(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 180 255 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
28.04.2010 Bulletin 2010/17

(21) Application number: **08792666.3**

(22) Date of filing: **15.08.2008**

(51) Int Cl.:
F23G 5/44 *(2006.01)* ***F23G 5/027*** *(2006.01)*

(86) International application number:
PCT/JP2008/065057

(87) International publication number:
WO 2009/025378 (26.02.2009 Gazette 2009/09)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(30) Priority: **21.08.2007 JP 2007214926**
18.09.2007 JP 2007241197
01.10.2007 JP 2007257584
04.08.2008 JP 2008200757

(71) Applicant: **KOBELCO ECO-SOLUTIONS CO., LTD.**
Kobe-shi
Hyogo 651-0072 (JP)

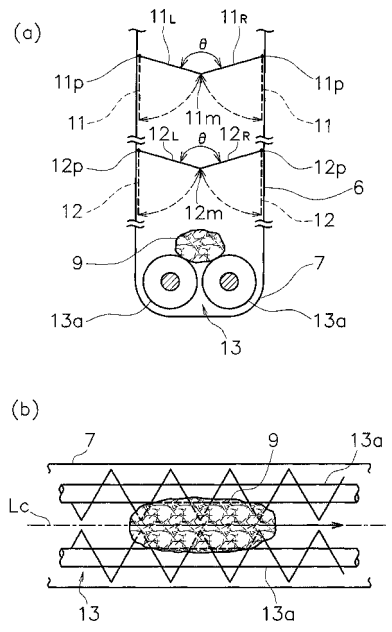
(72) Inventors:
- **MINAKAWA, Koji**
  Kobe-shi
  Hyogo 651-0072 (JP)
- **HOSODA, Hiroyuki**
  Kobe-shi
  Hyogo 651-0072 (JP)
- **MATSUMURA, Takuya**
  Kobe-shi
  Hyogo 651-0072 (JP)
- **SHIGEMORI, Yutaka**
  Kobe-shi
  Hyogo 651-0072 (JP)
- **ITO, Tadashi**
  Kobe-shi
  Hyogo 651-0072 (JP)

(74) Representative: **TBK-Patent**
Bavariaring 4-6
80336 München (DE)

(54) WASTE FEEDING APPARATUS, ITS SEALING METHOD, AND WASTE FEEDING METHOD

(57) Upper and lower dampers (11, 12) are provided in a vertical chute (6) of a waste-feeding apparatus (1). The upper and lower dampers (11, 12) have a sealing function that inhibits external air from entering a gasifier (20) and configured to be alternately opened and closed. The lower damper (12) includes a lower left damper (12_L) and a lower right damper (12_R) configured to be opened and closed through lower supporting shafts (12p), provided on opposite portions of an inner wall of the vertical chute (6) and parallel to a center line (Lc), the center line (Lc) extending in a longitudinal direction and passing through the center in a width direction of the waste-conveying device (7). A merged line (12m) defined by distal portions of the lower left damper (12_L) and the lower right damper (12_R) in a closed state is located above the center line (Lc) .

FIG.2



EP 2 180 255 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a waste-feeding apparatus, a sealing method thereof, and a waste-feeding method for continuously feeding waste, such as sludge and municipal waste, to a gasifier. In particular, the present invention relates to a waste-feeding apparatus and a waste-feeding method for a gasifier, the apparatus and method having good volumetric feeding performance of waste. Also, the present invention relates to a waste-feeding apparatus and a sealing method thereof for preventing a spark from occurring when double dampers having a sealing function that inhibits external air from entering a gasifier are closed and for preventing magnetized waste or fine waste from adhering to the dampers. Further, the present invention relates to a waste-feeding method for allowing waste to be easily removed, the waste which has been caught by an upper damper and a lower damper having a sealing function that prevents external air from entering a gasifier.

2. Description of the Related Art

[0002] Recently, a gasification and melting furnace has been popular, which can reduce the volume of waste, such as sludge and municipal waste, and render the ash of the waste harmless. The gasification and melting furnace gasifies the waste, such as sludge and municipal waste, in a gasifier (at temperatures from 500°C to 600°C), and decomposes the waste into combustible gas, fixed carbon, and ash. The decomposed combustible gas and fixed carbon are burned in a melting furnace. The temperature in the melting furnace is increased to 1300°C or higher to melt the ash. In addition, molten slag is cooled, for example, with water to produce water-cooled slag.

[0003] A waste-feeding apparatus that feeds waste to a gasifier requires volumetric feeding performance of the waste, and sealing performance.

(1) Volumetric feeding performance of waste

[0004] By reducing the variation in feeding amount of waste as much as possible, combustion is stabilized. Accordingly, the temperature in the melting furnace becomes stable, and the fusibility of ash becomes stable.

(2) Sealing performance

[0005] External air is inhibited from entering the gasifier and combustible gas (CO, H, CH_4, etc.) is inhibited from leaking out the gasifier.

[0006] For example, a waste-feeding apparatus for a gasifier having double dampers in a chute has been known.

[0007] A waste-feeding apparatus (a combustible-substance-feeding apparatus) for a gasifier according to related art will be described below with reference to the attached drawing. Fig. 7 illustrates the general configurations of a fluidized-bed gasifier and a combustible-substance-feeding apparatus (hereinafter, referred to as a waste-feeding apparatus) that feeds a combustible substance (hereinafter, referred to as waste) to the fluidized-bed gasifier, according to related art. Referring to Fig. 7, a fluidized-bed gasifier (hereinafter, referred to as gasifier) 50 includes a waste-feeding mechanism 62 at a waste inlet 53 in the gasifier 50, a chute 63 connected with the waste-feeding mechanism 62, and a conveyor 65 connected with the chute 63. The waste-feeding mechanism 62 includes a screw conveyor 64 that is driven by a motor 68. The chute 63 includes double dampers 59.

[0008] Waste 54 fed into a hopper 66 by a crane 61 or the like is lifted through the conveyor 65, and fed into an upper opening of the chute 63 from the distal end of the conveyor 65. The waste 54 fed into the chute 63 is intermittently fed into the waste-feeding mechanism 62 by the operation of the double dampers 59 having a sealing function. The screw conveyor 64 in the waste-feeding mechanism 62 reduces the intermittency of the intermittently fed waste 54 and allows the waste 54 to be fed into the gasifier 50 continuously by a predetermined constant amount (in a volumetric manner).

[0009] The waste 54 fed into the gasifier 50 is gasified in a reducing atmosphere in a fluidized bed 51 being fluidized with fluidizing gas 52 blown from a wind box at the bottom. Produced gas 57 produced through the gasification exits from the fluidized bed 51, passes through a freeboard 55, and is guided to a melting furnace (not shown) through a produced-gas outlet 56. In this case, the waste 54, which has been intermittently fed from the chute 63, is continuously fed by a substantially constant amount (in a volumetric manner) by the effect of the screw conveyor 64 in the waste-feeding mechanism 62. Thus, control for stable gasification operation of the gasifier 50, such as control for feeding the fluidizing gas 52 and control for the temperature in the furnace, is easily carried out. In addition, the sealing function of the double dampers 59 can inhibit external air from leaking into the gasifier 50 through the waste inlet 5 (for example, see Japanese Unexamined Patent Application Publication No. 2003-56822).

[0010] Since the waste-feeding mechanism 62 for the gasifier 50 according to the related art includes the double dampers having an upper damper and a lower damper, which are alternately opened and closed, in the chute 63, the waste-feeding mechanism 62 has good sealing performance. Also, since the waste-feeding mechanism 62 includes the screw conveyor 64, the waste-feeding mechanism 62 has good volumetric feeding performance for the waste 54 to the gasifier 50. However, the waste-feeding mechanism 62 for the gasifier 50 according to

the related art does not have sufficient volumetric feeding performance for the waste 54.

(1) A supporting shaft that supports the lower damper in an openable and closable manner is provided on the inner wall of the chute at a position close to the gasifier 50. Owing to this, the waste 54 is fed to a position on the screw conveyor 64 in the waste-feeding mechanism 62 farthest from the gasifier 50. The waste takes a time to reach the waste inlet 53 of the gasifier 50. There may be the period during which a small amount of the waste 54 is provided on the screw conveyor 64. Consequently, the feeding amount of the waste 54 to the gasifier 50 may vary.
(2) When the screw conveyor 64 in the waste-feeding mechanism 62 includes a pair of conveyance screws having rotation centers parallel to one another in a horizontal plane, the waste 54 may be unevenly distributed in the width direction and the longitudinal direction of the screw conveyor 64. In particular, the volume of the waste 54 may be increased at the left side or the right side in a range in the longitudinal direction of the screw conveyor 64. The feeding amount of the waste 54 to the gasifier 50 may vary.

[0011] As described above, the waste-feeding apparatus for the gasifier according to the related art has the good sealing performance and good volumetric feeding performance for the waste to the gasifier. Meanwhile, a damper is typically made of a SS member or a SUS member having good resistance to corrosion. When the chute is made of metal, a spark may occur due to an impact exerted when the damper is closed. For example, oil contained in the waste may be ignited with the spark.

[0012] Also, when the damper is made of the SS member, magnetized waste may adhere to the damper, and another magnetized waste may be hooked to the adhering magnetized waste, resulting in the waste being accumulated. It is difficult to smoothly feed the waste to the gasifier. Further, when the damper is made of metal, the metal damper has a high friction coefficient. Hence, wet fine waste may adhere to the damper. The sealing performance may be deteriorated.

[0013] As described above, the waste-feeding apparatus for the gasifier according to the related art has the good sealing performance and good volumetric feeding performance for the waste to the gasifier. However, when the waste is caught by the damper, the sealing performance cannot be maintained. Thus, it is difficult to inhibit external air from entering the gasifier. When the waste is caught by the damper, the operation of the waste-feeding apparatus has to be stopped, and the waste caught by the damper has to be removed through, for example, an access hole provided in the chute. This may decrease the operating ratio of the waste-feeding apparatus, and a troublesome work is needed for removing the waste. Thus, in the case of the waste-feeding apparatus for the gasifier according to the related art, the following operation is carried out to prevent the waste from being caught by the damper.

[0014] When the open damper is closed, the operation of upstream equipment for feeding the waste to the chute provided with the damper is temporarily stopped. After it is checked that the damper has been completely closed, the upstream equipment is operated. When the waste-feeding apparatus is operated in this manner, the following problems may occur.

(1) Since the operation of the upstream equipment, that is, waste primary feeding means is more frequently started and stopped, the life of the waste primary feeding means may be decreased, and hence the operating cost may be increased.
(2) The volumetric feeding performance of the waste is deteriorated, the processing efficiency of the waste is decreased, and the variation in the amount of produced gas, which is gasified in the gasifier, is increased. Thus, it is difficult to carry out the control for stable gasification operation of the gasifier and the control for stable operation of the melting furnace located downstream of the gasifier.

SUMMARY OF THE INVENTION

[0015] A first object of the present invention is to provide a waste-feeding apparatus of a gasifier and a waste-feeding method to the gasifier, the apparatus and method having good volumetric feeding performance of waste. A second object of the present invention is to provide a waste-feeding apparatus and a sealing method thereof for preventing a spark from occurring when double dampers having a sealing function that inhibits external air from entering a gasifier are closed and for preventing magnetized waste or fine waste from adhering to the dampers. A third object of the present invention is to provide a waste-feeding method for allowing waste to be easily removed, the waste which has been caught by an upper damper and a lower damper having a sealing function that prevents external air from entering a gasifier.

[0016] The present invention is made in light of the above situations. To attain the first object, a waste-feeding apparatus according to a first aspect of the present invention is provided. The waste-feeding apparatus includes a vertical chute and a waste-conveying device. The vertical chute includes upper and lower dampers separated from one another by a predetermined distance in an up-down direction. The upper and lower dampers have a sealing function that inhibits external air from entering a gasifier and configured to be alternately opened and closed. The waste-conveying device is connected with a lower end of the vertical chute and configured to convey waste, which is fed through the lower damper, toward the gasifier. The lower damper includes a lower left damper and a lower right damper configured to be opened and closed through supporting shafts. The supporting shafts are provided on opposite portions of an

inner wall of the vertical chute and parallel to a center line. The center line extends in a longitudinal direction and passing through the center in a width direction of the waste-conveying device. A merged line defined by distal portions of the lower left damper and the lower right damper in a closed state is located above the center line.

[0017] Preferably, in a waste-feeding apparatus according to a second aspect of the present invention, on the basis of the waste-feeding apparatus according to the first aspect, the lower left damper and the lower right damper of the lower damper may be lowered toward the distal portions from the supporting shafts in the closed state.

[0018] Preferably, in a waste-feeding apparatus to a gasifier according to a third aspect of the present invention, on the basis of the waste-feeding apparatus according to the first or second aspect, the waste-conveying device may be a screw conveyor including a pair of conveyance screws having rotation centers parallel to one another in a horizontal plane.

[0019] Preferably, in a waste-feeding apparatus according to a fourth aspect of the present invention, on the basis of the waste-feeding apparatus according to the third aspect, a waste disintegrator may be provided at a forward position of a distal end of the screw conveyor, the waste disintegrator configured to disintegrate the waste conveyed by the screw conveyor.

[0020] A waste-feeding method to a gasifier by a waste-feeding apparatus according to a fifth aspect of the present invention is provided. The waste-feeding apparatus includes a vertical chute and a waste-conveying device. The vertical chute includes upper and lower dampers separated from one another by a predetermined distance in an up-down direction. The upper and lower dampers have a sealing function that inhibits external air from entering the gasifier and configured to be alternately opened and closed. The waste-conveying device is connected with a lower end of the vertical chute and configured to convey waste, which is fed through the lower damper, toward the gasifier. The waste-feeding method includes the steps of, after the upper damper is closed, opening the lower damper around supporting shafts as pivots, the supporting shafts being provided on opposite portions of an inner wall of the vertical chute and parallel to a center line, the center line extending in a longitudinal direction and passing through the center in a width direction of the waste-conveying device; and dropping the waste, which has been received while the upper damper is opened, toward the center line to convey the waste by the waste-conveying device.

[0021] Preferably, a waste-feeding method according to a sixth aspect of the present invention, on the basis of the waste-feeding method according to the fifth aspect, may further include the step of feeding the waste, which has been conveyed by the waste-conveying device, into the gasifier while disintegrating the waste by a waste disintegrator.

[0022] To attain the second object, a waste-feeding apparatus according to a seventh aspect of the present invention is provided. The waste-feeding apparatus includes a vertical chute and a waste-conveying device. The vertical chute includes upper and lower dampers separated from one another by a predetermined distance in an up-down direction, the upper and lower dampers having a sealing function that inhibits external air from entering a gasifier and configured to be alternately opened and closed. The waste-conveying device is configured to convey waste, which has been fed through the vertical chute, toward the gasifier. The upper and lower dampers have damper bodies, each of the damper bodies having a damper substrate and a hard low-friction resin plate fixed to an upper surface of the damper substrate by mechanical fastening means. When the upper or lower damper is closed, an upper surface of an outer edge portion of the hard low-friction resin plate contacts a sealing surface formed on an inner side of the vertical chute.

[0023] Preferably, in a waste-feeding apparatus according to an eighth aspect of the present invention, on the basis of the waste-feeding apparatus according to the seventh aspect, the mechanical fastening means may be a small flat-head screw that is screwed into an internal thread formed in the damper substrate such that an upper surface of a screw head is lower than an upper surface of the hard low-friction resin plate. A resin coating layer may be formed on the upper surface of the screw head.

[0024] A sealing method of a waste-feeding apparatus for inhibiting external air from entering a gasifier according to a ninth aspect of the present invention is provided. The waste-feeding apparatus includes a vertical chute and a waste-conveying device. The vertical chute includes upper and lower dampers separated from one another by a predetermined distance in an up-down direction. The waste-conveying device configured to convey waste, which has been fed through the vertical chute, toward the gasifier. The sealing method includes the step of, when the upper and lower dampers are alternately closed for sealing, bringing an upper surface of an outer edge portion of a hard low-friction resin plate on a damper body in each of the upper and lower dampers into contact with a sealing surface formed on an inner side of the vertical chute.

[0025] The inventors have learned that, if the upper and lower dampers are opened and closed at an interval of, for example, 15 seconds, each damper is opened and closed 240 times per hour, however, the number of times the waste is caught by the upper damper per hour is no more than two (1/120). The inventors have assumed that the aforementioned problems (1) and (2), described in Description of the Related Art, can be markedly improved and the third object can be attained if the unnecessary starting and stopping of the upstream devices by 238 times are omitted. Thus, the inventors have implemented the waste-feeding method according to an aspect of the present invention. The phenomenon that the number of

times the waste is caught by the upper damper per hour is not more than two can be attained by the following reasons. A block of waste roughly crushed by a crusher is dropped and fed onto the upper damper at a certain individual interval, and hence the block of waste is less frequently dropped at a predetermined position simultaneously when the upper damper is closed. Also, as the apparatus is operated for a long term, a muddy substance may adhere onto the lower damper.

[0026] Accordingly, to attain the third object, a waste-feeding method by a waste-feeding apparatus according to a tenth aspect of the present invention is provided. The waste-feeding apparatus includes a vertical chute and a waste-conveying device. The vertical chute includes upper and lower dampers separated from one another by a predetermined distance in an up-down direction, the upper and lower dampers having a sealing function that inhibits external air from entering a gasifier and configured to be alternately opened and closed. The waste-conveying device is configured to convey waste, which has been fed through the vertical chute, toward the gasifier. The waste-feeding method comprising the steps of, if a damper-closed signal is not received although an upper cylinder, which opens and closes the upper damper, has been operated to close the upper damper, determining that the waste is caught by the upper damper, and temporarily stopping feeding of the waste to the vertical chute; during the stop of the feeding of the waste, opening the upper damper to remove the caught waste, and closing the open upper damper; and if the damper-closed signal is received, determining that the waste caught by the upper damper has been removed, and starting the feeding of the waste to the vertical chute.

[0027] Preferably, a waste-feeding method according to an eleventh aspect of the present invention, on the basis of the waste-feeding method according to the tenth aspect, may further include the steps of starting counting an elapsed time by a timer since the operation of the upper cylinder to close the upper damper has started; and if the damper-closed signal is not output although a predetermined period has elapsed, stopping the counting, and determining that the waste is being caught by the upper damper.

[0028] Preferably, in a waste-feeding method according to a twelfth aspect of the present invention, on the basis of the waste-feeding method according to the tenth or eleventh aspect, the damper-closed signal of the upper damper may be output from a limit switch that detects a stroke of the upper cylinder.

[0029] Preferably, a waste-feeding method according to a thirteenth aspect of the present invention, on the basis of the waste-feeding method according to the tenth aspect, may further include the steps of, if the damper-closed signal is not received although a lower cylinder, which opens and closes the lower damper, has been operated to close the lower damper, determining that the waste is caught by the lower damper, opening the lower damper to remove the caught waste, and closing the lower damper; and if the damper-closed signal is received, determining that the waste, which has been caught by the lower damper, is removed, and opening the upper damper.

[0030] Preferably, a waste-feeding method according to a fourteenth aspect of the present invention, on the basis of the waste-feeding method according to the thirteenth aspect, may further include the steps of starting counting an elapsed time by a timer since the operation of the lower cylinder to close the lower damper has started; and if the damper-closed signal is not output although a predetermined period has elapsed, stopping the counting, and determining that the waste is being caught by the lower damper.

[0031] Preferably, in a waste-feeding method according to a fifteenth aspect of the present invention, on the basis of the waste-feeding method according to the thirteenth or fourteenth aspect, the damper-closed signal of the lower damper may be output from a limit switch that detects a stroke of the lower cylinder.

[0032] In the waste-feeding apparatus according to the first aspect of the present invention, the lower damper includes the lower left damper and the lower right damper configured to be opened and closed through the supporting shafts. The supporting shafts are provided on the opposite portions of the inner wall of the vertical chute and parallel to the center line. The center line extends in the longitudinal direction and passing through the center in the width direction of the waste-conveying device. The merged line defined by the distal portions of the lower left damper and the lower right damper in the closed state is located above the center line. Also, the waste-feeding method according to the fifth aspect of the present invention includes the steps of, after the upper damper is closed, opening the lower damper around the supporting shafts as the pivots, the supporting shafts being provided on the opposite portions of the inner wall of the vertical chute and parallel to the center line, the center line extending in the longitudinal direction and passing through the center in the width direction of the waste-conveying device; and dropping the waste, which has been received while the upper damper is opened, toward the center line to convey the waste by the waste-conveying device.

[0033] With the waste-feeding apparatus according to the first aspect of the present invention and with the waste-feeding method according to the fifth aspect of the present invention, the waste having the length corresponding to the length of the lower damper in a direction toward the gasifier is fed to the waste-conveying device. Also, the waste is dropped at the center in the width direction of the waste-conveying device immediately after the lower left damper and the lower right damper start to be opened. Then, as the opening becomes larger, the area in which the waste is dropped becomes larger in a direction away from the center in the width direction. Thus, the waste on the waste-conveying device has a cross section in a mound-like shape at any position in

the longitudinal direction toward the gasifier. The variation in volume of the waste in the left-right direction can be reduced. The volumetric feeding performance of the waste to the gasifier is improved.

[0034] In the waste-feeding apparatus according to the second aspect of the present invention, the lower left damper and the lower right damper of the lower damper may be lowered toward the distal portions from the supporting shafts in the closed state. With the waste-feeding apparatus according to the second aspect of the present invention, the upper surfaces of the lower left damper and the lower right damper are inclined in the closed state, and hence have a hopper-like shape. The waste can be efficiently fed onto the waste-conveying device when the lower left damper and the lower right damper start to be opened.

[0035] In the waste-feeding apparatus according to the third aspect of the present invention, the waste-conveying device may be the screw conveyor including the pair of conveyance screws having the rotation centers parallel to one another in the horizontal plane. With the waste-feeding apparatus according to the third aspect of the present invention, the waste having the length corresponding to the length of the lower damper in a direction toward the gasifier is fed from the lower damper to an area between the pair of conveyance screws of the screw conveyor.

[0036] In the waste-feeding apparatus according to the fourth aspect of the present invention, the waste disintegrator may be provided at the forward position of the distal end of the screw conveyor, the waste disintegrator configured to disintegrate the waste conveyed by the screw conveyor.

[0037] Also, the waste-feeding method according to the sixth aspect of the present invention may further include the step of feeding the waste, which has been conveyed by the waste-conveying device, into the gasifier while disintegrating the waste by the waste disintegrator.

[0038] With the waste-feeding apparatus according to the fourth aspect of the present invention and with the waste-feeding method according to the sixth aspect of the present invention, since the waste disintegrator disintegrates the waste, which has been conveyed by the screw conveyor or the waste-conveying device, the volumetric feeding performance of the waste can be further improved.

[0039] In the waste-feeding apparatus according to the seventh aspect of the present invention and in the sealing method according to the ninth aspect of the present invention, the upper surface of the outer edge portion of the hard low-friction resin plate on the damper body in each of the upper and lower dampers provided in the vertical chute of the waste-feeding apparatus contacts the sealing surface formed on the inner side of the vertical chute.

[0040] With the waste-feeding apparatus according to the seventh aspect of the present invention and with the sealing method according to the ninth aspect of the present invention, when the upper or lower damper is closed, the upper surface of the outer edge portion of the hard low-friction resin plate contacts the sealing surface formed on the inner side of the vertical chute. Accordingly, even when the sealing surface formed on the vertical chute is made of metal, a spark does not occur. Further, magnetized waste does not adhere to the hard low-friction resin plate. Also, since the hard low-friction resin plate has a low friction coefficient, wet fine waste does not adhere to the hard low-friction resin plate. Hence, the sealing performance is not deteriorated.

[0041] In the waste-feeding apparatus according to the eighth aspect of the present invention, the hard low-friction resin plate is may be attached to the damper substrate by the small flat-head screw (the mechanical fastening means). Accordingly, the hard low-friction resin plate can be easily attached to and detached from (replaced in) the damper substrate. Also, the resin coating layer may be formed on the upper surface of the screw head of the small flat-head screw. Accordingly, magnetic substances can be prevented from adhering to the screw head of the small flat-head screw, and corrosive substances can be prevented from contacting the screw head.

[0042] In the waste-feeding method according to the tenth aspect of the present invention includes the steps of, if the damper-closed signal is not received although the upper cylinder, which opens and closes the upper damper, has been operated to close the upper damper, determining that the waste is caught by the upper damper, and temporarily stopping feeding of the waste to the vertical chute; during the stop of the feeding of the waste, opening the upper damper to remove the caught waste, and closing the open upper damper; and if the damper-closed signal is received, determining that the waste caught by the upper damper has been removed, and starting the feeding of the waste to the vertical chute.

[0043] With the waste-feeding method according to the tenth aspect of the present invention, if the waste is not caught by the upper damper, the feeding of the waste to the vertical chute is continued, and the operation of waste primary feeding means located upstream of the vertical chute is not stopped. The following advantages can be attained.

(1) Since the operation of the waste primary feeding means at the upstream side is less frequently started and stopped, the life of the waste primary feeding means is not decreased, and hence, the operating cost can be decreased.

(2) The volumetric feeding performance of the waste is hardly deteriorated, the processing efficiency of the waste is increased, and the variation in the amount of produced gas, which is gasified in the gasifier, can be decreased. Thus, it is easy to carry out the control for stable gasification operation of the gasifier and the control for stable operation of the melting furnace located downstream of the gasifier.

[0044] The waste-feeding method according to the eleventh aspect of the present invention may further include the steps of starting counting an elapsed time by a timer since the operation of the upper cylinder to close the upper damper has started; and if the damper-closed signal is not output although a predetermined period has elapsed, stopping the counting, and determining that the waste is being caught by the upper damper. Thus, with the waste-feeding method according to the eleventh aspect of the present invention, the unused stop period of the waste-feeding apparatus can be decreased. Thus, the time required for removing the waste caught by the upper damper can be decreased.

[0045] In the waste-feeding method according to the twelfth aspect of the present invention, the damper-closed signal of the upper damper may be output from the limit switch that detects the stroke of the upper cylinder. With the waste-feeding method according to the twelfth aspect of the present invention, at least one limit switch is required. The configuration of the control system for controlling damper operating means does not become complicated or expensive.

[0046] The waste-feeding method according to the thirteenth aspect of the present invention, may further include the steps of, if the damper-closed signal is not received although a lower cylinder, which opens and closes the lower damper, has been operated to close the lower damper, determining that the waste is caught by the lower damper, opening the lower damper to remove the caught waste, and closing the lower damper; and if the damper-closed signal is received, determining that the waste, which has been caught by the lower damper, is removed, and opening the upper damper.

[0047] With the waste-feeding method according to the thirteenth aspect of the present invention, in addition to the advantages of the waste-feeding method according to the tenth aspect, it can be recognized that the waste is caught by the lower damper. Also, the waste caught by the lower damper can be reliably removed. The waste is not accumulated and stayed on the lower damper as a result of the waste being caught by the lower damper, and the waste can be reliably conveyed by the waste-conveying device and fed into the waste inlet. Accordingly, the volumetric feeding performance for the waste is hardly deteriorated, and the processing efficiency for the waste can be increased.

[0048] The waste-feeding method according to the fourteenth aspect of the present invention may further include the steps of starting counting an elapsed time by a timer since the operation of the lower cylinder to close the lower damper has started; and if the damper-closed signal is not output although a predetermined period has elapsed, stopping the counting, and determining that the waste is being caught by the lower damper. Thus, with the waste-feeding method according to the fourteenth aspect of the present invention, the unused stop period of the waste-feeding apparatus can be decreased. Thus, the time required for removing the waste caught by the lower damper can be decreased.

[0049] In the waste-feeding method according to the fifteenth aspect of the present invention, the damper-closed signal of the lower damper may be output from the limit switch that detects the stroke of the lower cylinder. With the waste-feeding method according to the fifteenth aspect of the present invention, at least two limit switches are required. The configuration of the control system for controlling damper operating means does not become complicated or expensive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050]

Fig. 1 is an explanatory view schematically showing the configuration of a waste-feeding apparatus for a gasifier according to Embodiment 1 of the present invention;

Fig. 2A is a cross-sectional view taken along line A-A in Fig. 1, Fig. 2A being an explanatory view showing the open and closed states of upper and lower dampers and showing the shape of waste fed by a pair of conveyance screws of a screw conveyor (a waste-conveying device);

Fig. 2B is a cross-sectional view taken along line B-B in Fig. 1, Fig. 2B being an explanatory view showing the plan state of the waste conveyed by the pair of conveyance screws of the screw conveyor;

Fig. 3 is an explanatory view schematically showing the configuration of a waste-feeding apparatus according to Embodiment 2 of the present invention, Fig. 3 also showing a gasifier for gasification of the waste;

Fig. 4A is an explanatory view schematically showing the configurations of upper and lower dampers according to Embodiment 2 of the present invention;

Fig. 4B is an enlarged cross-sectional view showing part C in Fig. 4A;

Fig. 5 is an explanatory view schematically showing the configuration of a pressure generator and a control device that controls the pressure generator, the pressure generator operating upper and lower cylinders of upper and lower dampers in a waste-feeding apparatus according to Embodiment 3 of the present invention;

Fig. 6 is an explanatory view schematically showing the configuration of a pressure generator and a control device that controls the pressure generator, the pressure generator operating upper and lower cylinders of upper and lower dampers in a waste-feeding apparatus according to Embodiment 3a of the present invention; and

Fig. 7 illustrates the general configurations of a fluidized-bed gasifier and a waste-feeding apparatus that feeds waste to the fluidized-bed gasifier, according to related art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0051] A waste-feeding apparatus according to Embodiment 1 of the present invention will be described below with reference to the attached drawings. Fig. 1 is an explanatory view schematically showing the configuration of a waste-feeding apparatus according to Embodiment 1 of the present invention. Fig. 2A is a cross-sectional view taken along line A-A in Fig. 1, Fig. 2 being an explanatory view showing the open and closed conditions of upper and lower dampers and showing the shape of waste fed by a pair of conveyance screws of a screw conveyor (a waste-conveying device). Fig. 2B is a cross-sectional view taken along line B-B in Fig. 1, Fig. 2B being an explanatory view showing the plan state of the waste conveyed by the pair of conveyance screws of the screw conveyor.

[0052] Reference numeral 1 shown in Fig. 1 denotes the waste-feeding apparatus according to Embodiment 1. The waste-feeding apparatus 1 includes a vertical chute 6 (described below), a waste-conveying device 7 to which waste 9 is fed from the vertical chute 6, and a waste-feeding chute 8 connected with the waste-conveying device 7. The waste-feeding chute 8 obliquely extends and communicates with a waste inlet 21 in a gasifier 20, to feed the waste 9. To be more specific, a waste-dumping device (not shown) such as a crane feeds the waste 9 into a waste hopper 2. A pusher 3 pushes the waste 9. A crusher 4 roughly crushes the pushed waste 9. Then, a conveyor 5 provided in an air-tight conveyor housing lifts the waste 9, which has been roughly crushed by the crusher 4, obliquely upward. The waste 9 is dropped and fed into the vertical chute 6.

[0053] The vertical chute 6 includes double dampers having a sealing function, which will be described later. The double dampers each have a rectangular cross section. The waste-conveying device 7 is connected with the lower end of the vertical chute 6. The waste-conveying device 7 includes a screw conveyor and a waste disintegrator, which will be described later. The screw conveyor conveys the waste 9 toward the gasifier 20. The upper end of the waste-feeding chute 8 is connected with the lower distal end of the waste-conveying device 7. The waste-feeding chute 8 extends obliquely downward and communicates with the waste inlet 21 of the gasifier 20.

[0054] The double dampers provided in the vertical chute 6 include an upper damper 11 and a lower damper 12. The lower damper 12 is provided below the upper damper 11 and separated from the upper damper 11 by a predetermined distance. The upper and lower dampers 11 and 12 are configured as shown in Fig. 2. The configuration of the upper damper 11 will be described first. The upper damper 11 includes an upper left damper 11_L and an upper right damper 11_R. The upper left damper 11_L is opened and closed through an upper supporting shaft 11p. The upper supporting shaft 11p is parallel to a center line Lc extending in the longitudinal direction and passing through the center in the width direction of the waste-conveying device 7. The upper supporting shaft 11p is provided on a left portion of the inner wall of the vertical chute 6 in a view facing the gasifier 20. The upper right damper 11_R is opened and closed through an upper supporting shaft 11p. The upper supporting shaft 11p is parallel to the center line Lc extending in the longitudinal direction and passing through the center in the width direction of the waste-conveying device 7. The upper supporting shaft 11p is provided on a right portion of the inner wall of the vertical chute 6 in a view facing the gasifier 20.

[0055] A merged line 11m is defined when the upper left damper 11_L and the upper right damper 11_R are closed and distal portions of the upper left damper 11_L and the upper right damper 11_R contact one another, the distal portions being straight and facing one another. The merged line 11m is located at the center in the left-right direction of the vertical chute 6, that is, at a position above the center line Lc extending in the longitudinal direction and passing through the center in the width direction of the waste-conveying device 7. In a state in which the upper left damper 11_L and the upper right damper 11_R are closed, the upper left damper 11_L and the upper right damper 11_R are lowered toward the distal portions from the upper supporting shafts 11p. In particular, in that state, the upper left damper 11_L and the upper right damper 11_R define an angle θ of, for example, 150°.

[0056] In Embodiment 1, the upper damper 11 has the two dampers including the upper left damper 11_L and the upper right damper 11_R. However, similar to the damper in the related art, the upper damper 11 may have a single damper and may be opened and closed through an upper supporting shaft provided on the inner wall of the vertical chute 6 at a position close to the gasifier 20.

[0057] The configuration of the lower damper 12 will be described next. The lower damper 12 includes a lower left damper 12_L and a lower right damper 12_R. The lower left damper 12_L is opened and closed through a lower supporting shaft 12p. The lower supporting shaft 12p is parallel to the center line Lc extending in the longitudinal direction and passing through the center in the width direction of the waste-conveying device 7. The lower supporting shaft 12p is provided on a left portion of the inner wall of the vertical chute 6 in a view facing the gasifier 20. The lower right damper 12_R is opened and closed through a lower supporting shaft 12p. The lower supporting shaft 12p is parallel to the center line Lc extending in the longitudinal direction and passing through the center in the width direction of the waste-conveying device 7. The lower supporting shaft 12p is provided on a right portion of the inner wall of the vertical chute 6 in a view facing the gasifier 20.

[0058] A merged line 12m is defined when the lower left damper 12_L and the lower right damper 12_R are closed and distal portions of the lower left damper 12_L and the lower right damper 12_R contact one another, the distal portions being straight and facing one another. The merged line 12m is located at the center in the left-right

direction of the vertical chute 6, namely, at a position above the center line Lc extending in the longitudinal direction and passing through the center in the width direction of the waste-conveying device 7. In a state in which the lower left damper 12_L and the lower right damper 12_R are closed, the lower left damper 12_L and the lower right damper 12_R are lowered toward the distal portions from the lower supporting shafts 12p. In particular, in that state, the lower left damper 12_L and the lower right damper 12_R define an angle θ of, for example, 150°.

[0059] With the lower damper 12, the upper surfaces of the lower left damper 12_L and the lower right damper 12_R are inclined in the closed state, and hence have a hopper-like shape. The waste 9 can be efficiently fed onto the screw conveyor (described below) when the lower left damper 12_L and the lower right damper 12_R start to be opened.

[0060] The upper damper 11 and the lower damper 12 are alternately opened and closed such that at least one of the upper damper 11 and the lower damper 12 is closed, in order to inhibit external air from entering the gasifier 20.

[0061] The waste-conveying device 7 houses a screw conveyor 13 that conveys the waste 9 fed through the lower damper 12 toward the gasifier 20. The screw conveyor 13 includes a pair of conveyance screws 13a having rotation centers parallel to one another in a horizontal plane. In addition, a waste disintegrator 14 is provided at the distal side of the screw conveyor 13 at a position not occupied by the screw conveyor 13. The waste disintegrator 14 disintegrates the waste 9 pushed by the screw conveyor 13.

[0062] The waste disintegrator 14 in Embodiment 1 is rotary type; however, a configuration of rocking type may be used.

[0063] The operation mode of the waste-feeding apparatus 1 having the above-described configuration will be described below. The pusher 3 pushes the waste 9 fed into the waste hopper 2. The crusher 4 roughly crushes the pushed waste 9. The conveyor 5 lifts the waste 9, which has been roughly crushed by the crusher 4, obliquely upward. The waste 9 is dropped and fed onto the upper damper 11 of the vertical chute 6.

[0064] When the waste 9 is stacked on the upper damper 11 by a predetermined amount, the upper damper 11 is opened, and then closed after several seconds has elapsed. During this period, the waste 9 stacked on the upper damper 11 by the predetermined amount and the waste 9 lifted obliquely upward by the conveyor 5 are fed onto the upper surface of the lower damper 12. When several seconds has elapsed after the upper damper 11 is closed, the lower damper 12 is opened and the open state is maintained for several seconds. When the waste 9 fed onto the lower damper 12 is fed to the screw conveyor 13, the distal portions of the lower left damper 12_L and the lower right damper 12_R are opened, the distal portions being straight and facing one another. Thus, the waste 9 is dropped on the center line Lc extending in the longitudinal direction and passing through the center in the width direction of the waste-conveying device 7. In particular, the waste 9 is dropped in an area between the pair of conveyance screws 13a of the screw conveyor 13.

[0065] Accordingly, the waste 9 having the length corresponding to the length of the lower damper 12 in a direction toward the gasifier 20 is fed to the pair of conveyance screws 13a of the screw conveyor 13. Also, the waste 9 is stacked in a mound-like shape in the width direction of the pair of conveyance screws 13a of the screw conveyor 13. The variation in volume of the waste 9 in the left-right direction can be reduced. The waste 9 fed to the screw conveyor 13 is conveyed by rotation of the pair of conveyance screws 13a. The waste disintegrator 14 disintegrates the waste 9 into smaller pieces. The waste 9 is fed into the gasifier 20 through the waste-feeding chute 8 and then through the waste inlet 21. The waste 9 fed into the gasifier 20 is gasified at temperatures from 500°C to 600°C, and decomposed into combustible gas, fixed carbon, and ash. Then, the decomposed combustible gas and fixed carbon are burned in a melting furnace (not shown). The ash is molten at temperatures of 1300°C or higher, and becomes molten slag. The lower damper 12 is closed when several seconds has elapsed after the waste 9 is fed to the screw conveyor 13. Then, the upper damper 11, which has been previously closed, is opened. In this way, the upper damper 11 and the lower damper 12 are alternately opened and closed at an interval of predetermined seconds.

[0066] In the waste-feeding apparatus 1 according to Embodiment 1 of the present invention, as described above, the lower damper 12 includes the lower left damper 12_L and the lower right damper 12_R. The lower left damper 12_L and the lower right damper 12_R are provided on the opposite portions of the inner wall of the vertical chute 6 and opened and closed through the lower supporting shafts 12p. The lower supporting shafts 12p are parallel to the center line Lc. The center line Lc extends in the longitudinal direction and passes through the center in the width direction of the waste-conveying device 7. The merged line 12m defined by the distal portions of the lower left damper 12_L and the lower right damper 12_R in the closed state is located above the center line Lc.

[0067] Accordingly, with the waste-feeding apparatus 1 according to Embodiment 1 of the present invention, the waste 9 having the length corresponding to the length of the lower damper 12 in the direction toward the gasifier 20 can be fed to the screw conveyor 13. Also, the waste 9 is dropped at the center in the width direction of the screw conveyor 13 immediately after the lower left damper 12_L and the lower right damper 12_R start to be opened (or the waste 9 is dropped at the position of the center line Lc extending in the longitudinal direction and passing through the center in the width direction of the waste-conveying device 7). That is, the waste 9 is dropped in the area between the pair of conveyance screws 13a. Then, as the opening becomes larger, the area in which the waste 9 is dropped becomes larger in a direction away

from the center in the width direction. Thus, the waste 9 has a cross section in a mound-like shape at any position in the direction toward the gasifier 20 along the pair of conveyance screws 13a of the screw conveyor 13. The variation in volume of the waste 9 in the left-right direction can be reduced. The volumetric feeding performance of the waste 9 to the gasifier is improved.

[0068] Also, in the waste-feeding apparatus 1 according to Embodiment 1 of the present invention, the lower left damper 12_L and the lower right damper 12_R are lowered toward the distal portions from the lower supporting shafts 12p in the closed state. The upper surfaces of the lower left damper 12_L and the lower right damper 12_R are inclined in the closed state, and hence have a hopper-like shape. The waste 9 can be efficiently fed onto the screw conveyor 13 when the lower left damper 12_L and the lower right damper 12_R start to be opened.

[0069] Also, the waste disintegrator 14, which disintegrates the waste 9 pushed by the screw conveyor 13, is provided at a forward position of the distal end of the screw conveyor 13. The waste disintegrator 14 disintegrates the waste 9 conveyed by the rotation of the pair of conveyance screws 13a into smaller pieces. The waste 9 is fed into the gasifier 20 through the waste-feeding chute 8 and then through the waste inlet 21. Thus, a large block of waste 9 will not be fed, contributing to improvement in volumetric feeding. In addition, toxic substances can be prevented from being produced in exhaust gas, and variation in the amount of produced gas can be reduced. The performance of a gasification and melting plant can be improved, and the allowance ratios for respective devices can be decreased. Consequently, the cost of the gasification and melting plant can be decreased.

[0070] The waste-feeding apparatus for the gasifier according to Embodiment 1 is merely a specific example of the present invention, and the design thereof can be freely changed within the technical scope of the present invention. The configuration of the waste-feeding apparatus for the gasifier is not limited to the above-described embodiment.

[0071] For example, in the above-described embodiment, the waste-feeding apparatus 1 includes the conveyor 5. However, the conveyor may be omitted, and the waste 9 crushed by the crusher 4 may be directly dropped and fed into the vertical chute 6. With this configuration, the installation space can be small, and the building for housing the equipment can be small. This is economically advantageous to decrease the equipment cost for the waste-feeding apparatus.

[0072] Also, the crusher 4 may be provided separately from the waste-feeding apparatus 1. With this configuration, even when the crusher 4 is stopped during operation because of a trouble, the waste-feeding apparatus 1 can continuously feed the waste 9 to the gasifier 20. Accordingly, continuous operating performance can be increased.

[0073] A waste-feeding apparatus according to Embodiment 2 of the present invention will be described below with reference to the attached drawings. Embodiment 2 implements a waste-feeding method of the present invention. The same reference numerals refer components equivalent to those in Embodiment 1, and the same names are applied thereto throughout the description. Fig. 3 is an explanatory view schematically showing the configuration of a waste-feeding apparatus according to Embodiment 2 of the present invention, Fig. 3 also showing a gasifier for gasification of the waste. Fig. 4A is an explanatory view schematically showing the configurations of upper and lower dampers. Fig. 4B is an enlarged cross-sectional view showing part C in Fig. 4A.

[0074] Reference numeral 1 shown in Fig. 3 denotes the waste-feeding apparatus according to Embodiment 2. Embodiment 2 implements the waste-feeding method of the present invention. The waste-feeding apparatus 1 includes a vertical chute 6 (described below), a waste-conveying device 7 to which waste 9 is fed from the vertical chute 6, and a waste-feeding chute 8 connected with the waste-conveying device 7. The waste-feeding chute 8 obliquely extends and communicates with a waste inlet 21 in a gasifier 20, to feed the waste 9. To be more specific, a waste-dumping device (not shown) such as a crane feeds the waste 9 into a waste hopper 2. A pusher 3 pushes the waste 9. A crusher 4 roughly crushes the pushed waste 9. Then, a conveyor 5 provided in an air-tight conveyor housing lifts the waste 9, which has been roughly crushed by the crusher 4, obliquely upward. The waste 9 is dropped and fed into the vertical chute 6.

[0075] The vertical chute 6 includes double dampers having a sealing function, which will be described later. The double dampers each have a rectangular cross section. The waste-conveying device 7 is connected with the lower end of the vertical chute 6. The waste-conveying device 7 includes a screw conveyor and a waste disintegrator, which will be described later. The screw conveyor conveys the waste 9 toward the gasifier 20. The upper end of the waste-feeding chute 8 is connected with the lower distal end of the waste-conveying device 7. The waste-feeding chute 8 extends obliquely downward and communicates with the waste inlet 21 of the gasifier 20.

[0076] The double dampers provided in the vertical chute 6 include an upper damper 11 and a lower damper 12. The lower damper 12 is provided below the upper damper 11 and separated from the upper damper 11 by a predetermined distance. An upper supporting shaft 11p is provided on the inner wall of the vertical chute 6 at a position close to the gasifier 20. The upper damper 11 is rotated downward by 75° around the upper supporting shaft 11p as a pivot from a closed position inclined at 15° to a horizontal line. The upper damper 11 is opened to a vertical position at which the upper damper 11 is orthogonal to the horizontal line.

[0077] The lower damper 12 is provided in the vertical chute 6 at the position below the upper damper 11 and separated from the upper damper 11 by a predetermined distance. A lower supporting shaft 12p is provided on the

inner wall of the vertical chute 6 at a position close to the gasifier 20. The lower damper 12 is rotated downward by 75° around the lower supporting shaft 12p as a pivot from a closed position inclined at 15° to a horizontal line. The lower damper 12 is opened to a vertical position at which the lower damper 12 is orthogonal to the horizontal line.

[0078] In Embodiment 2, as described above, the upper and lower dampers 11 and 12 each have an inclination angle of 15° to the horizontal line in the closed state. However, the inclination angle of the upper and lower dampers to the horizontal line does not have to be 15° and may be properly determined.

[0079] Also, in Embodiment 2, the upper and lower supporting shafts 11p and 12p are provided on the inner wall of the vertical chute 6 at the positions close to the gasifier 20. However, it is not limited thereto, and the following arrangement may be employed.

(1) Both the upper and lower supporting shafts 11p and 12p may be provided on the inner wall of the vertical chute 6 at positions far from the gasifier 20.
(2) The lower supporting shaft 12p may remain at the position of the vertical chute 6 close to the gasifier 20, and the upper supporting shaft 11p may be provided on the inner wall of the vertical chute 6 at the position far from the gasifier 20.
(3) The upper supporting shaft 11p may remain at the position of the vertical chute 6 close to the gasifier 20, and the lower supporting shaft 12p may be provided on the inner wall of the vertical chute 6 at the position far from the gasifier 20.

[0080] As described in (2) and (3), when the upper and lower supporting shafts 11p and 12p are provided on the inner wall of the vertical chute 6 at the opposite positions, the waste 9 can be dropped from the upper damper 11 onto a position close to the lower supporting shaft 12p of the lower damper 12. Thus, a substance adhering to the upper surface of the lower damper 12 is continuously wiped out because the waste 9 dropped from the upper damper 11 slides on the upper surface of the lower damper 12. The frequency of cleaning for the lower damper 12 can be reduced. The maintenance cost for the waste-feeding apparatus can be decreased.

[0081] The upper and lower dampers 11 and 12 are configured as shown in Figs. 4A and 4B. The upper damper 11 includes an upper damper body 11a and an upper supporting arm 11h. The upper damper body 11a includes a damper substrate 11b made of, for example, a SS member or a SUS member, and a hard low-friction resin plate 11c fixed to the upper surface of the damper substrate 11b. The upper supporting arm 11h has one end that is rotatably supported by the upper supporting shaft 11p, and the other end that rotatably supports the upper damper body 11a through a bracket 11e and a coupling pin 11f.

[0082] The hard low-friction resin plate 11c is fixed to the upper surface of the damper substrate 11b by a plurality of small flat-head screws 11d (mechanical fastening means) that are respectively screwed into a plurality of internal threads 11s formed in the damper substrate 11b.

[0083] Also, coating layers 11g each having an inverted cone shape are provided to fill spaces above the upper surfaces of the small flat-head screws 11d housed in inverted-cone-shaped screw-head housing holes in the hard low-friction resin plate 11c, so that the upper surfaces of the coating layers 11g are flush with the surface of the hard low-friction resin plate 11c. The coating layers 11g prevent corrosive substances from contacting the upper surfaces of the small flat-head screws 11d, and prevent magnetic substances contained in the waste 9 from adhering thereto.

[0084] An upper arm 11i has one end fixed to a shaft end of the upper supporting shaft 11p that supports the upper supporting arm 11h, the shaft end protruding from the vertical chute 6. An expansion rod of an upper cylinder 11j has a distal end pivotally attached to a distal end of the upper arm 11i. When the expansion rod of the upper cylinder 11j is expanded and contracted, the upper damper body 11a is rotated by 75° through the upper arm 11i, the upper supporting shaft 11p, and the upper supporting arm 11h.

[0085] The lower damper 12 includes a lower damper body 12a and a lower supporting arm 12h. The lower damper body 12a includes a damper substrate 12b made of, for example, a SS member or a SUS member, and a hard low-friction resin plate 12c fixed to the upper surface of the damper substrate 12b. The lower supporting arm 12h has one end that is rotatably supported by the lower supporting shaft 12p, and the other end that rotatably supports the lower damper body 12a through a bracket 12e and a coupling pin 12f.

[0086] The hard low-friction resin plate 12c is fixed to the upper surface of the damper substrate 12b by a plurality of small flat-head screws 12d (mechanical fastening means) that are respectively screwed into a plurality of internal threads 12s formed in the damper substrate 12b.

[0087] Also, coating layers 12g each having an inverted cone shape are provided to fill spaces above the upper surfaces of the small flat-head screws 12d housed in inverted-cone-shaped screw-head housing holes in the hard low-friction resin plate 12c, so that the upper surfaces of the coating layers 12g are flush with the surface of the hard low-friction resin plate 12c. The coating layers 12g prevent corrosive substances from contacting the upper surfaces of the small flat-head screws 12d, and prevent magnetic substances contained in the waste 9 from adhering thereto.

[0088] A lower arm 12i has one end fixed to a shaft end of the lower supporting shaft 12p that supports the lower supporting arm 12h, the shaft end protruding from the vertical chute 6. An expansion rod of a lower cylinder 12j has a distal end pivotally attached to a distal end of the lower arm 12i. When the expansion rod of the lower cylinder 12j is expanded and contracted, the lower damp-

er body 12a is rotated by 75° through the lower arm 12i, the lower supporting shaft 12p, and the lower supporting arm 12h. As described above in detail, the upper damper 11 and the lower damper 12 have the same operation mechanisms.

[0089] The hard low-friction resin plate 11c in the upper damper body 11a and the hard low-friction resin plate 12c in the lower damper body 12a each are made of ultra high molecular weight polyethylene resin with an ultra high molecular weight of three millions to eight millions. In this embodiment, as described above, the ultra high molecular weight polyethylene resin has been used. However, it is not limited thereto. For example, polycarbonate (PC) resin or acrylonitrile butadiene styrene (ABS) resin may be used. That is, the material of the hard low-friction resin plate is not limited to particular types of resin as long as the material has good wear resistance, good shock resistance, and good chemical resistance.

[0090] The upper damper 11 and the lower damper 12 are alternately opened and closed such that at least one of the upper damper 11 and the lower damper 12 is closed, in order to inhibit external air from entering the gasifier 20.

[0091] The waste-conveying device 7 houses a screw conveyor 13 that conveys the waste 9 fed through the lower damper 12 toward the gasifier 20. The screw conveyor 13 includes a pair of conveyance screws 13a having rotation centers parallel to one another in a horizontal plane. In addition, a waste disintegrator 14 is provided at the distal side of the screw conveyor 13 at a position not occupied by the screw conveyor 13. The waste disintegrator 14 disintegrates the waste 9 pushed by the screw conveyor 13. The waste disintegrator 14 in Embodiment 2 is rotary type; however, a configuration of rocking type may be used.

[0092] The operation mode of the waste-feeding apparatus 1 having the above-described configuration will be described below. The pusher 3 pushes the waste 9 fed into the waste hopper 2. The crusher 4 roughly crushes the pushed waste 9. The conveyor 5 lifts the waste 9, which has been roughly crushed by the crusher 4, obliquely upward. The waste 9 is dropped and fed onto the upper damper 11 of the vertical chute 6.

[0093] When the waste 9 is stacked on the upper surface of the upper damper 11 by a predetermined amount, the upper damper 11 is opened, and then closed after several seconds has elapsed. During this period, the waste 9 stacked on the upper damper 11 by the predetermined amount and the waste 9 lifted obliquely upward by the conveyor 5 are fed onto the upper surface of the lower damper 12. When several seconds has elapsed after the upper damper 11 is closed, the lower damper 12 is opened and the open state is maintained for several seconds. Thus, the waste 9 fed onto the lower damper 12 is dropped on the screw conveyor 13, more particularly, on the pair of conveyance screws 13a.

[0094] The waste 9 dropped on the pair of conveyance screws 13a is conveyed by rotation of the pair of conveyance screws 13a. The waste disintegrator 14 disintegrates the waste 9 discharged from the distal end of the screw conveyor 13 into smaller pieces. The waste 9 is fed into the gasifier 20 through the waste-feeding chute 8 and then through the waste inlet 21. The waste 9 fed into the gasifier 20 is gasified at temperatures from 500°C to 600°C, and decomposed into combustible gas, fixed carbon, and ash.

[0095] Then, the decomposed combustible gas and fixed carbon are burned in a melting furnace (not shown). The ash is molten at temperatures of 1300°C or higher, and becomes molten slag. The lower damper 12 is closed when several seconds has elapsed after the waste 9 is fed to the screw conveyor 13. Then, the upper damper 11, which has been previously closed, is opened. In this way, the upper damper 11 and the lower damper 12 are alternately opened and closed at an interval of predetermined seconds.

[0096] In the waste-feeding apparatus 1 according to Embodiment 2 of the present invention, in the above-described process, the upper surfaces of the upper damper body 11a and the lower damper body 12a are formed of the hard low-friction resin plates. Even when a sealing surface (not shown) formed on the vertical chute 6 is made of metal, a spark does not occur due to an impact exerted when either damper is closed. Thus, oil contained in the waste 9 is not ignited with the spark. Also, magnetized waste does not adhere to either damper. This can prevent the phenomenon from occurring, the phenomenon in which the magnetized waste adheres to the damper, another magnetized waste is hooked to the adhering magnetized waste, resulting in the waste being accumulated, and hence the waste cannot be smoothly fed into the gasifier. Further, the damper has a low friction coefficient. Thus, the sealing performance is not deteriorated.

[0097] A waste-feeding apparatus according to Embodiment 3 of the present invention will be described below with reference to the attached drawings. Embodiment 3 implements a waste-feeding method of the present invention. The same reference numerals refer components equivalent to those in the aforementioned embodiment, and the same names are applied thereto throughout the description. Fig. 5 is an explanatory view schematically showing the configuration of a pressure generator and a control device that controls the pressure generator, the pressure generator operating upper and lower cylinders of upper and lower dampers in a waste-feeding apparatus according to Embodiment 3 of the present invention. The waste-feeding apparatus according to Embodiment 3 of the present invention has the same configuration as Embodiment 2. The configuration of the waste-feeding apparatus will be described with reference to Fig. 3.

[0098] Reference numeral 1 shown in Fig. 3 denotes the waste-feeding apparatus according to Embodiment 3 of the present invention. Embodiment 3 implements the waste-feeding method of the present invention. The waste-feeding apparatus 1 includes a vertical chute 6

(described below), a waste-conveying device 7 to which waste 9 is fed from the vertical chute 6, and a waste-feeding chute 8 connected with the waste-conveying device 7. The waste-feeding chute 8 obliquely extends and communicates with a waste inlet 21 in a gasifier 20, to feed the waste 9. To be more specific, a waste-dumping device (not shown) such as a crane feeds the waste 9 into a waste hopper 2. A pusher 3 pushes the waste 9. A crusher 4 roughly crushes the pushed waste 9. Then, a conveyor 5 provided in an air-tight conveyor housing lifts the waste 9, which has been roughly crushed by the crusher 4, obliquely upward. The waste 9 is dropped and fed into the vertical chute 6. In Embodiment 3, waste primary feeding means includes the waste hopper 2, the pusher 3, the crusher 4, and the conveyor 5.

[0099] The vertical chute 6 includes double dampers having a sealing function, which will be described later. The double dampers each have a rectangular cross section. The waste-conveying device 7 is connected with the lower end of the vertical chute 6. The waste-conveying device 7 includes a screw conveyor and a waste disintegrator, which will be described later. The screw conveyor conveys the waste 9 toward the gasifier 20. The upper end of the waste-feeding chute 8 is connected with the lower distal end of the waste-conveying device 7. The waste-feeding chute 8 extends obliquely downward and communicates with the waste inlet 21 of the gasifier 20.

[0100] The double dampers provided in the vertical chute 6 include an upper damper 11 and a lower damper 12. The lower damper 12 is provided below the upper damper 11 and separated from the upper damper 11 by a predetermined distance. An upper supporting shaft 11p is provided on the inner wall of the vertical chute 6 at a position close to the gasifier 20. The upper damper 11 is rotated downward by 75° around the upper supporting shaft 11p as a pivot from a closed position inclined at 15° to a horizontal line. The upper damper 11 is opened to a vertical position at which the upper damper 11 is orthogonal to the horizontal line.

[0101] The lower damper 12 is provided in the vertical chute 6 at the position below the upper damper 11 and separated from the upper damper 11 of the vertical chute 6 by a predetermined distance. A lower supporting shaft 12p is provided on the inner wall of the vertical chute 6 at a position close to the gasifier 20. The lower damper 12 is rotated downward by 75° around the lower supporting shaft 12p as a pivot from a closed position inclined at 15° to a horizontal line. The lower damper 12 is opened to a vertical position at which the lower damper 12 is orthogonal to the horizontal line.

[0102] In Embodiment 3, as described above, the upper supporting shaft 11p and the lower supporting shaft 12p are provided on the inner wall of the vertical chute 6 at the positions close to the gasifier 20 (at the right side in Figs. 3 and 5) .

[0103] However, a similar advantage can be attained even when the upper supporting shaft 11p and the lower supporting shaft 12p are provided on the inner wall of the vertical chute 6 at positions far from the gasifier 20 (at the left side in Figs. 3 and 5). In Embodiment 3, the upper damper 11 and the lower damper 12 are inclined by 15° to the horizontal line in the closed state. However, the inclination angle of the upper and lower dampers 11 and 12 to the horizontal line does not have to be 15° and may be properly determined.

[0104] The upper damper 11 and the lower damper 12 are opened and closed by upper and lower cylinders 11j and 12j that are operated by a pressure generator P_U. The pressure generator P_U feeds or cuts compressed air under the control of a control device C_L as shown in Fig. 5. In particular, an upper arm 11i has one end fixed to a shaft end of the upper supporting shaft 11p that rotatably supports the upper damper 11, the shaft end protruding from the vertical chute 6. An expansion rod of an upper cylinder 11j has a distal end pivotally attached to a distal end of the upper arm 11i. When the expansion rod of the upper cylinder 11j is expanded and contracted, the upper damper 11 is rotated by 75° through the upper arm 11i and the upper supporting shaft 11p to be opened and closed (the upper damper 11 being closed when the expansion rod is contracted, and opened when the expansion rod is expanded). Also, a limit switch 11sw is provided. The limit switch 11sw contacts the upper arm 11i when the upper arm 11i rotates the upper damper 11 to the closed position. Then, the limit switch 11sw detects that the upper damper 11 is at the closed position, and transmits the detection signal to the control device C_L (described below).

[0105] A lower arm 12i has one end fixed to a shaft end of the lower supporting shaft 12p that rotatably supports the lower damper 12, the shaft end protruding from the vertical chute 6. An expansion rod of a lower cylinder 12j has a distal end pivotally attached to a distal end of the lower arm 12i. When the expansion rod of the lower cylinder 12j is expanded and contracted, the lower damper 12 is rotated by 75° through the lower arm 12i and the lower supporting shaft 12p to be opened and closed (the lower damper 12 being closed when the expansion rod is contracted, and opened when the expansion rod is expanded). As described above in detail, the upper and lower dampers 11 and 12 have similar damper-operating mechanisms for opening and closing the upper and lower dampers 11 and 12, except for the provision of the limit switch 11sw.

[0106] The expansion rods of the upper and lower cylinders 11j and 12j for opening and closing the upper and lower dampers 11 and 12 are operated with the compressed air fed or cut by the pressure generator P_U. The pressure generator P_U is controlled by the control device C_L. The control device C_L receives an arm-detection signal output from the limit switch 11sw and indicating that the limit switch 11sw has contacted the upper arm 11i. In other words, the control device C_L receives a damper-closed signal indicating that the upper damper 11 has been closed. To be more specific, if the control device C_L receives the damper-closed signal from the limit

switch 11sw, the control device C_L determines that the waste 9 is not caught by the upper damper 11, and controls the pressure generator P_U to alternately operate the upper and lower cylinders 11j and 12j in accordance with a normal program.

[0107] In contrast, if the control device C_L does not receive the damper-closed signal from the limit switch 11sw, the control device C_L determines that the waste 9 is caught by the upper damper 11, stops the control of the pressure generator P_U that normally operates the upper and lower cylinders 11j and 12j in accordance with the aforementioned program. The control device C_L controls the pressure generator P_U as described below, and controls the pusher 3 and the conveyor 5 as described below.

[0108] In this case, the determination that the waste 9 is caught by the upper damper 11 is made as follows. A timer (not shown) counts the elapsed time since the operation of the upper cylinder 11j has been started to close the upper damper 11 (or since the expansion of the expansion rod has been started). If the damper-closed signal is not output from the limit switch 11sw although a predetermined period (for example, 5 to 10 seconds) has been elapsed, the counting operation is stopped, and it is determined that the waste 9 is caught by the upper damper 11. The set period of the timer can be changed depending on the opening and closing speed of the upper damper 11. With this configuration, the unused stop period of the waste-feeding apparatus 1 can be decreased. Thus, the time required for removing the waste 9 caught by the upper damper 11 can be decreased.

[0109] If it is determined that the waste 9 is caught by the upper damper 11, the operation of the pusher 3 and the conveyor 5 is stopped by the control device C_L, and hence feeding of the waste 9 to the vertical chute 6 is temporality stopped. During the stop of the feeding of the waste 9, the pressure generator P_U is controlled to operate the upper cylinder 11j. Thus, the upper damper 11 is opened so that the waste 9 caught by the upper damper 11 is dropped and removed. After the upper damper 11, which has been opened for the removal of the caught waste 9, is closed, the operation of the pusher 3 and the conveyor 5 is controlled to be started so that feeding of the waste 9 to the vertical chute 6 is started.

[0110] In this case, the removal of the waste 9 caught by the upper damper 11 is determined if the damper-closed signal output from the limit switch 11sw is received. The upper damper 11 and the lower damper 12 are alternately opened and closed such that at least one of the upper damper 11 and the lower damper 12 is closed, in order to inhibit external air from entering the gasifier 20.

[0111] The waste-conveying device 7 houses a screw conveyor 13 that conveys the waste 9 fed through the lower damper 12 toward the gasifier 20. The screw conveyor 13 includes a pair of conveyance screws 13a having rotation centers parallel to one another in a horizontal plane (in Fig. 3, however, only one of the conveyance screws 13a is shown). In addition, a waste disintegrator 14 is provided at the distal side of the screw conveyor 13 at a position not occupied by the screw conveyor 13. The waste disintegrator 14 disintegrates the waste 9 pushed by the screw conveyor 13. The waste disintegrator 14 in Embodiment 3 is rotary type; however, a configuration of rocking type may be used.

[0112] The operation mode of the waste-feeding apparatus 1 having the above-described configuration for implementing a waste-feeding method will be described below. The pusher 3 pushes the waste 9 fed into the waste hopper 2. The crusher 4 roughly crushes the pushed waste 9. The conveyor 5 lifts the waste 9, which has been roughly crushed by the crusher 4, obliquely upward. The waste 9 is dropped and fed onto the upper damper 11 of the vertical chute 6.

[0113] When the waste 9 is stacked on the upper damper 11 by a predetermined amount, the upper damper 11 is opened, and then closed after several seconds has elapsed. During this period, the waste 9 stacked on the upper damper 11 by the predetermined amount and the waste 9 lifted obliquely upward by the conveyor 5 are fed onto the lower damper 12. When several seconds has elapsed after the upper damper 11 is closed, the lower damper 12 is opened and the open state is maintained for several seconds. Thus, the waste 9 fed onto the lower damper 12 is dropped on the screw conveyor 13, more particularly, on the pair of conveyance screws 13a.

[0114] The waste 9 dropped on the pair of conveyance screws 13a is conveyed by rotation of the pair of conveyance screws 13a. The waste disintegrator 14 disintegrates the waste 9 discharged from the distal end of the screw conveyor 13 into smaller pieces. The waste 9 is fed into the gasifier 20 through the waste-feeding chute 8 and then through the waste inlet 21. The waste 9 fed into the gasifier 20 is gasified at temperatures from 500°C to 600°C, and decomposed into combustible gas, fixed carbon, and ash. Then, the decomposed combustible gas and fixed carbon are burned in a melting furnace (not shown). The ash is molten at temperatures of 1300°C or higher, and becomes molten slag.

[0115] Meanwhile, in Embodiment 3, the lower damper 12 is closed when several seconds has elapsed after the waste 9 is fed to the screw conveyor 13. Then, the upper damper 11, which has been previously closed, is opened. In this way, the upper damper 11 and the lower damper 12 are repeatedly alternately opened and closed at an interval, for example, from 15 seconds to 3 minutes. The interval of the operation for opening and closing each of the upper and lower dampers 11 and 12 is not limited to the above-described interval, and may be properly determined.

[0116] In the above-described process, when the waste 9 is caught by the upper damper 11, the limit switch 11sw is not operated because the expansion rod does not achieve the minimum stroke (the most contracted state) although the closing operation of the upper damper

11 is selected, in which the expansion rod of the upper cylinder 11j is contracted. Thus, the damper-closed signal is not transmitted to the control device C_L. Then, the control device C_L outputs an operation stop instruction signal, and hence the operation of the pusher 3 and the conveyor 5 is stopped. Accordingly, feeding of the waste 9 to the vertical chute 6 is temporarily stopped.

[0117] During the stop of the feeding of the waste 9, under the control of the control device C_L, the pressure generator P_U switches the operation to the opening operation of the upper damper 11, in which the expansion rod of the upper cylinder 11j is expanded, to open the upper damper 11. Thus, the waste 9 caught by the upper damper 11 is removed. Then, the expansion rod of the upper cylinder 11j is contacted to close the upper damper 11, which has been opened for removal of the caught waste 9. If the control device C_L receives the damper-closed signal, the operation of the pusher 3 and the conveyor 5 is started to start the feeding of the waste 9 to the vertical chute 6. Thereafter, the operation state is recovered to the normal operation state.

[0118] In the waste-feeding apparatus 1 according to Embodiment 3 for implementing the waste-feeding method of the present invention, in some cases, the waste 9 cannot be removed although the upper damper 11 has been opened for the removal of the caught waste 9, and the damper-closed signal cannot be received although the upper damper 11 has been operated to be closed.

[0119] In such a case, the opening and closing operation for the upper damper 11 is repeated until the damper-closed signal is received. By repeating the opening and closing operation for the upper damper 11, external air can be reliably inhibited from entering the gasifier 20. At the same time, the operating ratio of the waste-feeding apparatus 1 and the waste-processing amount may be degraded. However, the time required for repeating the opening and closing operation is markedly shorter than the time required for removing the waste 9 by opening an access hole. Thus, the operating ratio of the waste-feeding apparatus 1 and the waste-processing amount can be less degraded.

[0120] With the waste-feeding method by the waste-feeding apparatus 1 according to Embodiment 3 of the present invention, the above-described operation is carried out when the waste 9 is caught by the upper damper 11. In contrast, if the control device C_L receives the damper-closed signal, and it is determined that the upper damper 11 is completely closed and the waste 9 is not caught by the upper damper 11, the feeding of the waste 9 to the vertical chute 6 is continued, and the operation of the waste primary feeding means located upstream of the vertical chute 6, that is, the operation of the pusher 3 and the conveyor 5 is not stopped. The following advantages can be attained.

(1) Since the operation of the waste primary feeding means located at the upstream side is less frequently started and stopped, the life of the waste primary feeding means is not decreased, and hence, the operating cost can be decreased.

(2) The volumetric feeding performance of the waste 9 is hardly deteriorated, the processing efficiency of the waste 9 is increased, and the variation in the amount of produced gas, which is gasified in the gasifier 20, can be decreased. Thus, it is easy to carry out the control for stable gasification operation of the gasifier 20 and the control for stable operation of the melting furnace located downstream of the gasifier 20.

(3) Since at least one limit switch is required, the configuration of the control system including the pressure generator and the control device for controlling the operation of the upper cylinder 11j does not become complicated or expensive.

[0121] A waste-feeding apparatus according to Embodiment 3a for implementing a waste-feeding method of the present invention will be described below with reference to Fig. 6, which is an explanatory view schematically showing the configuration of a pressure generator and a control device that controls the pressure generator, the pressure generator operating upper and lower cylinders of upper and lower dampers. Embodiment 3a has a configuration similar to that of Embodiment 3 except for the position of a lower supporting shaft that rotatably supports a lower damper. The same reference numerals refer components equivalent to those in Embodiment 3 or components having the same functions as those in Embodiment 3. The point of Embodiment 3a different from Embodiment 3 will be mainly described.

[0122] Similar to Embodiment 3, an upper supporting shaft 11p is provided on the inner wall of the vertical chute 6 at a position close to the gasifier 20 (at the right side in Fig. 6). The upper damper 11 is rotated downward by 75° around the upper supporting shaft 11p as a pivot from a closed position inclined at 15° to a horizontal line. The upper damper 11 is opened to a vertical position at which the upper damper 11 is orthogonal to the horizontal line. A lower supporting shaft 12p is provided on the inner wall of the vertical chute 6 at a position far from the gasifier 20 (at the left side in Fig. 6). The lower damper 12 is rotated downward by 75° around the lower supporting shaft 12p as a pivot from a closed position inclined at 15° to a horizontal line. The lower damper 12 is opened to a vertical position at which the lower damper 12 is orthogonal to the horizontal line.

[0123] Thus, in the waste-feeding apparatus according to Embodiment 3a for implementing the waste-feeding method of the present invention, only the position of the lower supporting shaft 12p that rotatably supports the lower damper 12 is different. Thus, a similar advantage to that of the waste-feeding apparatus according to Embodiment 3 can be attained. Also, in the waste-feeding apparatus according to Embodiment 3a of the present invention, the waste 9 is dropped from the upper damper 11 toward the lower supporting shaft 12p of the lower

damper 12, slides on the upper surface of the lower damper 12, and is dropped onto the position close to the next process. Thus, the waste 9 can be prevented from adhering to the upper surface of the lower damper 12, and the waste 9 on the upper surface of the lower damper 12 can be removed by wiping effect of the waste 9 as a result of sliding. The interval for cleaning of the lower damper 12 can be increased, the operating cost of the waste-feeding apparatus can be decreased, and the operating ratio can be improved.

[0124] In Embodiment 3 and Embodiment 3a, the upper damper 11 is opened and closed when the waste 9 is caught by the upper damper 11, and it is determined that the caught waste 9 has been removed in response to the damper-closed signal from the limit switch 11sw. However, it is preferable to add a configuration for removing the waste 9 caught by the lower damper 12, to the waste-feeding apparatus having the configuration for removing the waste 9 caught by the upper damper 11. The waste 9 is less frequently caught by the lower damper 12 as compared with the upper damper 11. However, as the apparatus is operated for a long term, the lower damper 12 may not become completely closed, for example, due to a muddy substance adhering onto the damper surface.

[0125] More specifically, in Embodiment 3b of the present invention, a limit switch (not shown) is provided. The limit switch contacts a lower arm 12i when a lower cylinder 12j makes a minimum stroke, detects that the lower damper 12 is at a closed position, and transmits the detection signal to the control device C_L. If the control device C_L does not receive the damper-closed signal from the limit switch although the lower cylinder 12j, which opens and closes the lower damper 12, has been operated to close the lower damper 12 and a predetermined time counted by a timer has been elapsed, it is determined that the waste 9 is caught by the lower damper 12. The lower damper 12 is opened to remove the caught waste 9, and then the open lower damper 12 is closed. After the operation, if the control device C_L receives the damper-closed signal from the limit switch, it is determined that the waste 9 caught by the lower damper 12 is removed. The upper damper 11 is opened, so that the waste 9 stacked on the upper damper 11 is dropped and fed onto the lower damper 12.

[0126] With the waste-feeding method according to Embodiment 3b of the present invention, in addition to the advantages of the waste-feeding method according to Embodiments 3 and 3a, it can be recognized that the waste 9 is caught by the lower damper 12. Also, the waste 9 caught by the lower damper 12 can be reliably removed. Thus, the waste 9 is not accumulated or stayed on the lower damper 12 as a result of the waste 9 being caught by the lower damper 12. The waste 9 can be reliably conveyed by the waste-conveying device 7 and fed into the waste inlet 21, the volumetric feeding performance for the waste 9 is hardly deteriorated, and the processing efficiency for the waste 9 can be increased. Also, the unused stop period of the waste-feeding apparatus can be decreased. Thus, the time required for removing the waste 9 caught by the lower damper 12 can be decreased. Since at least two limit switches are required, the configuration of the control system for controlling damper operating means does not become complicated or expensive.

[0127] Meanwhile, in the waste-feeding apparatus 1 according to any of Embodiments 3, 3a, and 3b, the upper and lower dampers are closed when the upper and lower cylinders are contracted, and the upper and lower dampers are opened when the upper and lower dampers are expanded. However, it is not limited thereto. The upper and lower dampers may be closed when the upper and lower cylinders are expanded, and the upper and lower dampers may be opened when the upper and lower cylinders are contacted (for example, the directions of the arms may be opposite to the directions shown in Figs. 5 and 6, or if the directions of the arms are the same as the directions shown in Figs. 5 and 6, the upper and lower cylinders may be configured such that the expansion rods are expanded downward).

[0128] The waste-feeding apparatus according to any of the above-described embodiments, and the waste-feeding apparatus according to any of the above-described embodiments for implementing the waste-feeding methods of the present invention, are merely examples of the present invention, and the design thereof can be feely changed within the technical scope of the present invention. Therefore, the configuration of the waste-feeding apparatus is not limited to the configuration of the waste-feeding apparatus 1 according to any of the above-described embodiments.

Claims

1. A waste-feeding apparatus (1), comprising:

a vertical chute (6) including upper and lower dampers (11, 12) separated from one another by a predetermined distance in an up-down direction, the upper and lower dampers (11, 12) having a sealing function that inhibits external air from entering a gasifier (20) and configured to be alternately opened and closed; and
a waste-conveying device (7) connected with a lower end of the vertical chute (6) and configured to convey waste (9), which is fed through the lower damper (12), toward the gasifier (20),

wherein the lower damper (12) includes a lower left damper (12_L) and a lower right damper (12_R) configured to be opened and closed through supporting shafts (12p), the supporting shafts (12p) being provided on opposite portions of an inner wall of the vertical chute (6) and parallel to a center line (Lc), the center line (Lc) extending in a longitudinal direc-

tion and passing through the center in a width direction of the waste-conveying device (7), and
wherein a merged line (12m) defined by distal portions of the lower left damper (12_L) and the lower right damper (12_R) in a closed state is located above the center line (Lc) .

2. The waste-feeding apparatus (1) according to claim 1, wherein the lower left damper (12_L) and the lower right damper (12_R) of the lower damper (12) are lowered toward the distal portions from the supporting shafts (12p) in the closed state.

3. The waste-feeding apparatus (1) according to claim 1 or 2, wherein the waste-conveying device (7) is a screw conveyor (13) including a pair of conveyance screws (13a) having rotation centers parallel to one another in a horizontal plane.

4. The waste-feeding apparatus (1) according to claim 3, wherein a waste disintegrator (14) is provided at a forward position of a distal end of the screw conveyor (13), the waste disintegrator (14) configured to disintegrate the waste (9) conveyed by the screw conveyor (13).

5. A waste-feeding method to a gasifier (20) by a waste-feeding apparatus (1),
wherein the waste-feeding apparatus (1) includes
a vertical chute (6) including upper and lower dampers (11, 12) separated from one another by a predetermined distance in an up-down direction, the upper and lower dampers (11, 12) having a sealing function that inhibits external air from entering the gasifier (20) and configured to be alternately opened and closed, and
a waste-conveying device (7) connected with a lower end of the vertical chute (6) and configured to convey waste (9), which is fed through the lower damper (12), toward the gasifier (20),
the waste-feeding method comprising the steps of:

after the upper damper (11) is closed, opening the lower damper (12) around supporting shafts (12p) as pivots, the supporting shafts (12p) being provided on opposite portions of an inner wall of the vertical chute (6) and parallel to a center line (Lc), the center line (Lc) extending in a longitudinal direction and passing through the center in a width direction of the waste-conveying device (7); and
dropping the waste (9), which has been received while the upper damper (11) is opened, toward the center line (Lc) to convey the waste (9) by the waste-conveying device (7).

6. The waste-feeding method according to claim 5, further comprising the step of feeding the waste (9), which has been conveyed by the waste-conveying device (7), into the gasifier (20) while disintegrating the waste (9) by a waste disintegrator (14).

7. A waste-feeding apparatus (1), comprising:

a vertical chute (6) including upper and lower dampers (11, 12) separated from one another by a predetermined distance in an up-down direction, the upper and lower dampers (11, 12) having a sealing function that inhibits external air from entering a gasifier (20) and configured to be alternately opened and closed; and
a waste-conveying device (7) configured to convey waste (9), which has been fed through the vertical chute (6), toward the gasifier (20),

wherein the upper and lower dampers (11, 12) have damper bodies (11a, 12a), each of the damper bodies (11a, 12a) having a damper substrate (11b, 12b) and a hard low-friction resin plate (11c, 12c) fixed to an upper surface of the damper substrate (11b, 12b) by mechanical fastening means, and
wherein, when the upper or lower damper (11, 12) is closed, an upper surface of an outer edge portion of the hard low-friction resin plate (11c, 12c) contacts a sealing surface formed on an inner side of the vertical chute (6).

8. The waste-feeding apparatus (1) according to claim 7, wherein the mechanical fastening means is a small flat-head screw (11d, 12d) that is screwed into an internal thread (11s, 12s) formed in the damper substrate (11b, 12b) such that an upper surface of a screw head is lower than an upper surface of the hard low-friction resin plate (11c, 12c), and
wherein a resin coating layer is formed on the upper surface of the screw head.

9. A sealing method of a waste-feeding apparatus (1) for inhibiting external air from entering a gasifier (20),
wherein the waste-feeding apparatus (1) includes
a vertical chute (6) including upper and lower dampers (11, 12) separated from one another by a predetermined distance in an up-down direction, and
a waste-conveying device (7) configured to convey waste (9), which has been fed through the vertical chute (6), toward the gasifier (20),
the sealing method comprising the step of:

when the upper and lower dampers (11, 12) are alternately closed for sealing, bringing an upper surface of an outer edge portion of a hard low-friction resin plate (11c, 12c) on a damper body (11a, 12a) in each of the upper and lower dampers (11, 12) into contact with a sealing surface formed on an inner side of the vertical chute (6).

10. A waste-feeding method by a waste-feeding apparatus (1),
wherein the waste-feeding apparatus (1) includes
a vertical chute (6) including upper and lower dampers (11, 12) separated from one another by a predetermined distance in an up-down direction, the upper and lower dampers (11, 12) having a sealing function that inhibits external air from entering a gasifier (20) and configured to be alternately opened and closed, and
a waste-conveying device (7) configured to convey waste (9), which has been fed through the vertical chute (6), toward the gasifier (20),
the waste-feeding method comprising the steps of:

if a damper-closed signal is not received although an upper cylinder (11j), which opens and closes the upper damper (11), has been operated to close the upper damper (11), determining that the waste (9) is caught by the upper damper (11), and temporarily stopping feeding of the waste (9) to the vertical chute (6);
during the stop of the feeding of the waste (9), opening the upper damper (11) to remove the caught waste (9), and closing the open upper damper (11); and
if the damper-closed signal is received, determining that the waste (9) caught by the upper damper (11) has been removed, and starting the feeding of the waste (9) to the vertical chute (6).

11. The waste-feeding method according to claim 10, further comprising the steps of:

starting counting an elapsed time by a timer since the operation of the upper cylinder (11j) to close the upper damper (11) has started; and
if the damper-closed signal is not output although a predetermined period has elapsed, stopping the counting, and determining that the waste (9) is being caught by the upper damper (11).

12. The waste-feeding method according to claim 10 or 11, wherein the damper-closed signal of the upper damper (11) is output from a limit switch (11sw) that detects a stroke of the upper cylinder (11j).

13. The waste-feeding method according to claim 10, further comprising the steps of:

if the damper-closed signal is not received although a lower cylinder (12j), which opens and closes the lower damper (12), has been operated to close the lower damper (12), determining that the waste (9) is caught by the lower damper (12), opening the lower damper (12) to remove the caught waste (9), and closing the lower damper (12); and
if the damper-closed signal is received, determining that the waste (9), which has been caught by the lower damper (12), is removed, and opening the upper damper (11).

14. The waste-feeding method according to claim 13, further comprising the steps of:

starting counting an elapsed time by a timer since the operation of the lower cylinder (12j) to close the lower damper (12) has started; and
if the damper-closed signal is not output although a predetermined period has elapsed, stopping the counting, and determining that the waste (9) is being caught by the lower damper (12).

15. The waste-feeding method according to claim 13 or 14, wherein the damper-closed signal of the lower damper (12) is output from a limit switch that detects a stroke of the lower cylinder (12j).

FIG.1

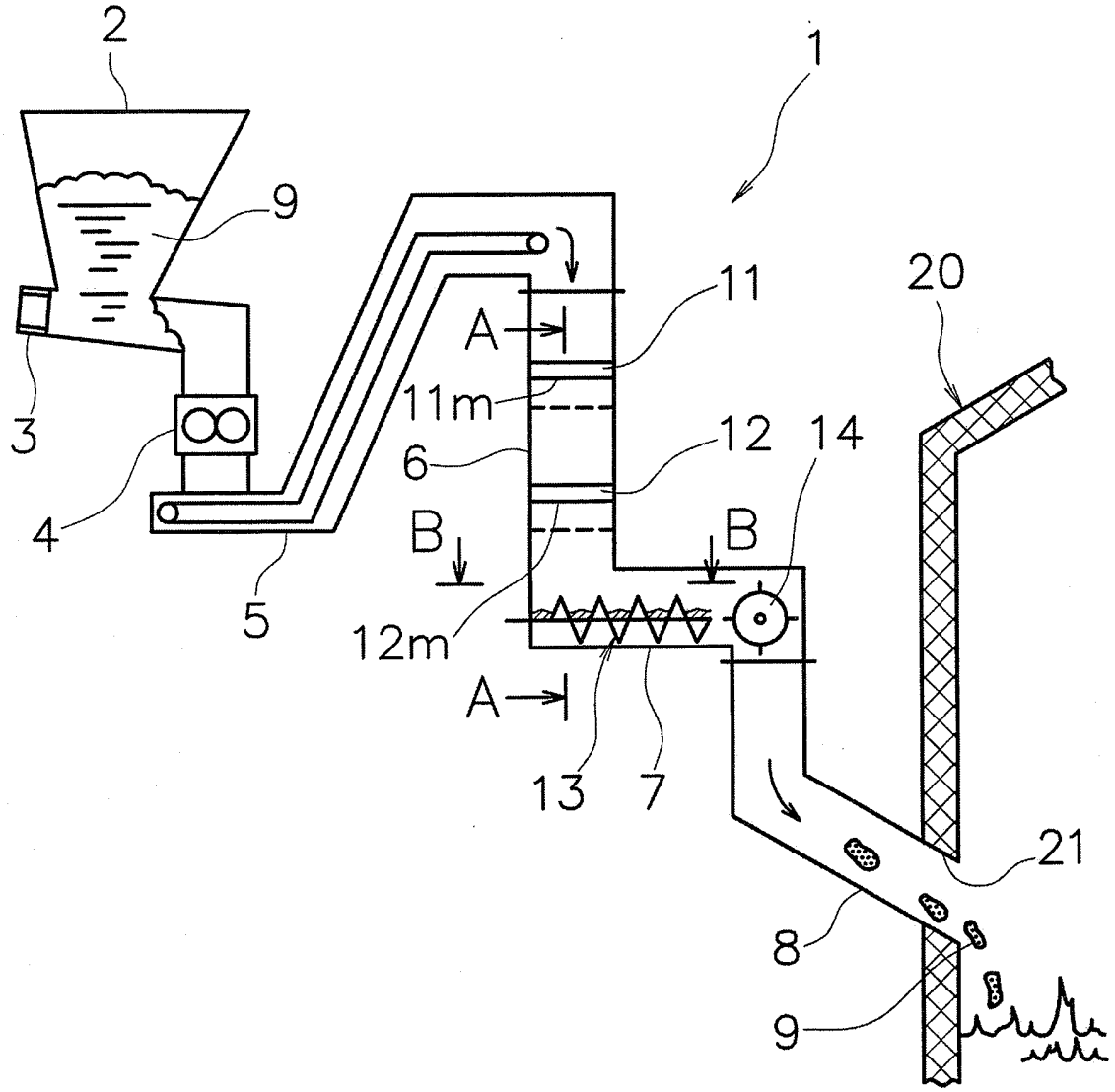


FIG.2

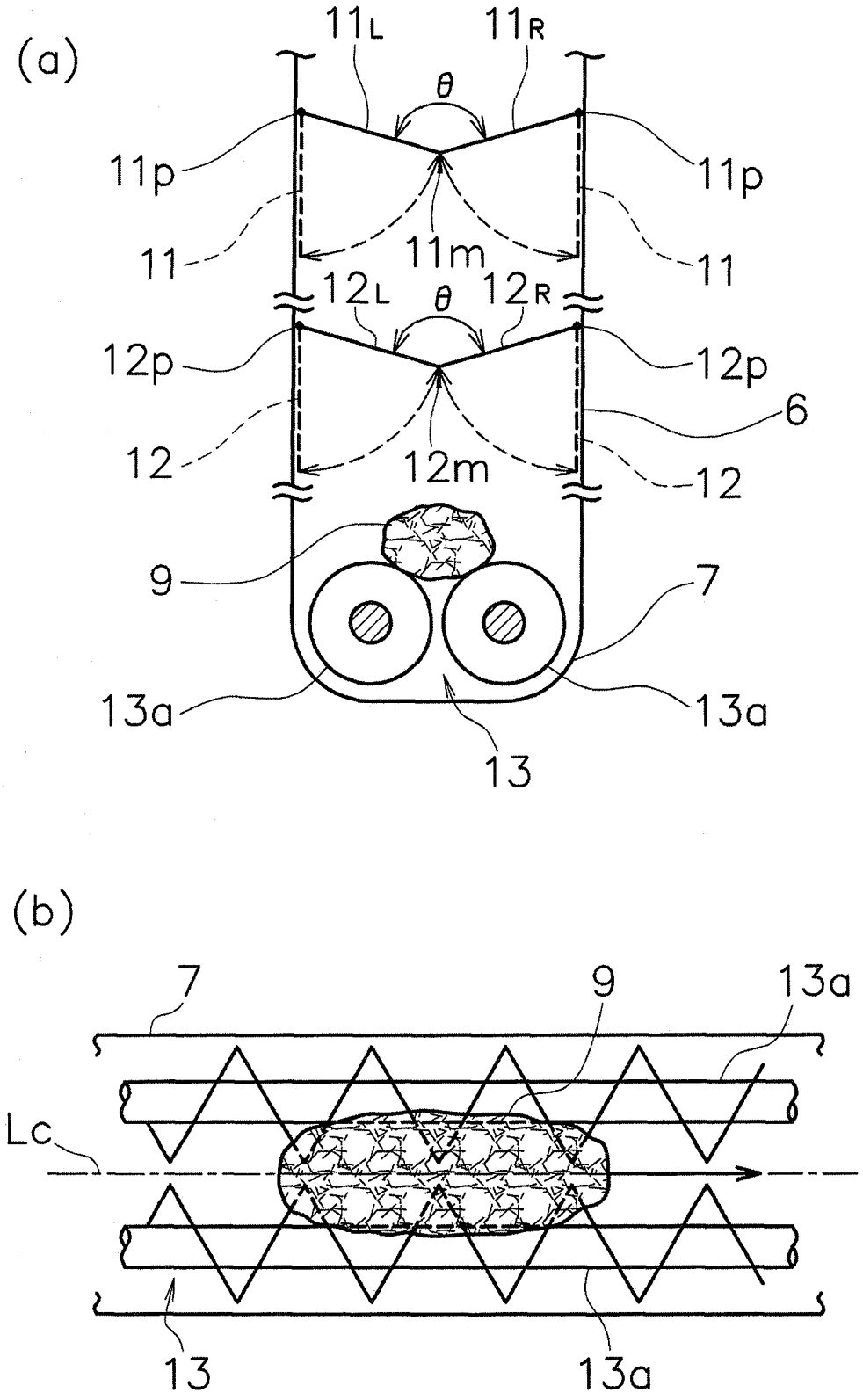

(a)
11L
11R
θ
11p
11p
11
11m
11
12L
θ
12R
12p
12p
6
12
12m
12
9
7
13a
13a
13
(b)
7
9
13a
Lc
13
13a

FIG.3

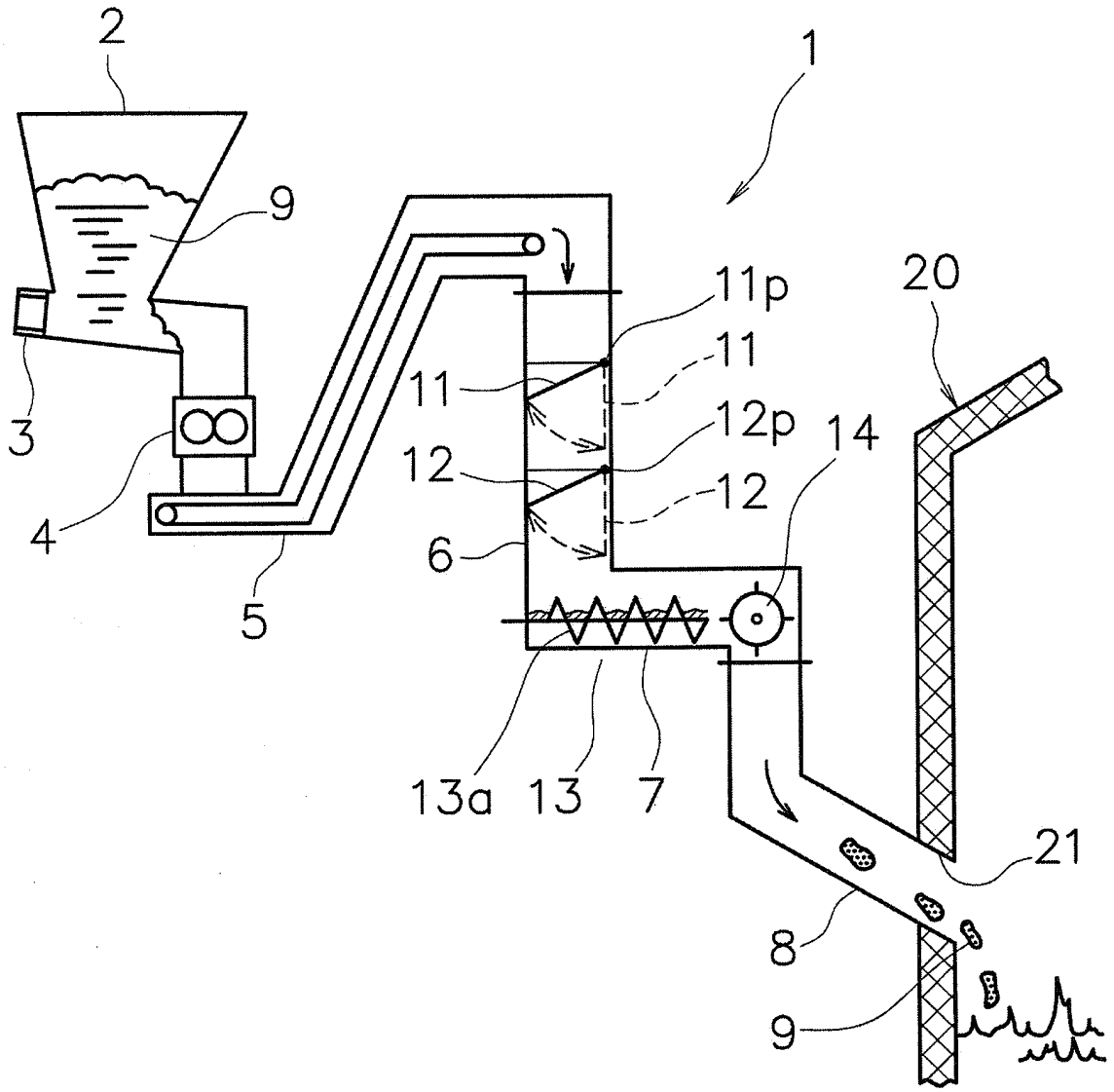


FIG. 4

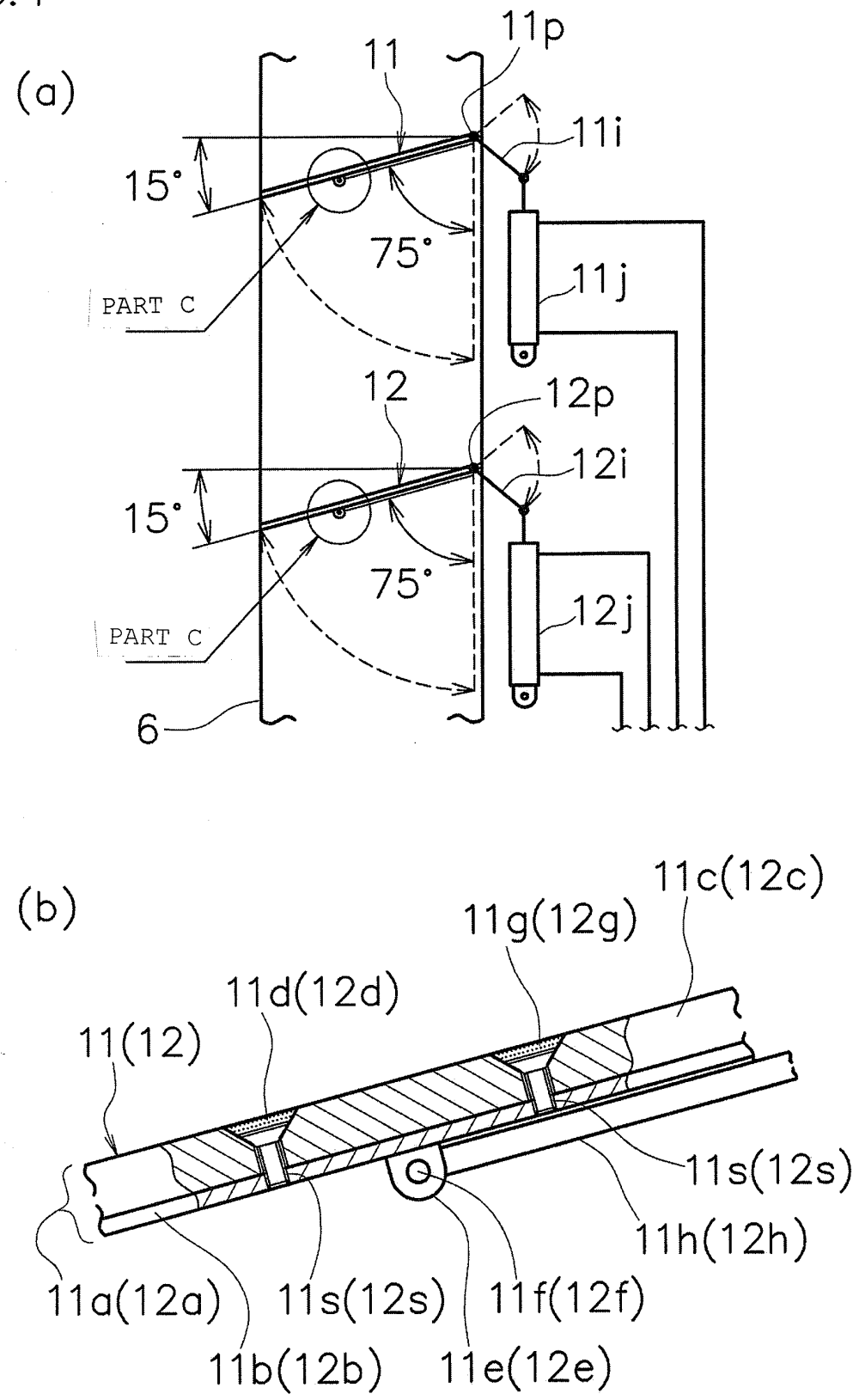

(a)
11
11p
11i
15°
75°
PART C
11j
12
12p
12i
15°
75°
PART C
12j
6
(b)
11c(12c)
11g(12g)
11d(12d)
11(12)
11s(12s)
11h(12h)
11a(12a)
11s(12s)
11f(12f)
11b(12b)
11e(12e)

FIG.5

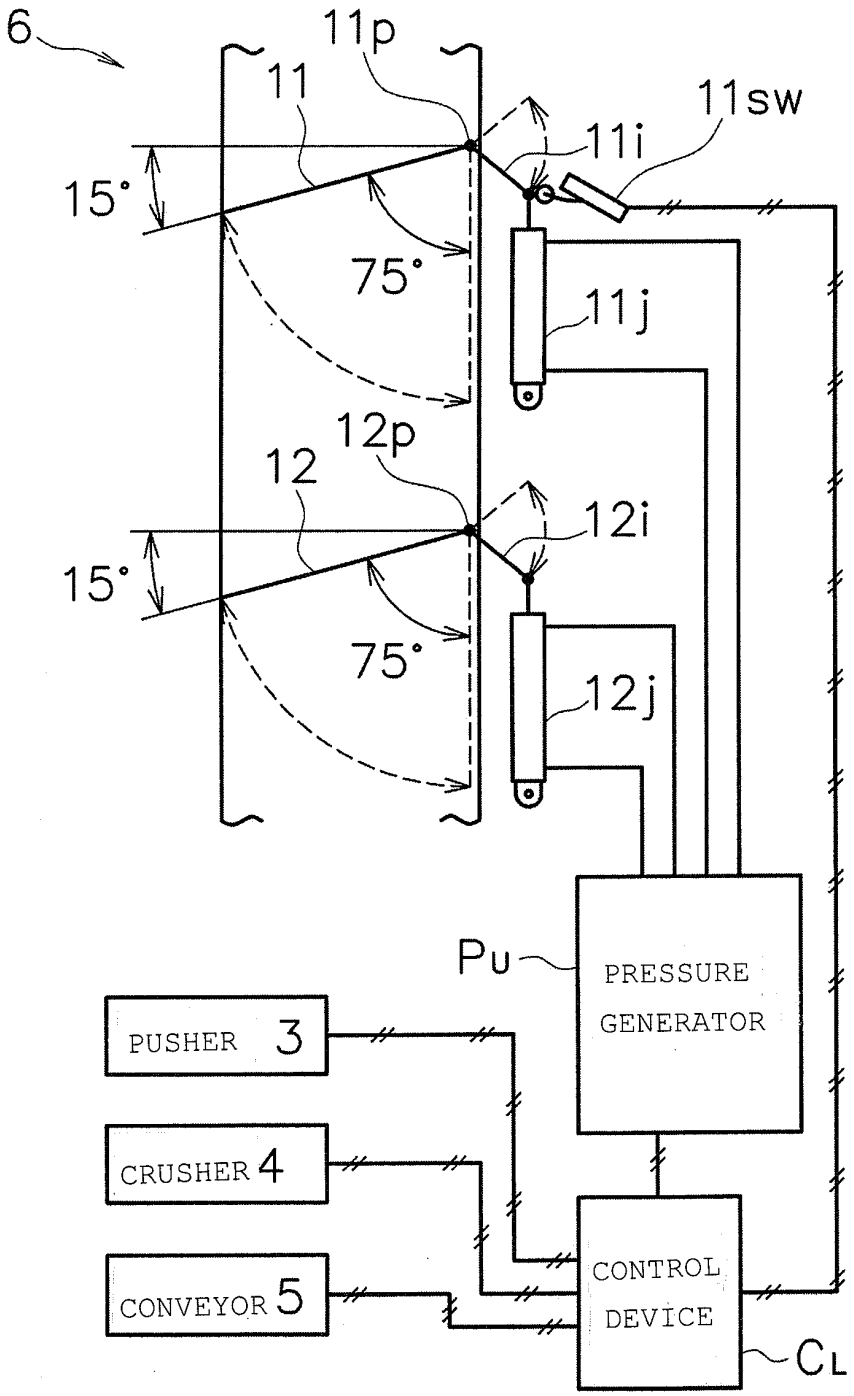

6
11p
11
11sw
11i
15°
75°
11j
12p
12
12i
15°
75°
12j
Pu
PRESSURE GENERATOR
PUSHER 3
CRUSHER 4
CONVEYOR 5
CONTROL DEVICE
CL

FIG.6

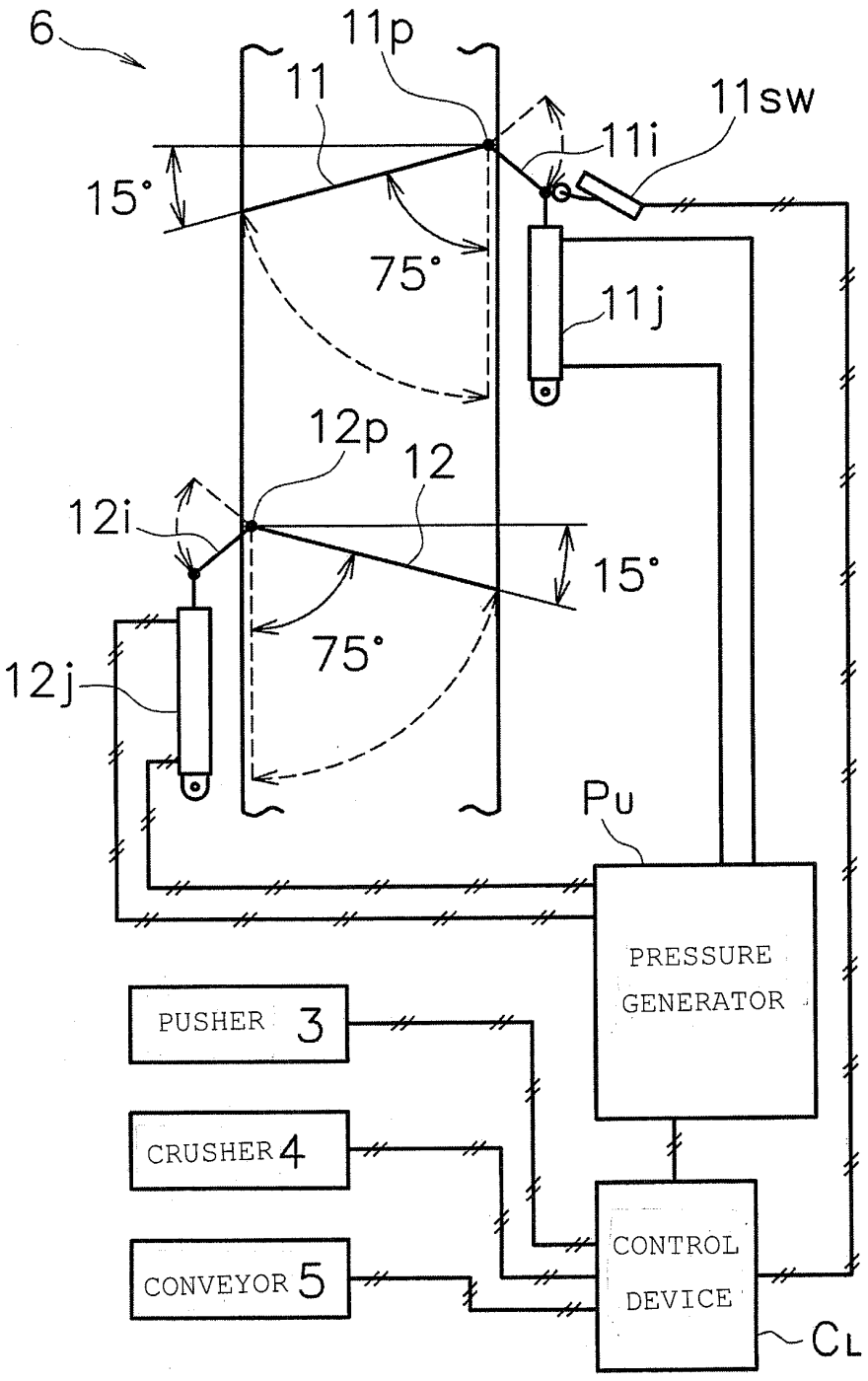
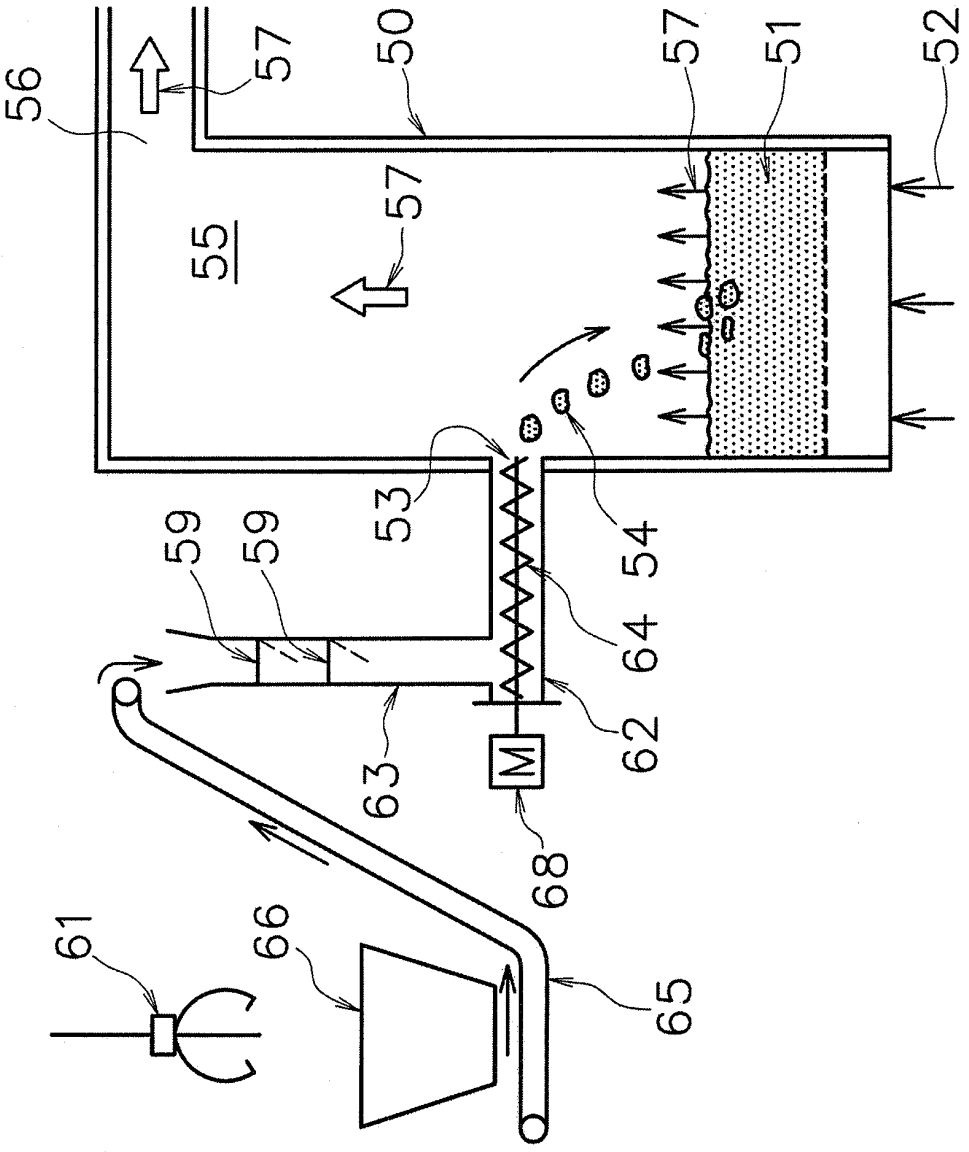

6
11p
11
11sw
11i
15°
75°
11j
12p
12
12i
15°
75°
12j
Pu
PRESSURE GENERATOR
PUSHER 3
CRUSHER 4
CONVEYOR 5
CONTROL DEVICE
CL

FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/065057

A. CLASSIFICATION OF SUBJECT MATTER
F23G5/44(2006.01)i, *F23G5/027*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F23G5/44, F23G5/027

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2008
Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 10-160149 A (The Furukawa Electric Co., Ltd.), 19 June, 1998 (19.06.98), Full text; all drawings (Family: none)	1-15
A	JP 62-017513 A (Kabushiki Kaisha Dozen Chikuro Kogyo), 26 January, 1987 (26.01.87), Full text; all drawings & US 4774896 A	1-15
A	JP 2006-046939 A (Tsukishima Kikai Co., Ltd.), 16 February, 2006 (16.02.06), Full text; all drawings (Family: none)	1-15

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 November, 2008 (04.11.08)	18 November, 2008 (18.11.08)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/065057

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2000-249321 A (Hitachi Zosen Corp.), 12 September, 2000 (12.09.00), Full text; all drawings (Family: none)	1-15
A	JP 2003-056822 A (Ebara Corp.), 26 February, 2003 (26.02.03), Full text; all drawings (Family: none)	1-15
A	JP 2007-147270 A (Ebara Corp.), 14 June, 2007 (14.06.07), Page 12, lines 40 to 46; Fig. 6 & US 5620488 A & US 5725614 A & US 5858033 A & US 5922090 A & US 6190429 B1 & US 2001/0011438 A1 & US 6350288 B1 & EP 0676464 A3 & EP 1111304 A2 & EP 1286113 A2 & EP 1367324 A1	1-15
A	JP 05-272746 A (Ebara Corp.), 19 October, 1993 (19.10.93), Full text; all drawings (Family: none)	7-9
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 040719/1991(Laid-open No. 138530/1992) (Hitachi Zosen Corp.), 25 December, 1992 (25.12.92), Full text; all drawings (Family: none)	7-9
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 136764/1983(Laid-open No. 043830/1985) (Ebara Corp.), 28 March, 1985 (28.03.85), Full text; all drawings (Family: none)	7-9
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 107662/1985(Laid-open No. 018537/1987) (NGK Insulators, Ltd.), 04 February, 1987 (04.02.87), Full text; all drawings (Family: none)	7-9

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/065057

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2002-372218 A (NKK Corp.), 26 December, 2002 (26.12.02), Full text; all drawings (Family: none)	10-15
A	JP 11-248122 A (NGK Insulators, Ltd.), 14 September, 1999 (14.09.99), Full text; all drawings (Family: none)	10-15

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2003056822 A **[0009]**