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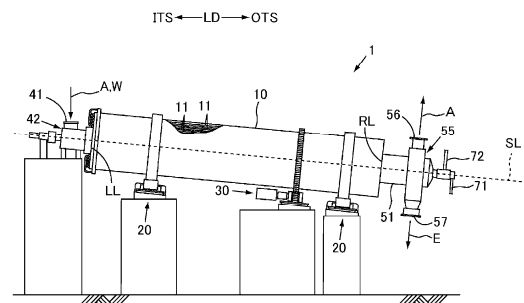
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(54) **HORIZONTAL-TYPE ROTARY DRYER**

(57) To provide a horizontal rotary dryer capable of adjusting a hold up ratio of a processing material in a rotating shell.

A horizontal rotary dryer 1 that solves the above problem includes: a rotating shell 10 that has a feed port 41 of a processing material W on one end side ITS and a discharge port 50 of the processing material W on the other end side OTS, and is rotatable in a circumferential direction; a discharge pipe 51 connected to the discharge port 50 formed at a central portion of the rotating shell 10 on the other end side; and a first lifting member 60 that is located on the other end side OTS of the rotating shell 10, rotates in the circumferential direction of the rotating shell 10, and lifts the processing material W deposited on a lower portion of the rotating shell 10 on the other end side OTS, and guides the processing material W into the discharge pipe 51. The first lifting member is a variable lifting member capable of changing an area of a front surface of the first lifting member 60 facing a rotation direction thereof.

[FIG.1]



Description

Technical Field

[0001] The present invention relates to a horizontal rotary dryer that heats and dries a processing material. In particular, the present invention relates to a processing material discharge mechanism disposed on a discharge side of a rotating shell of the horizontal rotary dryer.

Background Art

[0002] In a conventional horizontal rotary dryer, a weir board is disposed inside a rotating shell, and the weir board ensures a desired hold up ratio of a processing material and desired drying performance thereof.

[0003] In addition to a form in which a weir board is disposed inside a rotating shell, those having a mechanism as described in Patent Literatures 1 to 5 below exist.

[0004] A rotary drum type dryer of Patent Literature 1 includes a rotary drum and an agitating flight (vane) disposed astride in a longitudinal direction within the rotary drum, in which a position of a distal end portion of a flight (vane) plate in the agitating flight (vane) is set so as to pass through a height position of 2/3 or more of an outlet weir on a terminal end side of the rotary drum and to pass through a height position of 3/3 or less of the outlet weir at least on a rotary transporting direction side of stayed dust at a bottom part of the rotary drum. A lifter disposed on an inner surface of the rotary drum has a height equal to or less than 1/3 of the height of the outlet weir disposed at the terminal end of the rotary drum, its upper part is formed as a pointed shape, its front surface and its rear surface are slanted toward the inner surface of the rotary drum in a shape spreading toward an end. According to the rotary drum type dryer, an increased adhesion of dust to the inner surface of the rotary drum is prevented, a flow of dust from its inlet side to a discharging side is not prohibited, and a decrease in its processing capability due to a reduced staying amount does not occur.

[0005] A drum dryer of Patent Literature 2 receives a drying object from an inlet side of one end of a rotary drum, dries the drying object with hot air while rotating the rotary drum, and discharges the dried object from an outlet side of the other end, in which a plurality of lifters formed of single flights (vanes) slanted so as to deliver back the drying object in an inlet direction of the drying object upon normal rotation of the rotary drum and to deliver the drying object toward an outlet side upon reverse rotation are disposed. According to this drum dryer, it is possible to improve a drying efficiency upon normal rotation in a drum dryer capable of discharging a drying object by rotating a rotary drum in reverse.

[0006] In a horizontal rotary dryer of Patent Literature 3, a dried object take-out part formed in a cylindrical main body, a relay chamber disposed adjacent to the dried object take-out part, and a discharge chamber adjacent

to the relay chamber are formed in a connected manner, and a scrape and return device of the dried object is disposed on a circumference face of a shaft pipe extended from the dried object take-out part to the relay chamber, and the scrape and return device is operated with rotation of the main body. According to the horizontal rotary dryer, when an upper surface of the dried object in the discharge chamber rises, a screw formed in a shaft cylinder that rotates with rotation of the main body scrapes back the dried object that has reached or exceeded a repose angle of the dried object and has flown back to the relay chamber into the main body. Therefore, the dried object is prevented from being strongly pushed into the discharge chamber and agglomerated.

[0007] In a method for taking out a content of a rotary kiln disclosed in Patent Literature 4, an inlet pipe and an outlet pipe are disposed at both center ends of a kiln, bearings are attached to the inlet pipe and the outlet pipe, respectively, and a sprocket is attached to one of the bearings. The bearings are set on a frame, and a reduction gear with a sprocket and the sprocket of the kiln are connected by a roller chain. A rotation direction of the reduction gear is changeable. According to this method, when a content in a batch type rotary kiln is taken out, a rotation direction of a kiln only needs to be rotated in a taking-out time direction by a switch, which is considered to be convenient.

[0008] In a rotary heat treatment furnace of Patent Literature 5, a furnace body portion integrally formed with a cylindrical container-shaped heating drum and an introduction tube portion and a discharge tube portion in which screw flights (vanes) are internally disposed and fixed to both ends of a central axis of the heating drum is rotatably disposed such that a heating drum portion is housed in a heat-insulating muffle including a heat generator in a lower portion, and end portions of the introduction tube portion and the discharge tube portion are connected to a raw material feed portion and a processed product discharge portion by a sealing sliding seal mechanism. According to this rotary heat treatment furnace, with a mechanism in which the screw flights (vanes) that feed and discharge a particulate matter are internally disposed and fixed in the introduction tube portion and the discharge tube portion, which serve as a rotation axis of the heating drum, the particulate matter can be smoothly conveyed using rotation of the furnace body itself, and furthermore, an airtight furnace structure can be constituted.

Citation List

Patent Literature

[0009]

Patent Literature 1: JP H09-310978 A
Patent Literature 2: JP 2001-272166 A
Patent Literature 3: JP 2007-263481 A

Patent Literature 4: JP H09-166382 A

Patent Literature 5: JP H07-002889 A

Summary of Invention

Technical Problem

[0010] In a conventional horizontal rotary dryer that heats and dries a processing material in a process in which the processing material moves from one end side to the other end side in a rotating shell, when the processing material has high fluidity, even if a hollow disk-shaped weir board is disposed in the rotating shell so as to be in contact with an inner peripheral wall of the rotating shell along a transverse cross section of the rotating shell in order to increase a hold up ratio of the processing material on one end side of the rotating shell, the processing material may easily move to the other end side through a hollow portion of a central portion of the weir board. Therefore, there is a problem that the hold up ratio of the processing material at a portion on one end side of the weir board is not a sufficient value, leading to deterioration of drying performance of the processing material.

[0011] In the above Patent Literature 1, a flight (vane) plate is disposed inside the rotary drum to reduce the scraping amount of stayed dust and to stabilize a flow of transportation of dust to the discharge side. Such a flight (vane) plate stabilizes a flow of transportation of dust, and does not adjust the hold up ratio of stayed dust in the rotary drum.

[0012] In the above Patent Literature 2, an annular weir board is disposed on an outlet-side end surface of the rotary drum, and a cutout portion and a guide flight (vane) are disposed in a part of the annular weir board to adjust a retention time of the drying object. However, according to the drawing of Patent Literature 2, the guide flight (vane) is merely a plate member obliquely extending inward from one side of the cutout portion, and thus does not have a function of appropriately adjusting a hold up ratio of the drying object in the rotary drum.

[0013] In addition, in the above Patent Literatures 3 to 5, various mechanisms for discharging the processing material in the rotating shell are disclosed, but there is no mechanism capable of adjusting a hold up ratio of the processing material in the rotating shell.

[0014] Therefore, a main object of the present invention is to provide a horizontal rotary dryer capable of appropriately adjusting a hold up ratio of a processing material in a rotating shell.

Solution to Problem

[0015] The present invention solving the above problem is as follows.

(First Aspect)

[0016] A horizontal rotary dryer including:

- 5 a rotating shell that has a feed port of a processing material on one end side and a discharge port of the processing material on the other end side, and is rotatable in a circumferential direction;
- 10 a discharge pipe connected to the discharge port formed at a central portion of the rotating shell on the other end side; and
- 15 a first lifting member that is located on the other end side of the rotating shell, rotates in the circumferential direction of the rotating shell, and lifts the processing material deposited on a lower portion of the rotating shell on the other end side, and guides the processing material into the discharge pipe, wherein the first lifting member is a variable lifting member capable of changing an area of a front surface of the first lifting member facing a rotation direction thereof.

(Action and effect)

- 25 **[0017]** In the horizontal rotary dryer according to the present aspect, the first lifting member lifts the processing material deposited on the lower portion of the rotating shell on the other end side, and guides the lifted processing material into the discharge pipe. In the horizontal rotary dryer, since the area of the front surface of the first lifting member facing the rotation direction can be changed, the lifting amount of the processing material by the first lifting member can be adjusted, and as a result, a hold up ratio of the processing material in the rotating shell can be appropriately adjusted.
- 30
- 35

(Second Aspect)

[0018] The horizontal rotary dryer according to the first aspect, including,

- 40 inside the rotating shell, a large number of heating tubes through which a heating medium passes, wherein
- 45 the horizontal rotary dryer indirectly heats and dries the processing material by bringing the processing material into contact with outer surfaces of the heating tubes while the processing material moves from one end side to the other end side of the rotating shell.
- 50

(Action and effect)

- 55 **[0019]** The horizontal rotary dryer according to the second aspect is an indirect heating-type horizontal rotary dryer. The indirect heating-type horizontal rotary dryer is a dryer called a steam tube dryer or the like. In the indirect heating-type horizontal rotary dryer, in order to make the water content of the processing material

discharged from the rotating shell a desired value, it is important to control a contact ratio between the large number of heating tubes and the processing material, and a hold up ratio of the processing material in the rotating shell is an element involved in the contact ratio. In the indirect heating-type horizontal rotary dryer, it is important to adjust the hold up ratio of the processing material in the rotating shell, and since the area of the front surface of the first lifting member with respect facing the rotation direction can be changed, it is easy to adjust the hold up ratio of the processing material.

(Third Aspect)

[0020] The horizontal rotary dryer according to the first or second aspect, wherein

a through hole is formed in a part of the first lifting member, and
the first lifting member has an opening and closing door capable of covering the through hole.

(Action and effect)

[0021] In a state where the opening and closing door is opened, when the first lifting member is rotated, the processing material placed on the front surface of the first lifting member in the rotation direction falls out of the through hole of the first lifting member.

[0022] On the other hand, in a state where the opening and closing door is closed, when the first lifting member is rotated, it is possible to prevent the processing material placed on the front surface of the first lifting member in the rotation direction from falling out of the through hole of the first lifting member.

[0023] As described above, since the lifting amount of the processing material can be changed by opening and closing of the opening and closing door, the hold up ratio of the processing material in the rotating shell can be adjusted.

(Fourth Aspect)

[0024] The horizontal rotary dryer according to the third aspect, wherein the opening and closing door is a swing door that opens to at least one of a front side and a rear side of the first lifting member in a rotation direction thereof.

(Action and effect)

[0025] As the opening and closing door, a swing door that opens to at least one of the front side and the rear side of the first lifting member in the rotation direction can be used. The action and effect of the third aspect can be achieved by the swing door.

(Fifth Aspect)

[0026] The horizontal rotary dryer according to the third or fourth aspect, wherein

the first lifting member
is disposed between an outer wall of the discharge pipe and an inner wall of the rotating shell,
extends from an inner side to an outer side of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell,
an inner side portion of the first lifting member is located behind an outer side portion of the first lifting member in a rotation direction of the first lifting member, and
an intermediate portion connecting the inner side portion of the first lifting member and the outer side portion of the first lifting member extends from a rear side to a front side of the first lifting member in the rotation direction.

(Action and effect)

[0027] The horizontal rotary dryer according to the fifth aspect is characterized by the shape of the first lifting member extending from the inner side to the outer side of the rotating shell in an intersecting cross section intersecting with the axis of the rotating shell. Specifically, the inner side portion of the first lifting member is located behind the outer side portion of the first lifting member in the rotation direction of the first lifting member, and the intermediate portion connecting the inner side portion of the first lifting member and the outer side portion of the first lifting member extends from a rear side to a front side of the first lifting member in the rotation direction. By forming the first lifting member in such a shape, the processing material lifted by the first lifting member can be temporarily stored in a recessed portion formed by the inner side portion and the intermediate portion of the first lifting member, and therefore the lifted processing material is easily discharged to the discharge pipe.

(Sixth Aspect)

[0028] The horizontal rotary dryer according to any one of the first to fifth aspects, wherein the first lifting member has a side wall on at least one of a feed port side and a discharge port side of the processing material.

(Action and effect)

[0029] A side wall is preferably formed on at least one of the feed port side and the discharge port side of the processing material in the first lifting member. In a case where the side wall is formed on the feed port side, when the processing material is lifted by the first lifting member, the lifted processing material is less likely to fall from the feed port side. Therefore, the processing material lifted

by the first lifting member is more easily discharged to the discharge pipe than a case where the side wall is not formed on the feed port side.

[0030] In a case where the side wall is formed on the discharge port side, similarly, the lifted processing material is less likely to fall from the discharge port side, and therefore the processing material lifted by the first lifting member is more easily discharged to the discharge pipe than a case where the side wall is not formed on the discharge port side.

[0031] Note that it is preferable to form side walls on both the feed port side and the discharge port side of the processing material in the first lifting member from a viewpoint of easily discharging the processing material lifted by the first lifting member to the discharge pipe.

(Seventh Aspect)

[0032] The horizontal rotary dryer according to the first or second aspect, wherein

the first lifting member
is disposed between an outer wall of the discharge
pipe and an inner wall of the rotating shell, and
includes:

an inner side lifting flight extending from an inner
side to an outer side of the rotating shell in an
intersecting cross section intersecting with an
axis of the rotating shell; and
an outer side lifting flight disposed adjacent to
the inner side lifting flight and movable to an
outer side with respect to the inner side lifting
flight, and
an extension length of the first lifting member
can be changed by moving the outer side lifting
flight to an inner side or an outer side.

(Action and effect)

[0033] In the horizontal rotary dryer according to the present aspect, when the height of the processing material deposited on a lower portion of the rotating shell exceeds a predetermined height, the processing material in a portion of the height exceeding the predetermined height is scraped by the first lifting member and poured into the discharge pipe. According to the present aspect, there is an advantage that the predetermined height, that is, a boundary line by which whether or not the processing material is scraped is determined can be easily changed by changing the extension length of the first lifting member. In addition, since the processing material in a portion exceeding the predetermined height is scraped by the first lifting member, there is also an advantage that it is easier to adjust a hold up ratio of the processing material by adjusting the lifting amount of the processing material in the rotating shell.

(Eighth Aspect)

[0034] The horizontal rotary dryer according to the first or second aspect, wherein

the first lifting member
is disposed between an outer wall of the discharge
pipe and an inner wall of the rotating shell, and
includes:

a fixed flight having a proximal end portion di-
rectly or indirectly fixed to a peripheral wall of the
discharge pipe, and extending from an inner
side to an outer side of the rotating shell in an
intersecting cross section intersecting with an
axis of the rotating shell; and
a plurality of rotating flights disposed on an outer
side of the fixed flight and capable of being
connected to a distal end portion of the fixed
flight,
the horizontal rotary dryer includes
a rotary member having a rotation axis extend-
ing from an inner side to an outer side of the
rotating shell in an intersecting cross section
intersecting with the axis of the rotating shell,
the plurality of rotating flights
have different lengths extending to an outer side
of the rotating shell in an intersecting cross
section intersecting with the axis of the rotating
shell,
are fixed to the rotary member, and
rotate in a circumferential direction of the rota-
tion axis along with rotation of the rotary mem-
ber, and
the rotating flights connected to the fixed flight
can be changed by rotating the rotary member.

(Action and effect)

[0035] Also in the present aspect, similarly to the hor-
izontal rotary dryer according to the third aspect, a portion
exceeding a predetermined height of the processing
material deposited on a lower portion of the rotating shell
is scraped by the first lifting member and poured into the
discharge pipe. In the present aspect, the lifting amount
of the processing material can be adjusted by changing
the rotating flights connected to the fixed flight. There-
fore, a hold up ratio of the processing material can be
easily adjusted by the first lifting member according to the
present aspect.

(Ninth Aspect)

[0036] The horizontal rotary dryer according to the first or second aspect, wherein

the first lifting member extends from an inner side to
an outer side of the rotating shell in an intersecting

cross section intersecting with an axis of the rotating shell in a state where a proximal end portion of the first lifting member is directly or indirectly attached to a peripheral wall of the discharge pipe, another first lifting member extending to an outer side of the rotating shell in an intersecting cross section intersecting with the axis of the rotating shell and having a different length is prepared in advance, and the first lifting member is replaceable to the peripheral wall of the discharge pipe.

(Action and effect)

[0037] By replacing the first lifting member directly or indirectly attached to the peripheral wall of the discharge pipe with a first lifting member having a different length, the lifting amount of the processing material can be changed. According to the horizontal rotary dryer of the present aspect, capable of replacing the first lifting member, a hold up ratio of the processing material can be easily adjusted.

(Tenth Aspect)

[0038] The horizontal rotary dryer according to the first or second aspect, wherein

the first lifting member has a proximal end portion directly or indirectly attached to a peripheral wall of the discharge pipe, extends from an inner side to an outer side of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell, and an extension member that extends an outer side extension length of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell is attachable to a distal end portion of the first lifting member.

(Action and effect)

[0039] By attaching an extension member that extends an outer side extension length of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell to a distal end portion of the first lifting member, the lifting amount of the processing material can be changed. According to the horizontal rotary dryer according to the present aspect, capable of attaching an extension member to a distal end portion of the first lifting member, a hold up ratio of the processing material can be easily adjusted.

(Eleventh Aspect)

[0040] The horizontal rotary dryer according to the first, second, fifth, seventh, eighth, ninth, or tenth aspect, wherein the first lifting member extends radially outward

from an outer wall of the discharge pipe.

(Action and effect)

[0041] For example, in a case where the first lifting member is to be extended to the vicinity of an inner wall of the rotating shell, when the first lifting member is extended in a radial direction of the rotating shell, the extension length of the first lifting member can be minimized. That is, when the extending direction of the first lifting member is inclined more than the radial direction of the rotating shell, the extension length of the first lifting member needs to be longer than a case where the first lifting member is extended in the radial direction of the rotating shell. Therefore, there is a disadvantage that more power is required to rotate the first lifting member, or material cost of the first lifting member increases. By extending the first lifting member in the radial direction of the rotating shell, occurrence of such a disadvantage can be prevented.

(Twelfth Aspect)

[0042] The horizontal rotary dryer according to any one of the first to eleventh aspects, including

a second lifting member that is located on the other end side of the rotating shell, rotates in a circumferential direction of the rotating shell, lifts the processing material deposited on a bottom portion of the rotating shell on the other end side, and guides the processing material into the discharge pipe, wherein a through hole is formed in a part of the second lifting member, and the second lifting member has an opening and closing door capable of covering the through hole.

(Action and effect)

[0043] In the twelfth aspect, the second lifting member is further disposed in addition to the first lifting member.

[0044] In a state where the opening and closing door is opened, when the second lifting member is rotated, the processing material placed on the front surface of the second lifting member in the rotation direction falls out of the through hole of the second lifting member.

[0045] On the other hand, in a state where the opening and closing door is closed, when the second lifting member is rotated, it is possible to prevent the processing material placed on the front surface of the second lifting member in the rotation direction from falling out of the through hole of the second lifting member.

[0046] As described above, since the processing material can be lifted or not lifted by opening and closing of the opening and closing door, the hold up ratio of the processing material can be easily adjusted by using the first lifting member, and in addition, the processing material deposited on the bottom portion of the rotating shell

on the other end side can be lifted by the second lifting member and easily discharged from the inside of the rotating shell.

(Thirteenth Aspect)

[0047] The horizontal rotary dryer according to the twelfth aspect, wherein the opening and closing door is a sliding door movable to an inner side and an outer side of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell.

(Action and effect)

[0048] As the opening and closing door, a sliding door that moves to an inner side and an outer side of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell can be used. The action and effect of the twelfth aspect can be achieved by the sliding door.

(Fourteenth Aspect)

[0049] The horizontal rotary dryer according to the twelfth aspect, wherein the opening and closing door is a swing door that opens to at least one of a front side and a rear side of the second lifting member fixed to the discharge pipe in a rotation direction thereof.

(Action and effect)

[0050] As the opening and closing door, a swing door that opens to at least one of the front side and the rear side of the second lifting member in a rotation direction thereof can be used. The action and effect of the twelfth aspect can be achieved by the swing door.

Advantageous Effects of Invention

[0051] According to the present invention, it is possible to provide a horizontal rotary dryer capable of adjusting a hold up ratio of a processing material in a rotating shell.

Brief Description of Drawings

[0052]

[Fig. 1] Fig. 1 is a side view of a horizontal rotary dryer according to the present invention.

[Fig. 2] Fig. 2 is a cross-sectional view of the other end portion of the horizontal rotary dryer according to the present invention as viewed from a side surface.

[Fig. 3] Fig. 3 is a transverse cross-sectional view of the other end portion of the horizontal rotary dryer according to the present invention as viewed from one end side.

[Fig. 4] Fig. 4 illustrates a state where a first lifting member is extended as compared with Fig. 3.

[Fig. 5] Fig. 5 is a perspective view illustrating the first lifting member and a peripheral portion thereof.

[Fig. 6] Fig. 6 illustrates a state where the first lifting member is shrunk as compared with Fig. 5.

[Fig. 7] Fig. 7 is a side view illustrating the first lifting member and a peripheral portion thereof.

[Fig. 8] Fig. 8 illustrates a state where the first lifting member is shrunk as compared with Fig. 7.

[Fig. 9] Fig. 9 is a perspective view illustrating a first lifting member according to a second embodiment and a peripheral portion thereof.

[Fig. 10] Fig. 10 illustrates a state where a rotation control rod is rotated from the state of Fig. 9.

[Fig. 11] Fig. 11 illustrates a state where the rotation control rod is further rotated from the state of Fig. 10.

[Fig. 12] Fig. 12 is a perspective view of the state of Fig. 9 as viewed from another angle (the outside of a rotating shell).

[Fig. 13] Fig. 13 is a perspective view illustrating a first lifting member according to a third embodiment and a peripheral portion thereof.

[Fig. 14] Fig. 14 is a perspective view illustrating a state where the first lifting member in Fig. 13 is replaced with another first lifting member.

[Fig. 15] Fig. 15 is a perspective view illustrating a first lifting member according to a fourth embodiment and a peripheral portion thereof.

[Fig. 16] Fig. 16 is a perspective view illustrating a state where an extension member is attached to the state of Fig. 15.

[Fig. 17] Fig. 17 is a perspective view illustrating a state where another extension member is attached to the state of Fig. 15.

[Fig. 18] Fig. 18 is a side view of Fig. 15.

[Fig. 19] Fig. 19 is a side view of Fig. 16.

[Fig. 20] Fig. 20 is a side view of Fig. 17.

[Fig. 21] Fig. 21 is a perspective view illustrating a second lifting member according to a fifth embodiment and a peripheral portion thereof.

[Fig. 22] Fig. 22 is a perspective view illustrating a state where an opening and closing door is opened from the state of Fig. 21.

[Fig. 23] Fig. 23 is a perspective view illustrating a second lifting member according to a sixth embodiment and a peripheral portion thereof.

[Fig. 24] Fig. 24 is a perspective view illustrating a state where an opening and closing door is opened from the state of Fig. 23.

[Fig. 25] Fig. 25 is a perspective view illustrating a state where the opening and closing door is further opened from the state of Fig. 24.

[Fig. 26] Fig. 26 is a perspective view illustrating a first lifting member according to a seventh embodiment and a peripheral portion thereof.

[Fig. 27] Fig. 27 is a perspective view illustrating a state where an opening and closing door is opened from the state of Fig. 26.

[Fig. 28] Fig. 28 is a perspective view illustrating a

state where the opening and closing door is further opened from the state of Fig. 27.

[Fig. 29] Fig. 29 is a transverse cross-sectional view of the other end portion of the horizontal rotary dryer according to the seventh embodiment as viewed from one end side.

Description of Embodiments

[0053] Hereinafter, preferred embodiments of the present invention will be described with reference to the drawings. Note that the following description and drawings illustrate only embodiments of the present invention, and the contents of the present invention should not be interpreted as being limited to these embodiments.

[0054] Note that, in the following description, in an intersecting cross section intersecting with an axis of a rotating shell 10, a direction approaching the axis of the rotating shell 10 is referred to as an inner side BS, a proximal end side BS, or an inside BS, and a direction away from the axis of the rotating shell 10 is referred to as an outer side TS, a distal end side TS, or an outside TS. In the intersecting cross section intersecting with the axis of the rotating shell 10, a direction intersecting with the axis of the rotating shell 10 is referred to as a radial direction RD.

[0055] In the following description, an axis SL of the rotating shell 10 is a rotation axis of the rotating shell 10, and is a line connecting a central portion of an upper surface of the rotating shell 10 and a central portion of a bottom surface thereof. For example, in the case of the rotating shell 10 illustrated in Fig. 1, since the rotating shell 10 is laid, a left side LL of one end side ITS of the rotating shell 10 can be regarded as the upper surface, and a right side RL of the other end side OTS of the rotating shell 10 can be regarded as the bottom surface. On the other hand, the left side LL of one end side ITS of the rotating shell 10 may be regarded as the bottom surface, and the right side RL of the other end side OTS of the rotating shell 10 may be regarded as the upper surface.

[0056] In the following description, a longitudinal cross section of the rotating shell 10, a transverse cross section of the rotating shell 10, and an intersecting cross section intersecting with the axis SL of the rotating shell 10 are as follows.

[0057] The longitudinal cross section of the rotating shell 10 refers to a cut surface obtained by cutting the rotating shell 10 longitudinally along the axis SL thereof. The longitudinal cross section of the first lifting member or the second lifting member refers to a cut surface obtained by cutting the first lifting member or the second lifting member longitudinally in the same direction as the longitudinal cross section of the rotating shell 10.

[0058] The transverse cross section of the rotating shell 10 refers to a cut surface obtained by cutting the rotating shell 10 along a plane orthogonal to the axis SL thereof. The transverse cross section of the first lifting

member or the second lifting member refers to a cut surface obtained by cutting the first lifting member or the second lifting member in the same direction as the transverse cross section of the rotating shell 10.

[0059] The intersecting cross section intersecting with the axis SL of the rotating shell 10 refers to a cut surface obtained by cutting the rotating shell 10 along a plane intersecting with the axis SL thereof. The intersecting cross section of the first lifting member or the second lifting member refers to a cut surface obtained by cutting the first lifting member or the second lifting member in the same direction as the intersecting cross section of the rotating shell 10.

[0060] In the following description, intersecting with the axis SL of the rotating shell 10 includes not only a case of being orthogonal to the axis SL of the rotating shell 10 but also a case of intersecting with the axis SL of the rotating shell 10 at a predetermined angle. In particular, a case of being orthogonal to the axis SL of the rotating shell 10 is typical.

(Processing material W)

[0061] The processing material W as a drying target provided to the horizontal rotary dryer 1 is not particularly limited. Specific examples thereof include coal, ores such as copper ore, iron powder, and zinc powder, metallic materials, inorganic substances such as gypsum, alumina, and soda ash, and dehydrated sludge.

(Horizontal rotary dryer 1)

[0062] Next, the horizontal rotary dryer 1 will be described. The horizontal rotary dryer 1 is not particularly limited, and for example, an indirect heating-type horizontal rotary dryer (also referred to as a "steam tube dryer") or a kiln can be used. Note that a drying method is not limited to indirect heating, and may be direct drying.

[0063] In the indirect heating-type horizontal rotary dryer, it is necessary to increase a frequency of contact between a heating tube and a processing material in order to sufficiently dry the processing material, and it is important to adjust a hold up ratio of the processing material in the rotating shell 10 within an appropriate range in order to increase the contact frequency. Therefore, the following configuration capable of adjusting the hold up ratio of the processing material within an appropriate range is particularly suitable for the indirect heating-type rotary dryer.

[0064] Hereinafter, the indirect heating-type horizontal rotary dryer illustrated in Figs. 1 and 2 will be described as an example.

[0065] As illustrated in Figs. 1 and 2, a structure of the horizontal rotary dryer 1 includes a cylindrical rotating shell 10 which is disposed such that its axial center is slightly inclined with respect to a horizontal plane, and one end side ITS (a feed port side of the processing material W) of the rotating shell 10 is located higher than

the other end side OTS (a discharge port side of the processing material W). Below the rotating shell 10, two support units 20 and a motor unit 30 are disposed so as to support the rotating shell 10, and the rotating shell 10 is rotatable about its own axial center by the motor unit 30. The rotating shell 10 rotates in one direction. The direction can be arbitrarily determined, and for example, the rotating shell 10 can be rotated counterclockwise in a state where the other end side OTS is viewed from one end side ITS.

[0066] Inside the rotating shell 10, a large number of steam tubes (heating tubes) 11, which are made of metal, are attached as heat transfer tubes to the processing material W while extending along the axial center of the rotating shell 10. For example, the plurality of heating tubes 11 are arranged in a circumferential direction and the plurality of heating tubes 11 are arranged in a radial direction so as to form concentric circles with respect to the axial center of the rotating shell 10. The heating tubes 11 are warmed by steam or the like as a heating medium flowing through the heating tubes 11.

[0067] A screw feeder 42 is connected to one end side ITS of the rotating shell 10. A gas blowing unit (not illustrated) that blows a carrier gas A (inert gas) into the rotating shell 10 from the feed port 41 is disposed in the vicinity of the screw feeder 42, and for example, the carrier gas A blown by the gas blowing unit flows through the rotating shell 10 toward the other end side OTS of the rotating shell 10, and then is exhausted from an exhaust port 56. Note that the carrier gas A may be blown into the rotating shell 10 from another feed port (not illustrated) formed on one end side ITS other than the feed port 41. In addition, the carrier gas A may be blown from a feed port (not illustrated) on the other end side OTS and exhausted from an exhaust port (not illustrated) on one end side ITS.

[0068] A discharge port 50 is formed at a central portion of the other end side OTS of the rotating shell 10. A discharge pipe 51 is connected to the discharge port 50 so as to penetrate the discharge port 50. A plurality of openings X are formed on an outer surface of one end side ITS of the discharge pipe 51. Inside the discharge pipe 51, a screw flight (vane) 24 that delivers a dried processing material, that is, a processed material E from one end side ITS to the other end side OTS is disposed.

[0069] A discharge casing 55 capable of discharging the processed material E and the carrier gas A may be disposed on the other end side OTS of the discharge pipe 51 so as to cover the other end side OTS of the discharge pipe 51. The discharge casing 55 is formed of, for example, a thick metal, has, on a bottom surface thereof, a discharge port 57 through which the dried processed material E is discharged and has, on a top surface thereof, an exhaust port 56 through which the carrier gas A is discharged.

[0070] On the other end side OTS of the discharge casing 55, a steam feed pipe 72 that feeds steam into the heating tube 11 and a drain discharge pipe 71 are disposed.

(Drying process)

[0071] Next, a process of drying the processing material W in the horizontal rotary dryer 1 will be described with reference to Figs. 1 and 2.

[0072] The processing material W is fed from the feed port 41 into the screw feeder 42, and is fed into the rotating shell 10 by rotating a screw disposed in the screw feeder 42 by a driving unit (not illustrated). The processing material W fed from the feed port 41 moves to the other end side OTS of the rotating shell 10 and is deposited on a lower portion thereof while being heated and dried by coming into contact with an outer surface of the heating tube 11 heated by steam. The processing material W deposited on the other end side OTS lower portion of the rotating shell 10 is lifted by a first lifting member 60, and is guided into the discharge pipe 51 through the opening X. The dried processing material W (that is, the processed material E) guided into the discharge pipe 51 is delivered to the other end side OTS by the screw flight (vane) 24, then enters the discharge casing 55, and is discharged from the discharge port 57 formed below the discharge casing 55.

[0073] On the other hand, the carrier gas A blown from the feed port 41 by the gas blowing unit disposed on one end side ITS of the rotating shell 10 passes through the rotating shell 10 and a gas passage U2, and is exhausted from the exhaust port 56 formed above the discharge casing 55.

[0074] The steam fed from the steam feed pipe 72 into the heating tube 11 becomes drain by heat exchange between the processing material W and the heating tube 11 in contact with each other, and is discharged from the drain discharge pipe 71.

(Discharge mechanism)

[0075] Next, a discharge mechanism of the processing material W that delivers the processing material W from the other end portion of the rotating shell 10 into the discharge pipe 51 will be described. Note that description of portions overlapping with the above description will be omitted.

[0076] When the processing material W fed into the rotating shell 10 reaches the other end portion of the rotating shell 10, the processing material W is lifted by the first lifting member 60 that rotates together with the rotating shell 10 along with rotation of the rotating shell 10. Note that, in Figs. 3 to 11 and 13 to 20 described later, a rotation direction of the rotating shell 10 is denoted by a reference sign R. When the first lifting member 60 is located on an upper side of the rotating shell 10, the processing material W lifted by the first lifting member 60 naturally falls due to gravity, and enters a delivery passage U1 through the opening X of the discharge pipe 51 disposed at a central portion of the other end side OTS of the rotating shell 10.

[0077] In addition, along with the rotation of the rotating

shell 10, the discharge pipe 51 fixed to the central portion of the other end side OTS of the rotating shell 10 also rotates. Since the screw flight (vane) 24 is fixed to an inner surface of the discharge pipe 51, the screw flight (vane) 24 also rotates along with rotation of the discharge pipe 51. Therefore, the processed material E obtained by drying the processing material W is delivered by a delivery action of the screw flight (vane) 24 toward openings 21 and 22 in the delivery passage U1, and is discharged from the openings 21 and 22. The discharged processed material E is discharged from the discharge port 57 below the discharge casing 55 by its own weight.

[0078] A steam path (an internal steam feed pipe 91 and an internal drain discharge pipe 92) penetrating the discharge casing 55 and extending into a partition wall 23 is disposed integrally with the rotating shell 10. The internal steam feed pipe 91 communicates with an inlet header portion of the heating tube 11 in an end plate portion 17, and the internal drain discharge pipe 92 communicates with an outlet header portion of the heating tube 11 in the end plate portion 17. The steam feed pipe 72 and the drain discharge pipe 71 are connected to the internal steam feed pipe 91 and the internal drain discharge pipe 92, respectively, via a rotary joint 63.

(First lifting member 60 according to first embodiment)

[0079] The first lifting member 60 according to a first embodiment has a structure including an adjustment mechanism capable of slidably moving to an inner side BS and an outer side TS of the rotating shell 10. An example of the structure is illustrated in Figs. 5 to 8. The first lifting member 60 in Figs. 5 to 8 includes two slidably movable plate-shaped lifting flights (vanes) 60A and 60B disposed at positions adjacent to each other. Specifically, the first lifting member 60 includes the inner side lifting flight (vane) 60A extending from an outer peripheral wall of the discharge pipe 51 to an outer side TS in a radial direction RD, and an outer side lifting flight (vane) 60B disposed on the outer side TS in the radial direction RD with respect to the inner side lifting flight (vane) 60A. The inner side lifting flight (vane) 60A is disposed on a back side in the drawings of Figs. 5 and 6, and the outer side lifting flight (vane) 60B is disposed on a front side in the drawings of Figs. 5 and 6.

[0080] Note that, in Figs. 5 to 8 illustrating the first embodiment, the first lifting member 60 is directly attached to an outer wall of the discharge pipe 51, and the first lifting member 60 directly extends from an outer peripheral wall of the discharge pipe 51. However, the present invention is not limited to such a form. That is, the first lifting member 60 may be indirectly attached to the outer peripheral wall of the discharge pipe 51 via another member (for example, a plate member), and the first lifting member 60 may indirectly extend from the outer peripheral wall of the discharge pipe 51. This is not limited to the first embodiment, and the same applies to other embodiments such as second to seventh embodiments

described later.

[0081] In Figs. 5 to 8 illustrating the first embodiment, the first lifting member 60 (the inner side lifting flight (vane) 60A and the outer side lifting flight (vane) 60B according to those illustrated in Figs. 5 to 8, and the same applies hereinafter) extends in the radial direction RD. However, the extending direction of the first lifting member 60 is not limited to the radial direction RD. That is, the extending direction is not limited to the direction passing through the axis of the rotating shell 10. Specifically, the first lifting member 60 only needs to extend from the inner side BS to the outer side TS of the rotating shell 10 in an intersecting cross section intersecting with the axis of the rotating shell 10. That is, the extending direction of the first lifting member 60 does not necessarily intersect with the axis of the rotating shell 10. The same applies not only to the first embodiment but also to other embodiments such as the second to seventh embodiments.

[0082] In Figs. 5 to 8 illustrating the first embodiment, the first lifting member 60 is disposed between an outer wall of the discharge pipe 51 and an inner wall of the rotating shell 10. The same applies not only to the first embodiment but also to other embodiments such as the second to seventh embodiments.

[0083] At a distal end portion of the inner side lifting flight (vane) 60A in the first embodiment, a fixing member 60C whose cross section orthogonal to the extending direction of inner side lifting flight (vane) 60A has a clamp shape is disposed, and the outer side lifting flight (vane) 60B moves inside the fixing member 60C. The fixing member 60C can prevent the outer side lifting flight (vane) 60B from separating from the inner side lifting flight (vane) 60A. Note that the illustrated fixing member 60C is an example. Another fixing member 60C may be used as long as the inner side lifting flight (vane) 60A and the outer side lifting flight (vane) 60B can be kept adjacent to each other, and the outer side lifting flight (vane) 60B can continuously or temporarily move to the outer side TS and the inner side BS.

[0084] A distal end portion of the outer side lifting flight (vane) 60B is bent in a rotation direction S of the first lifting member 60. The bent distal end portion is referred to as a protruding portion 60D. The processing material W deposited on a lower portion of the rotating shell 10 is lifted mainly by the outer side lifting flight (vane) 60B.

[0085] A means for moving the outer side lifting flight (vane) 60B to the inner side BS and the outer side TS is not particularly limited. For example, a control rod 70 as illustrated in Figs. 5 to 8 can be used. The control rod 70 is attached to a back surface (a surface in a direction in which the protruding portion 60D extends is referred to as a front surface, and a surface in a direction opposite thereto is referred to as a back surface) of the outer side lifting flight (vane) 60B. As illustrated in Figs. 5 and 7, when the control rod 70 is pulled to the outer side TS, the outer side lifting flight (vane) 60B moves to the outer side TS. On the other hand, as illustrated in Figs. 6 and 8, when the control rod 70 is pushed to the inner side BS, the

outer side lifting flight (vane) 60B moves to the inner side BS.

[0086] Specifically, as illustrated in Figs. 7 and 8, a side wall of the inner side BS of the control rod 70 is coupled to the back surface of the outer side lifting flight (vane) 60B by welding or the like. In Figs. 7 and 8, a welded portion between the control rod 70 and the outer side lifting flight (vane) 60B is indicated by a reference sign 69. The control rod 70 extends from the welded portion 69 to the outer side TS. Specifically, the control rod 70 extends from the inner side BS of the rotating shell 10 to the outer side TS through a through hole 10H formed in the rotating shell 10.

[0087] A nut 66 and a support portion 65 that supports the nut 66 are disposed immediately outside the through hole 10H of the rotating shell 10. The support portion 65 has a substantially U-shaped cross section by being integrated with the rotating shell 10, and the nut 66 is inserted into a portion between the rotating shell 10 and the support portion 65. The nut 66 and the support portion 65 also have through holes 66H and 65H, respectively, and the control rod 70 extends to the outer side TS through the through holes 66H and 65H.

[0088] Since the nut 66 is sandwiched between the rotating shell 10 and the support portion 65, the nut 66 can rotate but does not move to the inner side BS and the outer side TS. In the embodiment illustrated in Figs. 7 and 8, the control rod 70 is a bolt screwed with the nut 66, the control rod 70 moves to the inner side BS or the outer side TS by rotation of the nut 66, and the outer side lifting flight (vane) 60B also moves to the inner side BS or the outer side TS along with movement of the control rod 70.

[0089] In the description of Figs. 7 and 8, the mechanism using a bolt and a nut has been described as the moving mechanism of the control rod 70, but the moving mechanism of the control rod 70 is not limited to such a form. Although not illustrated, for example, a mechanism may be used in which the control rod 70 is moved to the inner side BS or the outer side TS by a cylinder or the like, and a fastener or the like for holding a state after the movement is disposed.

[0090] Note that the first lifting member 60 illustrated in Figs. 5 to 8 is merely an example, and the present invention is not limited to this form. For example, the first lifting member 60 may be formed of three or more lifting flights (vanes) instead of being formed of two lifting flights (vanes).

[0091] In addition, the first lifting member 60 illustrated in Fig. 5 illustrates a state where the outer side lifting flight (vane) 60B is fully extended to the outer side TS. At this time, an outer surface of the protruding portion 60D of the outer side lifting flight (vane) 60B is in contact with an inner surface of the rotating shell 10. In this manner, the outer side lifting flight (vane) 60B may be configured to be able to extend until it can come into contact with the inner surface of the rotating shell 10, but does not have to be able to extend until it comes into contact with the inner surface of the rotating shell 10.

[0092] Specifically, when a distance from an outer surface of the discharge pipe 51 to an inner surface of the rotating shell 10 is assumed to be 100, a distance by which the lifting flight (vane) 60 can be extended (a distance extending from the outer surface of the discharge pipe 51 to the outer side TS) is preferably 40 or more, and more preferably, the lifting flight (vane) 60 can be extended until the distance becomes 100 (until the lifting flight (vane) 60 comes into contact with the inner surface of the rotating shell 10). If the distance is shorter than 40, an amount by which the processing material W can be lifted by the first lifting member 60 is too small, and thus there is a disadvantage that the processing material W is excessively stored in the other end side OTS lower portion of the rotating shell 10.

[0093] On the other hand, if the distance is too long, a problem hardly occurs. This is because, during normal operation, the length of the first lifting member 60 need not be increased so as not to excessively discharge the processing material W in the other end side OTS lower portion of the rotating shell 10. On the other hand, when operation of the horizontal rotary dryer 1 is ended, as illustrated in Fig. 5, by making the length of the first lifting member 60 as long as possible, the whole amount of the processing material W deposited on the other end side OTS lower portion of the rotating shell 10 only needs to be discharged from the rotating shell 10.

[0094] As described above, with the configuration as illustrated in Figs. 5 to 8, the length by which the first lifting member 60 extends can be arbitrarily changed. That is, the area of a front surface (referred to a surface on the rotation direction S side, the same applies hereinafter) of the first lifting member 60 facing the rotation direction S can be arbitrarily changed. Fig. 3 illustrates a state before the first lifting member 60 extends to the outer side TS, and Fig. 4 illustrates a state after the first lifting member 60 extends to the outer side TS with respect to that in Fig. 3.

[0095] Note that Fig. 3 illustrates an example in which the extending directions of the first lifting member 60 located in a lower portion of the drawing and in an upper right portion of the drawing are set to the radial direction RD, and the extending direction of the first lifting member 60 located in an upper left portion of the drawing is not set to the radial direction RD. In Fig. 4, the extending directions of all the first lifting members 60 are set to the radial direction RD. As illustrated in Fig. 3, the extending directions of the plurality of first lifting members 60 may be different directions, or as illustrated in Fig. 4, all the extending directions of the plurality of first lifting members 60 may be the same direction. Note that the extending direction of the first lifting member 60 located in an upper left portion of Fig. 3 is not set to the radial direction RD, but the first lifting member 60 extends from the inner side BS to the outer side TS of the rotating shell 10 in an intersecting cross section intersecting with the axis of the rotating shell 10.

[0096] The longer the length by which the first lifting

member 60 extends to the outer side TS is, the more the processing material W deposited on the other end side OTS lower portion of the rotating shell 10 can be lifted. Therefore, by changing the length of the first lifting member 60, as illustrated in Figs. 3 and 4, the amount of the processing material W deposited on the other end side OTS lower portion of the rotating shell 10 (hence, a hold up ratio of the processing material W) can be easily controlled.

[0097] Note that, in Figs. 3 and 4, the deposition amount of the processing material W in a state where the rotating shell 10 is stopped is illustrated for easy understanding. Note that, when the rotating shell 10 is actually rotated, the processing material W is lifted upward also by the heating tube 11, and therefore the processing material W is dispersed in a crescent shape inside the rotating shell 10.

[0098] In addition, in not only the first embodiment but also other embodiments such as the second to seventh embodiments, it is possible to arbitrarily determine how many first lifting members 60 are disposed inside the rotating shell 10, and there is no particular limitation. For example, although three first lifting members 60 are disposed in the examples illustrated in Figs. 3 and 4, one, two, or four or more first lifting members 60 may be disposed.

[0099] In addition, in not only the first embodiment but also other embodiments such as the second to seventh embodiments, it is possible to arbitrarily determine where the first lifting members 60 are disposed in a circumferential direction of the rotating shell 10, and there is no particular limitation. In the examples illustrated in Figs. 3 and 4, the three first lifting members 60 are disposed at intervals of about 120 degrees with respect to the axis of the rotating shell 10, but the intervals between the plurality of first lifting members 60 do not necessarily need to be even in this manner. Note that, by making the intervals between the first lifting members 60 in the circumferential direction of the rotating shell 10 as even as possible, rotational dynamics of the processing material W in the other end side OTS end portion of the rotating shell 10 can be stabilized, and as a result, the processing material W can be constantly guided to the opening X.

[0100] Note that, in not only the first embodiment but also other embodiments such as the second to seventh embodiments, when the heating tube 11 is disposed inside the rotating shell 10 as illustrated in, for example, Figs. 3 and 4, it is necessary to prevent the first lifting member 60 from hitting the heating tube 11 when the first lifting member 60 is extended.

(Lifting member 61 according to second embodiment)

[0101] A first lifting member 61 according to a second embodiment is illustrated in Figs. 9 to 12. The first lifting member 61 according to the second embodiment includes a fixed flight (vane) 61A, an outer side rotating flight (vane) 61B, an inner side rotating flight (vane) 61C,

and an intermediate rotating flight (vane) 61D. Note that the intermediate rotating flight (vane) 61D does not necessarily have to be disposed, and may be omitted.

[0102] The fixed flight (vane) 61A illustrated in Figs. 9 to 12 is formed of a flat plate, and a proximal end portion thereof is fixed to an outer surface of the discharge pipe 51. The fixed flight (vane) 61A extends to the outer side TS from a connection portion between the discharge pipe 51 and the fixed flight (vane) 61A.

[0103] In the example of Figs. 9 to 12, an annular support ring 81 is fixed to a front surface (a surface in a direction in which a rotation direction extending wall 61Bb described later extends is referred to as a front surface, and a surface in a direction opposite thereto is referred to as a back surface) of the fixed flight (vane) 61A by welding or the like. Specifically, the support ring 81 in Figs. 9 to 12 has an annular shape, and is disposed such that an axial center of the support ring 81 is in the radial direction RD (not limited to the radial direction RD, and the axial center may extend from the inner side BS to the outer side TS of the rotating shell 10 in an intersecting cross section intersecting with the axis of the rotating shell 10), and a part of an outer peripheral surface of the support ring 81 is fixed to the front surface of the fixed flight (vane) 61A.

[0104] A rotation control rod 80 (an example of a rotary member) is inserted into a through hole inside the support ring 81. Specifically, a proximal end portion of the rotation control rod 80 is inserted into the through hole of the support ring 81, and the inserted rotation control rod 80 is rotatable about the axial center of the rotation control rod 80 inside the support ring 81. As described above, the proximal end portion of the rotation control rod 80 is inserted into the through hole of the support ring 81, whereby the proximal end side of the rotation control rod 80 is supported by the support ring 81.

[0105] On the other hand, the rotation control rod 80 extends from a portion inserted into the support ring 81 to the outer side TS in the radial direction RD, and a distal end side portion thereof is fixed to the rotating shell 10. Note that the extending direction of the rotation control rod 80 is not limited to the radial direction RD, and the rotation control rod 80 may extend from the inner side BS to the outer side TS of the rotating shell 10 in an intersecting cross section intersecting with the axis of the rotating shell 10. When the rotation control rod 80 is fixed to the rotating shell 10, the rotation control rod 80 is preferably gently fixed so as to be rotatable. For example, as illustrated in Fig. 12, a through hole 10A is formed in the rotating shell 10, and a tubular fixing pipe 10B extending from a peripheral portion of the through hole 10A of the rotating shell 10 to the outer side TS of the rotating shell 10 is disposed. The rotation control rod 80 may be fixed so as to further extend to the outer side TS through the through hole 10A and the fixing pipe 10B.

[0106] Note that, in the examples of Figs. 9 to 12, the rotation control rod 80 is disposed on the other end side OTS in the other end side OTS end portion of the rotating

shell 10 in a longitudinal direction LD thereof, but the position where the rotation control rod 80 is disposed is not limited to this position, and the rotation control rod 80 may be disposed on one end side ITS on the other end side OTS end of the rotating shell 10 in the longitudinal direction LD.

[0107] As illustrated in Fig. 9, the rotation control rod 80 can rotate in a circumferential direction about an axial center portion of the rotation control rod 80. The rotation control rod 80 in Fig. 9 rotates clockwise (the left side in Fig. 9). A rotation direction CD of the rotation control rod 80 in Fig. 9 is indicated by a dotted arrow. In addition, since the rotation control rod 80 can be rotated in both directions of clockwise and counterclockwise (both the left and right sides in Fig. 10) from the state of Fig. 10, and the rotation control rod 80 can be rotated counterclockwise (the right side in Fig. 11) from the state of Fig. 11, the rotation directions CD thereof are also indicated by dotted arrows.

[0108] The outer side rotating flight (vane) 61B, the intermediate rotating flight (vane) 61D, and the inner side rotating flight (vane) 61C are fixed to a peripheral wall of the rotation control rod 80.

[0109] The outer side rotating flight (vane) 61B has a shape obtained by bending a plate member into an L shape. The outer side rotating flight (vane) 61B includes an outer side extending wall 61Ba extending to the outer side TS, and a rotation direction extending wall 61Bb extending in the rotation direction S of the first lifting member 61 from a distal end portion of the outer side extending wall 61Ba. In the outer side rotating flight (vane) 61B illustrated in Figs. 9 to 11, an inner angle between the outer side extending wall 61Ba and the rotation direction extending wall 61Bb is substantially a right angle. For example, when operation of the horizontal rotary dryer 1 is ended, it is necessary to discharge the whole amount of the processing material W from the inside of the rotating shell 10. In order to discharge the whole amount of the processing material W from the inside of the rotating shell 10, as illustrated in Fig. 9, the outer side rotating flight (vane) 61B is preferably located in the vicinity of an inner wall of the rotating shell 10, and a distal end portion of the rotation direction extending wall 61Bb in the extending direction is preferably in contact with the inner wall of the rotating shell 10. In order to make it possible to achieve such a state, an inner angle between the outer side extending wall 61Ba and the rotation direction extending wall 61Bb is preferably substantially a right angle. In the state illustrated in Fig. 9, the outer side rotating flight (vane) 61B forms a lifting flight (vane) that lifts the processing material W by the fixed flight (vane) 61A and the outer side rotating flight (vane) 61B. The processing material W is lifted upward while being held at an inner angle portion between the outer side extending wall 61Ba and the rotation direction extending wall 61Bb along with rotation of the rotating shell 10.

[0110] On the inner side BS of the outer side rotating

flight (vane) 61B and on the rotation direction S side of the first lifting member 61 with respect to the outer side rotating flight (vane) 61B, the flat plate-shaped inner side rotating flight (vane) 61C extending in a direction substantially perpendicular to the extending direction of the fixed flight (vane) 61A is disposed. In order to avoid a state where the inner side rotating flight (vane) 61C is caught by the fixed flight (vane) 61A and does not move when the rotation control rod 80 is rotated to rotate the inner side rotating flight (vane) 61C until a state as illustrated in Figs. 9 to 11 is obtained, the inner side rotating flight (vane) 61C is preferably disposed at a position where an outer side TS edge of the fixed flight (vane) 61A and an inner side BS surface of the inner side rotating flight (vane) 61C are slightly in contact with each other. That is, the inner side rotating flight (vane) 61C is preferably disposed at a position on a slightly outer side TS of the outer side TS edge of the fixed flight (vane) 61A. In the state illustrated in Fig. 11, the inner side rotating flight (vane) 61C forms a lifting flight (vane) that lifts the processing material W by the fixed flight (vane) 61A and the inner side rotating flight (vane) 61C. That is, the processing material W is lifted upward while being held at an inner angle portion between the fixed flight (vane) 61A and the inner side rotating flight (vane) 61C along with rotation of the rotating shell 10.

[0111] The intermediate rotating flight (vane) 61D is preferably disposed between the rotation direction extending wall 61Bb of the outer side rotating flight (vane) 61B and the inner side rotating flight (vane) 61C. In the embodiment illustrated in Figs. 9 to 12, similarly to the outer side rotating flight (vane) 61B, the intermediate rotating flight (vane) 61D has a shape obtained by bending a plate member into an L shape. The intermediate rotating flight (vane) 61D includes an outer side extending wall 61Da extending to the outer side TS, and a rotation direction extending wall 61Db extending in the rotation direction S of the first lifting member 61 from a distal end portion of the outer side extending wall 61Da. In the intermediate rotating flight (vane) 61D illustrated in Figs. 9 to 12, an inner angle between the outer side extending wall 61Da and the rotation direction extending wall 61Db is substantially a right angle, but the inner angle is not limited to the right angle, and may be about 60 to 90 degrees. In the state illustrated in Fig. 10, the intermediate rotating flight (vane) 61D forms a lifting flight (vane) that lifts the processing material W by the fixed flight (vane) 61A and the intermediate rotating flight (vane) 61D. The processing material W is lifted upward while being held at an inner angle portion between the outer side extending wall 61Da and the rotation direction extending wall 61Db along with rotation of the rotating shell 10.

[0112] Note that, in Figs. 9 to 11, in the front surface (the right surface in Figs. 9 to 11) of the outer side extending wall 61Ba of the outer side rotating flight (vane) 61B and the end surface of the rotation direction extending wall 61Bb, portions located on the other end side OTS of the

rotating shell 10 in the longitudinal direction LD are fixed to the rotation control rod 80. Similarly, in the front surface (the right surface in Figs. 9 to 11) of the outer side extending wall 61Da of the intermediate rotating flight (vane) 61D and the end surface of the rotation direction extending wall 61Db, portions located on the other end side OTS of the rotating shell 10 in the longitudinal direction LD are fixed to the rotation control rod 80. In addition, in the end surface of the inner side rotating flight (vane) 61C, portions located on the other end side OTS of the rotating shell 10 in the longitudinal direction LD are fixed to the rotation control rod 80.

[0113] With the above configuration, the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D rotate in a circumferential direction of the rotation axis of the rotation control rod 80. The rotation directions of the flights (vanes) 61B, 61C, and 61D are the same direction as the rotation direction of the rotation control rod 80. That is, when the rotation control rod 80 rotates clockwise (the left side in Figs. 9 to 11), the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D also rotate clockwise (the left side in Figs. 9 to 11). Note that, for example, from the state of Figs. 10 or 11, the rotation control rod 80 may be rotated counterclockwise (the right side in Figs. 10 and 11), and the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D may be rotated counterclockwise (the right side in Figs. 10 and 11).

[0114] A rotation angle when the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D rotate clockwise or counterclockwise is not limited, but the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D are preferably rotated at once until the rotation angle reaches any predetermined angle. After the rotation control rod 80 is rotated, any one of the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D is preferably connected to the fixed flight (vane) 61A.

[0115] The rotation of the rotation control rod 80 will be described in detail below.

[0116] Fig. 9 illustrates a state where the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D are located on a frontmost side (the right side in Fig. 9). When Fig. 9 is the first state, a state after the first rotation is illustrated in Fig. 10, and a state after the second rotation is illustrated in Fig. 11. In the state of Fig. 9, the processing material W is lifted mainly by the fixed flight (vane) 61A and the outer side rotating flight (vane) 61B, in the state of Fig. 10, the processing material W is lifted mainly by the fixed flight (vane) 61A and the intermediate rotating flight (vane) 61D, and in the state of Fig. 11, the processing material W is lifted mainly by the

fixed flight (vane) 61A and the inner side rotating flight (vane) 61C.

[0117] In the state of Fig. 9, the outer side extending wall 61Ba of the outer side rotating flight (vane) 61B and the fixed flight (vane) 61A are in a state of being linearly connected (continuous state) in the radial direction RD. By rotating the first lifting member 61 in the rotation direction S of the first lifting member 61 in this state, the outer side rotating flight (vane) 61B scrapes most of the processing material W deposited on the lower portion of the rotating shell 10, the scraped processing material W is lifted upward by the outer side rotating flight (vane) 61B and the fixed flight (vane) 61A, and the lifted processing material W is guided into the discharge pipe 51 through the opening X. At this time, the inner side rotating flight (vane) 61C and the intermediate rotating flight (vane) 61D are not continuous with the fixed flight (vane) 61A, and therefore hardly function as a means for lifting the processing material W.

[0118] When the rotation control rod 80 is rotated clockwise (the left side in Fig. 9) by about one stage to be brought into the state illustrated in Fig. 10, the outer side extending wall 61Da of the intermediate rotating flight (vane) 61D and the fixed flight (vane) 61A are brought into a state of being linearly connected (continuous state) in the radial direction RD. By rotating the first lifting member 61 in the rotation direction S of the first lifting member 61 in this state, the intermediate rotating flight (vane) 61D scrapes a part of the processing material W deposited on the lower portion of the rotating shell 10, the scraped processing material W is lifted upward by the intermediate rotating flight (vane) 61D and the fixed flight (vane) 61A, and the lifted processing material W is guided into the discharge pipe 51 through the opening X. Note that, at this time, the outer side rotating flight (vane) 61B and the inner side rotating flight (vane) 61C are not continuous with the fixed flight (vane) 61A, and therefore hardly function as a means for lifting the processing material W.

[0119] When the rotation control rod 80 is further rotated clockwise (the left side in Fig. 10) by about one stage to be brought into the state illustrated in Fig. 11, the inner side rotating flight (vane) 61C and the fixed flight (vane) 61A are brought into a state of being connected in an L shape (continuous state). By rotating the first lifting member 61 in the rotation direction S of the first lifting member 61 in this state, the inner side rotating flight (vane) 61C further scrapes a part of the processing material W deposited on the lower portion of the rotating shell 10, the scraped processing material W is lifted upward by the inner side rotating flight (vane) 61C and the fixed flight (vane) 61A, and the lifted processing material W is guided into the discharge pipe 51 through the opening X. Note that, at this time, the outer side rotating flight (vane) 61B and the intermediate rotating flight (vane) 61D are not continuous with the fixed flight (vane) 61A, and therefore hardly function as a means for lifting the processing material W.

[0120] When the states in Figs. 9 to 11 are compared with each other, since the outer side rotating flight (vane) 61B is located in the outermost side TS among the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D, the most processing material W can be lifted in the state where the fixed flight (vane) 61A and the outer side rotating flight (vane) 61B are continuous as illustrated in Fig. 9. In addition, since the intermediate rotating flight (vane) 61D is located in the second outermost side TS among the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D, the second most processing material W can be lifted in the state where the fixed flight (vane) 61A and the intermediate rotating flight (vane) 61D are continuous as illustrated in Fig. 10. In addition, since the inner side rotating flight (vane) 61C is located in the innermost side BS among the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D, the lifting amount of the processing material W in the state where the fixed flight (vane) 61A and the inner side rotating flight (vane) 61C are continuous as illustrated in Fig. 11 is the smallest.

[0121] As described above, the rotation control rod 80 is rotated to make any one of the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D continuous with the fixed flight (vane) 61A. By arbitrarily selecting one of the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D to be continuous with the fixed flight (vane) 61A, the area of the front surface of the first lifting member 61 facing the rotation direction S can be arbitrarily changed, and the lifting amount of the processing material W can be freely changed.

[0122] For example, since a large amount of the processing material W is stored in the other end side OTS lower portion of the rotating shell 10, when it is desired to put a large amount of the processing material W into the discharge pipe 51 from the rotating shell 10, the outer side rotating flight (vane) 61B is preferably made continuous with the fixed flight (vane) 61A as illustrated in Fig. 9. On the other hand, when a hold up ratio of the processing material W inside the rotating shell 10 is low and it is desired to increase the hold up ratio, the inner side rotating flight (vane) 61C is preferably made continuous with the fixed flight (vane) 61A as illustrated in Fig. 11.

[0123] As described above, by disposing the inner side rotating flight (vane) 61C and the intermediate rotating flight (vane) 61D, there is an advantage that the lifting amount of the processing material W is more easily adjusted (and hence the hold up ratio of the processing material W is easily adjusted) than a case where the inner side rotating flight (vane) 61C and the intermediate rotating flight (vane) 61D are not disposed.

[0124] In Figs. 9 to 12, only one intermediate rotating

flight (vane) 61D is disposed, but the number of intermediate rotating flights (vanes) 61D to be disposed is not particularly limited, and two or more intermediate rotating flights (vanes) 61D may be disposed. As the number of the intermediate rotating flights (vanes) 61D increases, there is an advantage that the lifting amount of the processing material W is more easily adjusted.

[0125] Note that, as illustrated in Fig. 9, the state where the outer side rotating flight (vane) 61B is continuous with the fixed flight (vane) 61A is a state where the most processing material W can be lifted, and as illustrated in Fig. 11, the state where the inner side rotating flight (vane) 61C is continuous with the fixed flight (vane) 61A is a state where the lifting amount of the processing material W is small. An object of the intermediate rotating flight (vane) 61D is to finely adjust the lifting amount of the processing material W between such two states. Therefore, in the radial direction RD, the position of the rotation direction extending wall 61Db of the intermediate rotating flight (vane) 61D is preferably between the rotation direction extending wall 61Bb of the outer side rotating flight (vane) 61B and the inner side rotating flight (vane) 61C. When a plurality of the intermediate rotating flights (vanes) 61D are disposed, a plurality of the rotation direction extending walls 61Db of the intermediate rotating flights (vanes) 61D are preferably disposed between the rotation direction extending wall 61Bb of the outer side rotating flight (vane) 61B and the inner side rotating flight (vane) 61C in radial direction RD.

[0126] The second embodiment has the following advantages as compared with the first embodiment.

[0127] First, in the first embodiment, the control rod 70 may slide with the through holes 10H, 65H, and 66H formed in the rotating shell 10, the support portion 65, and the nut 66, respectively. At the same time, the outer side lifting flight (vane) 60B may slide with the inner side lifting flight (vane) 60A and the fixing member 60C. In such a case, in the first embodiment, the area of a portion that may slide is large. On the other hand, in the second embodiment, only the through hole 10A of the rotating shell 10 and the inner wall of the support ring 81 may slide with the rotation control rod 80, and the area of the portion that may slide is smaller than that in the first embodiment. Therefore, as compared with the control rod 70 of the first embodiment, the rotation control rod 80 of the second embodiment has an advantage of being easily operated.

[0128] In addition, in the first embodiment, the control rod 70 moves to the inner side BS and the outer side TS. Therefore, when the control rod 70 is moved to the outer side TS in a state where the processing material W is sandwiched between the through hole 10H of the rotating shell 10 and the control rod 70, a part of the processing material W sandwiched therebetween may leak from the rotating shell 10. On the other hand, in the second embodiment, since the rotation control rod 80 does not move to the inner side BS and the outer side TS, even if the processing material W is sandwiched between the through hole 10A of the rotating shell 10 and the rotation

control rod 80, there is an advantage that a possibility that a part of the processing material W leaks from the rotating shell 10 is low.

[0129] In addition, in the first embodiment, since the control rod 70 moves to the inner side BS and the outer side TS, when the control rod 70 is repeatedly moved to the inner side BS and the outer side TS in a state where the processing material W is sandwiched between the through hole 10H of the rotating shell 10 and the control rod 70, the amount of the processing material W entering a gap between the through hole 10H of the rotating shell 10 and the control rod 70 increases, and the processing material W entering the gap is gradually tightened and solidified. As a result, it may be finally difficult to move the control rod 70 to the inner side BS and the outer side TS. On the other hand, in the second embodiment, only the rotation control rod 80 is rotated, and the rotation control rod 80 is not moved to the inner side BS and the outer side TS unlike the first embodiment. Therefore, it is also possible to prevent occurrence of a defect such as an operation failure of the rotation control rod 80.

(First lifting member 73 according to third embodiment)

[0130] A first lifting member 73 according to a third embodiment is illustrated in Figs. 13 and 14.

[0131] In the third embodiment, the first lifting member 73 directly or indirectly attached to a peripheral wall of the discharge pipe 51 can be replaced.

[0132] For example, as illustrated in Fig. 13, a first lifting member 73A having a short length in the radial direction RD can be removed in a state where the first lifting member 73A is attached to the peripheral wall of the discharge pipe 51, and as illustrated in Fig. 14, the first lifting member 73A can be replaced with a first lifting member 73B having a longer length in the radial direction RD. By switching the first lifting member 73 attached to the peripheral wall of the discharge pipe 51 from the existing first lifting member 73A having a short length in the radial direction RD to the new first lifting member 73B having a long length in the radial direction RD, the area of a front surface of the first lifting member 73 facing the rotation direction S can be increased, and the lifting amount of the processing material W deposited on the other end side OTS lower portion of the rotating shell 10 can be increased. Note that, although not illustrated, for example, a bolt and a nut may be used as a method for attaching the first lifting member 73 to the discharge pipe 51.

[0133] On the other hand, when it is desired to reduce the lifting amount of the processing material W, the first lifting member 73B having a long length in the radial direction RD illustrated in Fig. 14 only needs to be removed and replaced with the first lifting member 73A having a short length in the radial direction RD as illustrated in Fig. 13.

[0134] In the above description, as the first lifting member 73, two types of the first lifting member 73A having a

short length in the radial direction RD and the first lifting member 73B having a long length in the radial direction RD are prepared and replaced with each other, but the present invention is not necessarily limited to such a form. For example, three or more types of first lifting members 73 having different lengths in the radial direction RD may be prepared as the first lifting member 73, and the first lifting members 73 may be replaced with each other according to the amount of the processing material W to be lifted. As the number of types of the first lifting members 73 prepared in advance (the first lifting members 73 having different lengths in the radial direction RD) increases, the lifting amount of the processing material W can be changed more precisely.

[0135] Note that a replacement time of the first lifting member 73 is preferably after rotation of the rotating shell 10 is stopped. Examples thereof include before start of operation of the horizontal rotary dryer 1, during suspension of the operation, after end of the operation.

[0136] Unlike the first and second embodiments, in the third embodiment, since the through hole 10A is not formed in the peripheral wall of the rotating shell 10, there is an advantage that there is no possibility that the processing material W in the rotating shell 10 leaks from the rotating shell 10 through the through hole 10A.

(First lifting member 75 according to fourth embodiment)

[0137] A first lifting member 75 according to a fourth embodiment is illustrated in Figs. 15 to 20.

[0138] In the fourth embodiment, the first lifting member 75 is directly or indirectly attached to the peripheral wall of the discharge pipe 51. By attaching an extension member 76 to a distal end portion of the first lifting member 75 formed to extend to the outer side TS directly or indirectly from the peripheral wall of the discharge pipe 51 in this manner, the length of the first lifting member 75 in the radial direction RD can be extended.

[0139] For example, from a state where the first lifting member 75 having a short length in the radial direction RD extends from the peripheral wall of the discharge pipe 51 as illustrated in Figs. 15 and 18, a first extension member 76A can be attached to the distal end portion of the first lifting member 75 as illustrated in Figs. 16 and 19. By attaching the first extension member 76A in this manner, it is possible to increase the lifting amount of the processing material W deposited on the other end side OTS lower portion of the rotating shell 10.

[0140] When it is desired to further increase the lifting amount of the processing material W deposited on the other end side OTS lower portion of the rotating shell 10, the extension member 76 having a longer length in the radial direction RD only needs to be attached to the distal end portion of the first lifting member 75. For example, as illustrated in Figs. 17 and 20, a second extension member 76B only needs to be attached to the distal end portion of the first lifting member 75. Since the length of the second extension member 76B in the radial direction RD is longer

than the length of the first extension member 76A in the radial direction RD, the lifting amount of the processing material W can be further increased.

[0141] On the other hand, when it is desired to reduce the lifting amount of the processing material W, the extension member 76 only needs not to be attached as illustrated in Figs. 15 and 18.

[0142] In the above description, as the extension member 76, two types of the first extension member 76A and the second extension member 76B are prepared, and they are added depending on a case. However, the present invention is not necessarily limited to such a form. For example, another extension member 76 (for example, a third extension member) having a different length in the radial direction RD from the first extension member 76A and the second extension member 76B may be prepared, and attached to the distal end portion of the first lifting member 75. As the number of types of the extension members 76 prepared in advance (the extension members 76 having different lengths in the radial direction RD) increases, the lifting amount of the processing material W can be changed more precisely.

[0143] A replacement time of the extension member 76 is preferably after rotation of the rotating shell 10 is stopped. Examples thereof include before start of operation of the horizontal rotary dryer 1, during suspension of the operation, after end of the operation.

[0144] Unlike the first and second embodiments, in the fourth embodiment, since the through hole 10A is not formed in the peripheral wall of the rotating shell 10, there is an advantage that there is no possibility that the processing material W in the rotating shell 10 leaks from the rotating shell 10 through the through hole 10A.

[0145] Note that a method for attaching the extension member 76 to the distal end portion of the first lifting member 75 is not particularly limited. For example, as illustrated in Figs. 15 to 20, by forming a connecting hole 77 at the distal end portion of the first lifting member 75, the first lifting member 75 and the extension member 76 can be connected via the connecting hole 77 using a bolt 78 and a nut 79.

[0146] In addition, in the above description, the form in which the extension member 76 is attached to the distal end portion of the first lifting member 75 has been described, but the present invention is not necessarily limited to such a form. For example, after the extension member 76 is attached to the distal end portion of the first lifting member 75, by further attaching another extension member 76 to the distal end portion of the extension member 76, the length of the entire portion connecting the first lifting member 75 and the extension member 76 in the radial direction RD may be consequently increased to increase the lifting amount of the processing material W.

[0147] Note that, as illustrated in Figs. 19 and 20, a transverse cross section of the first lifting member 75 according to the fourth embodiment has an L shape, and a transverse cross section of the extension member 76

connected to the first lifting member 75 also has a shape similar to an L shape. Specifically, the extension member 76 includes an outer side extending wall 76X extending to the outer side TS, a first rotation direction extending wall 76Y extending in the rotation direction S of the first lifting member 75 from an outer side TS end portion of the outer side extending wall 76X, and a second rotation direction extending wall 76Z extending in the rotation direction S of the first lifting member 75 from a middle portion of the outer side extending wall 76X. A front surface (a surface on the rotation direction S side) of the outer side extending wall 76X and an upper surface (a surface of the inner side BS) of the second rotation direction extending wall 76Z are fixed in a state of being in contact with the outer side TS portion of the first lifting member 75.

[0148] At this time, since the processing material W lifted by the extension member 76 easily enters a corner portion 76Q between a front surface of the outer side extending wall 76X and a lower surface (a surface of the outer side TS) of the second rotation direction extending wall 76Z, there is a problem that the processing material W hardly enters the opening X.

[0149] In order to solve such a problem, a plate-shaped guide member 74 is preferably disposed on the extension member 76 as illustrated in Figs. 16, 17, 19, and 20. Specifically, the guide member 74 extending from a portion between the first rotation direction extending wall 76Y and the second rotation direction extending wall 76Z of the outer side extending wall 76X toward the distal end portion of the second rotation direction extending wall 76Z is preferably disposed. By disposing the guide member 74, the processing material W is less likely to enter the corner portion 76Q between the front surface of the outer side extending wall 76X and the lower surface of the second rotation direction extending wall 76Z, and therefore the processing material W lifted by the extension member 76 can be smoothly guided to the opening X.

(Second lifting member 85 according to fifth embodiment)

[0150] A second lifting member 85 according to a fifth embodiment is illustrated in Figs. 21 and 22. In Figs. 21 and 22, the second lifting member 85 according to the fifth embodiment is disposed in addition to the first lifting member 75 according to the fourth embodiment. The second lifting member 85 of the fifth embodiment extends to an inner wall of the rotating shell 10, a through hole 86 is formed on the outer side TS, and the through hole 86 is covered or opened by slidably moving the opening and closing door 87 to the inner side BS and the outer side TS.

[0151] For example, when it is desired to discharge the whole amount of the processing material W remaining in the rotating shell 10 to empty the rotating shell 10 at the time of ending operation of the horizontal rotary dryer 1, the opening and closing door 87 is closed to cover the through hole 86 as illustrated in Fig. 21. As a result, the processing material W placed on the second lifting mem-

ber 85 does not leak from the through hole 86, and therefore the processing material W can be lifted.

[0152] In order to empty the processing material W in the rotating shell 10 only with the first lifting member 75 of the fourth embodiment, it is necessary to attach the extension member 76 to the first lifting member 75 and to locate the distal end portion of the extension member 76 in the vicinity of an inner wall of the rotating shell 10, which takes time and effort to attach the extension member 76.

[0153] By disposing the second lifting member 85 in addition to the first lifting member 75 as in the fifth embodiment, it is possible to lift the processing material W on the other end side OTS bottom portion of the rotating shell 10 by closing the opening and closing door 87 of the second lifting member 85 and covering the through hole 86 without attaching the extension member 76 to the first lifting member 75. Therefore, as compared with the case where the extension member 76 is attached to the first lifting member 75 of the fourth embodiment, in a case where both the first lifting member 75 and the second lifting member 85 are disposed, the processing material W on the other end side OTS bottom portion of the rotating shell 10 can be lifted and discharged to the outside of the rotating shell 10 more easily.

[0154] On the other hand, during normal operation of the horizontal rotary dryer 1, the opening and closing door 87 is opened to open the through hole 86 as illustrated in Fig. 22. As a result, most of the processing material W placed on the second lifting member 85 passes through the through hole 86 and leaks to a side opposite to the rotation direction S of the second lifting member 85. By adjusting the lifting amount of the processing material W by the first lifting member 75 without lifting the processing material W by the second lifting member 85 in this manner, a hold up ratio can be adjusted.

[0155] Note that a method for moving the opening and closing door 87 to the inner side BS and the outer side TS is not particularly limited. For example, as illustrated in Figs. 21 and 22, by connecting the control rod 88 to the opening and closing door 87, causing the outer side TS portion of the control rod 88 to be supported by the rotating shell 10, and moving the control rod 88 to the inner side BS or the outer side TS, the opening and closing door 87 may be moved to the inner side BS or the outer side TS.

[0156] Furthermore, in the forms of Figs. 21 and 22, the through hole 86 is formed on the outer side TS of the second lifting member 85, but the present invention is not necessarily limited to such a form. For example, the through hole 86 may be formed nearer to the inner side BS than those in Figs. 21 and 22.

(Second lifting member 95 according to sixth embodiment)

[0157] A second lifting member 95 according to a sixth embodiment is illustrated in Figs. 23 to 25. In the sixth

embodiment, the second lifting member 95 according to the sixth embodiment is disposed in addition to the first lifting member 75 according to the fourth embodiment. The second lifting member 95 of the sixth embodiment extends to the inner wall of the rotating shell 10, the through hole 96 is formed in the outer side TS, and the through hole 96 is shielded or opened by opening the opening and closing door 97 in a back side of the second lifting member 95 in the rotation direction S (in a direction opposite to the rotation direction S).

[0158] For example, when it is desired to discharge the whole amount of the processing material W remaining in the rotating shell 10 to empty the rotating shell 10 at the time of ending operation of the horizontal rotary dryer 1, the opening and closing door 97 is closed to close the through hole 96 as illustrated in Fig. 23. As a result, the processing material W placed on the second lifting member 95 does not leak from the through hole 96, and therefore the processing material W can be lifted.

[0159] In order to empty the processing material W from the rotating shell 10 only with the first lifting member 75 of the fourth embodiment, it is necessary to attach the extension member 76 to the first lifting member 75 and to locate the distal end portion of the extension member 76 in the vicinity of an inner wall of the rotating shell 10, which takes time and effort to attach the extension member 76.

[0160] By disposing the second lifting member 95 in addition to the first lifting member 75 as in the sixth embodiment, it is possible to lift the processing material W on the other end side OTS bottom portion of the rotating shell 10 by closing the opening and closing door 97 of the second lifting member 95 and covering the through hole 96 without attaching the extension member 76 to the first lifting member 75. Therefore, as compared with the case where the extension member 76 is attached to the first lifting member 75 of the fourth embodiment, in a case where both the first lifting member 75 and the second lifting member 95 are disposed, the processing material W on the other end side OTS bottom portion of the rotating shell 10 can be lifted and discharged to the outside of the rotating shell 10 more easily.

[0161] On the other hand, during normal operation, the opening and closing door 97 is opened to open the through hole 96 as illustrated in Figs. 24 and 25. As a result, most of the processing material W placed on the second lifting member 95 passes through the through hole 96 and leaks to a side opposite to the rotation direction S of the second lifting member 95. Therefore, by adjusting the lifting amount of the processing material W by the first lifting member 75 without lifting the processing material W by the second lifting member 95, a hold up ratio can be adjusted.

[0162] A method for opening and closing the opening and closing door 97 is not particularly limited. For example, as illustrated in Figs. 23 to 25, by connecting a control rod 98 to the opening and closing door 97, causing the outer side TS portion of the control rod 98 to be supported by the rotating shell 10, and rotating the control rod 98 in a

circumferential direction of the control rod 98, the opening and closing door 97 may be rotated.

[0163] In addition, Figs. 24 and 25 illustrate a form in which the opening and closing door 97 is opened to a back side of the second lifting member 95 in the rotation direction S (a side opposite to the rotation direction S of the second lifting member 95), but the present invention is not necessarily limited to such a form. For example, the opening and closing door 97 may be opened to a front side of the second lifting member 95 in the rotation direction S (in the same direction as the rotation direction S of the second lifting member 95). However, when the opening and closing door 97 is opened to the front side of the second lifting member 95 in the rotation direction S, the processing material W placed on the opening and closing door 97 may be lifted and discharged from the inside of the rotating shell 10 depending on an opening degree thereof, and thus, the opening and closing door 97 is preferably opened to the back side in the rotation direction S.

[0164] Furthermore, in the forms of Figs. 23 to 25, the through hole 96 is formed on the outer side TS of the second lifting member 95, but the present invention is not necessarily limited to such a form. For example, the through hole 96 may be formed on the inner side BS with respect to those in Figs. 23 to 25.

[0165] In the above description, a combination of the second lifting member 85 according to the fifth embodiment or the second lifting member 95 according to the sixth embodiment with the first lifting member 75 according to the fourth embodiment has been described. However, the present invention is not limited to this form. For example, in place of the first lifting member 75, any one of the first lifting member 60 of the first embodiment, the first lifting member 61 of the second embodiment, the first lifting member 73 of the third embodiment, and a first lifting member 105 of a seventh embodiment described later may be disposed in combination with the second lifting member 85 or the second lifting member 95 according to the sixth embodiment.

[0166] Note that the number of lifting members to be combined is not limited to two, and may be three or more. For example, a third lifting member (not illustrated) may be combined with the first lifting members 60, 61, 73, and 75, a first lifting member 105 described later, and the second lifting members 85 and 95. The number of number of lifting members to be combined is preferably two. A combination of the first lifting member 75 according to the fourth embodiment or the first lifting member 73 according to the third embodiment with the second lifting member 85 according to the fifth embodiment, or a combination of the first lifting member 75 according to the fourth embodiment or the first lifting member 73 according to the third embodiment with the second lifting member 95 according to the sixth embodiment is more preferable.

(First lifting member 105 according to seventh embodiment)

[0167] A first lifting member 105 according to a seventh embodiment is illustrated in Figs. 26 to 29. The first lifting member 105 of the seventh embodiment extends to the inner wall of the rotating shell 10, a through hole 106 is formed on the distal end side TS, and the through hole 106 is covered or opened by opening an opening and closing door 107 in a rear side of the first lifting member 105 in the rotation direction S (in a direction opposite to the rotation direction S).

[0168] The first lifting member 105 is disposed between an outer wall of the discharge pipe 51 and an inner wall of the rotating shell 10, and extends from an inner side to an outer side of the rotating shell 10 in an intersecting cross section intersecting with an axis of the rotating shell 10. An inner side portion 112 of the first lifting member 105 is located behind an outer side portion 114 of the first lifting member 105 in the rotation direction S of the first lifting member 105, and an intermediate portion 113 connecting the inner side portion 112 of the first lifting member 105 and an outer side portion 114 of the first lifting member 105 extends from a rear side to a front side of the first lifting member 105 in the rotation direction S.

[0169] With the above-described structure, a recessed portion 111 recessed to a rear side of the first lifting member 105 in the rotation direction S can be formed on an inner side of the first lifting member 105. The recessed portion 111 is located behind the outer side portion 114 of the first lifting member 105 in the rotation direction S. The recessed portion 111 is formed by connection between a distal end portion of the inner side portion 112 of the first lifting member 105 (an outer side portion of an intersecting cross section intersecting with an axis of the rotating shell 10 in the inner side portion 112 of the first lifting member 105) and a proximal end portion of the outer side portion 114 of the first lifting member 105 (an inner side portion of an intersecting cross section intersecting with the axis of the rotating shell 10 in the outer side portion 114 of the first lifting member 105) by the intermediate portion 113. Note that the recessed portion 111 is mainly constituted by the inner side portion 112 and the intermediate portion 113 of the first lifting member 105, and a side wall 109 and the like described later may be formed as necessary.

[0170] During normal operation of the horizontal rotary dryer 1, the opening and closing door 107 is opened to open the through hole 106 as illustrated in Figs. 27 and 28. As a result, most of the processing material W placed on the outer side portion 114 of the first lifting member 105 passes through the through hole 106 and leaks to a side opposite to the rotation direction S of the first lifting member 105. At this time, when the amount of the processing material W deposited on a bottom portion of the rotating shell 10 is large, and the height of the processing material W deposited on the bottom portion of the rotating

shell 10 is higher than the height of an upper end portion of the outer side portion 114 of the first lifting member 105 (the upper end portion means an end portion of the inner side BS of the outer side portion 114 of the first lifting member 105 in a case where the first lifting member 105 is below the rotating shell 10 and a wall surface of the first lifting member 105 is vertical, hereinafter, the same applies), the processing material W in a portion higher than the height of the upper end portion of the outer side portion 114 of the first lifting member 105 can be lifted by the inner side portion 112 and the intermediate portion 113 of the first lifting member 105, the lifted processing material W can be temporarily stored in the recessed portion 111, and the processing material W can be finally guided to the opening X.

[0171] On the other hand, for example, when it is desired to discharge the whole amount of the processing material W remaining in the rotating shell 10 to empty the rotating shell 10 at the time of ending operation of the horizontal rotary dryer 1, the opening and closing door 107 is closed to cover the through hole 106 as illustrated in Fig. 26. As a result, the processing material W placed on the first lifting member 105 can be lifted without leaking from the through hole 106.

[0172] According to the first lifting member 105 as described above, the lifting amount of the processing material W can be adjusted. In addition, by setting the extension length of the outer side portion 114 (the height of the upper end portion of the outer side portion 114) to a desired value when the first lifting member 105 is disposed, a hold up ratio of the processing material W in the rotating shell 10 can be adjusted to a desired value.

[0173] Note that a method for opening and closing the opening and closing door 107 is not particularly limited. For example, as illustrated in Figs. 26 to 28, by connecting a control rod 108 to the opening and closing door 107, causing the distal end side TS portion of the control rod 108 to be supported by the rotating shell 10, and rotating the control rod 108 in a circumferential direction of the control rod 108, the opening and closing door 107 may be rotated.

[0174] In addition, Figs. 27 and 28 illustrate a form in which the opening and closing door 107 is opened to a rear side of the first lifting member 105 in the rotation direction S (a side opposite to the rotation direction S of the first lifting member 105), but the present invention is not necessarily limited to such a form. For example, the opening and closing door 107 may be opened to a front side of the first lifting member 105 in the rotation direction S (in the same direction as the rotation direction S of the first lifting member 105). However, when the opening and closing door 107 is opened to the front side of the first lifting member 105 in the rotation direction S, the processing material W placed on the opening and closing door 107 may be lifted and discharged from the inside of the rotating shell 10 depending on an opening degree thereof, and thus, the opening and closing door 107 is preferably opened to the rear side in the rotation direction S.

[0175] Furthermore, in the forms of Figs. 26 to 28, the through hole 106 is formed on the outer side TS of the first lifting member 105, but the present invention is not necessarily limited to such a form. For example, the through hole 106 may be formed on the inner side BS with respect to those in Figs. 26 to 28.

[0176] Note that the side wall 109 is preferably formed on a side surface of the first lifting member 105. By forming the side wall 109, when the first lifting member 105 is rotated, it is possible to prevent the processing material W from falling from a front side of the first lifting member 105 in the rotation direction S to a side in the rotation direction S. Therefore, there is an advantage that most of the processing material W can be guided to the opening X.

[0177] When the side wall 109 is formed, the side wall 109 is preferably formed on the entire side of the first lifting member 105, that is, on each of the sides of the inner side portion 112, the intermediate portion 113, and the outer side portion 114 of the first lifting member 105. By forming the side wall 109 on the entire side of the first lifting member 105, the effect of preventing the processing material W from falling from the front side of the first lifting member 105 in the rotation direction S to the side in the rotation direction S is enhanced. When the side wall 109 is formed only on a part of the side of the first lifting member 105, the side wall 109 is preferably formed on the inner side portion 112 rather than the outer side portion 114. This is because the processing material W placed on the front surface of the first lifting member 105 in the rotation direction S gradually moves to the inner side BS of the rotating shell 10 along with rotation of the first lifting member 105, and thus it is more important to prevent the processing material W from falling from the inner side portion 112 to the side in the rotation direction S.

[0178] The length of the side wall 109 in the rotation direction S can be arbitrarily determined, but as the length of the side wall 109 increases, it is possible to further prevent the processing material W from falling from the side. As illustrated in Figs. 26 to 29, the length of the side wall 109 of the inner side portion 112 in the rotation direction S is preferably longer than the length of the side wall 109 of the outer side portion 114 in the rotation direction.

(Modification of shape of first lifting member)

[0179] Although not illustrated, the shapes of the first lifting members of the first to fourth embodiments may be similar to the shape of the first lifting member 105 of the seventh embodiment. That is, an inner side portion of the first lifting member may be located behind an outer side portion of the first lifting member in the rotation direction S of the first lifting member, and an intermediate portion connecting the inner side portion of the first lifting member and an outer side portion of the first lifting member may extend from a rear side to a front side of the first lifting

member in the rotation direction S. By forming the first lifting member in such a shape, a recessed portion is formed on the inner side BS of the first lifting member. As a result, when the first lifting member rotates, most of the processing material W lifted by the first lifting member can be temporarily stored in the recessed portion, and the amount of the processing material W discharged to the discharge pipe can be increased.

[0180] Specifically, the first to fourth embodiments may be modified as follows.

(Modification of First Embodiment)

[0181] The inner side lifting flight (vane) 60A is disposed in a rear side of the outer side lifting flight (vane) 60B in the rotation direction S of the first lifting flight (vane) 60, and an intermediate member connecting the inner side lifting flight (vane) 60A and the outer side lifting flight (vane) 60B is newly disposed.

(Modification of Second Embodiment)

[0182] The fixed flight (vane) 61A is disposed in a rear side of the rotating flight (vane) (the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D) in the rotation direction S, and an intermediate member connecting the fixed flight (vane) 61A and the rotating flight (vane) is newly disposed.

(Modification of Third Embodiment)

[0183] The shape of each of the first lifting members 73A and 73B is similar to the shape of the first lifting member 105 of the seventh embodiment.

(Modification of Fourth Embodiment)

[0184] The first lifting member 75 is disposed on a rear side of the extension member 76 in the rotation direction S, and an intermediate member connecting the first lifting member 75 and the extension member 76 is newly disposed.

(Side wall of first lifting member)

[0185] Similarly to the first lifting member 105, a side wall may be formed on a feed port side (one end side ITS of the rotating shell 10) of the processing material W of each first lifting member. By forming the side wall, it is possible to prevent the processing material W lifted by the first lifting member from falling from the feed port side of the processing material W, and therefore the processing material W lifted by the first lifting member is more easily guided to the opening X.

[0186] Specifically, the first to fourth embodiments may be modified as follows.

(Modification of First Embodiment)

[0187] A side wall is formed on a feed port side (one end side ITS of the rotating shell 10) of the processing material W in the inner side lifting flight (vane) 60A or the outer side lifting flight (vane) 60B. In this case, the side walls are preferably formed on both the inner side lifting flight (vane) 60A and the outer side lifting flight (vane) 60B, but the side wall may be formed on only one of them. When the side wall is formed on only one of them, the side wall is preferably formed on the inner side lifting flight (vane) 60A in order to easily guide the lifted processing material W to the opening X.

(Modification of Second Embodiment)

[0188] A side wall is formed on a feed port side of the processing material W (one end side ITS of the rotating shell 10) in each of the fixed flight (vane) 61A and the rotating flight (vane) (the outer side rotating flight (vane) 61B, the inner side rotating flight (vane) 61C, and the intermediate rotating flight (vane) 61D). In this case, the side walls are preferably formed on both the fixed flight (vane) 61A and the rotating flight (vane), but the side wall may be formed on only one of them. When the side wall is formed on only one of them, the side wall is preferably formed on the fixed flight (vane) 61A in order to easily guide the lifted processing material W to the opening X. Note that, when the side wall is formed on the inner side rotating flight (vane) 61C, the side wall is formed so as not to interfere with the side wall of the fixed flight (vane) 61A.

(Modification of Third Embodiment)

[0189] A side wall is formed on a feed port side of the processing material W (one end side ITS of the rotating shell 10) in each of the first lifting members 73A and 73B.

(Modification of Fourth Embodiment)

[0190] A side wall is formed on a feed port side of the processing material W (one end side ITS of the rotating shell 10) in the first lifting member 75 or the extension member 76. In this case, the side walls are preferably formed on both the first lifting member 75 and the extension member 76, but the side wall may be formed on only one of them. When the side wall is formed on only one of them, the side wall is preferably formed on the first lifting member 75 in order to easily guide the lifted processing material W to the opening X.

(Side wall of second lifting member)

[0191] As illustrated in Figs. 21 to 25, a side wall similar to that of the first lifting member 105 may be formed on each of the second lifting members of the fifth embodiment and the sixth embodiment. By forming the side wall, it is possible to prevent the processing material W lifted by

the second lifting member from falling from the feed port side of the processing material W, and therefore the processing material W lifted by the second lifting member is more easily guided to the opening X.

[0192] Regarding the side walls 109 of the first lifting member and the second lifting member of each of the above embodiments, the side wall 109 formed on one end side ITS of the rotating shell 10 has been described, but the side wall 109 may be formed on the other end side OTS. In addition, when the side walls are disposed on both one end side ITS and the other end side OTS, it is more effective for preventing the lifted processing material W from falling.

[0193] Note that when the other end side OTS side of the first lifting member or the second lifting member of each of the above embodiments is not adjacent to any wall on the other end side OTS (for example, as illustrated in Fig. 2, when there is a certain amount of space between the first lifting member 60 and an end plate inner wall 18), the side wall 109 is preferably formed on the other end side OTS of the first lifting member or the second lifting member. This is because the processing material W lifted by the first lifting member or the second lifting member is less likely to fall from the other end side OTS.

[0194] On the other hand, when the other end side OTS side surface of the first lifting member or the second lifting member of each of the above embodiments is adjacent to any wall on the other end side OTS (for example, as illustrated in Figs. 26 to 28, there is almost no gap between the first lifting member 105 and the end plate inner wall 18), the side wall 109 does not have to be formed on the other end side OTS of the first lifting member or the second lifting member. This is because some wall on the other end side OTS prevents the processing material W lifted by the first lifting member or the second lifting member from falling from the other end side OTS.

(Hold up ratio of processing material W)

[0195] Note that the hold up ratio of the processing material W refers to a value obtained by dividing the volume of the processing material W staying in the rotating shell 10 by the volume in the rotating shell 10, and can be obtained by the following formula 1.

[Numerical formula 1]

$$\eta = A_p / A_f \cdot 100$$

[0196] Here, η is a hold up ratio (%), A_p is a cross-sectional area (m^2) occupied by the processing material W with respect to a free cross-sectional area, and A_f is a free cross-sectional area (m^2) obtained by subtracting the cross-sectional area of all the heating tubes 11 from the entire cross-sectional area of the rotating shell 10.

[0197] As an example of a specific calculation method, the A_p is calculated by measuring the filling height of the processing material W inside the rotating shell 10 from an inspection port or the like formed at an end or the like of a main body of the horizontal rotary dryer 1. In addition, the A_f can be obtained from a design value. By applying A_p and A_f thus obtained to the above calculation formula, η (hold up ratio) can be derived.

10 (Rotation of first lifting members 60, 61, 73, 75, and 105 and second lifting members 85 and 95)

[0198] In the above description, it has been described that the first lifting members 60, 61, 73, 75, and 105 according to the first to fourth and seventh embodiments and the second lifting members 85 and 95 according to the fifth and sixth embodiments rotate. Since the first lifting members 60, 61, 73, 75, and 105 according to the first to fourth and seventh embodiments and the second lifting members 85 and 95 according to the fifth and sixth embodiments are fixed to the discharge pipe 51, when the discharge pipe 51 rotates, the first lifting members 60, 61, 73, 75, and 105 and the second lifting members 85 and 95 also rotate in the same direction as a rotation direction of the discharge pipe 51. In addition, since the discharge pipe 51 is fixed to the rotating shell 10, when the rotating shell 10 rotates, the discharge pipe 51 also rotates in the same direction as the rotating shell 10. Therefore, when the rotating shell 10, the discharge pipe 51, the first lifting members 60, 61, 73, 75, and 105, and the second lifting members 85 and 95 are connected to each other, the rotation direction R of the rotating shell 10 is the same as the rotation direction S of the first lifting members 60, 61, 73, 75, and 105 and the second lifting members 85 and 95.

(Attachment positions of first lifting members 60, 61, 73, 75, and 105 and second lifting members 85 and 95)

[0199] In the above description, the first lifting members 60, 61, 73, 75, and 105 according to the first to fourth and seventh embodiments and the second lifting members 85 and 95 according to the fifth and sixth embodiments are attached to an outer peripheral wall of the discharge pipe 51. However, the present invention is not necessarily limited to such a form. For example, a rotary pipe (not illustrated) extending in the same direction as the discharge pipe 51 may be disposed inside the discharge pipe 51, and the first lifting members 60, 61, 73, 75, and 105 according to the first to fourth and seventh embodiments and the second lifting members 85 and 95 according to the fifth and sixth embodiments may be attached to the rotary pipe.

55 (Inflow of processing material W into opening X)

[0200] In the above description, the first lifting members 60, 61, 73, 75, and 105 according to the first to fourth

and seventh embodiments, and the second lifting members 85 and 95 according to the fifth and sixth embodiments lift the processing material W, and the lifted processing material W flows into the discharge pipe 51 through the opening X formed in the discharge pipe 51. The inflow of the lifted processing material W into the discharge pipe 51 occurs in an upper portion inside the rotating shell 10. For example, in the form illustrated in Figs. 3 and 4, the processing material W on the first lifting member 60 flows into the discharge pipe 51 through the opening X in the vicinity of the first lifting member 60 located in the upper right of the drawing.

[0201] Note that Figs. 3 and 4 illustrate a state in which the rotating shell 10 is stopped, that is, a state in which the processing material W is not moved (a state in which the processing material W is allowed to stand) for easy understanding. When the rotating shell 10 and the first lifting member 60 rotate from this state, the processing material W is lifted in the same direction as the rotation direction R of the rotating shell 10 and the rotation direction S of the first lifting member 60. When the rotating shell 10 and the first lifting member 60 rotate in the direction illustrated in Figs. 3 and 4, the processing material W is lifted upward to the right in the drawing, and the processing material is dispersed in a crescent shape inside the rotating shell 10. The same applies to any case of the first to seventh embodiments.

(Advantageous Effects of Invention)

[0202] As described above, according to the horizontal rotary dryer 1 of the present invention, since the area of the front surface of the first lifting member 60 facing the rotation direction can be changed, there is an advantage that the hold up ratio of the processing material W in the rotating shell 10 can be easily adjusted to a desired value.

(Industrial Applicability)

[0203] The horizontal rotary dryer 1 according to the present invention can be used as a dryer that dries coal, ores such as copper ore, iron powder, and zinc powder, metallic materials, inorganic substances such as gypsum, alumina, and soda ash, dehydrated sludge, and the like.

Reference Signs List

[0204]

1 Horizontal rotary dryer
10 Rotating shell
11 Heating tube
17 End plate portion
18 End plate inner wall
41 Feed port
51 Discharge pipe
55 Discharge casing

56 Exhaust port
57 Discharge port
60 First lifting member (according to first embodiment)
5 60A Inner side lifting flight (vane)
60B Outer side lifting flight (vane)
60C Fixing member
60D Protruding portion
61 First lifting member (according to second embodiment)
10 61A Fixed flight (vane)
61B Outer side rotating flight (vane)
61Ba Outer side extending wall
61Bb Rotation direction extending wall
15 61C Inner side rotating flight (vane)
61D Intermediate rotating flight (vane)
61Da Outer side extending wall
61Db Rotation direction extending wall
65 Support portion
20 65H Through hole
66 Nut
66H Through hole
70 Control rod
71 Drain discharge pipe
25 72 Steam feed pipe
73 First lifting member (according to third embodiment)
73A First lifting member
73B First lifting member
30 74 Guide member
75 First lifting member (according to fourth embodiment)
76 Extension member
76A First extension member
35 76B Second extension member
76Q Corner portion
76X Outer side extending wall
76Y First rotation direction extending wall
76Z Second rotation direction extending wall
40 77 Connecting hole
78 Bolt
79 Nut
80 Rotation control rod
85 Second lifting member (according to fifth embodiment)
45 86 Through hole
87 Opening and closing door
88 Control rod
91 Internal steam feed pipe
50 92 Internal drain discharge pipe
95 Second lifting member (according to sixth embodiment)
96 Through hole
97 Opening and closing door
55 98 Control rod
105 First lifting member (according to seventh embodiment)
106 Through hole

107	Opening and closing door	
108	Control rod	
109	Side wall	
110	Through hole	
111	Recessed portion	5
112	Inner side portion of (first lifting member)	
113	Intermediate portion of (first lifting member)	
114	Outer side portion of (first lifting member)	
A	Carrier gas	
E	Processed material	10
R	Rotation direction of rotating shell	
S	Rotation direction (of first lifting member or second lifting member)	
W	Processing material	
LD	longitudinal direction (of rotating shell)	15
ITS	One end side	
OTS	Other end side	
RD	Radial direction	
BS	Proximal end side (inner side)	
TS	Distal end side (outer side)	20

Claims

1. A horizontal rotary dryer comprising:

a rotating shell that has a feed port of a processing material on one end side and a discharge port of the processing material on the other end side, and is rotatable in a circumferential direction;

a discharge pipe connected to the discharge port formed at a central portion of the rotating shell on the other end side; and

a first lifting member that is located on the other end side of the rotating shell, rotates in the circumferential direction of the rotating shell, and lifts the processing material deposited on a lower portion of the rotating shell on the other end side, and guides the processing material into the discharge pipe, wherein the first lifting member is a variable lifting member capable of changing an area of a front surface of the first lifting member facing a rotation direction thereof.

2. The horizontal rotary dryer according to claim 1, comprising,

inside the rotating shell, a large number of heating tubes through which a heating medium passes, wherein

the horizontal rotary dryer indirectly heats and dries the processing material by bringing the processing material into contact with outer surfaces of the heating tubes while the processing material moves from one end side to the other end side of the rotating shell.

3. The horizontal rotary dryer according to claim 1 or 2, wherein

a through hole is formed in a part of the first lifting member, and

the first lifting member has an opening and closing door capable of covering the through hole.

4. The horizontal rotary dryer according to claim 3, wherein the opening and closing door is a swing door that opens to at least one of a front side and a rear side of the first lifting member in a rotation direction thereof.

5. The horizontal rotary dryer according to claim 3, wherein

the first lifting member is disposed between an outer wall of the discharge pipe and an inner wall of the rotating shell,

extends from an inner side to an outer side of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell, an inner side portion of the first lifting member is located behind an outer side portion of the first lifting member in a rotation direction of the first lifting member, and

an intermediate portion connecting the inner side portion of the first lifting member and the outer side portion of the first lifting member extends from a rear side to a front side of the first lifting member in the rotation direction.

6. The horizontal rotary dryer according to claim 5, wherein the first lifting member has a side wall on at least one of a feed port side and a discharge port side of the processing material.

7. The horizontal rotary dryer according to claim 1 or 2, wherein

the first lifting member is disposed between an outer wall of the discharge pipe and an inner wall of the rotating shell, and includes:

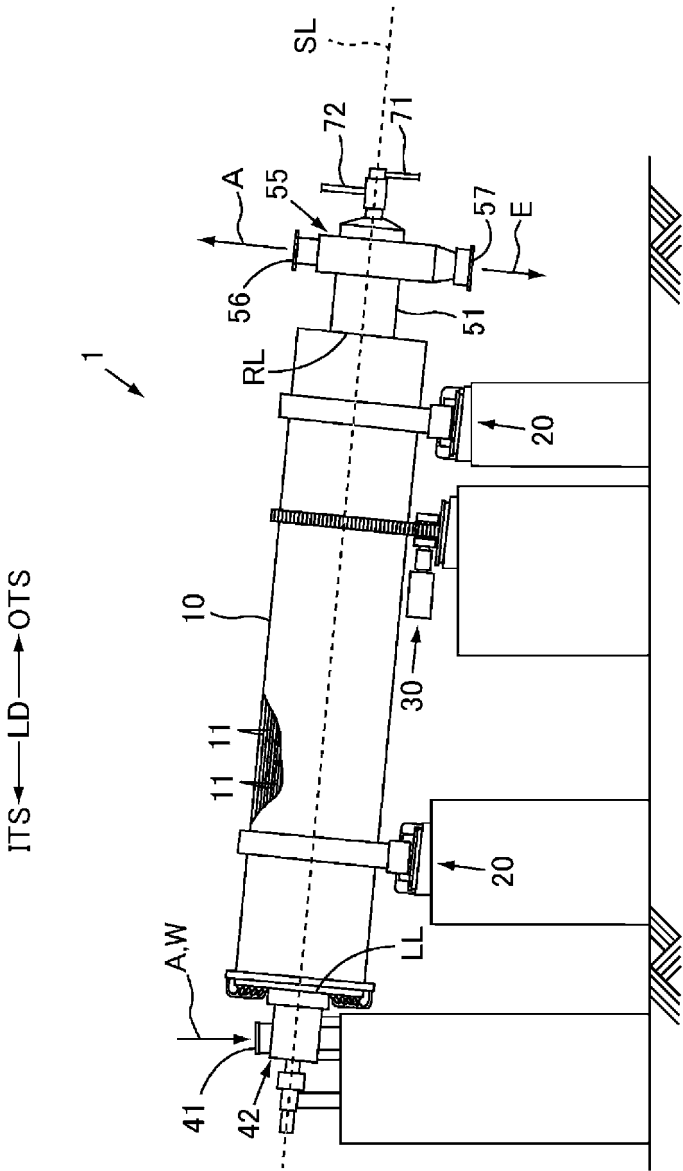
an inner side lifting flight extending from an inner side to an outer side of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell; and an outer side lifting flight disposed adjacent to the inner side lifting flight and movable to an outer side with respect to the inner side lifting flight, and an extension length of the first lifting mem-

- ber can be changed by moving the outer side lifting flight to an inner side or an outer side.
8. The horizontal rotary dryer according to claim 1 or 2, wherein
- the first lifting member is disposed between an outer wall of the discharge pipe and an inner wall of the rotating shell, and includes:
- a fixed flight having a proximal end portion directly or indirectly fixed to a peripheral wall of the discharge pipe, and extending from an inner side to an outer side of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell; and a plurality of rotating flights disposed on an outer side of the fixed flight and capable of being connected to a distal end portion of the fixed flight,
- the horizontal rotary dryer includes a rotary member having a rotation axis extending from an inner side to an outer side of the rotating shell in an intersecting cross section intersecting with the axis of the rotating shell, the plurality of rotating flights have different lengths extending to an outer side of the rotating shell in an intersecting cross section intersecting with the axis of the rotating shell, are fixed to the rotary member, and rotate in a circumferential direction of the rotation axis along with rotation of the rotary member, and the rotating flights connected to the fixed flight can be changed by rotating the rotary member.
9. The horizontal rotary dryer according to claim 1 or 2, wherein
- the first lifting member extends from an inner side to an outer side of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell in a state where a proximal end portion of the first lifting member is directly or indirectly attached to a peripheral wall of the discharge pipe, another first lifting member extending to an outer side of the rotating shell in an intersecting cross section intersecting with the axis of the rotating shell and having a different length is prepared in advance, and the first lifting member is replaceable to the

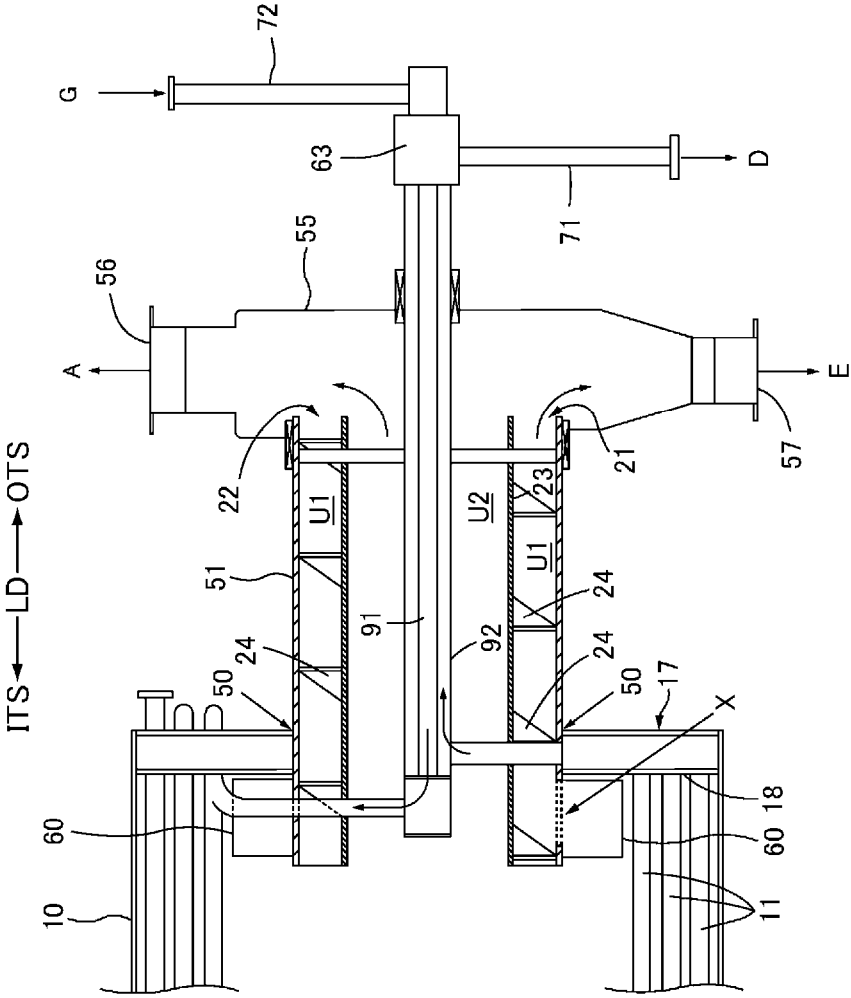
peripheral wall of the discharge pipe.

10. The horizontal rotary dryer according to claim 1 or 2, wherein
- the first lifting member has a proximal end portion directly or indirectly attached to a peripheral wall of the discharge pipe, extends from an inner side to an outer side of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell, and an extension member that extends an outer side extension length of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell is attachable to a distal end portion of the first lifting member.
11. The horizontal rotary dryer according to claim 1 or 2, wherein the first lifting member extends radially outward from an outer wall of the discharge pipe.
12. The horizontal rotary dryer according to claim 1 or 2, comprising
- a second lifting member that is located on the other end side of the rotating shell, rotates in a circumferential direction of the rotating shell, lifts the processing material deposited on a bottom portion of the rotating shell on the other end side, and guides the processing material into the discharge pipe, wherein a through hole is formed in a part of the second lifting member, and the second lifting member has an opening and closing door capable of covering the through hole.
13. The horizontal rotary dryer according to claim 12, wherein the opening and closing door is a sliding door movable to an inner side and an outer side of the rotating shell in an intersecting cross section intersecting with an axis of the rotating shell.
14. The horizontal rotary dryer according to claim 12, wherein the opening and closing door is a swing door that opens to at least one of a front side and a rear side of the second lifting member fixed to the discharge pipe in a rotation direction thereof.

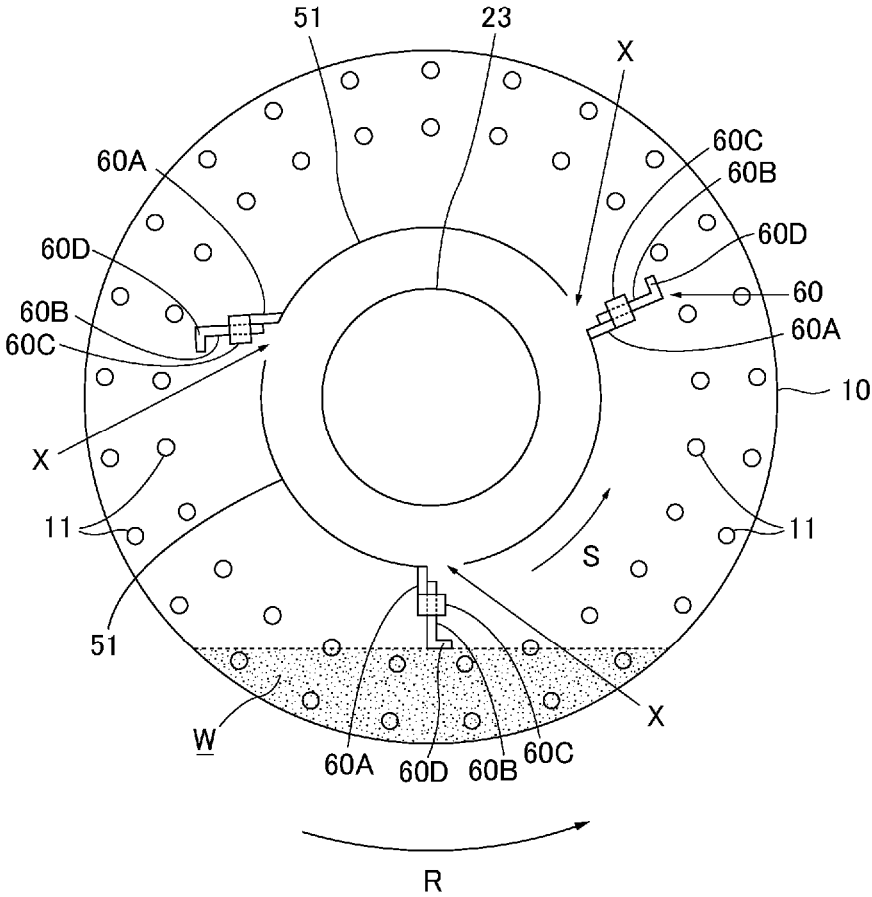
[FIG.1]



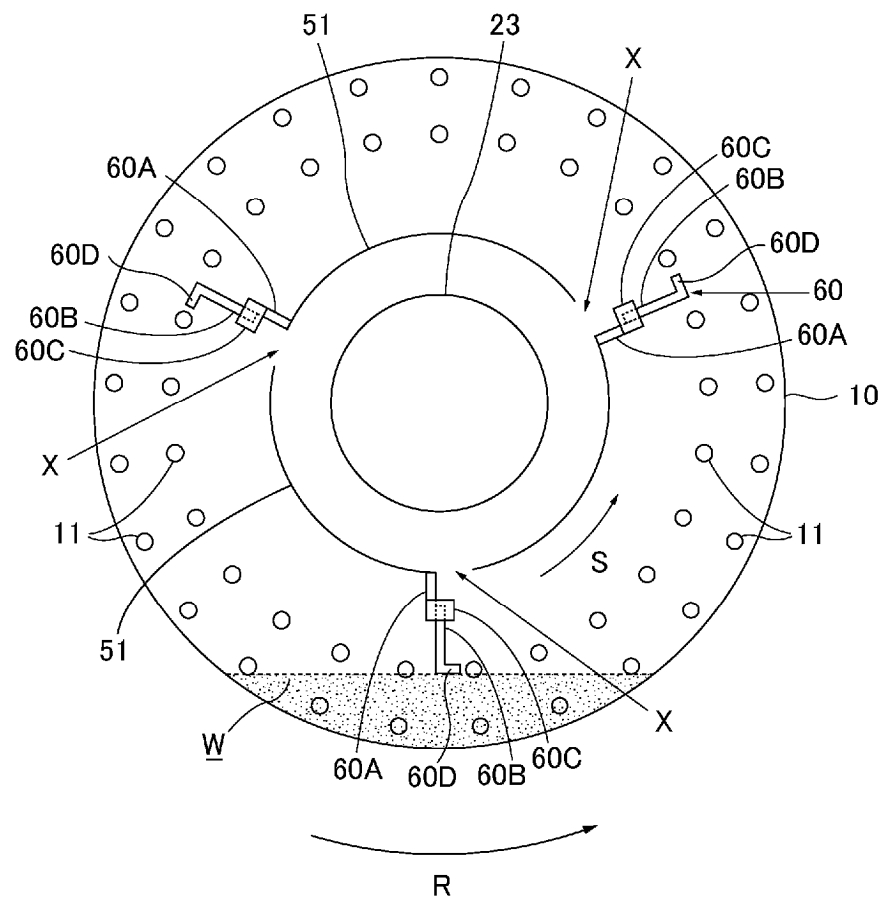
[FIG.2]



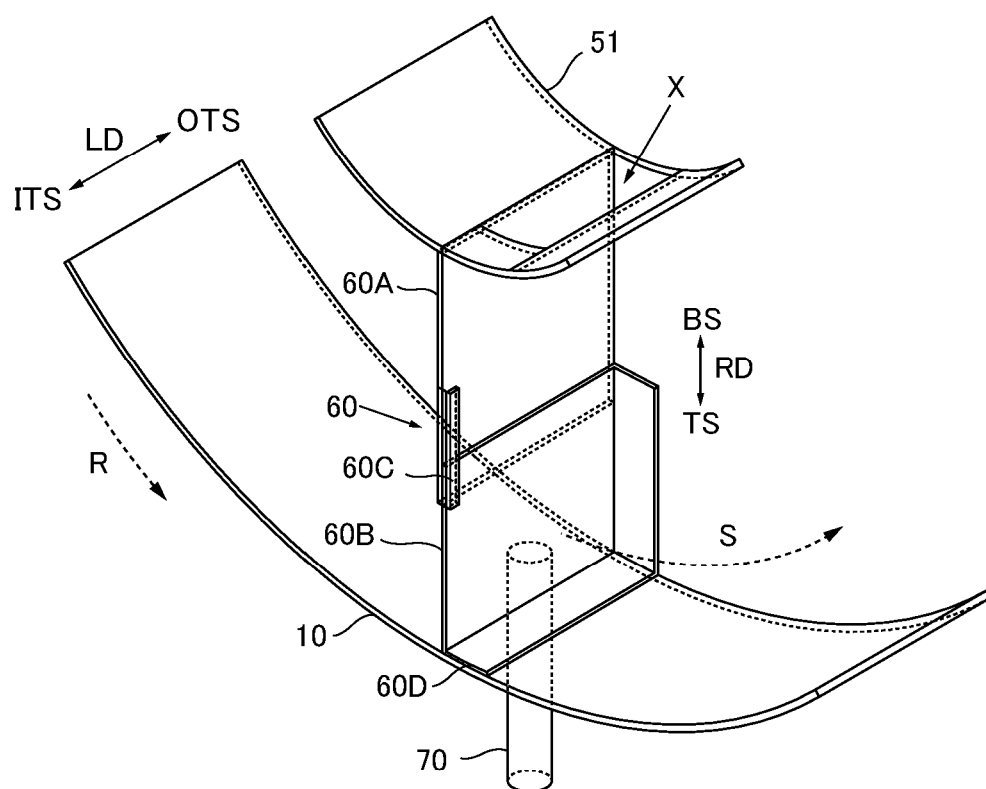
[FIG.3]



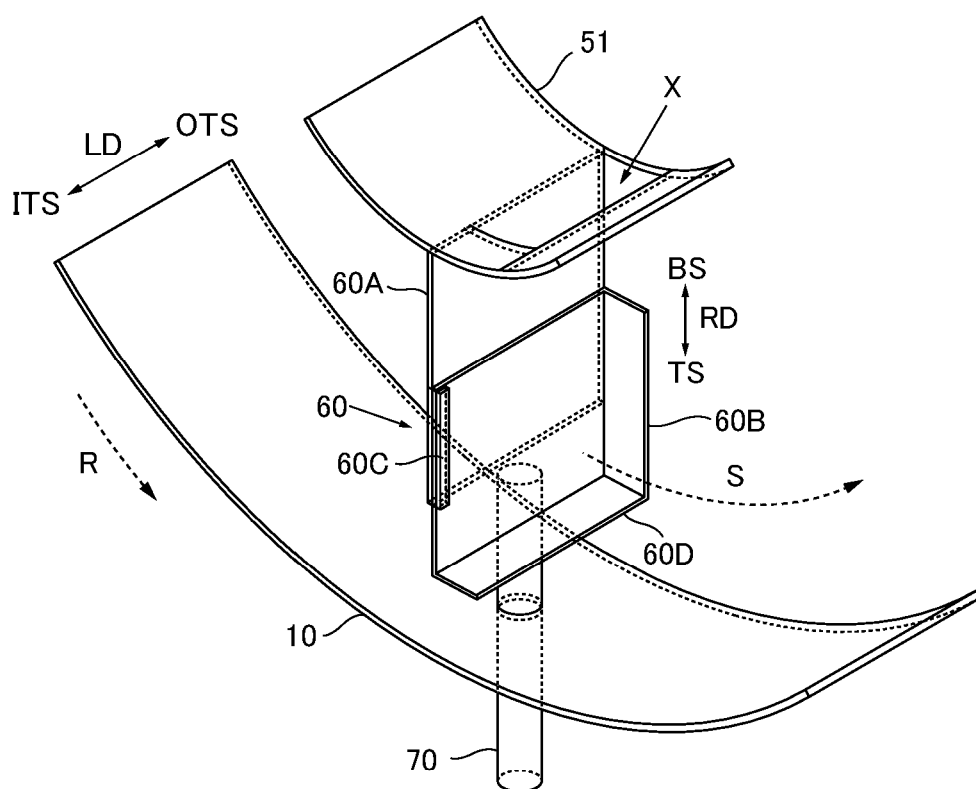
[FIG.4]



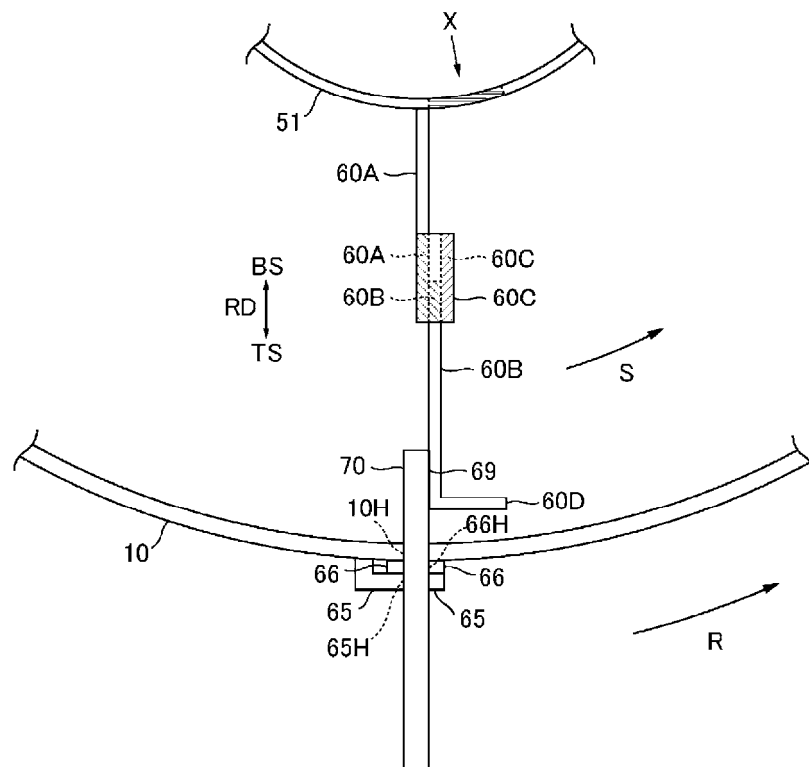
[FIG.5]



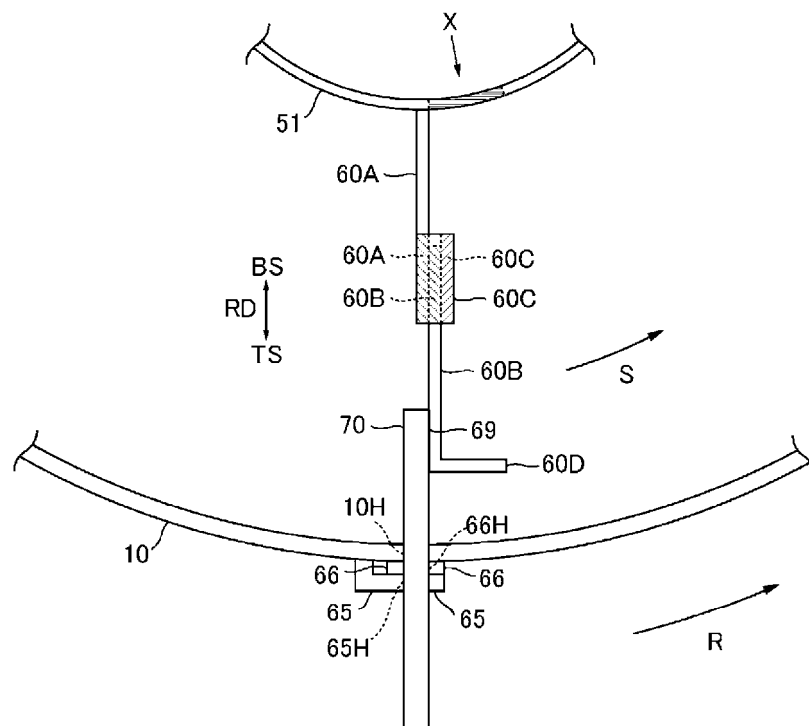
[FIG.6]



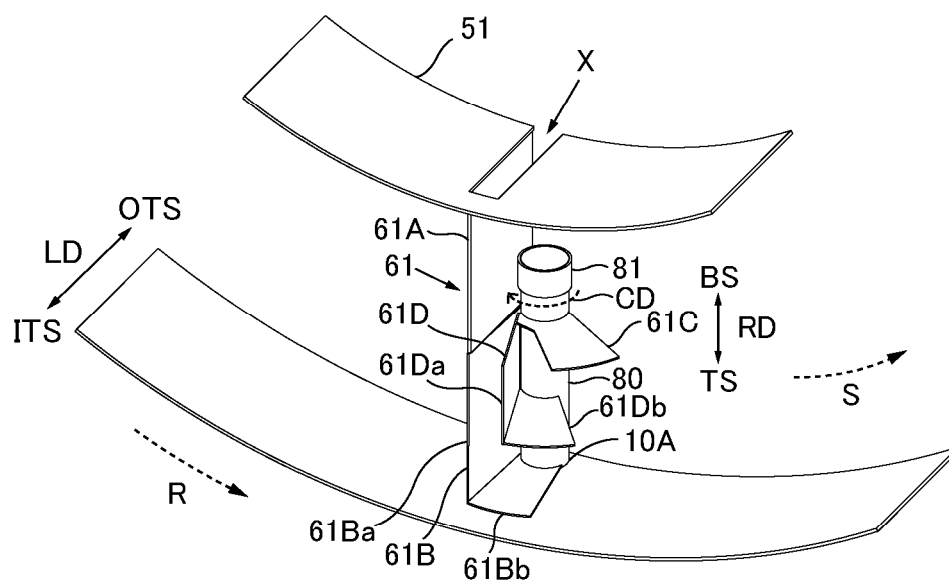
[FIG.7]



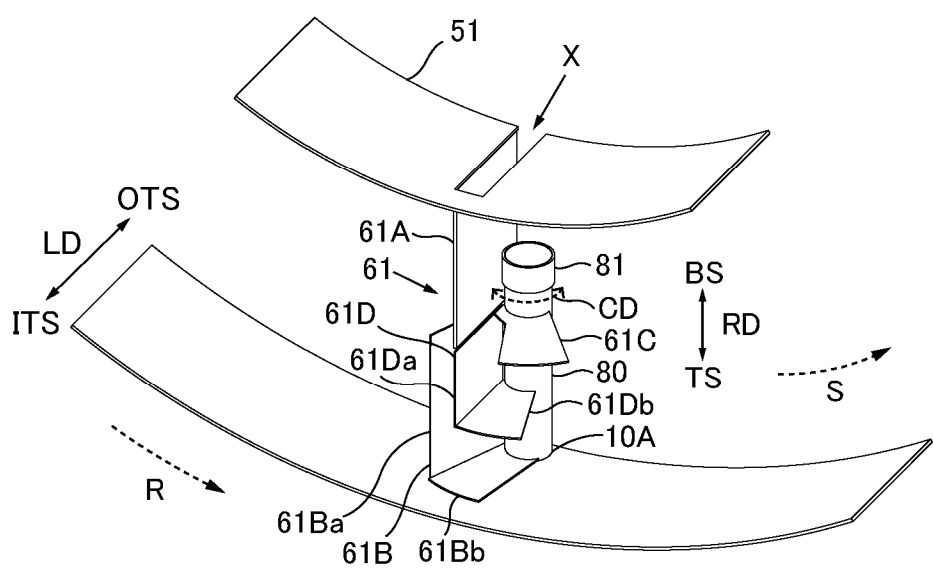
[FIG.8]



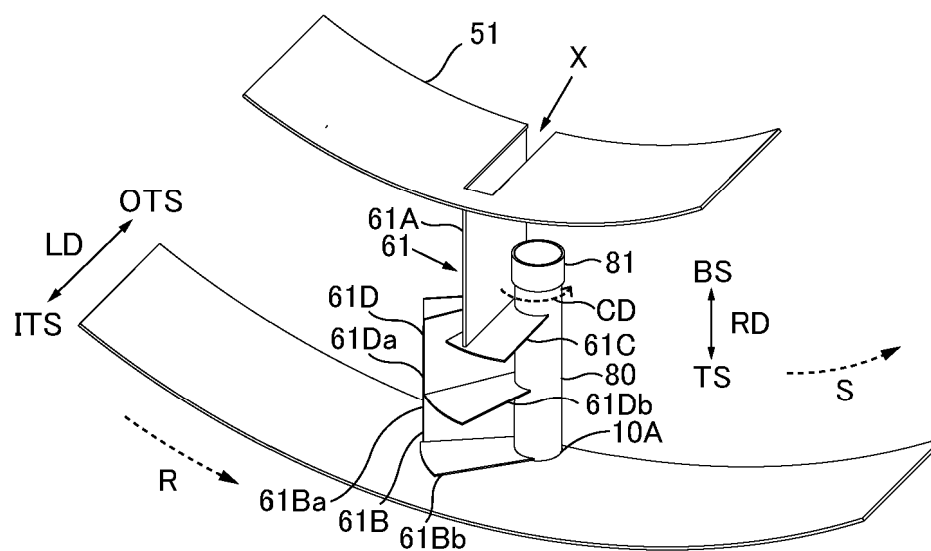
[FIG.9]



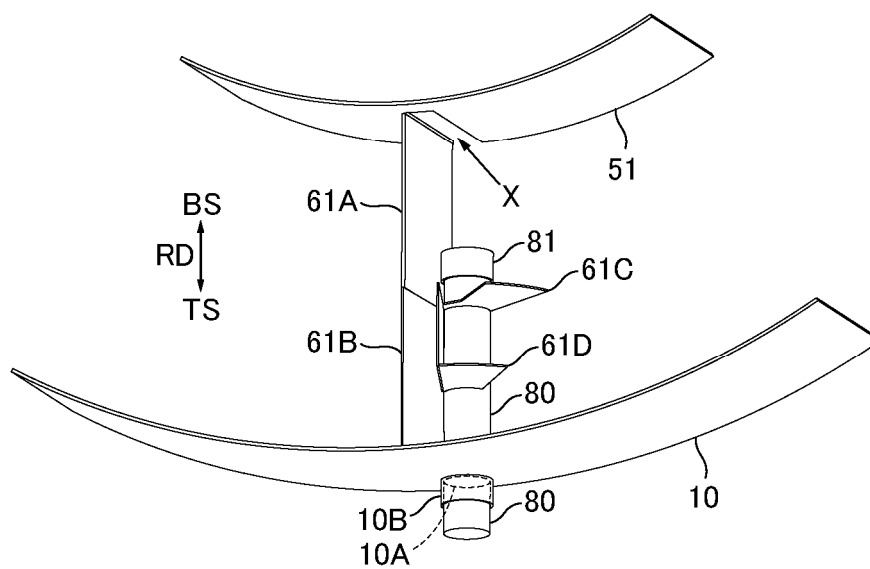
[FIG.10]



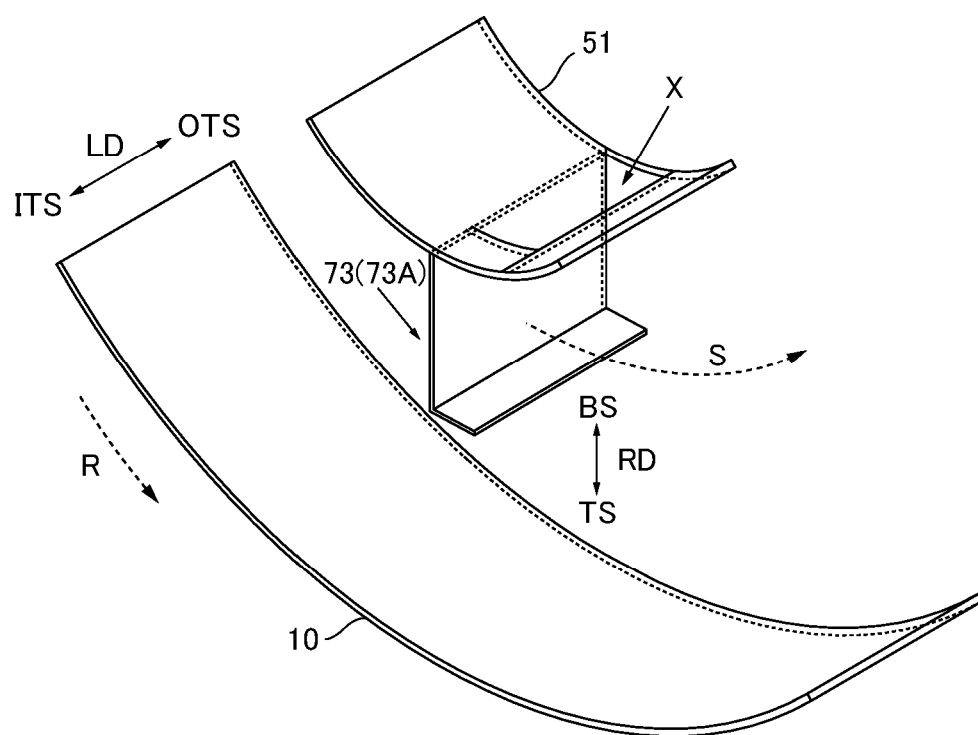
[FIG.11]



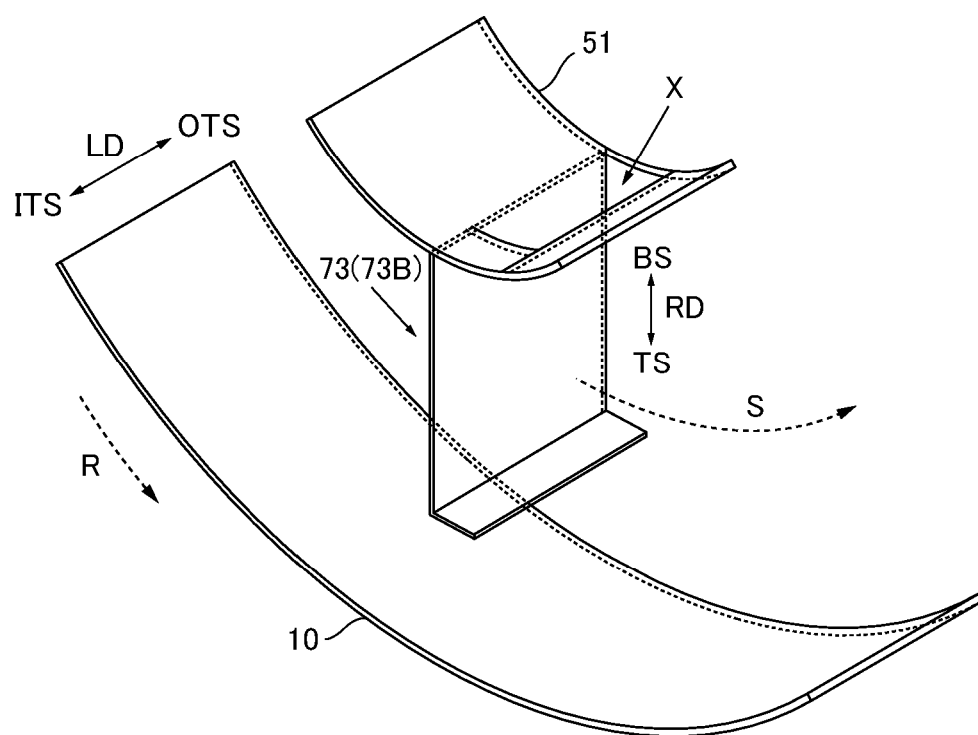
[FIG.12]



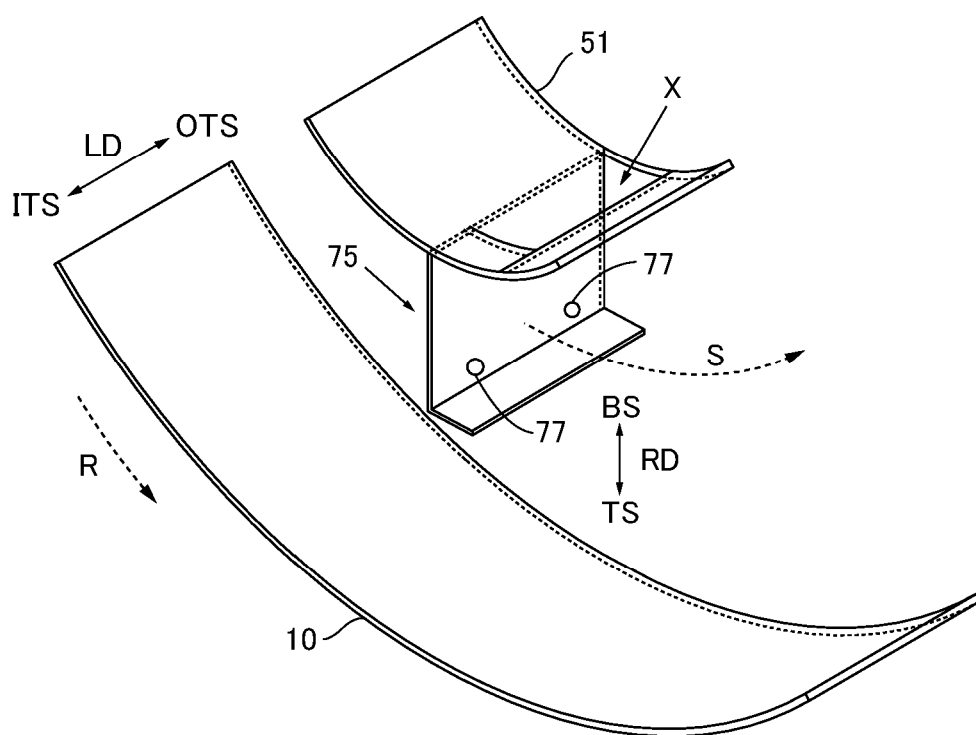
[FIG.13]



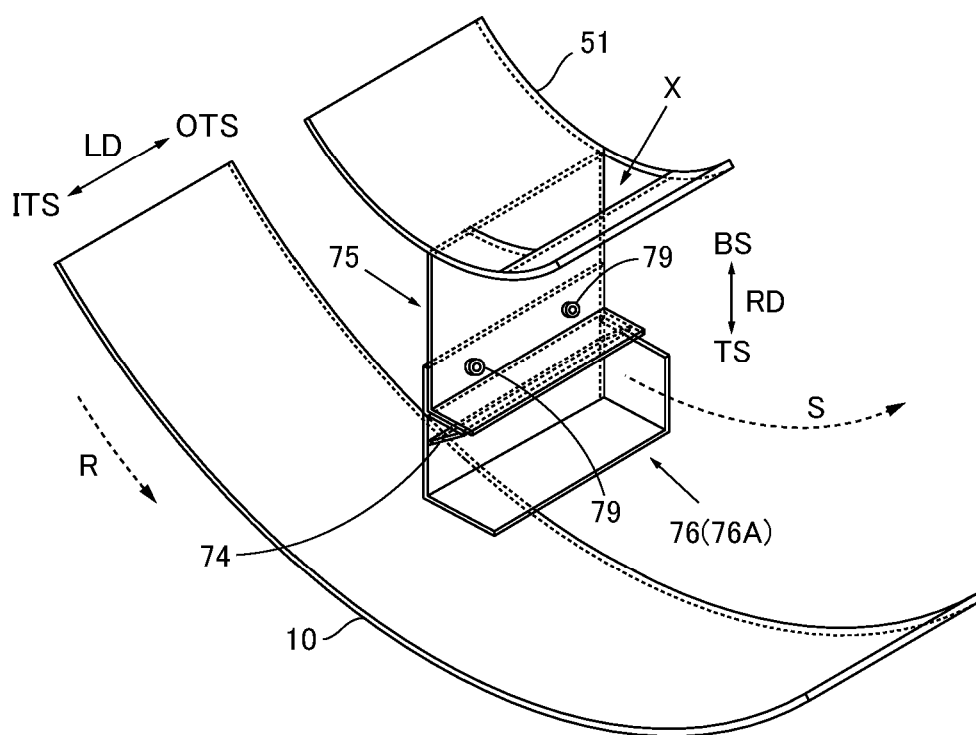
[FIG.14]



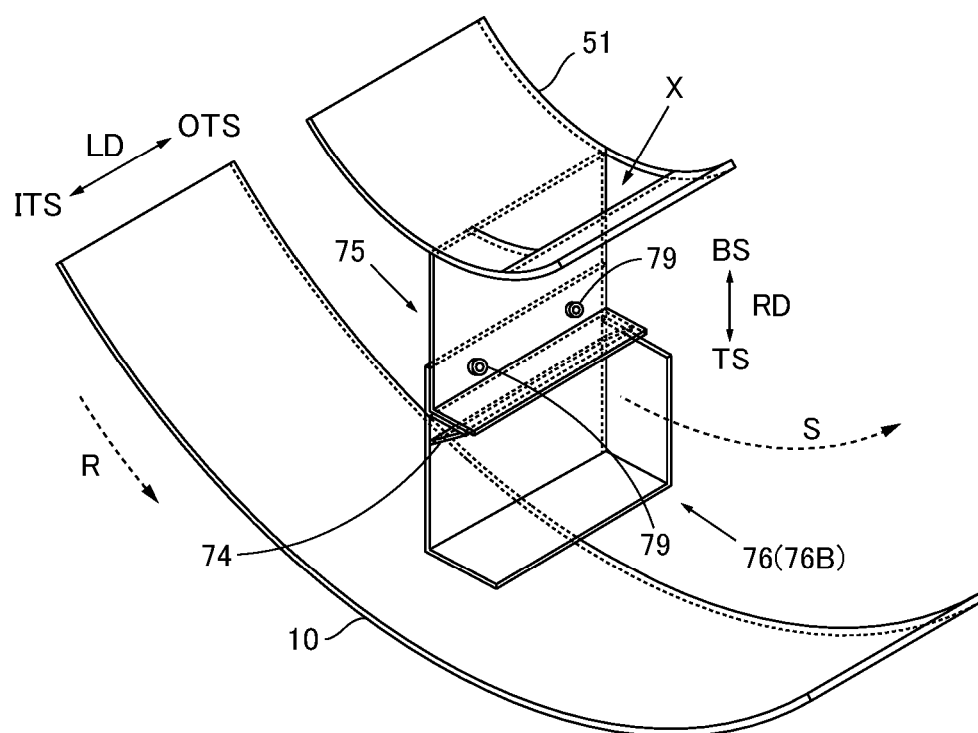
[FIG.15]



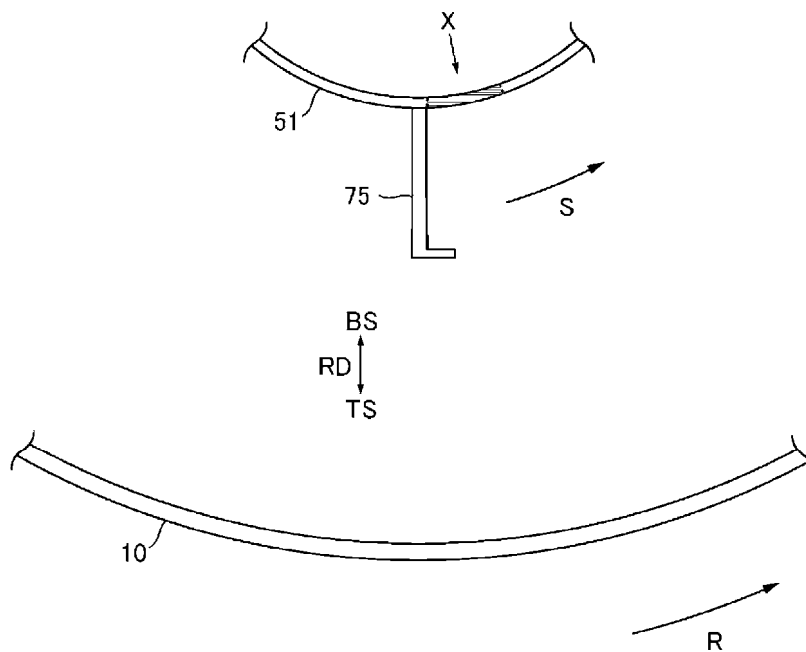
[FIG.16]



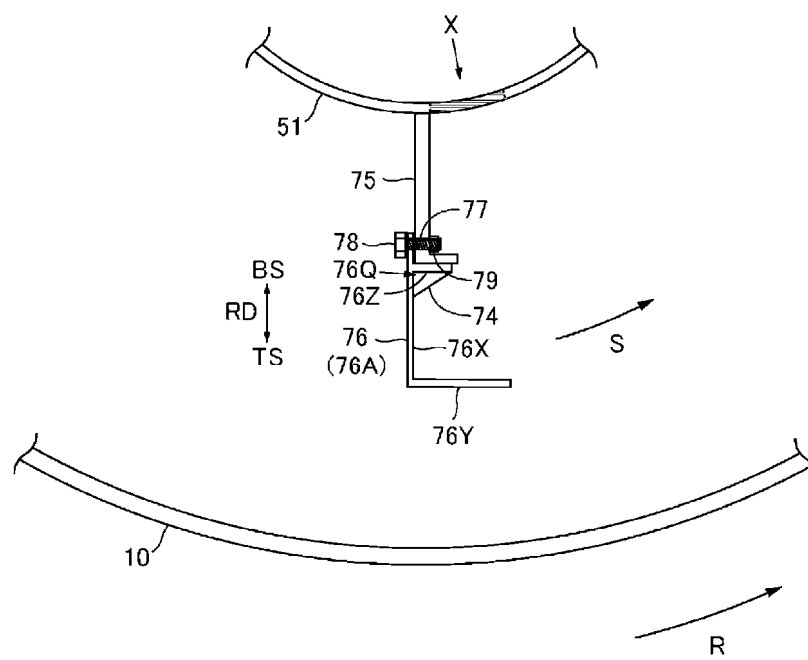
[FIG.17]



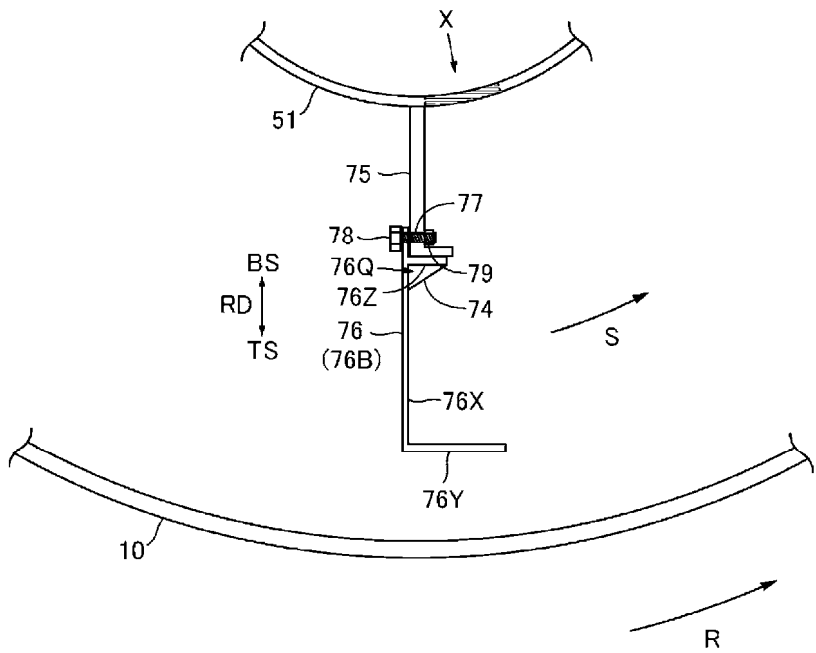
[FIG.18]



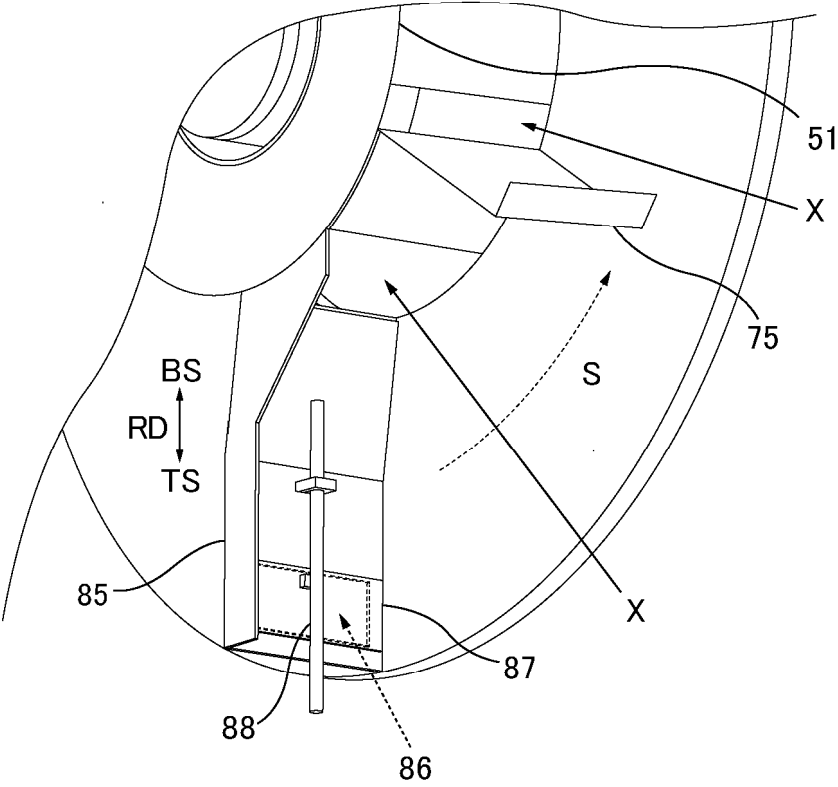
[FIG.19]



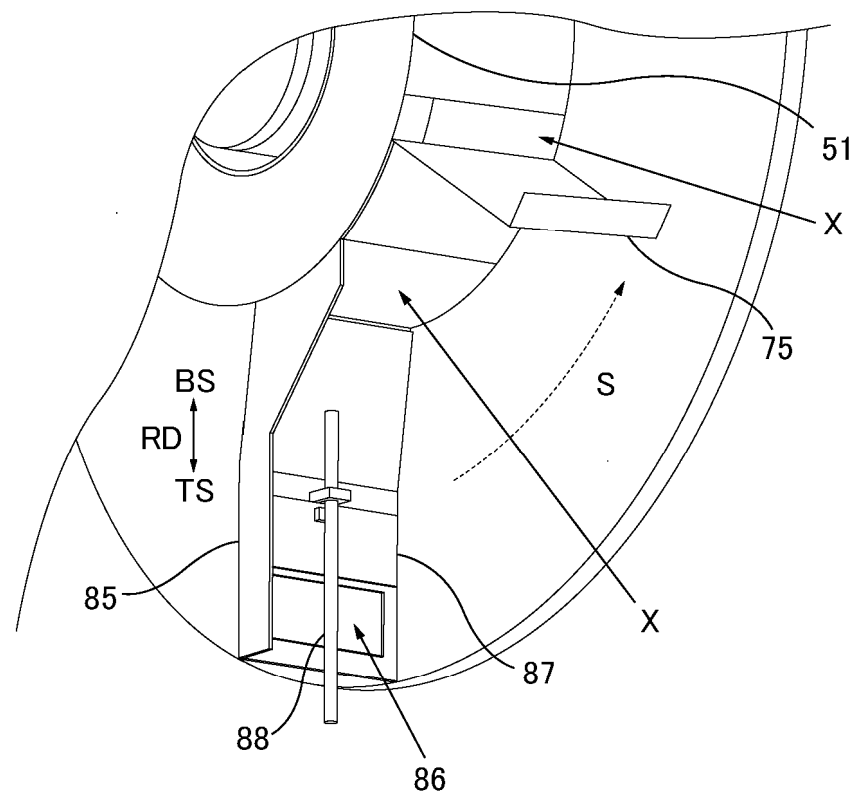
[FIG.20]



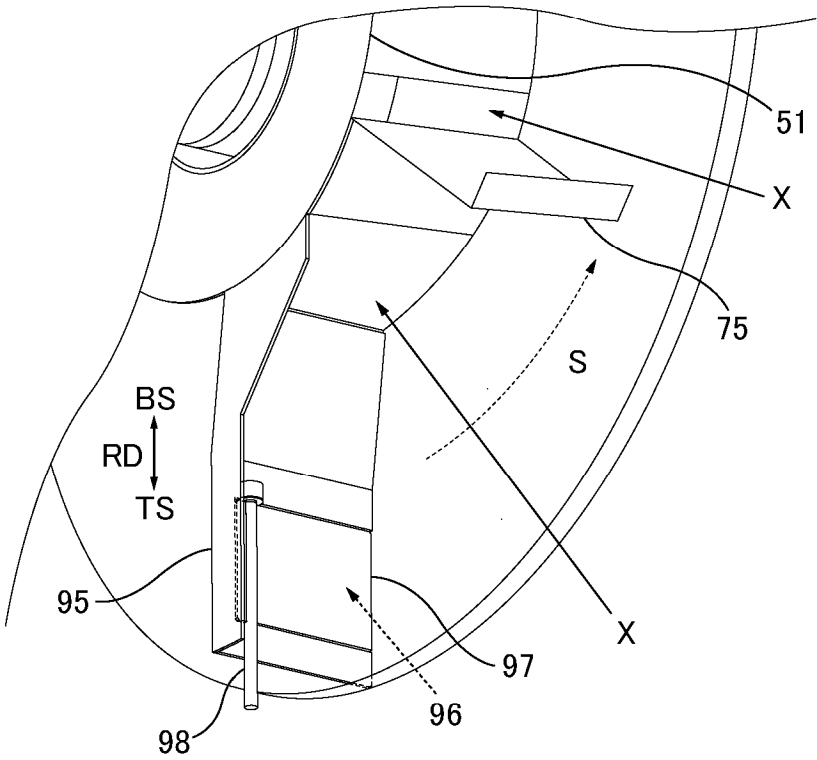
[FIG.21]



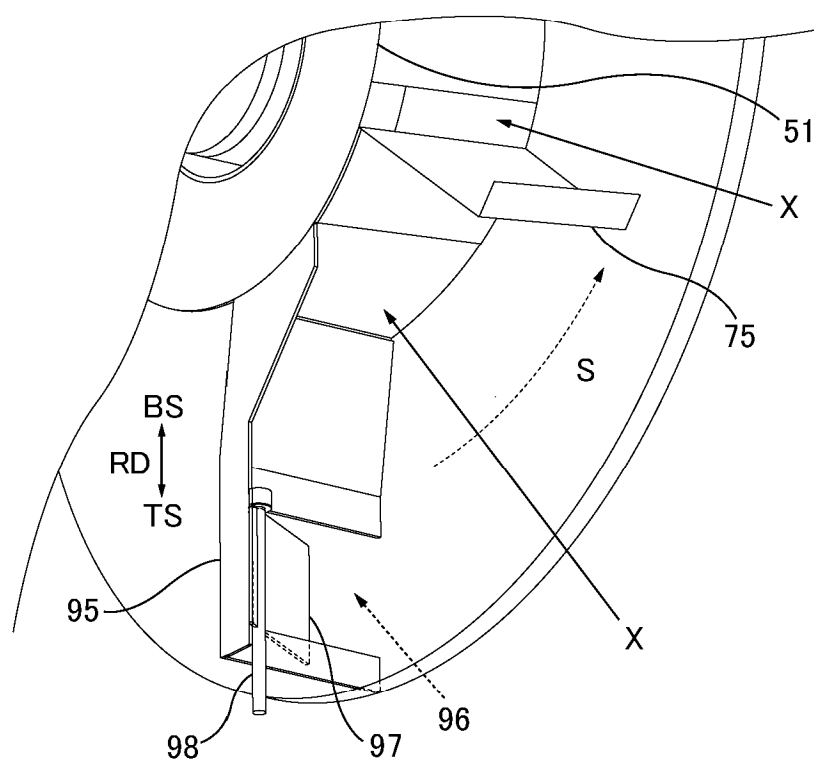
[FIG.22]



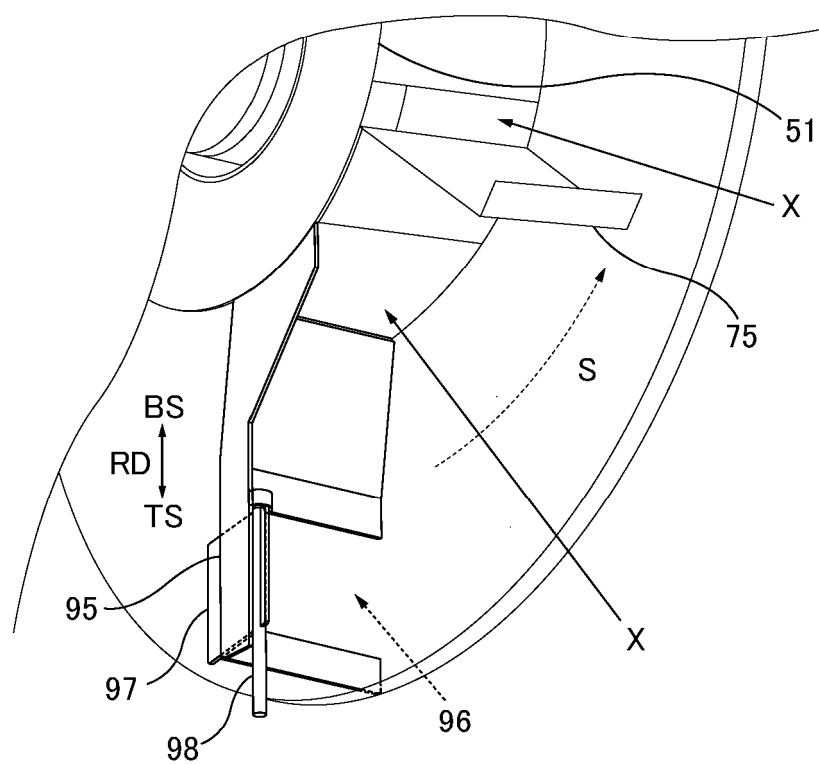
[FIG.23]



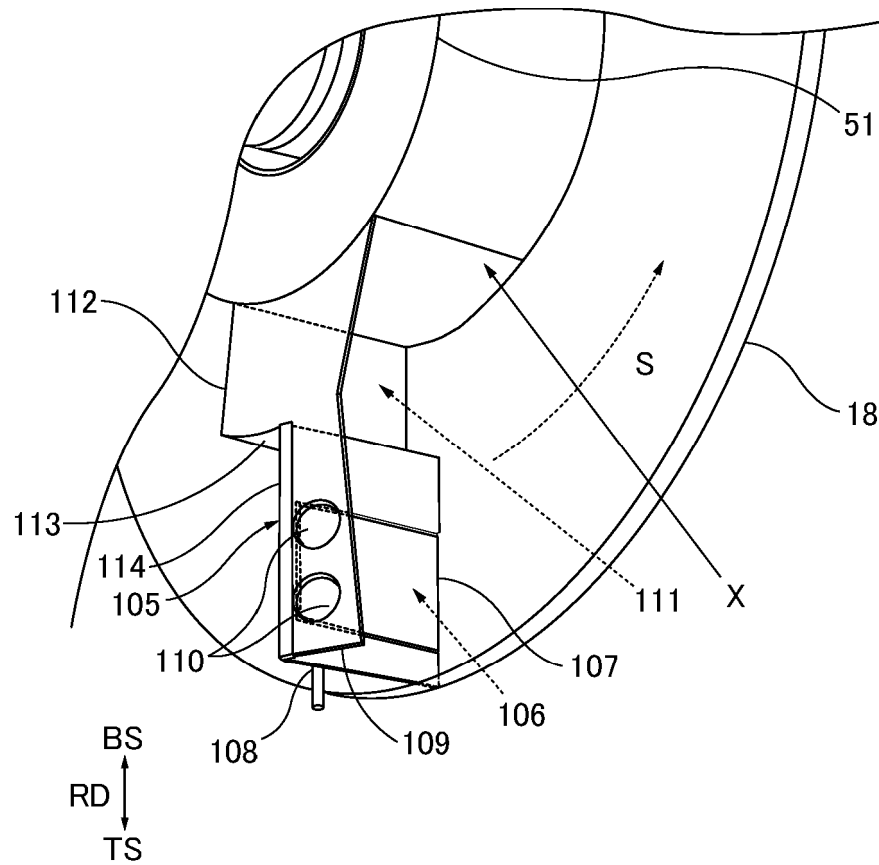
[FIG.24]



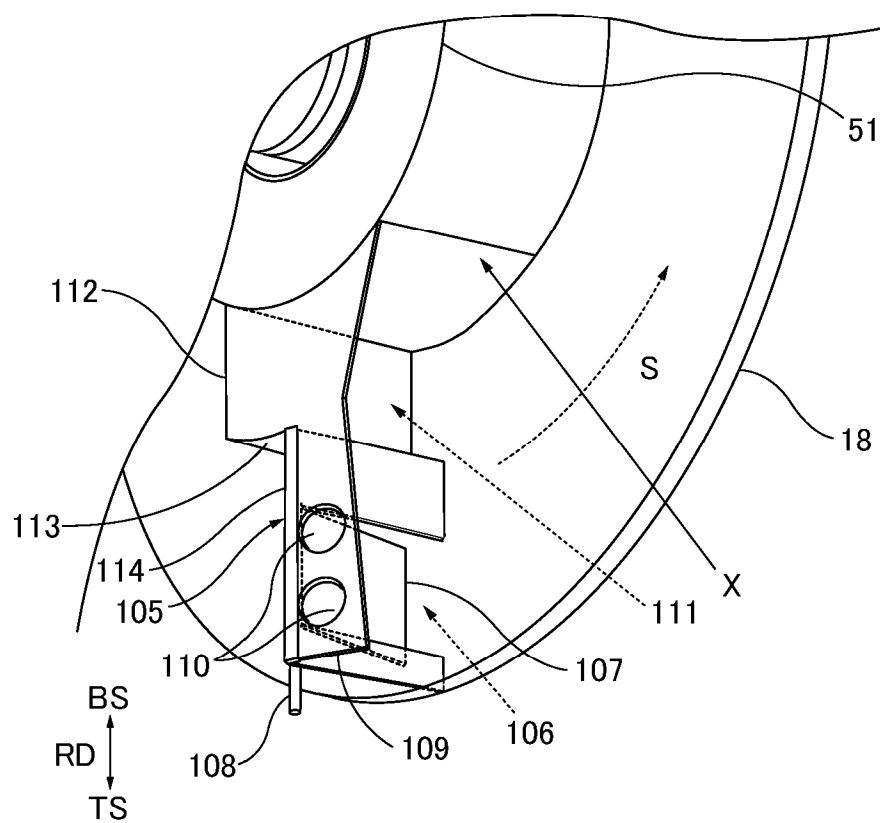
[FIG.25]



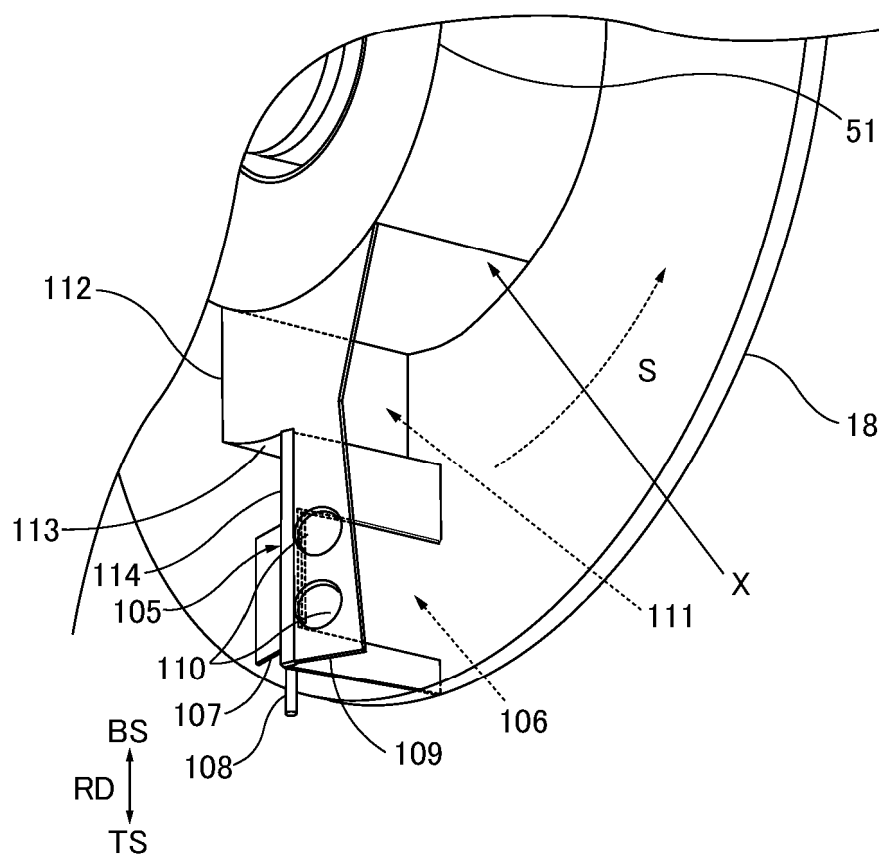
[FIG.26]



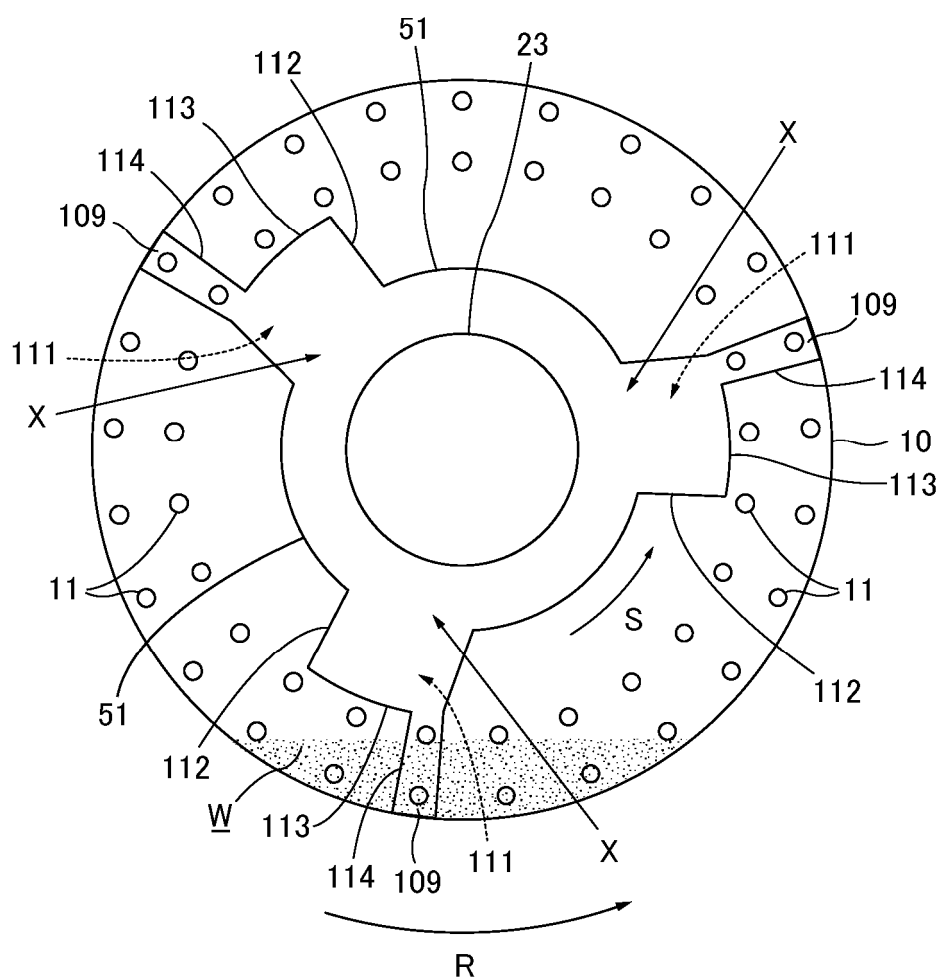
[FIG.27]



[FIG.28]



[FIG.29]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/030917

A. CLASSIFICATION OF SUBJECT MATTER**F26B 17/32**(2006.01)i; **F26B 25/04**(2006.01)i

FI: F26B17/32 E; F26B17/32 N; F26B17/32 G; F26B25/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F26B17/32; F26B25/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2024

Registered utility model specifications of Japan 1996-2024

Published registered utility model applications of Japan 1994-2024

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 01-171631 A (SANKIYUU PLANT KOGYO KK) 06 July 1989 (1989-07-06) p. 2, upper right column, line 17 to p. 4, upper left column, line 13, fig. 1, 5	1, 11
Y	p. 2, upper right column, line 17 to p. 4, upper left column, line 13, fig. 1, 5	2, 9-11
A	p. 2, upper right column, line 17 to p. 4, upper left column, line 13, fig. 1, 5	3-8, 12-14
Y	JP 2003-287369 A (TSUKISHIMA KIKAI CO.) 10 October 2003 (2003-10-10) paragraph [0021], fig. 1-3	2, 9-11
Y	JP 2016-200329 A (TSUKISHIMA KIKAI CO.) 01 December 2016 (2016-12-01) paragraphs [0028]-[0029], fig. 1-2	2, 9-11
Y	JP 2005-265323 A (KABUSHIKI KAISHA MEIDENSHA) 29 September 2005 (2005-09-29) paragraphs [0017]-[0024], fig. 1-2	9
A	KR 10-1621059 B1 (POSCO) 13 May 2016 (2016-05-13) entire text, all drawings	1-14

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

17 October 2024

Date of mailing of the international search report

29 October 2024

Name and mailing address of the ISA/JP

Japan Patent Office (ISA/JP)

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Japan

Authorized officer

Telephone No.

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C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 04-251184 A (BUERUREBUU SPA) 07 September 1992 (1992-09-07) entire text, all drawings	1-14
A	JP 2009-127946 A (IHI CORP.) 11 June 2009 (2009-06-11) entire text, all drawings	1-14

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/030917

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JP 2016-200329 A	01 December 2016	WO 2016/163044 A1 paragraphs [0028]-[0029], fig. 1-2 KR 10-2017-0134306 A	
JP 2005-265323 A	29 September 2005	(Family: none)	
KR 10-1621059 B1	13 May 2016	(Family: none)	
JP 04-251184 A	07 September 1992	US 5197205 A entire text, all drawings EP 459328 A1	
JP 2009-127946 A	11 June 2009	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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