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(54) **DEVICE FOR EXTRACTING POURED MOLDS AND METHOD FOR EXTRACTING POURED MOLDS**

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(57) **ABSTRACT**

A device for extracting poured molds is provided in which a large torque force can be generated by using an electric motor at an initial stage in a device for extracting molds, and then an upward extraction operation can be performed at a high speed. An electric motor, a driving mechanism including a rotating drive shaft driven by the electric motor, a lifting frame supporting a lower surface of a sand mold part to cause thereof to be capable of lifting, a link member provided between the driving mechanism and the lifting frame, and a rise regulating device abutting on an outer periphery of the molding flask casting frame to regulate rising of the molding flask casting frame. The driving mechanism includes a shifting portion and an upward extraction portion.

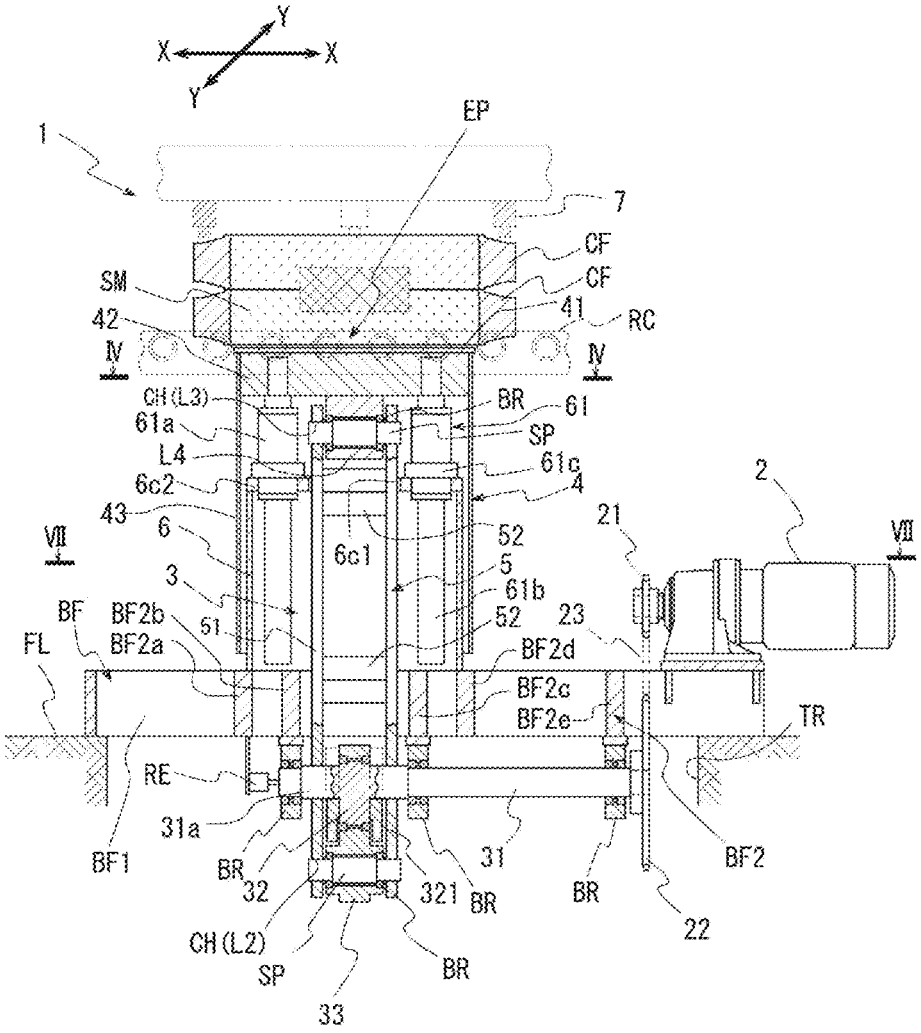


FIG. 1

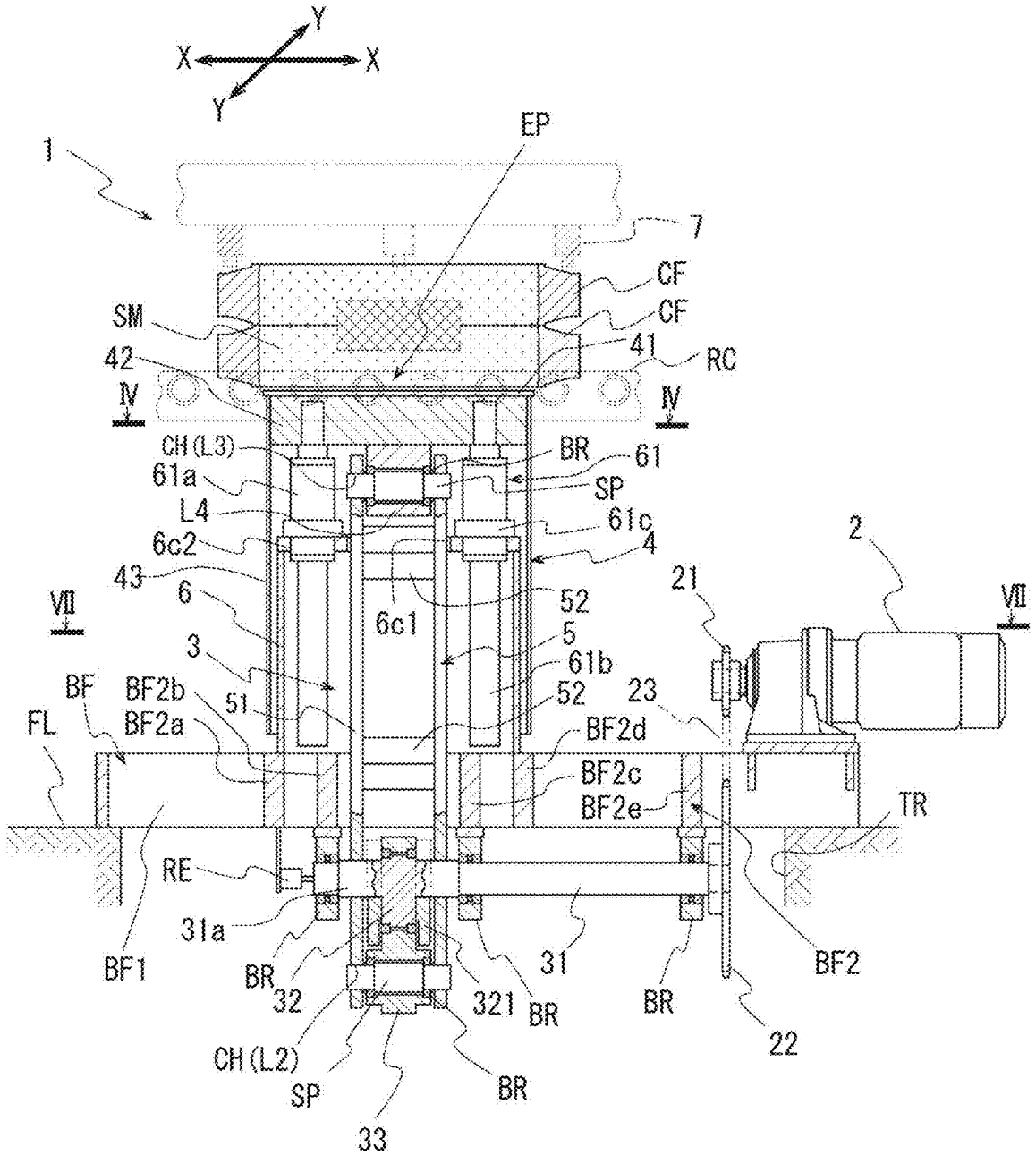

Y
X
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7
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RC
42
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IV
CH(L3)
BR
61
61a
SP
L4
61c
6c2
4
2
43
6
52
21
VII
VII
6c1
5
3
61b
BF
BF2b
51
52
23
FL
BF2a
BF2d
BF2c
BF2e
TR
RE
31a
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32
321
BR
31
BR
BF2
22
CH(L2)
SP
BR
33

FIG. 2

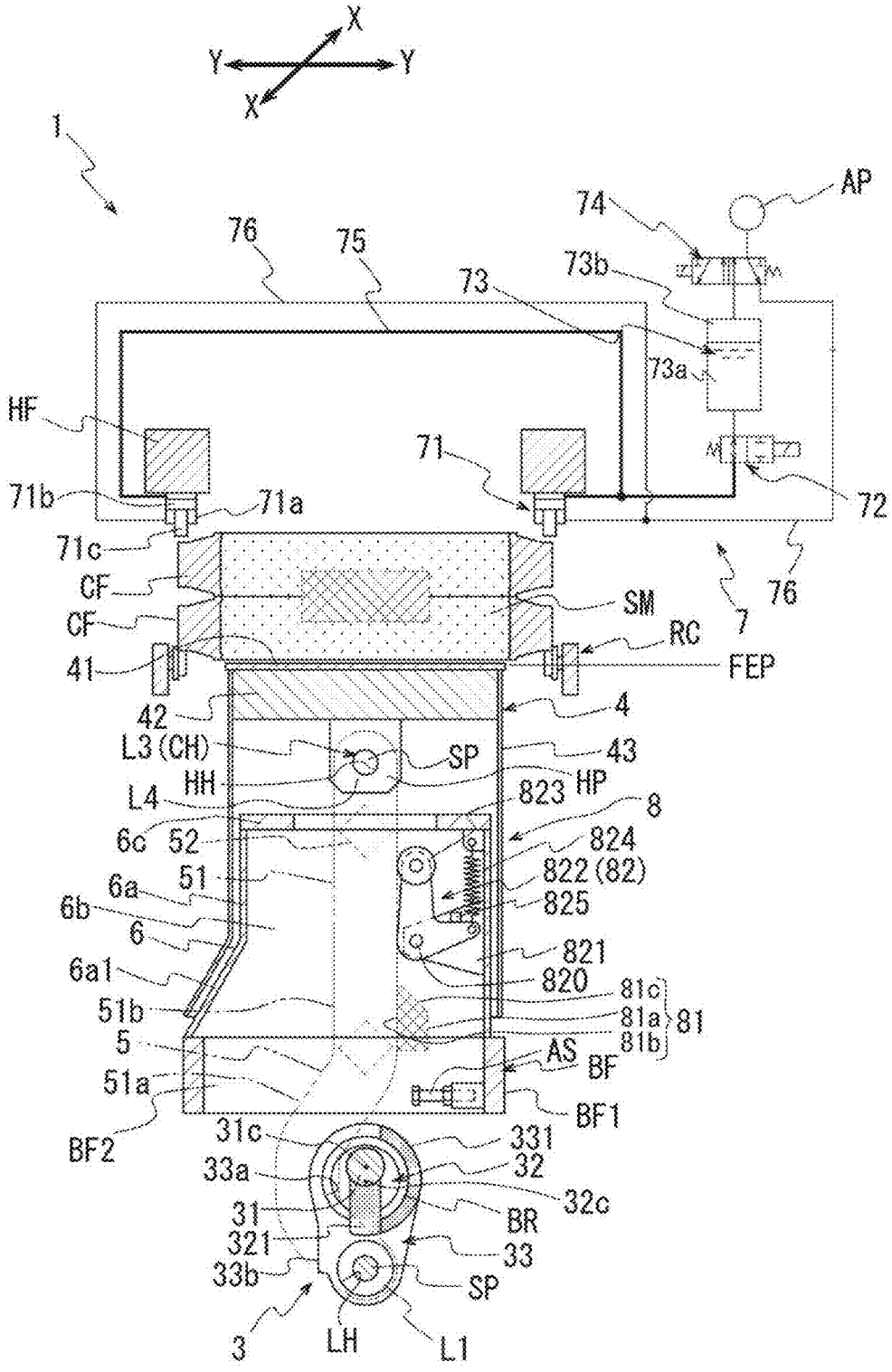

X
Y
Y
X
1
AP
74
76
75
73
73b
73a
HF
71
71b
71a
72
71c
CF
CF
SM
RC
7
76
41
FEP
42
4
L3(CH)
SP
43
HH
HP
L4
823
8
6c
52
824
6a
51
822(82)
6b
825
6
821
6a1
820
81c
51b
81a
81
5
81b
AS
BF
51a
BF1
BF2
31c
331
33a
32
32c
31
BR
321
33
33b
SP
3
LH
L1

FIG. 3

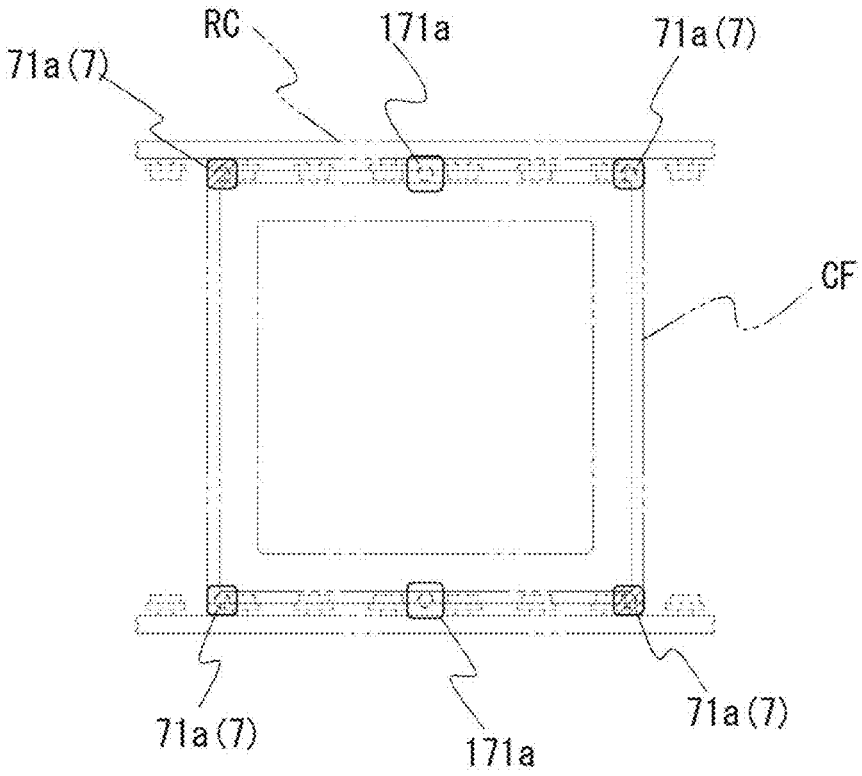


FIG. 4

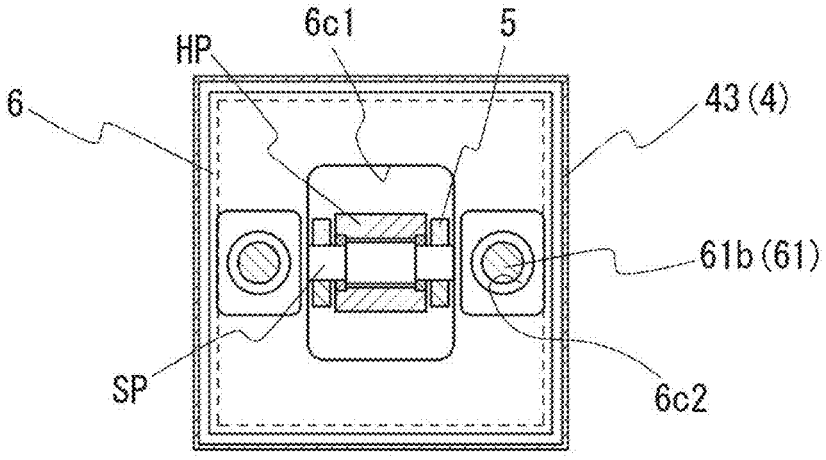


FIG. 5

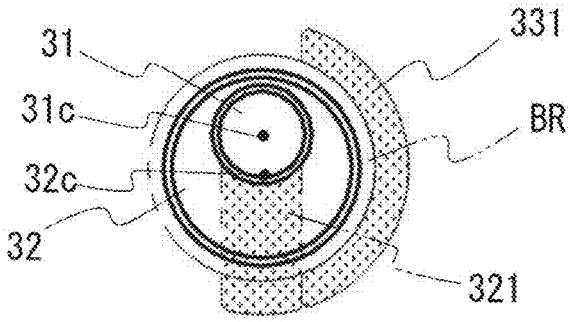


FIG. 6

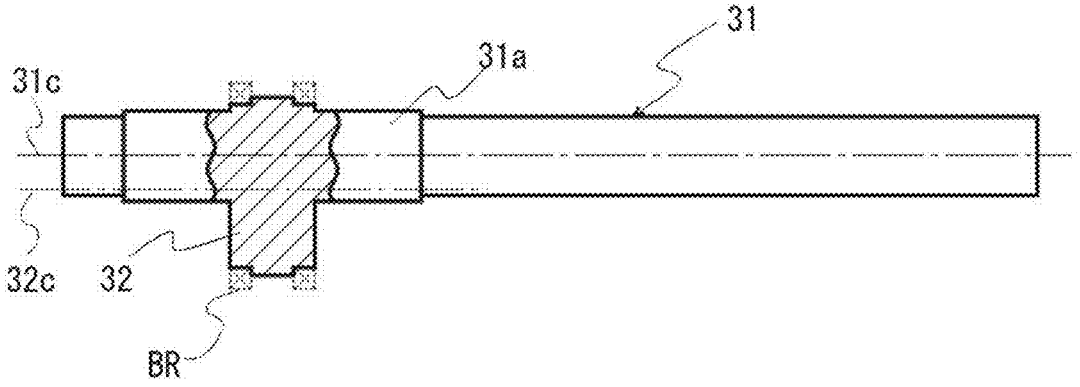


FIG. 7

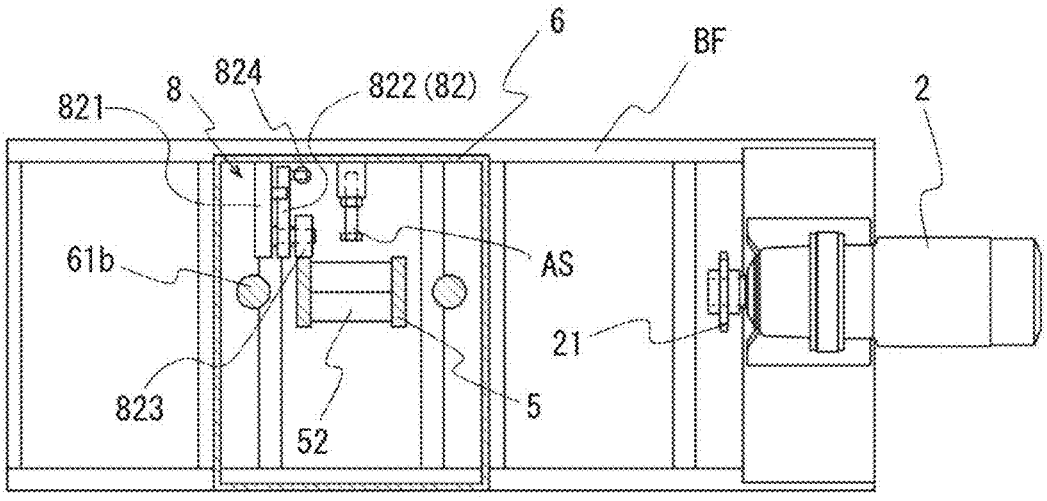


FIG. 8

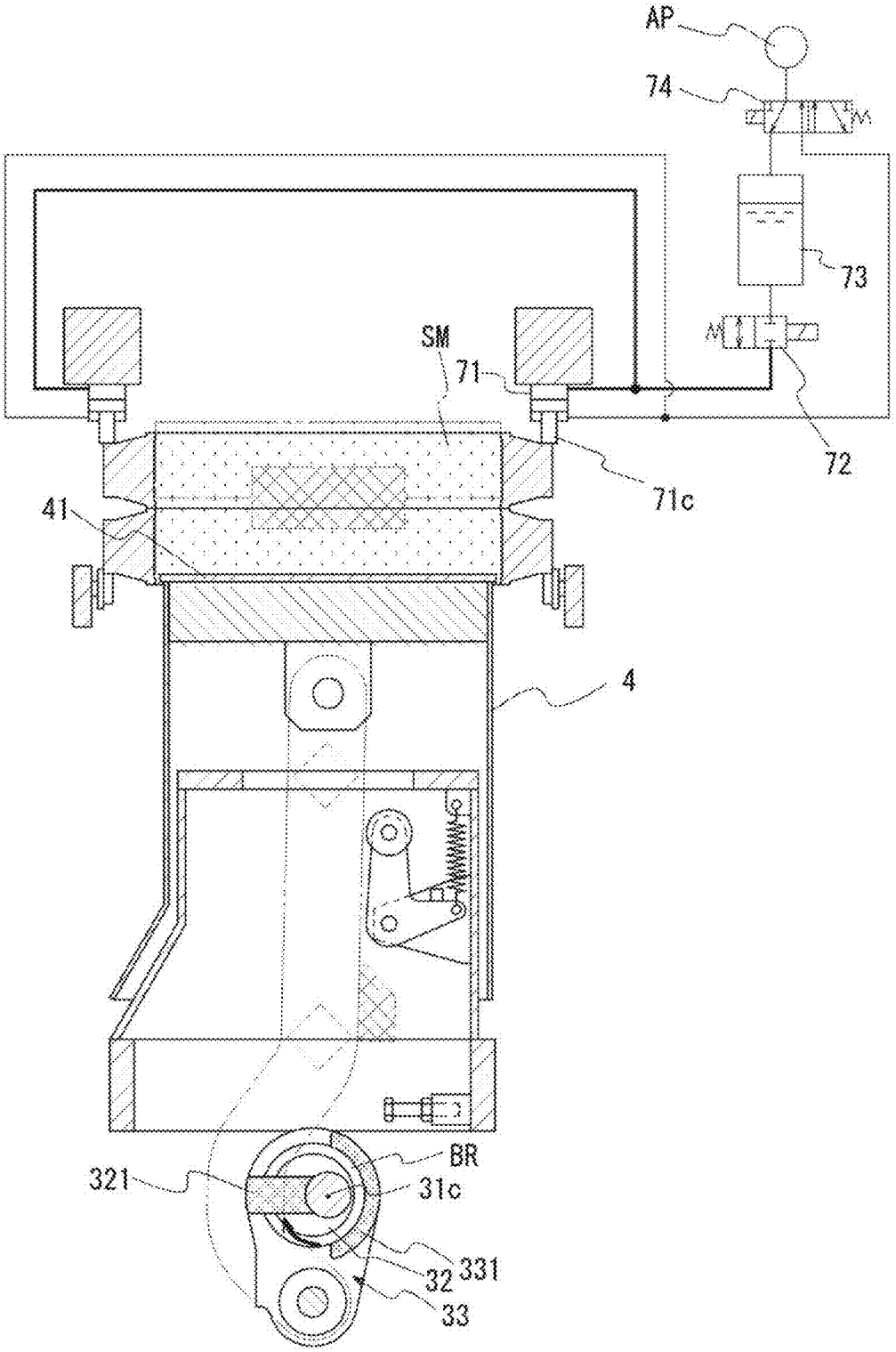


FIG. 9

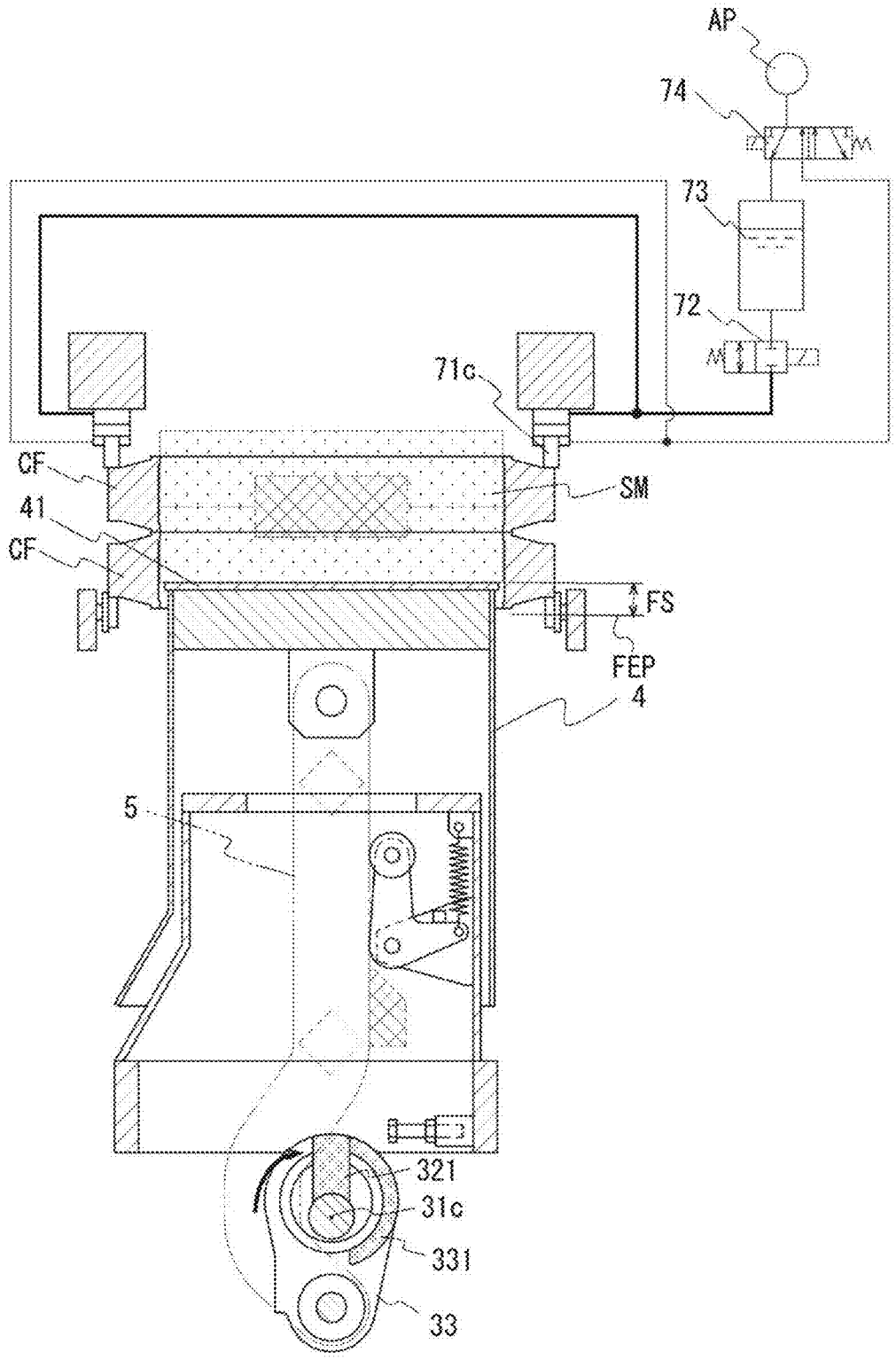


FIG. 10

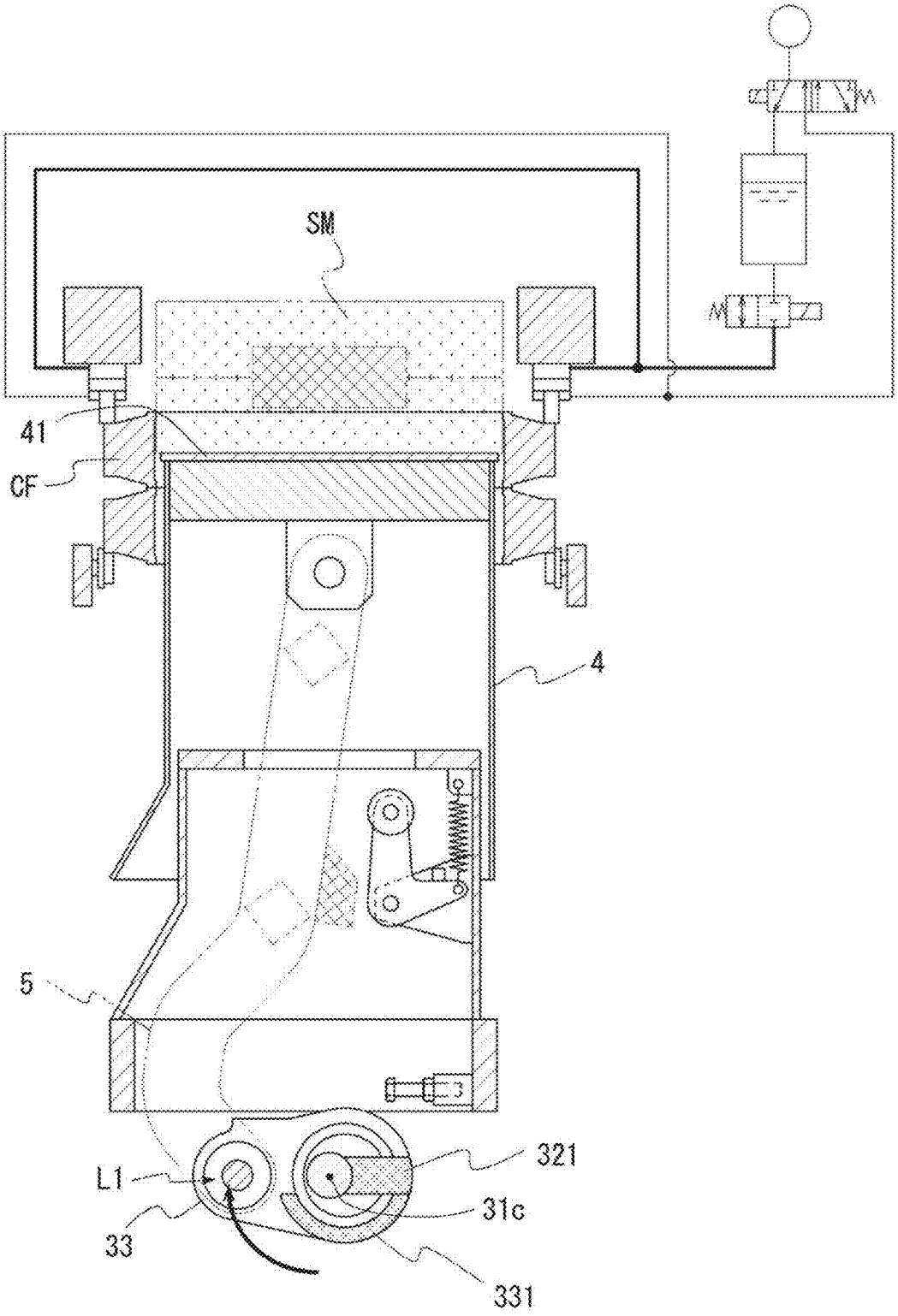


FIG. 11

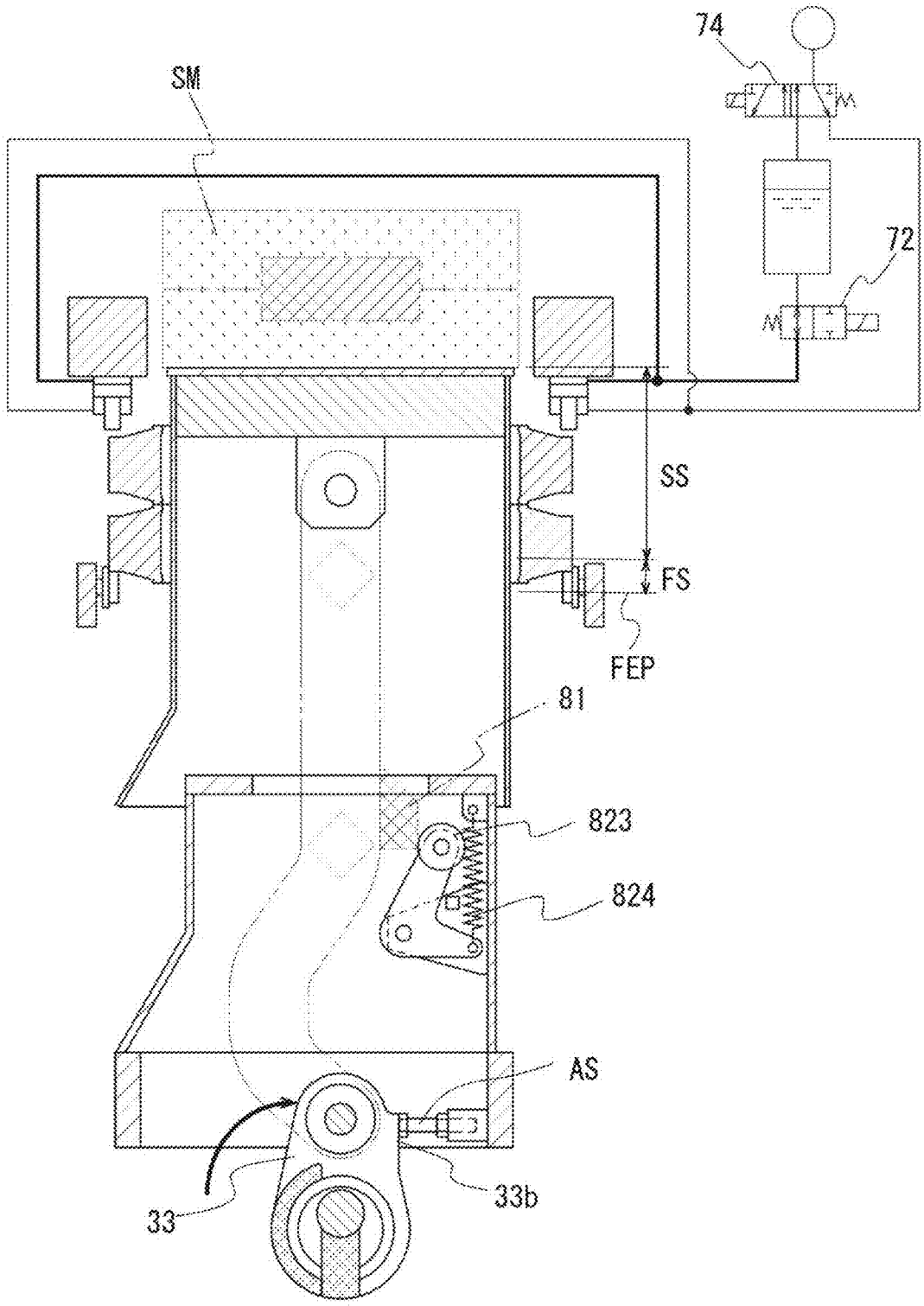


FIG. 12

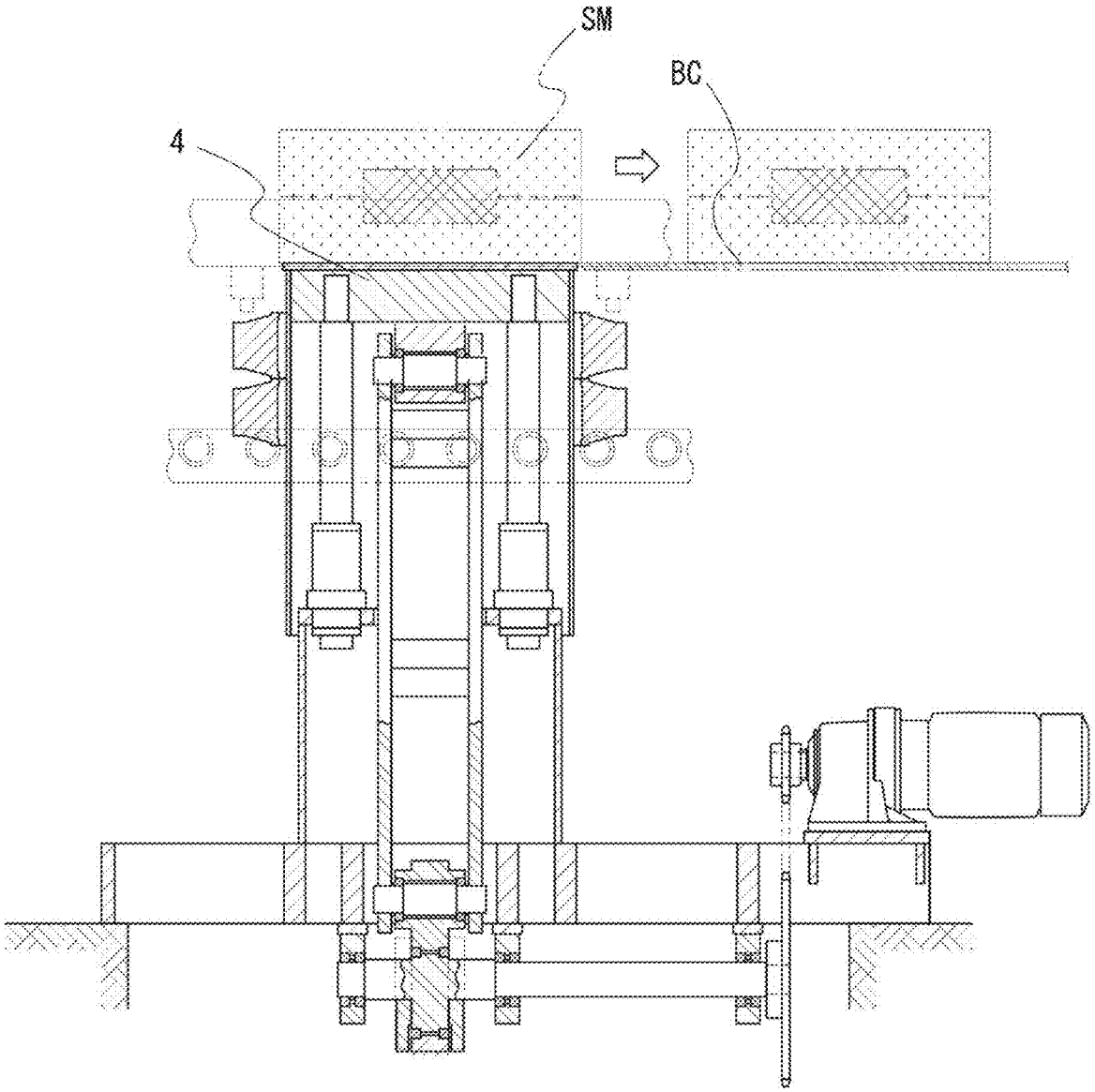


FIG. 13

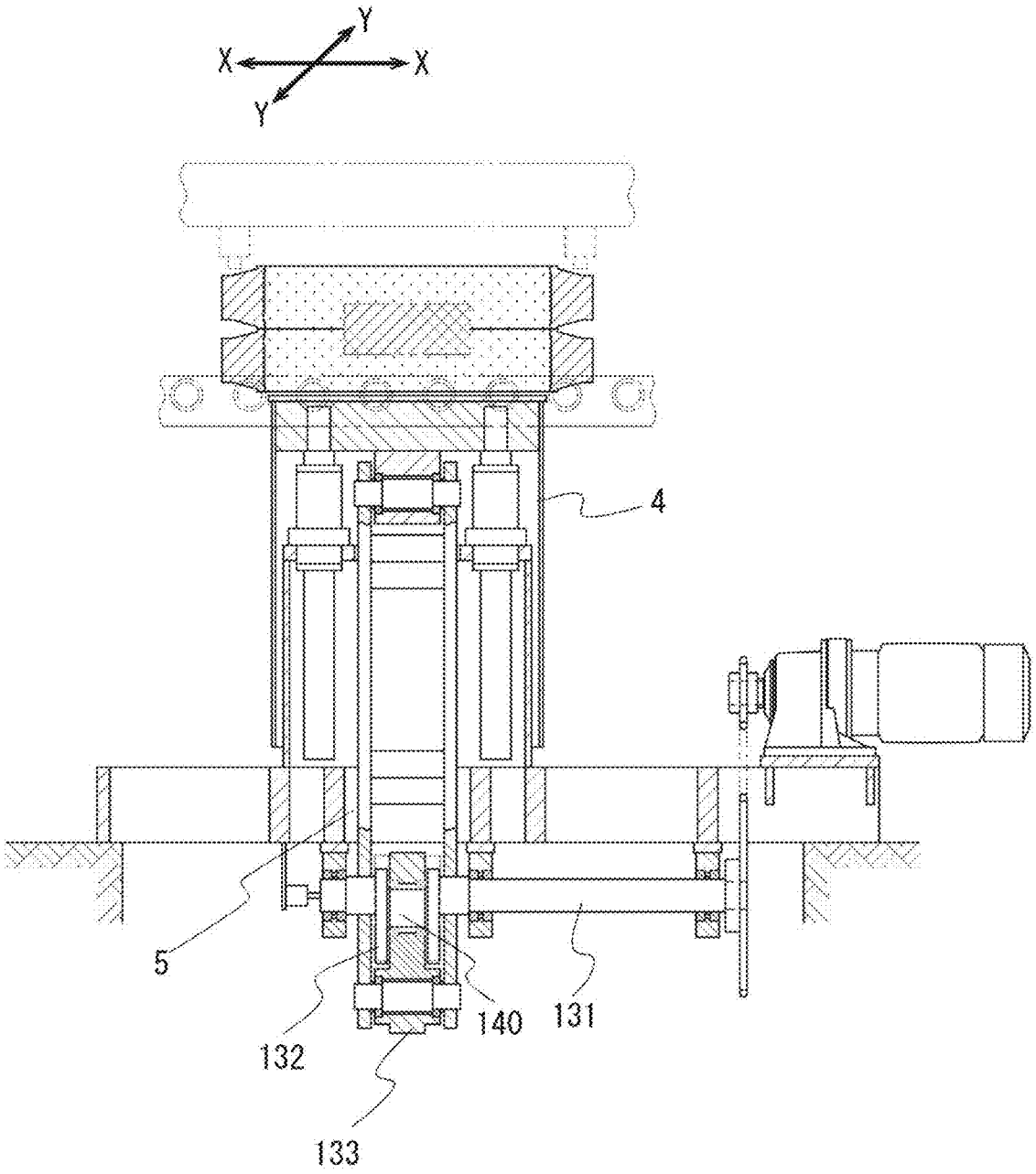


FIG. 14

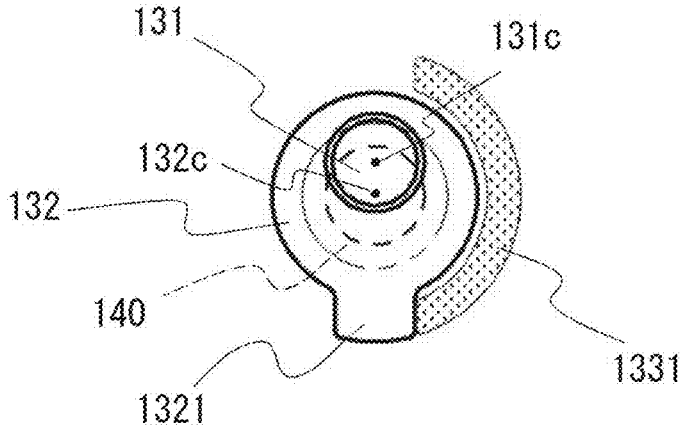


FIG. 15

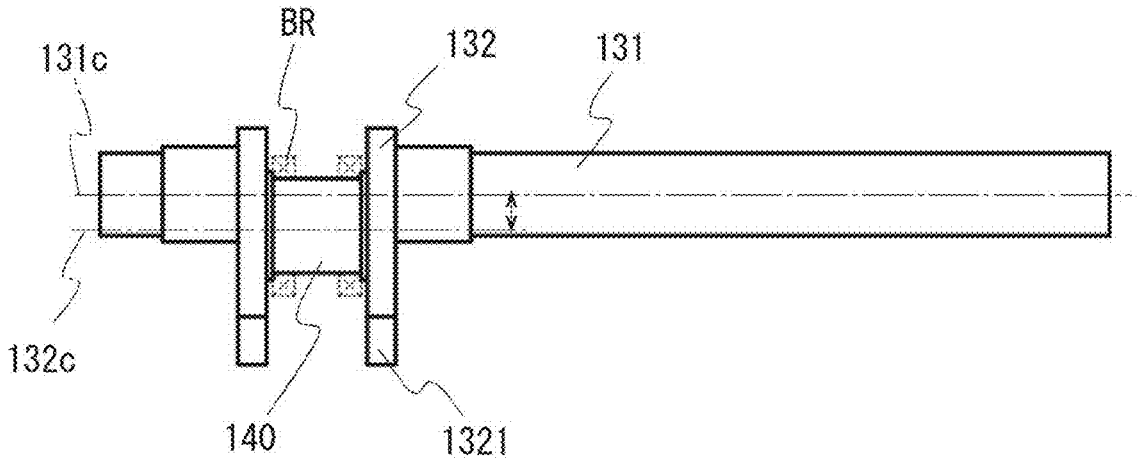
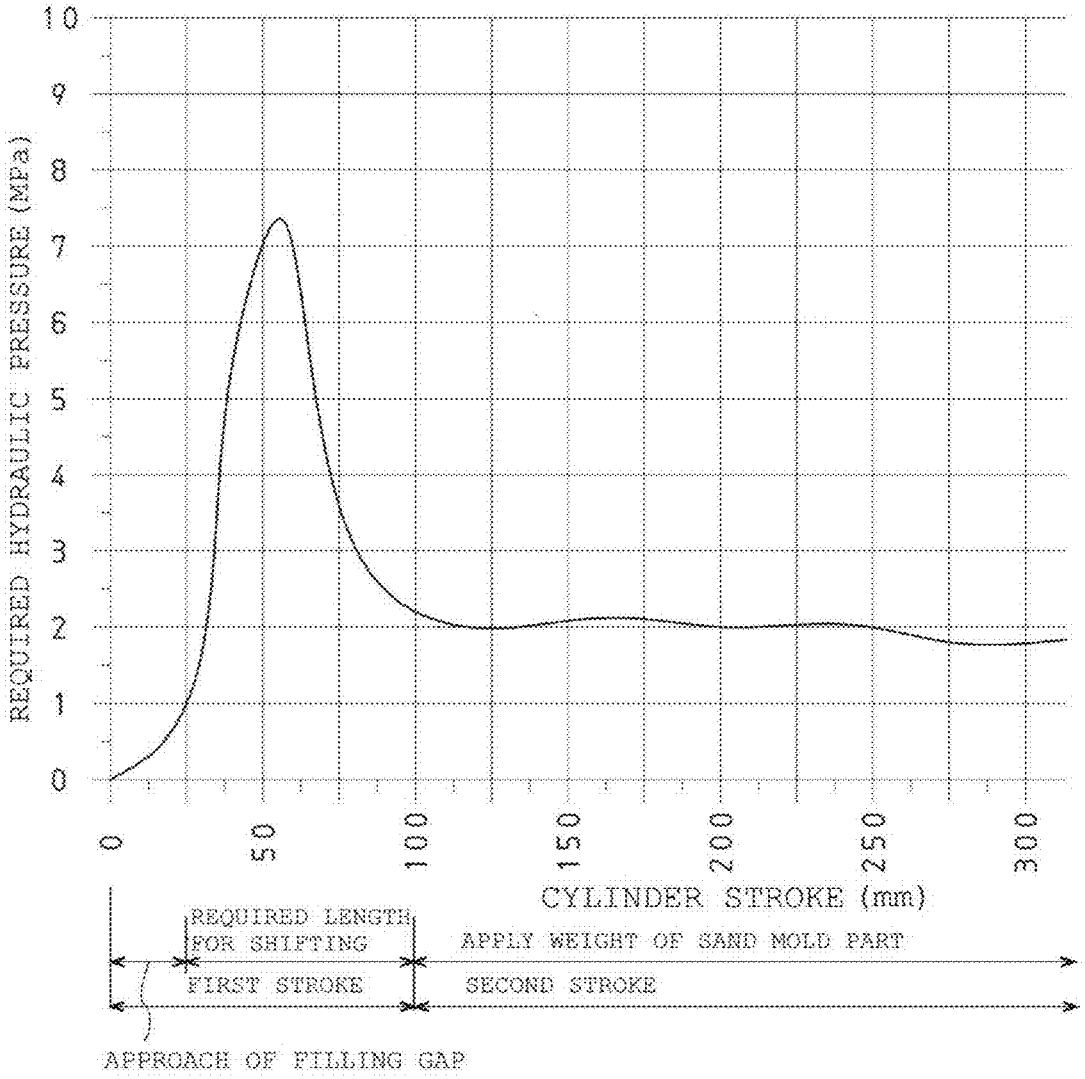


FIG. 16


REQUIRED HYDRAULIC PRESSURE (MPa)
10
9
8
7
6
5
4
3
2
1
0
0
50
100
150
200
250
300
CYLINDER STROKE (mm)
REQUIRED LENGTH FOR SHIFTING
APPLY WEIGHT OF SAND MOLD PART
FIRST STROKE
SECOND STROKE
APPROACH OF FILLING GAP

DEVICE FOR EXTRACTING POURED MOLDS AND METHOD FOR EXTRACTING POURED MOLDS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a national stage of PCT Application No. PCT/JP2023/030060, having a filing date of Aug. 21, 2023, based on Japanese Application No. 2022-132216, having a filing date of Aug. 23, 2022, the entire contents both of which are hereby incorporated by reference.

FIELD OF TECHNOLOGY

[0002] The following relates to a device for extracting molds and a method for extracting molds for extracting poured molds from a casting frame.

BACKGROUND

[0003] Conventionally, as a method for extracting poured molds from a casting frame, there is a method of extracting a mold upward from below the mold to directly above by a cylinder device as described in JP 2010-23094 A. The main purpose of this method is to slowly cool a product in the mold for a certain period of time after extracting the mold to the outside without breaking the mold as much as possible.

[0004] This method requires a large output when the mold is extracted from the casting frame, and thus it is common to use a hydraulic cylinder.

[0005] However, the hydraulic cylinder requires a hydraulic unit for operating and controlling the cylinder, and there is a problem that a hydraulic pump motor is often operated at all times during production, and the amount of electric power increases.

[0006] Therefore, in recent years, in order to save energy by reducing power consumption, a de-hydraulic cylinder has been examined, and the electrification of actuators has been promoted.

[0007] For example, a device for extracting the poured molds from the casting frame disclosed in JP 2010-23094 A has a structure in which a rotating arm portion having a length of ½ of a lifting stroke is provided on a rotating drive shaft to extract the mold upward by one rotating arm portion.

SUMMARY

[0008] However, as shown in test data in a device for extracting poured molds using the conventional hydraulic cylinder (see FIG. **16**), there is a characteristic that a short stroke but a large pressure is required at the beginning of extraction, and a large force is not required but a slightly long stroke is required to subsequently extract the mold (sand mold part) upward.

[0009] Thus, in a case of using an electric motor, there is a problem that a torque generated in a rotating drive shaft when the mold at the initial stage of extraction is separated from a casting frame inner wall is excessive, and a drive system is increased in size for increasing strength. In addition, there is a problem that in order to generate a large torque, a rotational speed of the rotating arm portion becomes slow, and an upward extraction operation takes time.

[0010] An aspect relates to a device for extracting poured molds and a method for extracting molds thereof, in which a large torque can be generated by using an electric motor at an initial stage in a device for extracting molds, and then an upward extraction operation can be performed at a high speed.

[0011] A device for extracting poured molds according to a first aspect of embodiments of the present invention includes: an electric motor, a driving mechanism including a rotating drive shaft driven by the electric motor, a lifting frame supporting a lower surface of a sand mold part serving as an inside of a casting frame of poured molds to cause thereof to be capable of lifting, a link member extending in a vertical direction and provided between the driving mechanism and the lifting frame, and a rise regulating device abutting on an outer periphery of the casting frame to regulate rising of the casting frame when the lifting frame is raised.

[0012] The driving mechanism includes, a shifting portion shifting the lifting frame upward relatively by a predetermined length in cooperation with the rise regulating device in order to separate the sand mold part from the casting frame in an adhered state at an extraction position where the sand mold part is extracted from the casting frame, and an upward extraction portion extracting the shifted sand mold part upward to a conveyance position with a force smaller than a force of shifting by the shifting portion and at a speed higher than a speed of shifting by the shifting portion.

[0013] According to this, by dividing the device for extracting molds into the shifting portion requiring a large force with a short stroke and the upward extraction portion requiring a high speed with a long stroke to work, miniaturization of the device and improvement of the work efficiency can be achieved.

[0014] According to the device for extracting poured molds of a further aspect of embodiments of the present invention, in the device for extracting poured molds of the first aspect, the shifting portion includes a rotating portion having a cylindrical shape and including an axis parallel to a rotation center of the rotating drive shaft, the axis being eccentric by a predetermined dimension from the rotation center of the rotating drive shaft.

[0015] The upward extraction portion is a rotating arm portion having a predetermined rotation radius extending in a radial direction of the rotating portion, and includes, on a base end portion side, an opening holding portion holding an outer periphery of the rotating portion so as to be relatively rotatable, and includes, on a tip portion side, the rotating arm portion having a first link portion.

[0016] The link member includes, at one end, a second link portion coupled to the first link portion of the rotating arm portion in a rotatable manner, and includes, at the other end, a third link portion, and the lifting frame includes a fourth link portion linked to the third link portion in a rotatable manner.

[0017] A rotation angle regulating portion is provided between the opening holding portion and the rotating portion in which when the rotating portion rotates relative to the opening holding portion by a predetermined angle, the relative rotation is regulated, so that the rotating portion and the rotating arm portion rotate integrally.

[0018] According to this, an eccentric axis moves from below the rotation center to above the rotation center by the rotation of the rotating portion, so that the link member is raised by a distance necessary for shifting. At this time, the rotating portion and the opening holding portion of the rotating arm portion relatively rotate (idle) and the rotating

arm portion does not rotate, and thus the link member rises by a distance necessary for shifting by the rotating portion.

[0019] When the rotating portion relatively rotates with respect to the opening holding portion by a predetermined angle, a relative rotation (idling) state of the rotating arm portion with respect to the rotating portion is released by a rotation angle regulating device, and the rotating arm portion rotates and the first link portion of the rotating arm portion moves from below the rotation center to above the rotation center, so that the link member is further raised. As a result, the shifted sand mold part can be extracted upward to a position where the sand mold part is conveyed.

[0020] According to the device for extracting poured molds of a further aspect of embodiments of the present invention, in the device for extracting poured molds of the further aspect, the eccentric predetermined dimension of the shifting portion is a dimension for generating a first stroke in the vertical direction necessary for shifting the poured sand mold in the casting frame from the inner wall of the casting frame, and at the same time, for causing the rotating portion to generate a force necessary for shifting by a rotational torque of the electric motor. A dimension of the predetermined rotation radius of the rotating arm portion is a dimension for generating a second stroke in the vertical direction necessary for extracting the sand mold part separated from the casting frame upward.

[0021] Note that the "dimension for generating" indicates not the first stroke itself but, for example, ½ of the first stroke or a dimension directly or indirectly related thereto. The same applies to the second stroke.

[0022] According to this, a dimension at an eccentric position of the rotating portion shifted by a predetermined dimension from the rotation center of the rotating drive shaft is set for generating the force and the first stroke necessary for separating the poured mold in the casting frame from the casting frame inner wall, and a dimension having a predetermined dimension from the rotation center of the rotating arm portion as the rotation radius is set for generating the force and the second stroke necessary for upward extracting after separating from the casting frame inner wall inside the casting frame.

[0023] As a result, the electric motor serving as only one drive source can efficiently set a high output range due to a low speed rise of the first stroke and a low output range due to a high speed rise of the second stroke according to a load.

[0024] According to the device for extracting poured molds of a further aspect of embodiments of the present invention, in the device for extracting poured molds of the further aspect, a link biasing device biasing the link member at the time of lowering of the lifting frame so that the rotating arm portion rotates in a direction opposite to a direction at the time of rising is provided.

[0025] According to this, by providing the link biasing device so as to press the link member by a predetermined dimension in the direction opposite to an operation in the rising direction at a rising end position of the lifting frame, the rotating arm portion is smoothly rotated in the direction opposite to that at the time of rising at a start of lowering of the lifting frame, so that a lowering step can be quickly and reliably performed.

[0026] According to a device for extracting poured molds of a further aspect of embodiments of the present invention, in the device for extracting poured molds of an aspect of embodiments of the present invention, the rise regulating device includes, at least a pair of hydraulic cylinders each including a piston rod capable of abutting on an outer periphery upper surface of an upper casting frame of the casting frame, an oil tank including an oil layer storing hydraulic oil and an air layer generated above the oil layer, a hydraulic switching valve provided between the oil tank and the hydraulic cylinder, a pneumatic pump applying a pressure to air to feed the air, and a pneumatic switching valve provided between the pneumatic pump and the air layer of the oil tank. The hydraulic oil is supplied from the oil tank to the hydraulic switching valve by an air pressure applied to the air layer of the oil tank.

[0027] According to this, the hydraulic oil is supplied to a hydraulic switching valve by an air pressure via the oil tank, so that it is possible to stop a large back pressure generated at the initial stage of upward extraction of the mold by a withstanding pressure of the hydraulic cylinder and the hydraulic switching valve without using a hydraulic unit.

[0028] According to a method for extracting poured molds of a further aspect of embodiments of the present invention, there is provided a method for extracting poured molds using a device for extracting poured molds including an electric motor, a driving mechanism driven by the electric motor, a lifting frame supporting a lower surface of a sand mold part serving as an inside of a casting frame of poured molds to cause thereof to be capable of lifting, a link member extending in a vertical direction and is provided between the driving mechanism and the lifting frame, and a rise regulating device abutting on an outer periphery of the molding flask to regulate rising of the molding flask when the lifting frame is raised.

[0029] In embodiments, the method includes, by using the driving mechanism, a shifting step of relatively shifting the sand mold part by a predetermined length in the vertical direction in order to separate the sand mold part that is in an adhered state from the casting frame in cooperation with the rise regulating device at an extraction position where the sand mold part is extracted from the casting frame, and an upward extracting step of extracting the shifted sand mold part upward to a conveyance position with a force smaller than a force of shifting by the shifting step and at a speed higher than a speed of shifting by the shifting step.

[0030] According to this, by dividing the device for extracting molds into the shifting step requiring a large force with a short stroke and the upward extracting step requiring a high speed with a long stroke to work, miniaturization of the device and improvement of the work efficiency can be achieved.

BRIEF DESCRIPTION

[0031] Some of the embodiments will be described in detail, with references to the following Figures, wherein like designations denote like members, wherein:

[0032] FIG. **1** is an outline drawing from the front side showing a partial cross-sectional view for an embodiment of a device for extracting poured molds;

[0033] FIG. **2** is an outline drawing from the side showing a partial cross-sectional view for an embodiment of the device for extracting poured molds;

[0034] FIG. **3** is a plan drawing of a positional relationship of a rise regulating device with respect to a casting frame;

[0035] FIG. **4** is a cross-sectional drawing taken along line IV-IV in FIG. **1**;

[0036] FIG. **5** is a drawing of a rotating drive shaft and a rotating portion as viewed from an X-axis direction;
[0037] FIG. **6** is a drawing of a rotating drive shaft and a rotating portion as viewed from a Y-axis direction;
[0038] FIG. **7** is a cross-sectional drawing taken along line VII-VII in FIG. **1**;
[0039] FIG. **8** is a drawing a state in which the rotating drive shaft is rotated by 90 degrees;
[0040] FIG. **9** is a drawing a state in which the rotating drive shaft is rotated by 180 degrees;
[0041] FIG. **10** is a drawing a state in which the rotating drive shaft is rotated by 270 degrees and the rotating arm portion is rotated by 90 degrees;
[0042] FIG. **11** is a drawing a state in which the rotating drive shaft is rotated by 360 degrees and the rotating arm portion is rotated by 180 degrees;
[0043] FIG. **12** is a drawing a state in which an extracted sand mold part is conveyed;
[0044] FIG. **13** is a drawing a device for extracting poured molds according to another example;
[0045] FIG. **14** is a drawing of a rotating drive shaft and a rotating portion as viewed from the X-axis direction;
[0046] FIG. **15** is a drawing of a rotating drive shaft and a rotating portion as viewed from the Y-axis direction; and
[0047] FIG. **16** is a graph showing a relationship between a hydraulic pressure output for extraction and a stroke in a device for extracting poured molds using a conventional hydraulic.

DETAILED DESCRIPTION

Embodiments

[0048] An embodiment of a device for extracting poured molds according to the present invention will be described below with reference to FIGS. **1** to **12**.
[0049] A horizontal direction in FIG. **1** is referred to as an X-axis direction, and a horizontal direction orthogonal to the X-axis direction is referred to as a Y-axis direction. When a virtual center line is considered for a tangible object, a side close to the center line is referred to as an inner side, and a side far from the center line is referred to as an outer side. As illustrated in FIG. **1**, a device for extracting poured molds **1** according to the embodiment includes an electric motor **2**, a driving mechanism **3**, a lifting frame **4**, a link member **5**, and a rise regulating device **7**.
[0050] The device for extracting poured molds **1** is installed such that a part of a lower portion is housed in a trench TR dug in a floor surface FL. A large part of the device for extracting poured molds **1** is installed on a base frame BF laterally bridged on upper end portions of the trench TR facing each other in the X-axis direction.

(Base Frame)

[0051] The base frame BF is made of, for example, iron and formed in a rectangular frame shape. Five horizontal bar portions BF**2** are laterally bridged between long side portions BF**1** facing each other so as to extend in the Y-axis direction. The long side portions BF**1** and the horizontal bar portions BF**2** are formed such that height positions coincide with each other at each upper end surface and each lower end surface.
[0052] A rectangular frame is formed on upper end surfaces of a first horizontal bar portion BF**2***a* and a fourth horizontal bar BF**2***d* of the horizontal bars BF**2** from the left side in FIG. **1** together with upper end surfaces of the long side portions BF**1** facing each other. And a lower end portion of a support leg portion **6** of the device for extracting poured molds **1** described later is fixedly supported on an upper surface of the rectangular frame.
[0053] A bearing BR supporting rotating drive shaft **31** described later is fixed on each of lower end surfaces of a second horizontal bar portion BF**2***b*, a third horizontal bar BF**2***c*, and a fifth horizontal bar BF**2***e* of the horizontal bars BF**2** from the left side in FIG. **1**.
[0054] For example, rotary encoder RE is attached as a rotation angle sensor to a lower end surface of the first horizontal bar BF**2***a* of the horizontal bar portions BF**2** from the left side in FIG. **1**.

(Electric Motor)

[0055] The electric motor **2** drives the driving mechanism **3** described later.
[0056] As the electric motor **2**, for example, an induction motor can be used. The induction motor is a type that does not require complicated control like a servomotor.
[0057] The electric motor **2** is assembled to an upper right end surface of the base frame BF in FIG. **1** via a pedestal. A small sprocket **21** is assembled to the outer periphery of an output shaft of the electric motor **2**. A large sprocket **22** having a diameter larger than that of the small sprocket **21** is provided at one end portion of the rotating drive shaft **31** of the driving mechanism **3** so as to face the small sprocket **21**. A rotation shaft of the small sprocket **21** and a rotation shaft of the large sprocket **22** are provided in parallel to each other.
[0058] An annular endless roller chain **23** is hooked between the large sprocket **22** and the small sprocket **21** to transmit a rotational torque of the electric motor **2** to the rotating drive shaft **31**.

(Driving Mechanism)

[0059] The driving mechanism **3** is driven by the electric motor **2**, and moves up and down the link member **5** lifting the lifting frame **4** described later.
[0060] The driving mechanism **3** includes the rotating drive shaft **31**, a rotating portion **32**, and a rotating arm portion **33**.

(Rotating Drive Shaft)

[0061] The rotating drive shaft **31** is made of, for example, iron, formed in a round rod shape, and disposed below the base frame BF so as to extend in the X-axis direction. A thick shaft portion **31***a* having a slightly large diameter and shifted inward by a predetermined width in the X-axis direction from the left end portion is circumferentially provided at a position on the left side in FIG. **1**. The large sprocket **22** having a large outer diameter is assembled to a right end portion of the rotating drive shaft **31** in FIG. **1** so as to be relatively non-rotatable. The rotation center of the large sprocket **22** is coaxial with an axis **32***c* of the rotating drive shaft **31**.
[0062] As described above, the rotary encoder RE is disposed at the left end portion of the rotating drive shaft **31** in FIG. **1**, and detects a rotation angle of the rotating drive shaft **31**.

[0063] The rotating portion **32** is integrally fixed to a central portion of the thick shaft portion **31***a* so as to protrude in a radial direction.

(Rotating Portion)

[0064] As illustrated in FIGS. **5** and **6**, the rotating portion **32** is formed in a short cylindrical shape having a diameter larger than that of the thick shaft portion **31***a* of the rotating drive shaft **31**. The rotating portion **32** constitutes a part of the shifting portion.

[0065] A rotation center **31***c* of rotating drive shaft **31** and the axis **32***c* of the rotating portion **32** are set to be parallel to each other, and the axis **32***c* of the rotating portion **32** is fixed in a state of being eccentric from the rotation center **31***c* of the rotating drive shaft **31** by a predetermined dimension. The rotation center **31***c* of the rotating drive shaft **31** and the axis **32***c* of the rotating portion **32** mainly constitute the shifting portion. The eccentric dimension is a dimension for generating a first stroke FS described later, and corresponds to ½ of the first stroke FS in the present embodiment.

[0066] The outer periphery of the rotating portion **32** is held in an opening holding portion **33***a* of the rotating arm portion **33** in a relatively rotatable manner described later (see FIG. **2**). The rotating portion **32** is provided with a locking portion **321**.

(Locking Portion)

[0067] As illustrated in FIG. **5**, when the rotating portion **32** relatively rotates forward or backward by 180 degrees, the locking portion **321** abuts on a locked portion **331** provided in the rotating arm portion **33** described later, so that a relative rotation angle between the rotating portion **32** and the rotating arm portion **33** is regulated.

[0068] The locking portion **321** is formed in a rectangular plate shape extending so as to protrude in a radial direction from the rotating drive shaft **31** (integral with the rotating portion **32**). The locking portions **321** are provided on both sides, respectively, of the rotating portion **32** so as to sandwich the rotating portion **32** along the X-axis direction, and are integrally assembled to the rotating drive shaft **31**.

(Rotating Arm Portion)

[0069] When cut along a virtual vertical surface including the Y-axis direction, the rotating arm portion **33** is formed to have a substantially oval cross section, and the opening holding portion **33***a* opened in the X-axis direction is formed on a base portion side. The locked portions **331** each having an arc shape shorter than a semicircular arc by a predetermined length are assembled to end edge portions on both sides, respectively, of an opening of the opening holding portion **33***a*.

(Locked Portion)

[0070] In the locked portion **331**, when the rotating arm portion **33** rotates around the rotating portion **32**, one or the other side surface of the locking portion **321** abuts on an upper end portion or a lower end portion of the locked portions **331** having the arc shape. Accordingly, the relative rotation between the rotating portion **32** and the rotating arm portion **33** after the abutment is regulated. In addition, by the locking portion **321** and the locked portion **331**, in the rotating arm portion **33**, specifically, 180 degrees is set to a range in relatively rotatable with respect to the rotating portion **32**. The locking portion **321** and the locked portion **331** constitute the rotation angle regulating portion.

[0071] A first link portion L**1** is formed on a tip portion side of the rotating arm portion **33**.

[0072] The first link portion L**1** includes a coupling hole LH, a bearing BR, and a shaft pin SP.

[0073] The coupling hole LH is penetratingly provided in a circular shape such that the axis extends in the X-axis direction, and pivotally supports the shaft pin SP via the bearings BR provided at both end edges of the opening, respectively.

[0074] The shaft pin SP is formed such that both end portions each have a diameter smaller than that of a central portion, and is provided such that two bearings BR sandwich two step portions which are boundaries between both end portions and the central portion.

[0075] Second link portions L**2** of the link member **5** are coupled to the tip portions on both sides, respectively, of the shaft pin SP. The second link portion L**2** includes communication holes CH formed in two members **51** each having a long plate shape of the link member **5** described later.

[0076] As illustrated in FIG. **2**, a contact surface **33***b* is provided on a side surface of the rotating arm portion **33** that is in front of rotation when the rotating arm portion **33** performs rotation to raise the link member **5**. The contact surface **33***b* is provided in parallel and flat with a line connecting the rotation center **31***c* of the rotating drive shaft **31** to the axis of the coupling hole LH.

[0077] When the rotating arm portion **33** rotates and the lifting frame **4** reaches a rising end, the contact surface **33***b* abuts on a rotating arm portion stopper AS provided so as to protrude toward the inside of the long side portion BF**1** of the base frame BF.

[0078] The rotating arm portion stopper AS includes a female screw cylinder having a cylindrical shape fixed to the inside of the long side portion BF**1** such that the axis extends in the Y-axis direction, a bolt having a base end portion screwed into the female screw cylinder, and a nut screwed into the bolt.

[0079] The contact surface **33***b* abuts on the rotating arm portion stopper AS, so that the rotating arm portion **33** is prevented from rotating by a desired rotation angle or more.

(Link Member)

[0080] The link member **5** transmits a driving force of the driving mechanism **3** to the lifting frame **4** described later. The link member **5** includes the two members **51** each made of, for example, iron and having the long plate shape and extending in the vertical direction. The two members **51** are integrally formed by being stacked with each other with a space therebetween. A curved portion **51***a* having a lower end provided with the second link portion L**2** is formed in each lower portion. A straight portion **51***b* continuous with the curved portion **51***a* is formed in an upper portion, and a third link portion L**3** is provided at an upper end of the straight portion **51***b*.

[0081] The curved portion **51***a* is formed to be curved along a side surface of the rotating drive shaft **31** so as to not come into contact with the rotating drive shaft **31**.

[0082] The communication hole CH is formed in each of the two members **51** at a lower end portion of the link member **5**. The communication hole CH is penetratingly provided such that an axis extends in the X-axis direction,

and pivotally supports the shaft pin SP. The communication hole CH at the lower end of the link member **5** constitutes the second link portion L**2**.

[0083] The two members **51** of the link member **5** are coupled and integrated by two bridging portions **52** each having a rectangular cross section.

[0084] The communication hole CH is formed in each of the two members **51** at an upper end portion of the link member **5**. The communication hole CH is penetratingly provided such that an axis extends in the X-axis direction, and pivotally supports the shaft pin SP. The communication hole CH at the upper end portion of the link member **5** constitutes the third link portion L**3**.

[0085] A fourth link portion L**4** coupled to the third link portion L**3** is provided on a bottom lower surface of the lifting frame **4**. The fourth link portion L**4** includes a holding portion HP formed in a substantially cubic shape, a holding hole HH formed in the holding portion HP, and the shaft pin SP. The holding hole HH is formed such that an axis extends along the X-axis direction. Bearings BR are provided at both ends, respectively, of an opening of the holding hole HH, and the shaft pin SP is freely rotatably supported by the bearings BR.

[0086] The lifting frame **4** described later is guided to move along the vertical direction by a guide portion **61** provided on the support leg portion **6** fixed on the base frame BF.

(Support Leg Portion)

[0087] The support leg portion **6** is made of, for example, iron and formed in a substantially rectangular tubular shape. The support leg portion **6** has a lower end portion fixed to the rectangular frame formed by two long side portions BF**1** extending in the X-axis direction of the base frame BF, the first (in FIG. **1**) horizontal bar BF**2***a*, and the fourth (in FIG. **1**) horizontal bar BF**2***d*.

[0088] The support leg portion **6** includes four side surface portions **6***a* and **6***b* and a top plate portion **6***c*, and is formed in a tower shape as a whole. One of the side surface portions **6***a* arranged in the Y-axis direction in the support leg portion **6** is formed with an inclined surface **6***a***1** having a lower portion inclined outward.

[0089] The inclined surface **6***a***1** prevents the curved portion **51***a* of the link member **5** from coming into contact with the support leg portion **6** when the rotating arm portion **33** rotates to a horizontal position.

[0090] Two side surface portions **6***b* arranged in the X-axis direction in the support leg portion **6** each have an upper portion formed in a rectangular shape and a lower portion formed in a trapezoidal shape in accordance with a shape of each of the side surface portions **6***a* arranged in the Y-axis direction. The upper portion and the lower portion are continuously integrated.

[0091] The top plate portion **6***c* having a rectangular shape is provided at an upper end of the support leg portion **6**. The top plate portion **6***c* is provided with a through hole **6***c***1** having a rectangular shape through which the link member **5** penetrates and an attachment hole **6***c***2** to which the guide portion **61** is fixed (see FIG. **4**).

[0092] The through hole **6***c***1** is formed in a size with a margin such that the link member **5** is loosely inserted. The attachment holes **6***c***2** are provided on both sides, respectively, across the through hole **6***c***1** along the X-axis direction.

(Guide Portion)

[0093] The guide portion **61** includes a guide tubular portion **61***a* and a guide rod **61***b*. The guide tubular portion **61***a* is formed in a cylindrical shape extending in the vertical direction, and is fixed to the attachment hole **6***c***2** with a lower portion of the guide tubular portion **61***a* penetrating through the attachment hole **6***c***2**. A flange-shaped portion **61***c* is circumferentially provided on a lower portion outer periphery of the guide tubular portion **61***a*, and a load from above applied to the guide tubular portion **61***a* is received by a peripheral edge portion of the attachment hole **6***c***2**.

[0094] The guide rod **61***b* is slidably inserted through the guide tubular portion **61***a*. The guide rod **61***b* is formed in a round rod shape extending in the vertical direction, and the lifting frame **4** is assembled to an upper end portion.

[0095] The guide portion **61** guides the lifting frame **4** to move along the vertical direction when the lifting frame **4** is pushed up and pulled down by the link member **5**.

(Lifting Frame)

[0096] The lifting frame **4** includes an upward extraction plate **41**, a support plate **42**, the fourth link portion L**4**, and a cover member **43**.

[0097] The upward extraction plate **41** is made of, for example, iron and a rectangular plate material, and supports a lower surface of a sand mold part SM formed inside a casting frame CF.

[0098] A lower surface of the upward extraction plate **41** is supported by the support plate **42**. The support plate **42** is made of iron and formed in a rectangular thick plate shape. When the mold (sand mold part SM) is shifted and extracted upward from the casting frame CF, the support plate **42** prevents the upward extraction plate **41** from being deformed by the force applied to the upward extraction plate **41**, and causes smooth shifting and upward extraction work.

[0099] The upward extraction plate **41** is provided with the cover member **43**. The cover member **43** is formed in a substantially rectangular tubular shape, is continuous with the lower surface of the upward extraction plate **41** at an upper end portion, and is provided so as to surround the four side surfaces of the support plate **42**. The cover member **43** extends to the vicinity of a lower end portion of the support leg portion **6** at a lower portion to cover the guide portion **61**, the link member **5**, and the support leg portion **6**, and prevents spilled sand from entering inside the driving mechanism In the cover member **43**, an inclined surface is formed on one of side surfaces arranged **3** in extracting the sand mold part SM. **[text missing or illegible when filed]** in the Y-axis direction so as to correspond to a shape of a lower portion of the support leg portion **6**, and side surfaces arranged in the X-axis direction are formed in a trapezoidal shape in which an upper portion is rectangular and a lower portion is continuous to the rectangular upper portion.

(Rise Regulating Device)

[0100] The rise regulating device **7** presses only the molding flask CF from above in extracting the mold, and is used to extract the sand mold part SM upward from the molding flask CF by the lifting frame **4**.

[0101] The rise regulating device **7** includes a hydraulic cylinder device **71**, a hydraulic switching valve **72**, an oil tank **73**, a pneumatic switching valve **74**, and a pneumatic pump AP.

[0102] The hydraulic cylinder device **71** includes a cylinder portion **71***a*, a piston portion **71***b*, and a piston rod **71***c*.

[0103] As illustrated in FIG. **2**, the cylinder portions **71***a* are fixed to lower surfaces of four corners of a support frame HF so as to face four corners, respectively, of an upper casting frame to be extracted (see FIG. **3**). The support frame HF is a part of a structure, and is formed in a rectangular frame shape with a center opened by a member having a rectangular cross section. The lower surface of the support frame HF is set at substantially the same height position as the height position of the rising end of the lifting frame **4**.

[0104] The cylinder portion **71***a* includes an opening opening downward, and the piston rod **71***c* having an upper end portion coupled to the piston portion **71***b* in the cylinder portion **71***a* moves forward and backward from the opening. The piston rod **71***c* is made of, for example, iron and formed in a rod shape. A lower end of the piston rod **71***c* abuts on a corner portion of an upper end surface of the casting frame CF from which the sand mold part SM is extracted. Note that in the present embodiment, the cylinder portions **71***a* abut on the four corner portions, respectively, of the upper casting frame, but embodiments of the present invention are not limited thereto. For example, as illustrated in FIG. **3**, a pair of cylinder portions **171***a* may be provided so as to abut on central portions of sides, respectively, facing each other of the upper casting frame.

[0105] The oil tank **73** is set such that an oil layer **73***a* in which hydraulic oil is stored is generated in a lower portion, and an air layer **73***b* filled with air is generated in an upper portion. The lower portion of the oil tank **73** having the oil layer **73***a* and the upper portion of the cylinder portion **71***a* communicate with each other via an oil feed pipe **75**. The hydraulic switching valve **72** (electromagnetic switching valve) is provided between the oil tank **73** and the cylinder portion **71***a*, and a control device controls oil feeding and stopping of the hydraulic oil.

[0106] An upper portion of the oil tank **73** having the air layer **73***b* communicates with the pneumatic pump AP via an air pipe **76**. The pneumatic switching valve **74** (electromagnetic switching valve) is provided between the oil tank **73** and the pneumatic pump AP to adjust the air pressure in the cylinder portion **71***a* and the oil tank **73**.

(Link Biasing Device)

[0107] At the time of lowering of the lifting frame **4**, a link biasing device **8** biases the link member **5** so that the rotating arm portion **33** rotates in a direction opposite to that at the time of rising.

[0108] As illustrated in FIGS. **2** and **7**, the link biasing device **8** includes a cam member **81** provided on one side surface of the two members **51** having the long plate shape of the link member **5**, and a driven node member **82** generating an biasing force when pressed by the cam member **81** to push back the cam member **81** and the link member **5**.

[0109] When cut along a virtual vertical plane including the Y-axis, the cam member **81** has a cross section of a trapezoidal shape rotated by 90 degrees. An upper base of the trapezoid is a vertical surface **81***a* facing a driven node member side described later, and a lower base is a vertical surface **81***b* connected in parallel to the link member **5**. An inclined surface **81***c* connecting an upper end edge of the vertical surface **81***a* of the upper base and an upper end edge portion of the vertical surface **81***b* of the lower base is included. The inclined surface **81***c* corresponds to an oblique side of the trapezoidal shape. The inclined surface **81***c* and the vertical surface **81***b* of the lower base form an acute angle expanding downward.

[0110] As the cam member **81**, the inclined surface **81***c* and the vertical surface **81***a* of the upper base are configured to abut on the driven node member **82**.

[0111] The driven node member **82** includes a support base **821** fixed to a vertical wall inside the support leg portion **6**, a bell crank portion **822** swingably attached to a support shaft **820** provided on the support base **821**, a guide roller portion **823** provided at a tip above the bell crank portion **822**, and a coil spring **824** having one end portion coupled to a tip below the bell crank portion **822**.

[0112] The coil spring **824** has the other end portion coupled to an attachment piece provided at an upper end corner inside the support leg portion **6**, and the guide roller portion **823** is configured to bias the bell crank portion **822** in a direction protruding toward the link member **5**. The support base **821** is provided with a stopper portion **825** preventing the guide roller portion **823** from excessively protruding so as to regulate the rotation of the bell crank portion **822**.

(Roller Conveyor)

[0113] The casting frame CF is conveyed by a roller conveyor RC extending in the X-axis direction to a horizontal position (extraction position EP), which is a height position when the upward extraction plate **41** of the lifting frame **4** is a lowering end, at which the upward extraction plate **41** can support the sand mold part SM. The casting frame CF with a mold before extraction is conveyed into the extraction position EP by the roller conveyor RC, and is positioned by a position sensor (not illustrated). The casting frame CF after the extraction is conveyed out from the extraction position EP. Since the roller conveyor RC is a known technique, the description thereof will be omitted.

(Mold Conveying Device)

[0114] The sand mold part SM extracted from the casting frame CF is conveyed to the next step by a mold conveying device provided at the height position where the sand mold part SM is extracted. As the mold conveying device, for example, a belt conveyor BC can be used.

(Control Device)

[0115] The control device (not illustrated) drives the electric motor **2** and controls the rotational position of the rotating drive shaft **31**. The control device controls switching operations of the hydraulic switching valve **72** and the pneumatic switching valve **74**.

(Operation)

[0116] The operation of the device for extracting poured molds **1** will be described below with reference to FIGS. **2**, **8**, **9**, **10**, **11**, and **12**.

[0117] First, FIG. **2** illustrates a state before the device for extracting poured molds **1** extracts the sand mold part SM from the casting frame CF.

[0118] The casting frame CF and the sand mold part SM, which are a poured mold, are conveyed into the extraction position EP and positioned by the roller conveyor RC.

[0119] The lifting frame **4** is held at a lowering end position FEP. At this time, the axis **32***c* of the rotating portion **32** and the locking portion **321** are located vertically directly below the rotation center **31***c* of the rotating drive shaft **31**. The first link portion L**1** of the rotating arm portion **33** is located vertically directly below the rotation center **31***c* of the rotating drive shaft **31**.

[0120] The locking portion **321** is in a state of abutting on an end portion below the locked portion **331**.

[0121] A gap is formed between the upper end portion of the lifting frame **4** and the lower end portion of the sand mold part SM.

[0122] The pneumatic switching valve **74** is positioned at a port which is a position at which the pneumatic pump AP communicates with the opening side of the hydraulic cylinder device **71**. The hydraulic switching valve **72** is positioned at a port which is a position at which the oil layer **73***a* of the oil tank **73** communicates with a cap side of the hydraulic cylinder device **71**. As a result, the piston rod **71***c* is held at a raised position without coming into contact with the conveyed casting frame CF.

[0123] Next, as illustrated in FIG. **8**, the control device rotates the rotating drive shaft **31** to rotate the rotating portion **32**. This rotation indicates a state in which the rotating drive shaft **31** is rotated from 0 degrees to 180 degrees, and FIG. **8** indicates a state at 90 degrees, which is a midpoint thereof. Since the rotating portion **32** is integral with the rotating drive shaft **31**, the axis **32***c* is eccentric from the rotation center **31***c*, but the rotating portion **32** rotates in conjunction with the rotating drive shaft **31**.

[0124] The locking portion **321** is located away from a lower end of the locked portion **331** and rotated by 90 degrees together with the rotating portion **32**.

[0125] The rotating arm portion **33** does not rotate, and the axis **32***c* of the rotating portion **32** rises to the same height as the rotation center **31***c* of the rotating drive shaft **31**. Thus, the rotating arm portion **33** rises at the position of 90 degrees by an amount of eccentricity between the rotation center **31***c* of the rotating drive shaft **31** and the axis **32***c* of the rotating portion **32**. As a result, the link member **5** raises the lifting frame **4**. First, an approach of filling a gap between the lifting frame **4** and the sand mold part SM is performed, and subsequently, "shift" is generated between the casting frame CF and the sand mold part SM.

[0126] At this time, the control device first positions the pneumatic switching valve **74** at a port such that the pneumatic pump AP communicates with the air layer **73***b* of the oil tank **73**. After the hydraulic pressure increases and the piston rod **71***c* advances, the hydraulic switching valve **72** is switched to a shut-off position, and a state in which the piston rod **71***c* presses the upper end portion of the casting frame CF is maintained.

[0127] FIG. **9** illustrates a state in which the rotating portion **32** is rotated up to 180 degrees while continuing the above state. A length from the lowering end position FEP to this raised position is the first stroke FS generated when the rotating portion is rotated by 180 degrees. The locking portion **321** abuts on the upper end of the locked portion **331**. As a result, the rotating portion **32** in FIG. **9** cannot relatively rotate with respect to the rotating arm portion **33** in the clockwise direction. Thus, when the rotating drive shaft **31** rotates by 180 degrees or more, the rotating arm portion **33** rotates integrally with the rotating portion **32** in the clockwise direction while the rotating drive shaft **31** rotates from 180 degrees to 360 degrees.

[0128] FIG. **10** illustrates a state in which the rotating drive shaft **31** is at a position of 270 degrees, which is a midpoint thereof. The first link portion L**1** of the rotating arm portion **33** is horizontally aligned with the rotation center **31***c* of the rotating drive shaft **31**. Thus, the lower portion of the link member **5** swings largely sideways.

[0129] The link member **5** greatly pushes up the lifting frame **4** in the upper portion to extract the sand mold part SM from the casting frame CF.

[0130] FIG. **11** illustrates a state in which the rotating drive shaft **31** is rotated to a position of 360 degrees. A length by which the lifting frame **4** is pushed up when the rotating drive shaft **31** is rotated from 180 degrees to 360 degrees to rotate the rotating arm portion **33** is the second stroke SS.

[0131] The contact surface **33***b* of the rotating arm portion **33** abuts on the rotating arm portion stopper AS to regulate further rotation of the rotating arm portion **33**.

[0132] The cam member **81** presses the guide roller portion **823** to rotate the bell crank portion **822** clockwise (in FIG. **11**). As a result, the coil spring **824** is stretched to generate a biasing force for biasing the bell crank portion **822** in the counterclockwise direction.

[0133] The control device positions the pneumatic switching valve **74** at a port such that the oil tank **73** communicates with the atmosphere and the pneumatic pump AP communicates with the opening side of the hydraulic cylinder device **71**. The control device positions the hydraulic switching valve **72** at a port at a position where the oil layer **73***a* of the oil tank **73** communicates with the cap portion side of the hydraulic cylinder device **71**.

[0134] The sand mold part SM is completely extracted from the casting frame CF and is raised to a height position of the belt conveyor BC to be conveyed. FIG. **12** illustrates a state in which the extracted sand mold part SM is conveyed to the next step by the belt conveyor BC.

[0135] The control device reversely rotates (counterclockwise rotation in FIG. **11**) the rotating drive shaft **31**, so that the lifting frame **4** is lowered. At this time, the link member **5** is biased in a direction in which the rotating arm portion **33** rotates in the reverse direction, and thus the link member **5** can smoothly and reliably rotate in the reverse direction to lower the lifting frame **4**. The casting frame CF s conveyed to the downstream side by the roller conveyor RC, and a new casting frame CF before extraction is conveyed into the extraction position EP from the upstream side.

[0136] As is clear from the above description, the device for extracting poured molds **1** according to the embodiment of the present invention includes the electric motor **2**, the driving mechanism **3** including the rotating drive shaft **31** driven by the electric motor **2**, the lifting frame **4** supporting the lower surface of the sand mold part SM inside the casting frame CF of the poured molds to cause thereof to be capable of lifting, the link member **5** extending in the vertical direction and provided between the driving mechanism **3** and the lifting frame **4**, and the rise regulating device **7** abutting on the outer periphery of the casting frame CF to regulate rising of the casting frame CF when the lifting frame **4** is raised.

[0137] The driving mechanism **3** includes the shifting portion (rotating portion **32**) shifting the lifting frame **4** upward relatively by a predetermined length in cooperation

with the rise regulating device **7** in order to separate the sand mold part SM from the casting frame CF in the adhered state at the extraction position EP where the sand mold part SM is extracted from the casting frame CF, and the upward extraction portion (rotating arm portion **33**) extracting the shifted sand mold part SM upward to a conveyance position TP with the force smaller than the force of shifting by the shifting portion and at the speed higher than the speed of shifting by the shifting portion.

[0138] According to this, by dividing the device for extracting poured molds **1** into the shifting portion requiring a large force with a short stroke and the upward extraction portion requiring a high speed with a long stroke to work, miniaturization of the device and improvement of the work efficiency can be achieved.

[0139] In addition, in the device for extracting poured molds of the first aspect, the shifting portion includes the rotating portion **32** having a cylindrical shape and including the axis **32***c* parallel to the rotation center **31***c* of the rotating drive shaft **31**, the axis **32***c* being eccentric by the predetermined dimension from the rotation center **31***c* of the rotating drive shaft **31**.

[0140] The upward extraction portion is the rotating arm portion **33** having the predetermined rotation radius extending in the radial direction of the rotating portion **32**, and includes, on the base end portion side, the opening holding portion **33***a* holding the outer periphery of the rotating portion **32** so as to be relatively rotatable, and includes, on the tip portion side, the rotating arm portion **33** having the first link portion L**1**.

[0141] The link member **5** includes, at one end, the second link portion L**2** coupled to the first link portion L**1** of the rotating arm portion **33** in a rotatable manner, and includes, at the other end, the third link portion L**3**, and the lifting frame **4** includes the fourth link portion L**4** linked to the third link portion L**3** in a rotatable manner.

[0142] The rotation angle regulating portion (locking portion **321** and locked portion **331**) is provided between the opening holding portion **33***a* and the rotating portion **32** in which when the rotating portion **32** relatively rotates with respect to the opening holding portion **33***a* by the predetermined angle, the relative rotation is regulated, so that the rotating portion **32** and the rotating arm portion **33** rotate integrally.

[0143] According to this, the eccentric axis **32***c* moves from below the rotation center **31***c* to above the rotation center **31***c* by the rotation of the rotating portion **32**, so that the link member **5** is raised by the distance necessary for shifting. At this time, the rotating portion **32** and the opening holding portion **33***a* of the rotating arm portion **33** relatively rotate (idle) and the rotating arm portion **33** does not rotate, and thus the link member **5** rises by the distance necessary for shifting by the rotating portion **32**.

[0144] When the rotating portion **32** relatively rotates with respect to the opening holding portion **33***a* by the predetermined angle, the relative rotation (idling) state of the rotating arm portion **33** with respect to the rotating portion **32** is released by the rotation angle regulating device (locking portion **321** and locked portion **331**), and the rotating arm portion **33** rotates and the first link portion L**1** of the rotating arm portion **33** moves from below the rotation center **31***c* to above the rotation center **31***c*, so that the link member **5** is further raised. As a result, the shifted sand mold part SM can be extracted upward to the position EP where the sand mold part SM is conveyed.

[0145] Further, the predetermined dimension in which the axis **32***c* of the rotating portion **32** is eccentric from the rotation center **31***c* of the rotating drive shaft **31** is a dimension for generating the first stroke FS in the vertical direction necessary for shifting the poured sand mold part SM in the casting frame CF from the inner wall of the casting frame CF, and at the same time, for causing the rotating portion **32** to generate a force necessary for shifting by the rotational torque of the electric motor **2**. The dimension of the predetermined rotation radius of the rotating arm portion **33** is a dimension for generating the second stroke SS in the vertical direction necessary for extracting the sand mold part SM separated from the casting frame CF upward.

[0146] According to this, an eccentric dimension at a position shifted by a predetermined dimension from the rotation center **31***c* of the rotating drive shaft **31** is set as a force and the first stroke FS necessary for separating the poured mold (sand mold part SM) in the casting frame CF from the casting frame inner wall, and a dimension having a predetermined dimension from the rotation center **31***c* of the rotating arm portion **33** as the rotation radius is set as a force and the second stroke SS necessary for upward extracting after separating from the casting frame inner wall.

[0147] A distance from the rotation center **31***c* of the rotating drive shaft **31** to the center of the first link portion L**1** rotated by the rotating arm portion **33** is longer than a distance from the rotation center **31***c* of the rotating drive shaft **31** to the axis **32***c* of the rotating portion **32**. Thus, when an angular velocity of the rotating drive shaft **31** is the same, a rotational speed of the rotating arm portion **33** becomes faster than a rotational speed of the rotating portion **32**, and accordingly, a speed of the first stroke FS associated with the rotation of the rotating portion **32** becomes slower than a speed of the second stroke SS associated with the rotation of the rotating arm portion **33**.

[0148] The torque is obtained by multiplying a "distance from the rotation center **31***c*" by a "circumferential force". Thus, even when the torque from the electric motor **2** generated in the rotating drive shaft **31** is the same, the force of the first stroke FS associated with the rotation of the rotating portion **32** having a short distance from the rotation center **31***c* is larger than the force of the second stroke SS associated with the rotation of the rotating arm portion **33** having a long distance from the rotation center **31***c*.

[0149] As a result, a drive source of one electric motor **2** can efficiently set a high output range due to a low speed rise of the first stroke FS and a low output range due to a high speed rise of the second stroke SS according to a load.

[0150] The link biasing device **8** biasing the link member **5** at the time of lowering of the lifting frame **4** so that the rotating arm portion **33** rotates in the direction opposite to that at the time of rising is provided.

[0151] According to this, by providing the link biasing device **8** so as to press the link member **5** by the predetermined dimension in the direction opposite to the operation in the rising direction at the rising end position of the lifting frame **4**, the rotating arm portion **33** is smoothly rotated in the direction opposite to that at the time of rising at the start of lowering of the lifting frame **4**, so that the lowering step can be quickly and reliably performed.

[0152] The rise regulating device **7** includes at least the pair of hydraulic cylinder devices **71** each including the piston rod **71***c* capable of abutting on the outer periphery upper surface of the upper casting frame of the casting frame CF, the oil tank **73** including the oil layer **73***a* storing the hydraulic oil and the air layer **72***b* generated above the oil layer **73***a*, the hydraulic switching valve **72** provided between the oil tank **73** and the hydraulic cylinder device **71**, the pneumatic pump AP applying a pressure to air to feed the air, and the pneumatic switching valve **74** provided between the pneumatic pump AP and the air layer **73***b* of the oil tank **73**. The hydraulic oil is supplied from the oil tank **73** to the hydraulic switching valve **72** by an air pressure applied to the air layer **73***b* of the oil tank **73**.

[0153] According to this, the hydraulic oil is supplied to the hydraulic switching valve **72** by the air pressure via the oil tank **73**, so that it is possible to stop large exhaust pressure generated at the initial stage of upward extraction of the mold by the withstanding pressure of the hydraulic cylinder device **71** and the hydraulic switching valve **72** without using the hydraulic unit. In addition, there is provided embodiments of the method for extracting poured molds using the device for extracting poured molds **1** including the electric motor **2**, the driving mechanism **3** driven by the electric motor **2**, the lifting frame **4** supporting the lower surface of the sand mold part SM inside the casting frame CF of the poured molds to cause thereof to be capable of lifting, the link member **5** extending in the vertical direction and provided between the driving mechanism **3** and the lifting frame **4**, and the rise regulating device **7** abutting on the outer periphery of the casting frame CF to regulate rising of the casting frame CF when the lifting frame **4** is raised.

[0154] In embodiments, the method includes the shifting step of relatively shifting the sand mold part SM by the predetermined length in the vertical direction by the shifting portion (rotating portion **32**) in order to separate the sand mold part SM from the casting frame CF in the adhered state in cooperation with the rise regulating device **7** at the extraction position EP where the sand mold part SM is extracted from the casting frame CF by using the driving mechanism **3**, and the upward extracting step of extracting the shifted sand mold part SM upward by the upward extraction portion (rotating arm portion **33**) to the conveyance position TP with a force smaller than the force of shifting by the shifting step and at the speed higher than the speed of shifting by the shifting step.

[0155] According to this, a work step is executed by dividing the extracting poured molds into the shifting portion (rotating portion **32**) requiring the large force with the short stroke and the upward extraction portion (rotating arm portion **33**) requiring the high speed with the long stroke, so that miniaturization of the device and improvement of the work efficiency can be achieved.

[0156] In the above embodiment, the rotating portion **32** constituting the shifting portion has a short cylindrical shape provided around the rotating drive shaft **31**, but embodiments of the present invention are not limited thereto. For example, as illustrated in FIGS. **13** to **15**, it may be configured in a crankshaft shape together with a rotating drive shaft **131**.

[0157] In this case, two rotating portions **132** are coupled to each other by a thin shaft **140** eccentric from a rotation center **131***c* of a rotating drive shaft **131**, and a rotating arm portion **133** forming the upward extraction portion is sandwiched from both sides. Further, locking portions **1321** are formed integrally with peripheral edge portions of the two rotating portions **132**, respectively, to protrude in a radial direction. Locked portions **1331** are integral with the rotating arm portion **133**, but are provided on both sides of the rotating arm portion **133** corresponding to the two locking portions **1321**, respectively.

[0158] Other configurations are the same as those of the above embodiment.

[0159] Although the present invention has been disclosed in the form of embodiments and variations thereon, it will be understood that numerous additional modifications and variations could be made thereto without departing from the scope of the invention.

[0160] For the sake of clarity, it is to be understood that the use of "a" or "an" throughout this application does not exclude a plurality, and "comprising" does not exclude other steps or elements. The mention of a "unit" or a "module" does not preclude the use of more than one unit or module.

REFERENCE SIGNS LIST

[0161] **1** Device for extracting poured molds
[0162] **2** Electric motor
[0163] **3** Driving mechanism
[0164] **31** Rotating drive shaft
[0165] **31***a* Rotation center
[0166] **32** Rotating portion (shifting portion)
[0167] **32***c* Axis
[0168] **321** Locking portion (rotation angle regulating portion)
[0169] **33** Rotating arm portion (upward extraction portion)
[0170] **33***a* Opening holding portion
[0171] **331** Locked portion (rotation angle regulating portion)
[0172] **4** Lifting frame
[0173] **5** Link member
[0174] **7** Rise regulating device
[0175] **71** Hydraulic cylinder device
[0176] **71***c* Piston rod
[0177] **72** Hydraulic switching valve
[0178] **73** Oil tank
[0179] **73***a* Oil layer
[0180] **73***b* Air layer
[0181] **74** Pneumatic switching valve
[0182] **8** Link biasing device
[0183] AP Pneumatic pump
[0184] CF Casting frame
[0185] EP Device for extracting
[0186] L**1** First link portion
[0187] L**2** Second link portion
[0188] L**3** Third link portion
[0189] L**4** Fourth link portion
[0190] SM Sand mold part
[0191] TP Conveyance position

1-6. (canceled)

7. A device for extracting poured molds comprising:

an electric motor:

a driving mechanism including a rotating drive shaft driven by the electric motor;

a lifting frame configured to support a lower surface of a sand mold part serving as an inside of a casting frame of poured molds to cause the sand mold part to be capable of lifting;

a link member extending in a vertical direction and provided between the driving mechanism and the lifting frame; and

a rise regulating device abutting on an outer periphery of the casting frame to regulate rising of the casting frame when the lifting frame is raised, wherein

the driving mechanism includes:

a rotating drive shaft of the electric motor and a rotating arm portion, and the rotating arm portion converts rotation of the rotating drive shaft into vertical movement of the link member,

wherein a rotating portion is interposed between the rotating drive shaft and the rotating arm portion, and an axis of the rotating portion is eccentric with respect to a rotation center of the rotating drive shaft,

wherein a rotation radius of the rotating arm portion is larger than an amount of eccentricity of the rotating portion,

wherein rotation of the rotating drive shaft is transmitted to the rotating portion at a first stage of an initial rotation of the rotating drive shaft, so that the rotating portion rotates to shift the lifting frame upward corresponding to an amount of eccentricity via the link member, and the sand mold part in a state of adhering to the casting frame is separated from the casting frame,

wherein the rotation of the rotating drive shaft is transmitted to the rotating arm portion at a second stage of further rotating the rotating drive shaft, so that the rotating arm portion rotates to further extracting the lifting frame upward corresponding to the rotation radius of the rotating arm portion via the link member, and the sand mold part separated from the casting frame is moved to a conveyance position,

wherein an upward extraction force at the second stage is smaller than a shifting force at the first stage, and an upward extraction speed at the second stage is faster than a shifting speed at the first stage.

8. A device for extracting poured molds comprising:

an electric motor;

a driving mechanism including a rotating drive shaft driven by the electric motor;

a lifting frame configured to support a lower surface of a sand mold part serving as an inside of a casting frame of poured molds to cause the sand mold part to be capable of lifting;

a link member extending in a vertical direction and provided between the driving mechanism and the lifting frame; and

a rise regulating device abutting on an outer periphery of the casting frame to regulate rising of the molding flask when the lifting frame is raised, wherein

the driving mechanism includes

a shifting portion configured to shift the lifting frame upward relatively by a predetermined length in cooperation with the rise regulating device to separate the sand mold part from the casting frame in an adhered state at an extraction position where the sand mold part is extracted from the casting frame; and

an upward extraction portion configured to extract the shifted sand mold part upward to a conveyance position with a force smaller than a force of shifting by the shifting portion and at a speed higher than a speed of shifting by the shifting portion,

wherein the shifting portion includes a rotating portion having a cylindrical shape and including an axis parallel to a rotation center of the rotating drive shaft, the axis being eccentric by a predetermined dimension from the rotation center of the rotating drive shaft,

wherein the upward extraction portion is a rotating arm portion having a predetermined rotation radius extending in a radial direction of the rotating portion, and includes, on a base end portion side, an opening holding portion configured to hold an outer periphery of the rotating portion to be relatively rotatable, and includes, on a tip portion side, the rotating arm portion having a first link portion,

wherein the link member includes, at one end, a second link portion coupled to the first link portion of the rotating arm portion in a rotatable manner, and includes, at the other end, a third link portion,

wherein the lifting frame includes a fourth link portion linked to the third link portion in a rotatable manner, and

wherein a rotation angle regulating portion is provided between the opening holding portion and the rotating portion wherein when the rotating portion rotates relative to the opening holding portion by a predetermined angle, the relative rotation is regulated, and the rotating portion and the rotating arm portion rotate integrally.

9. The device for extracting poured molds according to claim **8**, wherein,

the eccentric predetermined dimension of the shifting portion is a dimension for generating a first stroke in the vertical direction necessary for shifting the poured sand mold part in the casting frame from the inner wall of the casting frame, and at the same time, for causing the rotating portion to generate a force necessary for shifting by a rotational torque of the electric motor, and

a dimension of the predetermined rotation radius of the rotating arm portion is a dimension for generating a second stroke in the vertical direction necessary for extracting the sand mold part separated from the casting frame upward.

10. The device for extracting poured molds according to claim **8**, wherein a link biasing device configured to bias the link member at the time of lowering of the lifting frame, and the rotating arm portion rotates in a direction opposite to a direction at the time of rising is provided.

11. The device for extracting poured molds according to claim **8**, wherein

the rise regulating device includes

at least a pair of hydraulic cylinders each including a piston rod capable of abutting on an outer periphery upper surface of an upper casting frame of the casting frame,

an oil tank including an oil layer storing hydraulic oil and an air layer generated above the oil layer,

a hydraulic switching valve provided between the oil tank and the hydraulic cylinder,

a pneumatic pump configured to apply a pressure to air to feed the air, and

a pneumatic switching valve provided between the pneumatic pump and the air layer of the oil tank, and

wherein hydraulic oil is supplied from the oil tank to the hydraulic switching valve by an air pressure applied to the air layer of the oil tank.

12. A method for extracting poured molds using the device for extracting poured molds according to claim **7**, the method comprising:

by using the driving mechanism, shifting of relatively shifting the sand mold part by a predetermined length in the vertical direction to separate the sand mold part from the casting frame in an adhered state in cooperation with the rise regulating device at an extraction position where the sand mold part is extracted from the casting frame; and

upward extracting of extracting the shifted sand mold part upward to a conveyance position with a force smaller than a force of shifting by the shifting and at a speed higher than a speed of shifting by the shifting without changing the rotational torque of the electric motor itself.

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