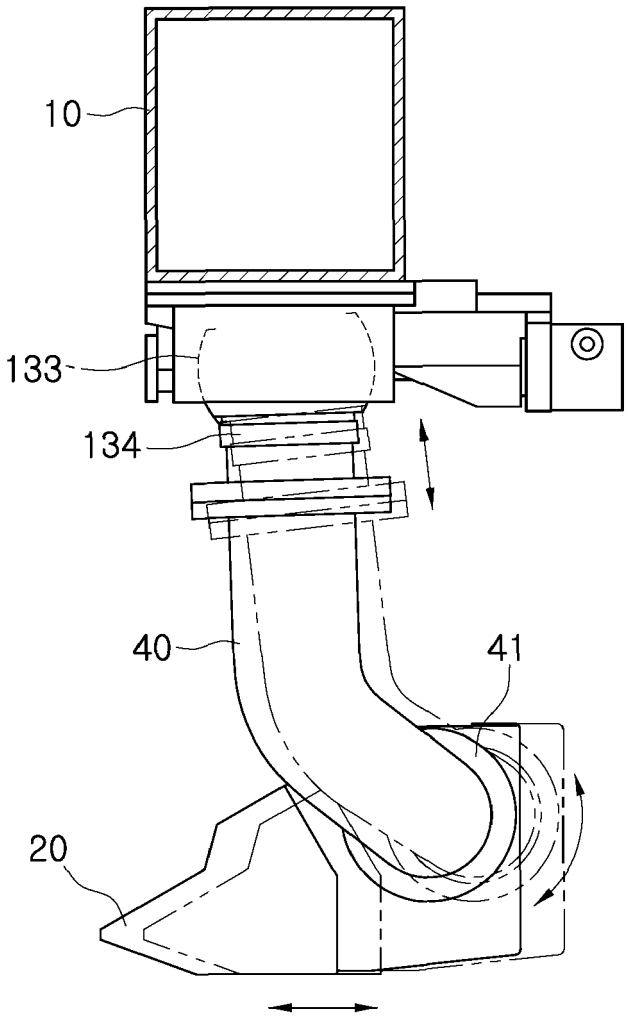

FIG. 7

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European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 22 21 1912

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	CN 110 804 720 A (TIANJIN BAOLAI IND & BUSINESS CO LTD) 18 February 2020 (2020-02-18) * claims 1-8 * -----	1-5	INV. C23C2/00 C23C2/14 C23C2/16 C23C2/18 C23C2/20 C23C2/40
A	KR 2003 0093586 A (POSCO [KR]) 11 December 2003 (2003-12-11) * claims 1-4 * -----	1-5	

TECHNICAL FIELDS SEARCHED (IPC)

C23C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 February 2023	Chalaftris, Georgios

CATEGORY OF CITED DOCUMENTS

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