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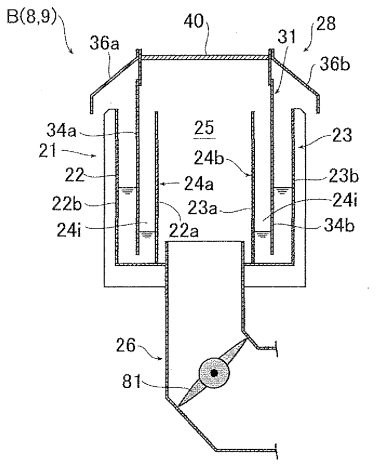
(54) AIR SUPPLY DEVICE AND HIGH TEMPERATURE PARTICULATE COOLING FACILITY EQUIPPED WITH SAME AIR SUPPLY DEVICE

(57) The present invention is to provide an air supply apparatus used for cooling hot grain/lump material such as sintered ore, a pellet and hot clinker, the air supply apparatus, and a cooling facility for hot grain/lump material provided with the air supply apparatus, which are superior in efficiency of use and excellent in maintenance performance. The upper part of the upper space of water seal chamber 24i and 24i on a movable air path 25 side is communicated with the upper part of the movable air path 25, which forms in a circle, and moreover, in each connection at each connection of the air duct 26, an air dumper 81 is provided which closes at a feed and discharge zone B and opensat a cooling zone C.

FIG.1



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Description

Technical Field

[0001] The present invention relates to an air supply apparatus for supplying air to a carriage which moves in a carriage path, and a cooling facility having the air supply apparatus for hot grain/lump material. The cooling facility loads hot sintered ore, pelletized ore and the like into the carriage and cools the same.

Background Art

[0002] A sintered ore cooling facility is one of cooling facilities for hot grain/lump material. The sintered ore cooling facility is formed so that sintered ore, which is a hot grain/lump material, is loaded into a carriage and the carriage is moved along a generally circular carriage path while cooling air is blown from a lower part of the carriage to an upper part in order to cool the sintered ore (refer to Patent References 1 to 3, for example).

[0003] In the sintered ore cooling facility, a carriage formed of plural connected pan carriages for loading the sintered ore thereinto is arranged between an inner circumferential sidewall and an outer circumferential sidewall, which extend along a circular path, so as to be freely movable. In a bottom part of the pan carriage, provided is a cool-air boxwhich the cooling air is supplied into. The cool-air box of each pan carriage is connected to a stationary circular duct through a connecting duct. The stationary circular duct is connected to a movable circular duct so that the movable circular duct is fitted into the stationary circular duct through a water sealing device so as to be freely movable. Further, a cooling air supply apparatus is arranged through the connecting air duct to supply cooling air.

[0004] The water sealing device has an inner circumferential circular water seal chamber and an outer circumferential circular water seal chamber, which are formed in the movable circular duct. The water sealing device comprises water sealing plates whose lower ends are sunk in sealing water in the inner circular water seal chamber and the outer circular water seal chamber, the water sealing plates being formed in the stationary circular duct.

[0005] Now, an example of the above-mentioned sintered ore cooling facility is described on the basis of Figs. 9 to 15.

[0006] In Fig. 10, a carriage 1 is provided along a circle-shaped carriage path A shown in Fig. 9 so as to be freely movable. The carriage 1 moves sintered ore from a material feed zone 8 to a material discharge zone 9 via a cooling zone C while cooling the sintered ore by means of cooling air. The material feed zone 8 and the material discharge zone 9 are collectively referred to as a feed and discharge zone B (or an atmospheric zone B), hereinafter. A waste heat recovery zone D is provided in a part of the cooling zone C in some cases, as shown in Fig. 15.

[0007] The carriage 1 comprises plural pan carriages 7, an inner circular sidewall 3 and an outer circular sidewall 4, as shown in Fig. 10. The plural pan carriages 7, linked each other, are provided on a pair of right and left guide rails 6a laid along a carriage path A through a guide wheels 5a so as to be freely movable. The inner circular sidewall 3 and the outer circular sidewall 4 are connected to each other by means of a connection beam 2 to be provided on the pan carriage 7 and include a side wheel 5b guided by a side rail 6b. Each of the pan carriages 7 is connected to the horizontal axis between the circular sidewalls 3 and 4 at its front part so as to be able to freely incline downward on the axis. In the material discharge zone 9, the guide rails 6a are bent downward with respect to a horizontal direction, as shown in Fig. 11, to incline the pan carriage 7 downward through the guide wheels 5a, so that the loaded sintered ore can be discharged downward.

[0008] Each of the pan carriages 7 comprises, as shown in Fig. 12, a pan carriage main body 11 including the guide wheels 5a on both sides, and a cool-air box 12 provided at a bottom part of the pan carriage main body 11. On the upper surface of the cool-air box 12, provided is an air-vent board 13 in which many air-vents are formed. Moreover, the cool-air box 12 is provided with openings, such as opening 14 under the inner circular sidewall 3. The inner circular sidewall 3 of the carriage 1 is provided, along the circular carriage path A shown in Fig. 9, with a movable circular duct 21 whose upper surface is open, as shown in Figs. 12 and 13. The cool-air box 12 of the pan carriage 7 and the movable circular duct 21 are communicated with each other through a connection air duct 26 connected to the opening 14. In the movable circular duct 21, an inner sidewall part 22 and an outer sidewall part 23 are formed into a double-wall structure by means of inner plates 22a and 23a and outer plates 22b and 23b, respectively, so that an inner circumferential circular water seal chamber 24a and an outer circumferential circular water seal chamber 24b are formed with upward opening, and , between the inner sidewall part 22 and the outer sidewall part 23 of the movable circular duct 21, and a circular movable air path 25 is formed.

[0009] A stationary circular duct 31 is provided so as to cover the upper part of the movable circular duct 21 all over and to form a circular stationary air path 37 communicating with the movable air path 25. In the stationary circular duct 31, a top cover plate 40 and both sidewall parts 32 and 33 are formed into the shape of "C" having an opening on its bottom side in cross section. The top cover plate 40 in the cooling zone C is connected to plural middle air ducts 38 from an arc-shaped air header 39 shown in Figs. 9 and 10 to supply the stationary air path 37 with cooling air. In the feed and discharge zone B (the material feed zone 8 and the material discharge zone 9), no middle air duct 38 is connected.

[0010] The stationary circular duct 31 is connected to

the movable circular duct 21 through a water sealing device 28, as shown in Figs. 12 and 13. The water sealing device 28 comprises the inner circumferential circular water seal chamber 24a, the outer circumferential circular water seal chamber 24b and water sealing plates 34a and 34b, which are suspended from the both sidewall parts 32 and 33 of the stationary circular duct 31 through a fitting flange 35 so that their lower ends sink under the surface of the water in the circular water seal chambers 24a and 24b on the both sides. Cover plates 36a and 36b are projectingly provided above and outside the respective water sealing plates 34a and 34b so as to cover the outside of the circular water seal chambers 24a and 24b. In Figs. 12 and 13, a numeric sign 24i denotes an upper space of the water seal chamber on a movable air path 25 side.

[0011] A dead plate 42 is mounted to the stationary circular duct 31 at a part other than the middle air duct 38 through an expansion joint 41. To the upper end parts of the inner plate 22a and the outer plate 23a, mounted are labyrinth sealing plates 43a and 43b whose top ends are close to the dead plate 42 to provide the labyrinth seal.

[0012] In an upper part of the carriage path A, provided is a stationary hood 51 formed from the inner and outer circumferential stationary plates 51a and 51b, which are provided at the upper end parts of the inner and outer circular sidewalls 23 and 24 through sealing devices, and a stationary top plate 51c for connecting the upper end parts of the inner and outer circumferential stationary plates 51a and 51b. An exhaust duct 52 is connected to a predetermined place of the stationary hood 51.

[0013] Furthermore, a partition plate 47 is provided for every connection air duct 26 (every pan carriage 7) in the movable air path 25 of the movable circular duct 21, as shown in Fag. 14. A labyrinth seal 43c is provided at the upper end of the partition plate 47 closely to the dead plate 42. This causes the movable air path 25 to be partitioned for every section having the connection air duct 26 in the circumferential direction (in a direction of rotation). On the other hand, the water sealing device 28 has no such partition plate. A waste heat recovery zone D may be provided in a part of the cooling zone C in some cases, as shown in Fig. 15. In the waste heat recovery zone D, heat is recovered from the hot air which is used for cooling sintered ore, and then, the air is sent to the stationary circular duct 31 again as the cooling air.

Patent Reference 1: JP-A-4-139380
Patent Reference 2: JP-A-6-257955
Patent Reference 3: JP-A-2000-310489

Disclosure of the Invention

Problems that the Invention is to Solve

[0014] The sintered ore cooling facility having the above-mentioned structure has the following problems.

[0015] The pressure of the movable air path 25 and the cool-air box 12 is the atmospheric pressure in the feed and discharge zone B. On the other hand, the pressure of the movable air path 25 in the cooling zone C is 300 to 500 mmAq (referred to as "differential pressure in cooling", hereinafter). The latter pressure is kept also in the upper space of the water seal chamber 24i by means of the dead plate 42 and the labyrinth sealing plates 43a, 43b and 43c due to the structure. The length of the dead plate 42, however, is 10 m or more, and therefore, it is difficult in view of technology of manufacture to completely seal the dead plate 42 having such long length. Moreover, combined with aging due to long-term use, generated is a gap between the labyrinth sealing plates 43a, 43b and 43c and the dead plate 42, so that the cooling air in the spaces of the water seal chambers 24i and 24i is leaked. This causes a lowering of cooling efficiency.

[0016] Further, the air as much as the air leakage leaked in the feed and discharge zone B flows into the upper spaces of the water seal chambers 24i and 24i from the movable air path 25 in the cooling zone C, and violently flows toward the feed and discharge zone B within the upper spaces of the water seal chambers 24i and 24i, due to the differential pressure of the cooling air. This causes, in the circular water seal chambers 24a and 24b in the feed and discharge zone B, wave in the sealing water, or the air leakage from the labyrinth sealing part to the movable air path 25, whichcauses water splash over the movable air path 25 together with sealing water in the circular water seal chambers 24a and 24b. The sealing water splashed and accumulated in the movable air path 25 will further splash about the pan carriage 7 to adhere to a wall surface in the feed and discharge zone B or in the pan carriage 7. And, the dust of the sintered ore adheres to the adhered drops of water and solidifies and grow to become the wet dust, which causes troubles such as corrosion or a clogging of the pan carriage 7, so that normal operation is disturbed. Furthermore, wave or splash of the sealing water deteriorates water-sealing performance. This lowers cooling efficiency.

[0017] In order to overcome the problems, levels of an upper end of the partition plate 47 and upper ends of the labyrinth sealing plates 43a, 43b and 43c should be adjusted in all over the zone to be controlled so that gaps between the dead plate 42 and the partition plate 47 become almost closed. It is difficult, however, to control the large number of labyrinth sealing plates 43a, 43b and 43c provided in the extremely long length of movable circular duct 21. The operations and aging of the facility further widen the gap and deteriorate the sealing performance, but it is impossible to rectify during the operation of the facility.

[0018] Patent Reference 3 has proposed that the upper spaces of the water seal chambers 24i and 24i on a movable air path 25 side are supplemented with compressed air (auxiliary air) in the feed and discharge zone B, as shown in Fig. 16, for the purpose of prevention of troubles caused by splashing of the sealing water. That is to say, an inlet side branch duct (an auxiliary air supply

means) 61a is connected to the middle air duct 38 provided at an end of an exit of the cooling zone C to branch off, a top end part of the inlet side branch duct 61a is connected to the top cover plate 40 of the stationary circular duct 31 provided at an entrance of the material discharge zone 9, an outlet side branch duct (an auxiliary air supply means) 61b is connected to the middle air duct 38 provided at an entrance end of the cooling zone C to branch off, and a top end part of the outlet side branch duct 61b is connected to the top cover plate 40 of the stationary circular duct 31 provided at an exit of the material feed zone 8. The auxiliary air supplied from the branch ducts 61a and 61b is supplied to the upper spaces of the inner water seal chambers 24i and 24i from a space between expansion joints 41, which are provided at intervals, through both side parts of the dead plate 42. This allows the auxiliary air supplemented from the branch ducts 61a and 61b to greatly decrease the speed of the air flowing in the upper spaces of the water seal chambers 24i and 24i toward the feed and discharge zone B. Accordingly, splashing of the sealing water can be prevented.

[0019] However, in the method proposed in Patent Reference 3, a large quantity of auxiliary air should be supplied as back pressure in the case where the air leakage is increased, resulting in an increase not only in air leakage quantity of the cooling air but also in troubles by loss of the balance caused by the air leakage.

[0020] In view of the above, the object of the present invention is to provide an air supply apparatus, which is used in cooling hot grain/lump material such as sintered ore and pelletized ore and a cooling facility for hot grain/lump material provided with the air supply apparatus, which are superior in efficiency of use and excellent in maintenance performance.

Means for Solving the Problems

[0021] In order to achieve the above object, the invention provides the following air supply apparatus and cooling facility for hot grain/lump material.

[1]. An air supply apparatus comprising:

plural carriages arranged along a circular carriage path so as to be movable;
a movable circular duct arranged along the carriage path and connected to each of the carriages through a connection air duct;
a stationary circular duct arranged along the carriage path and fitted into the movable circular duct through a water sealing device so as to be freely movable;
the movable circular duct and the stationary circular duct forming a circular air path;
the water sealing device comprising a circular water seal chamber arranged along the carriage path and a water sealing plate having a lower end part thereof sunk in sealing water in the circular water seal chamber; and
an atmospheric zone for stopping leakage of air in the carriage being provided in a predetermined position of the carriage path;
characterized in that:

an upper space of the circular water seal chamber on a circular air path side is communicated with the circular air path on a movable circular duct side,
the circular air path on the movable circular duct side communicates in a circumferential direction, and
a connection air duct closing mechanism for closing the connection air duct is provided in the atmospheric zone.

[2] The air supply apparatus according to [1],
characterized in that:
no partition plate for partitioning the movable air path on the movable circular duct side in the circumferential direction is provided in order to make the circular air path on the movable circular duct side communicate in the circumferential direction.

[3]. The air supply apparatus according to Claim 1,
characterized in that:
a notch part is provided in the partition plate for partitioning the circular air path on the movable circular duct side in the circumferential direction in order to make the circular air path on the movable circular duct side communicate in the circumferential direction.

[4]. The air supply apparatus according to any one of [1] to [3],
characterized in that:
the connection air duct closing mechanism is arranged so that the connection air duct is provided with an air damper, which is closed in the atmospheric zone, and is opened in zones other than the atmospheric zone.

[5]. The air supply apparatus according to any one of [1] to [3],
characterized in that:
the connection air duct closing mechanism is arranged so that the stationary circular duct in the atmospheric zone is provided with a connection air duct closing plate and an inlet of the connection air duct is closed by means of the connection air duct closing plate.

[6]. The air supply apparatus according to any one of [1] to [5],
characterized by:
comprising a foreign matter intrusion prevention plate for preventing a foreign matter from intruding into the circular water seal chamber from the circular air path,
the foreign matter intrusion prevention plate being

provided in an upper part on a circular air path side.

[7]. The air supply apparatus according to any one of [1] to [6], characterized by:
comprising a foreign matter collecting means for collecting a foreign matter in the circular water seal chamber.

[8]. A cooling facility for hot grain/lump material comprising:
the air supply apparatus according to any one of [1] to [7],
characterized in that air supplied to the carriage from the air supply apparatus is used to cool hot grain/lump material.

[9]. The cooling facility for hot grain/lump material according to [8],
characterized in that:

the carriage comprises:

a circular sidewall arranged inside and outside;
and plural pan carriages for loading the hot grain/lump material in a bottom part of the circular sidewall,
and
the air supplied to the carriage is the cooling air for cooling the hot grain/lump material loaded onto the pan carriage.

[10]. The cooling facility for hot grain/lump material according to [8] or [9],
characterized in that:
it comprises:

a side rail for guiding and holding the carriage in moving from a side of the carriage;
and side wheels,
and the side wheels have a structure so that the positions of the side wheels are adjustable even while the carriage is moving. dampdampdamp

Advantages of the Present Invention

[0022] The present invention provids an air supply apparatus, and a cooling facility for hot grain/lump material provided with the air supply apparatus, which are superior in efficiency of use and excellent in maintenance performance.

Brief Description of the Drawings

[0023]

Fig. 1 1 is an enlarged view of an integral part of the embodiment 1 in accordance with the invention.
Fig. 2 is an enlarged view of an integral part of the embodiment 1 in accordance with the invention.
Fig. 3 is an enlarged view of an integral part of the embodiment 1 in accordance with the invention.
Fig. 4 is an enlarged view of an integral part of the embodiment 1 in accordance with the invention.
Fig. 5 is an enlarged view of an integral part of the embodiment 2 in accordance with the invention.
Fig. 6 is an enlarged view of an integral part of the embodiment 2 in accordance with the invention.
Fig. 7 is an enlarged view of an integral part of the embodiment 3 in accordance with the invention.
Fig. 8 is an enlarged view of an integral part of the embodiment 3 in accordance with the invention.
Fig. 9 is an entire plan view of an example of a conventional sintered ore cooling facility.
Fig. 10 is a sectional view of an integral part of an example of a conventional sintered ore cooling facility.
Fig. 11 is a front view of an example of a conventional sintered ore cooling facility.
Fig. 12 illustrates a conventional sintered ore cooling facility.
Fig. 13 illustrates a conventional sintered ore cooling facility.
Fig. 14 illustrates a conventional sintered ore cooling facility.
Fig. 15 is an entire plan view of another example of a conventional sintered ore cooling facility.
Fig. 16 illustrates a conventional sintered ore cooling facility (Patent Reference 3).

Description of Reference Numerals and Signs

[0024]

A:	CARRIAGE PATH
B:	FEED AND DISCHARGE ZONE
C:	COOLING ZONE
D:	WASTE HEAT RECOVERY ZONE
1:	CARRIAGE
2:	CONNECTION BEAM
3:	INNER CIRCULAR SIDEWALL
4:	OUTER CIRCULAR SIDEWALL
5a:	GUIDE WHEEL
5b:	SIDE WHEEL
6a:	GUIDE RAIL
6b:	SIDE RAIL
7:	PAN CARRIAGE
8:	MATERIAL FEED ZONE
9:	MATERIAL DISCHARGE ZONE
11:	PAN CARRIAGE MAIN BODY
12:	COOL-AIR BOX
13:	AIR-VENT BOARD
14:	OPENING
21:	MOVABLE CIRCULAR DUCT
22:	INNER SIDEWALL PART
22a:	INNER PLATE OF INNER SIDEWALL PART
22b:	OUTER PLATE OF INNER SIDEWALL PART

23:	OUTER SIDEWALL PART
23a:	INNER PLATE OF OUTER SIDEWALL PART
23b:	OUTER PLATE OF OUTER SIDEWALL PART
24a:	INNER CIRCUMFERENTIAL CIRCULAR WATER SEAL CHAMBER
24b:	OUTER CIRCUMFERENTIAL CIRCULAR WATER SEAL CHAMBER
24i:	UPPER SPACE OF WATER SEAL CHAMBER
25:	MOVABLE AIR PATH
26:	CONNECTION AIR DUCT
28:	WATER SEALING DEVICE
31:	STATIONARY CIRCULAR DUCT
32, 33:	SIDEWALL PART
34a, 34b:	WATER SEALING PLATE
35:	FITTING FLANGE
36a, 36b:	COVER PLATE
37:	STATIONARY AIR PATH
38:	MIDDLE AIR DUCT
39:	ARC-SHAPED AIR HEADER
40:	TOP COVER PLATE
41:	EXPANSION JOINT
42:	DEAD PLATE
43a, 43b, 43c:	LABYRINTH SEALING PLATE
47:	PARTITION PLATE (CONVENTIONAL)
47a:	PARTITION PLATE (PRESENT INVENTION)
61a, 61b:	BRANCH DUCT
81:	AIR DUMPER
85:	FOREIGN MATTER INTRUSION PREVENTION PLATE
91:	DEAD PLATE
92a:	ROD AND DEAD PLATE HEIGHT INDICATOR
92b:	ROCK NUT
92c:	SEALING MECHANISM
93a:	SEALING RING
93b:	GROUND SEAL
94a:	ROD AND SEALING RING LEVEL METER
94b:	ROCK NUT
94c:	DISC SPRING
94d:	SEALING MECHANISM

Embodiments for Carrying out the Invention

[0025] Now, embodiments of the present invention are described as the examples of cooling facility of sintered ore, hot grain/lump material. In the description and the drawings, components having substantially the same function and structure are marked with the same reference numbers and signs for omitting redundancy.

Embodiment 1

[0026] A basic structure of a cooling facility of sintered ore in accordance with Embodiment 1 is the same as the structures shown in Figs. 9 to 11 mentioned above.

[0027] The cooling facility of the sintered ore in accordance with Embodiment 1 includes the carriage 1 provided along the circular carriage path A shown in Fig. 9 so as to be freely movable. The sintered ore is loaded into the carriage 1 and cooled by means of cooling air while it is carried from the material feed zone 8 to the material discharge zone 9 through the cooling zone C.

[0028] The carriage 1 comprises the plural pan carriages 7, the inner circular sidewall 3 and the outer circular sidewall 4, as shown in Fig. 10. The plural pan carriages 7, linked each other, are provided on the pair of right and left guide rails 6a laid along the carriage path A through the guide wheels 5a so as to be freely movable. The inner circular sidewall 3 and the outer circular sidewall 4 are connected to each other by means of the connection beam 2 and provided on the pan carriage 7. The inner circular sidewall 3 and the outer circular sidewall 4 include the side wheel 5b guided by the side rail 6b. Each of the pan carriages 7 is connected to the horizontal axis between the circular sidewalls 3 and 4 at its front part so as to be able to freely incline downward on the axis.

[0029] In the material discharge zone 9, the guide rails 6a are bent downward to incline the pan carriage 7 downward through the guide wheels 5a, so that the loaded sintered ore can be discharged downward.

[0030] Each of the pan carriages 7 comprises, as shown in Fig. 12, the pan carriage main body 11 including the guide wheels 5a on the both sides, and the cool-air box 12 provided at a bottom part of the pan carriage main body 11. On the upper surface of the cool-air box 12, provided is the air-vent board 13 with which free ventilation is achieved. Moreover, the cool-air box 12 is provided with the openings such as the opening 14 under the inner circular sidewall 3. The inner circular sidewall 3 is provided along the carriage path A with the movable circular duct 21 whose upper surface is open. The cool-air box 12 of the pan carriage 7 and the movable circular duct 21 are communicated with each other through the connection air duct 26 connected to the opening 14. In the movable circular duct 21, an inner sidewall part 22 and an outer sidewall part 23 are formed into a double-wall structure by means of inner plates 22a and 23a and outer plates 22b and 23b, respectively, so that the inner circumferential circular water seal chamber 24a and the outer circumferential circular water seal chamber 24b are formed with upward opening, between the inner sidewall part 22 and the outer sidewall part 23 of the movable circular duct 21, and a circular movable air path 25 is formed.

[0031] The stationary circular duct 31 is provided so as to cover an upper part of the movable circular duct 21 all over and to form a circular stationary air path 37 communicating with the movable air path 25. In the stationary

circular duct 31, the top cover plate 40 and the both sidewall parts 32 and 33 are formed into the shape of "C" having an opening on its bottom side in cross section. The top cover plate 40 in the cooling zone C is connected to the plural middle air ducts 38 from the arc-shaped air header 39 to supply the stationary air path 37 with cooling air. In the feed and discharge zone B (the material feed zone 8 and the material discharge zone 9), no middle air duct 38 is connected.

[0032] The stationary circular duct 31 is connected to the movable circular duct 21 through the water sealing device 28, as shown in Figs. 12 and 13. The water sealing device 28 comprises the inner circumferential circular water seal chamber 24a, the outer circumferential circular water seal chamber 24b and the water sealing plates 34a and 34b, which are suspended from the both sidewall parts 32 and 33 of the stationary circular duct 31 through the fitting flange 35 so that their lower ends sink under the surface of the water in the circular water seal chambers 24a and 24b on the both sides. The cover plates 36a and 36b are cover plates projectingly provided above and outside the water sealing plates 34a and 34b so as to cover the outside of the circular water seal chambers 24a and 24b.

[0033] In an upper part of the carriage path A, provided is a stationary hood 51 formed from the inner and outer circumferential stationary plates 51a and 51b, which are provided at the upper end parts of the inner and outer circular sidewalls 23 and 24 through sealing devices, and a stationary top plate 51c for connecting the upper end parts of the inner and outer circumferential stationary plates 51a and 51b. An exhaust duct 52 is connected to a predetermined place of the stationary hood 51.

[0034] A waste heat recovery zone D may be provided in a part of the cooling zone C in Embodiment 1, as shown in Fig. 15. In the waste heat recovery zone D, heat is recovered from the hot air which is used for cooling sintered ore, and then, the air is sent to the stationary circular duct 31 again for cooling.

[0035] Embodiment 1 has the following structure additionally to the above.

(A) The labyrinth sealing part (the dead plate 42 and the labyrinth sealing plates 43a and 43b), which has been conventionally provided between the upper spaces of the water seal chambers 24i and 24i on the movable air path 25 side and the movable air path 25, is not provided and an upper part of the upper spaces of the water seal chambers 24i and 24i on the movable air path 25 side and an upper part of the movable air path 25 is arranged to be communicated with each other to enable the air to circulate therethrough, as shown in Figs. 1 and 2. Figs. 1 and 2 are sectional views of an integral part of Embodiment 1 in accordance with the invention.
(B) The partition plate 47 and the labyrinth sealing plate 43c, which have been conventionally provided in the movable air path 25, are not provided and the movable air path 25 is arranged to communicate in the circumferential direction, as shown in Fig. 3.
(C) An air damper 81 is provided in each of the connection air ducts 26.

[0036] The air damper 81 is in a closed state in the material feed zone B to close the connection air duct 26, as shown in Fig. 1, so as to prevent the cooling air from flowing out. Moreover, the air damper 81 is in an open state in the cooling zone C to open the connection air duct 26, as shown in Fig. 2, so as to supply the cool-air box 12 with the cooling air. The air damper 81 is opened and closed automatically under mechanical or electrical control. A butterfly type air damper is used for the air damper 81 in Embodiment 1. The invention, however, is not limited to the above. It is possible to use a swing type air damper or another type air damper.

[0037] Such a structure causes the movable air path 25 and the upper spaces of the water seal chambers 24i and 24i to form an entirely communicated circular duct having no partition in the circumferential direction and an operation of the air damper 81 to properly prevent air leakage in the feed and discharge zone B. Accordingly, no difference in pressure between the feed and discharge zone B and the cooling zone C is made, so that no air flows in the movable air path 25 from the cooling zone C toward the feed and discharge zone B.

[0038] Further, the movable air path 25 and the upper spaces of the water seal chambers 24i and 24i are formed into an entirely communicated circular duct having no partition in the circumferential direction while the pressure in the movable air path 25 and the upper spaces of the water seal chambers 24i and 24i is the same in the circumferential direction.

[0039] Furthermore, no difference in pressure between the movable air path 25 and the upper spaces of the water seal chambers 24i and 24i in the circumferential direction causes no air flow to the circumferential direction in the movable air path 25 and the upper spaces of the water seal chambers 24i and 24i. Accordingly, no air flow occurs in the feed and discharge zone B from the upper spaces of the water seal chambers 24i and 24i toward the movable air path 25.

[0040] This results in prevention of a trouble such as corrosion of the pan carriage 7 and the like and decrease in cooling efficiency due to scatter of sealing water from the circular water seal chambers 24a and 24b. Moreover, the air damper 81 provided in the connection air duct 26 is easy to be maintained and controlled more than the conventional labyrinth sealing part (the dead plate 42 and the labyrinth sealing plates 43a, 43b and 43c), so that performance in maintenance is excellent. In addition, the middle air duct 38 can be provided also on an entrance side and an exit side of the feed and discharge zone B and on an exit side of the waste heat recovery zone D although it cannot be provided in the above places conventionally due to the dead plate 42. This allows the cooling performance to be improved while the scale of the

system is kept as it is.

[0041] In the waste heat recovery zone D, the heat recovery is performed for the air having high temperature due to cooling of sintered ore, and then, the air is fed again as the cooling air. This often causes a foreign matter such as dust of the sintered ore to be intruded into the cooling air. Intrusion and accumulation of such a foreign matter in the circular water seal chambers 24a and 24b causes deterioration of the water sealing performance due to damage of the water sealing plates 34a and 34b and the like. Accordingly, it is preferable to provide a foreign matter intrusion prevention plate (an obstacle plate) 85, which is for preventing the foreign matter intruded into the cooling air from intruding into the circular water seal chambers 24a and 24b from a space between upper ends of the inner plates 22a and 23a of the circular water seal chambers 24a and 24b and the fitting flange 35 through the upper spaces of the water seal chambers 24i and 24i, in upper parts of the upper spaces of the water seal chambers 24i and 24i, as shown in Fig. 4. The foreign matter intrusion prevention plate 85 can be similarly provided in a place other than the waste heat recovery zone D, of course, in the case where a foreign matter is intruded into the cooling air to be supplied.

[0042] Further, in the case where a foreign matter such as dust is intruded into the circular water seal chambers 24a and 24b, and thereby, piled therein, preferably provided is a sucking device (not shown) for sucking and collecting the foreign matter from the circular water seal chambers 24a and 24b. The sucking device may be provided in the feed and discharge zone B where a room is left.

[0043] Further, in the case of an improper positional relation between the side rail 6b and the side wheel 5b, which are provided for guiding and holding the running pan carriage 7 from the side, the pan carriage 7 runs off the circle. This causes the movable circular duct 21 connected to the pan carriage 7 through the connection air duct 26 to also run off in rotation. As a result, a great difference in relative relation occurs between the circular water seal chambers 24a and 24b provided on the movable circular duct 21 side and the water sealing plates 34a and 34b provided on the stationary circular duct 31 side, so that the water sealing performance is lowered. In order to prevent the lowering, a gap between the side rail 6b and the side wheel 5b, which causes running off, should be adjusted. The gap, however, can be only adjusted in a standstill state because of a conventional stationary type for liner adjustment. Accordingly, adjustment simultaneous with confirmation of a rotational state cannot be carried out during running, so that accurate adjustment has been difficult.

[0044] In view of the above, the side wheel 5b is arranged so that it can be adjusted by means of a screw jack in Embodiment 1. This allows a position of the side wheel 5b to be adjusted even during running, and thereby, rotation of the circular water seal chambers 24a and 24b to be kept at a high degree of circle. The water sealing performance is thus prevented from being lowered.

Embodiment 2

[0045] Embodiment 2 is basically similar in structure to Embodiment 1 mentioned above. In Embodiment 1, however, the movable air path 25 is made to communicate in the circumferential direction and the partition plate having been conventionally provided in the movable air path 25 is removed. On the other hand, a part of the conventional partition plate 47 is notched so that a function of guiding the cooling air would be left while the movable air path 25 would be made to communicate in the circumferential direction in Embodiment 2.

[0046] That is to say, in Embodiment 2, a partition plate 47a formed by notching an upper part of the conventional partition plate 47 is provided so that the movable air path 25 would communicate in the circumferential direction, as shown in Figs. 5 and 6, which are sectional views of an integral part of Embodiment 2.

[0047] The upper part of the conventional partition plate 47 is notched in Figs. 5 and 6. A notched hole, however, may be formed in a part of the conventional partition plate 47.

Embodiment 3

[0048] Embodiment 3 basically has a structure similar to that of Embodiment 1 mentioned above. The air damper 81, however, is provided in the connection air duct 26 as a means for closing the connection air duct 26 in the feed and discharge zone B in Embodiment 1 while a connection air duct closing plate is mounted to the stationary circular duct 31 in the feed and discharge zone B so as to close an inlet of the connection air duct 26 by means of the connection air duct closing plate in Embodiment 3.

[0049] That is to say, in Embodiment 3, a connection air duct closing plate (a dead plate) 91 is mounted to the lower end of a rod and dead plate height indicator 92a, which is fixed to the top cover plate 40 of the stationary circular duct 31 by means of a rock nut 92b, in the feed and discharge zone B so as to close the inlet of the connection air duct 26 by means of the dead plate 91, as shown in Figs. 7 and 8. Figs. 7 and 8 are sectional views of integral parts of Embodiment 3. The inlet of the connection air duct 26 is arranged to be sealed with a sealing ring 93a and a ground seal 93b, which are mounted to the upper end of a rod and sealing ring level meter 94a fixed to the connection air duct 26 by means of a rock nut 94b and disc spring 94c, in order to improve an effect of prevention of air leakage in closing the inlet of the connection air duct 26 by means of the dead plate 91.

[0050] 92c in Fig. 7 denotes a sealing mechanism provided between the rod 92a and the top cover plate 40. 94d in Fig. 7 denotes a sealing mechanism provided between the rod 93a and the connection air duct 26.

[0051] A position in height of the dead plate 91 can be adjusted to a proper position by means of the rod 92a

and the lock nut 92b. A position in height of the sealing ring 93a can be adjusted to a proper position by means of the rod 94a and the lock nut 94b.

[0052] Moreover, an inlet guide roll 95 is provided at a forward top end of the dead plate 91 toward the feed and discharge zone B, as shown in Fig. 8. This allows the dead plate 91 to smoothly close the inlet of the connection air duct 26 as the connection air duct 26 moves.

[0053] As a result, forming a complete communication circular duct with no partition plate in the movable air chamber 25 allows an effect similar to that of Embodiment 1 to be achieved even in Embodiment 3.

[0054] In Embodiments 1 to 3, provided is the waste heat recovery zone D. It goes without saying, however, that the invention is also applicable in the case where no waste heat recovery zone D is provided.

[0055] Further, the stationary circular duct 31 is arranged to cover the movable circular duct 21 from the upper side in Embodiments 1 to 3. The invention, however, is also applicable in the case where the movable circular duct 21 covers the stationary circular duct 31 from the upper side as described in Patent Reference 1.

[0056] Furthermore, preventing deterioration of the water sealing function by means of a bracket structure in which a position of the side wheel 5b can be adjusted by means of a screw jack is extremely effective in Embodiments 1 to 3 in which there is no sealing function of the labyrinth sealing part. The bracket structure in which a position of the side wheel 5b can be adjusted can be applied to a sintered ore cooling facility comprising a similar water sealing mechanism (Patent References 1 to 3, for example) other than Embodiments 1 to 3.

[0057] In the above description, exemplified is a cooling facility for sintered ore. The invention, however, may be also applicable to a cooling facility for another hot grain/lump material such as a pellet and a hot clinker.

[0058] Preferred embodiments of the invention have been described above with reference to the attached drawings. The invention, however, is not limited to the embodiments. It is clear that a person skilled in the art can conceive a variety of modifications and revisions within a range of the technical idea described in Claims. The modifications and revisions are also included in the technical range of the invention, naturally.

Claims

1. An air supply apparatus comprising:

plural carriages arranged along a circular carriage path so as to be movable;
a movable circular duct arranged along the carriage path and connected to each of the carriages through a connection air duct;
a stationary circular duct arranged along the carriage path and fitted into the movable circular duct through a water sealing device so as to be freely movable;
the movable circular duct and the stationary circular duct forming a circular air path;
the water sealing device comprising a circular water seal chamber arranged along the carriage path and a water sealing plate having a lower end part thereof sunk in sealing water in the circular water seal chamber; and
an atmospheric zone for stopping leakage of air in the carriage being provided in a predetermined position of the carriage path;
characterized in that
an upper space of the circular water seal chamber on a circular air path side is communicated with the circular air path on a movable circular duct side,
the circular air path on the movable circular duct side communicates in a circumferential direction, and
a connection air duct closing mechanism for closing the connection air duct is provided in the atmospheric zone.

2. The air supply apparatus according to Claim 1, **characterized in that** no partition plate for partitioning the movable air path on the movable circular duct side in the circumferential direction is provided in order to make the circular air path on the movable circular duct side communicate in the circumferential direction.

3. The air supply apparatus according to Claim 1, **characterized in that** a notch part is provided in the partition plate for partitioning the circular air path on the movable circular duct side in the circumferential direction in order to make the circular air path on the movable circular duct side communicate in the circumferential direction.

4. The air supply apparatus according to any one of Claims 1 to 3, **characterized in that** the connection air duct closing mechanism is arranged so that the connection air duct is provided with an air damper, the air damper is closed in the atmospheric zone, and the air damper is opened in zones other than the atmospheric zone.

5. The air supply apparatus according to any one of Claims 1 to 3, **characterised in that** the connection air duct closing mechanism is arranged so that the stationary circular duct in the atmospheric zone is provided with a connection air duct closing plate and an inlet of the connection air duct is closed by means of the connection air duct closing plate.

6. The air supply apparatus according to any one of Claims 1 to 5, **characterized by** comprising a foreign matter intrusion prevention plate for preventing a for-

eign matter from intruding into the circular water seal chamber from the circular air path, the foreign matter intrusion prevention plate being provided in an upper part on a circular air path side.

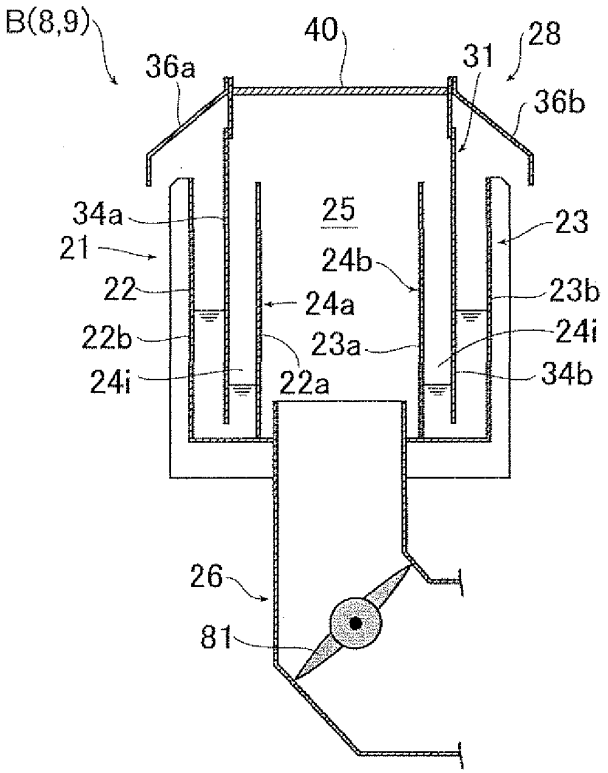
7. The air supply apparatus according to any one of Claims 1 to 6, **characterized by** comprising a foreign matter collecting means for collecting a foreign matter in the circular water seal chamber.

8. A cooling facility for hot grain/lump material comprising the air supply apparatus according to any one of Claims 1 to 7, **characterized in that** air supplied to the carriage from the air supply apparatus is used to cool hot grain/lump material.

9. The cooling facility for hot grain/lump material according to Claim 8, **characterized in that**
the carriage comprises: a circular sidewall arranged inside and outside; and plural pan carriages for loading the hot grain/lump material in a bottom part of the circular sidewall,
and
the air supplied to the carriage is cooling air for cooling the hot grain/lump material loaded onto the pan carriage.

10. The cooling facility for hot grain/lump material according to Claim 8 or 9, **characterized by** comprising: a side rail for guiding and holding the carriage in moving from a side of the carriage; and a side wheel,
the side wheel having a structure that a position of the side wheel is adjustable even during movement of the carriage.

FIG.1


B(8,9)
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28
31
36a
36b
34a
25
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21
24b
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23b
24a
22b
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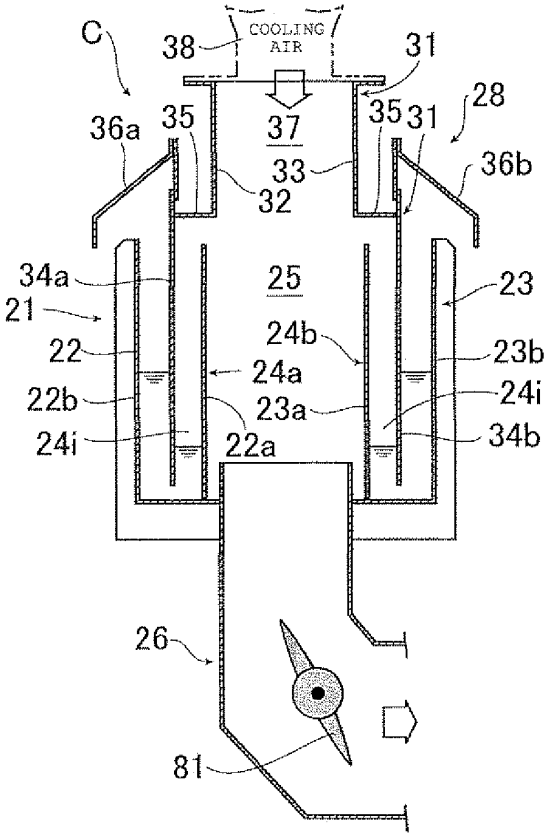
24i
24i
22a
34b
26
81

FIG.2


C
COOLING AIR
38
31
28
36a
35
37
35
31
36b
33
32
34a
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23
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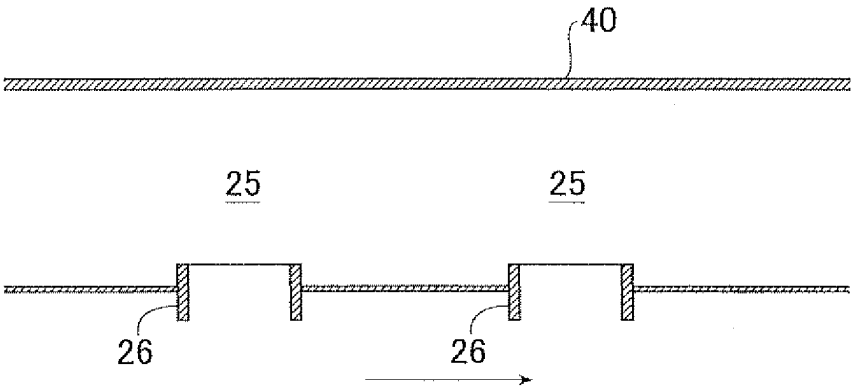
22b
23a
24i
22a
34b
26
81

FIG.3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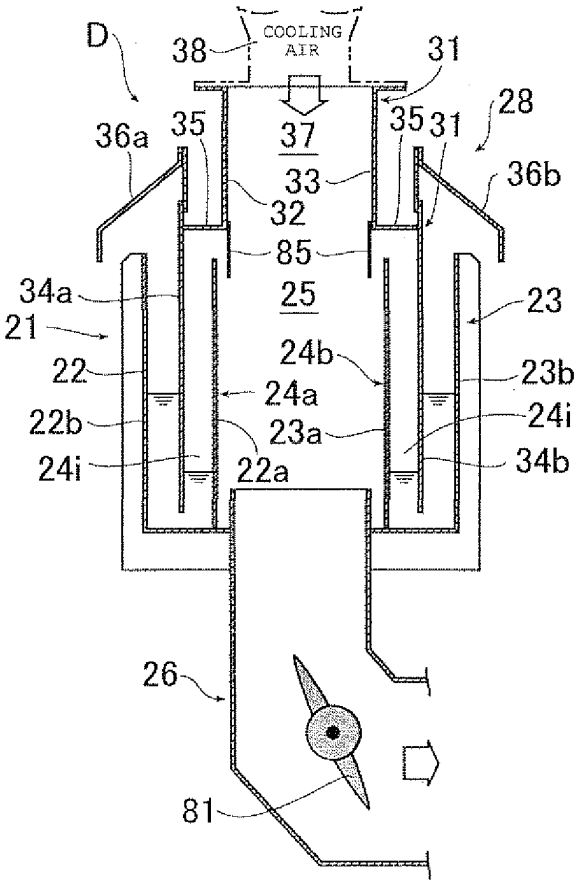
26

FIG.4


D
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31
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36a
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37
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36b
33
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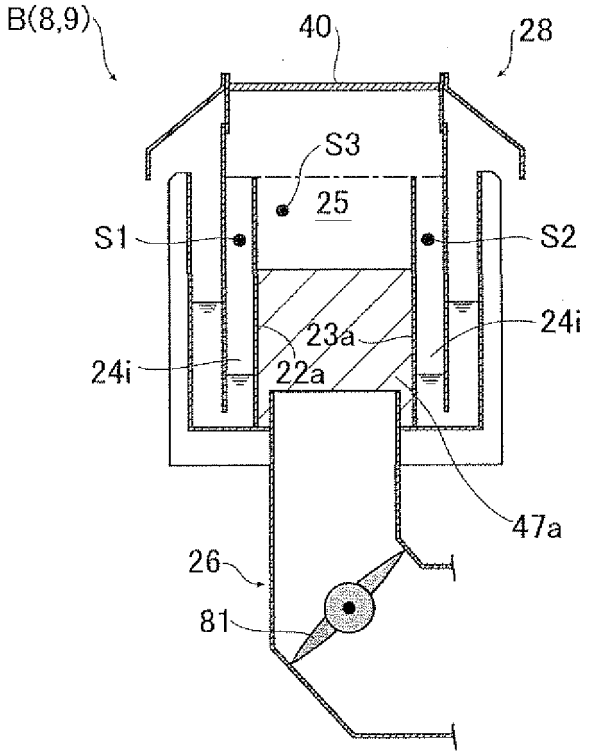
24i
22a
34b
26
81

FIG. 5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S3
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S1
S2
24i
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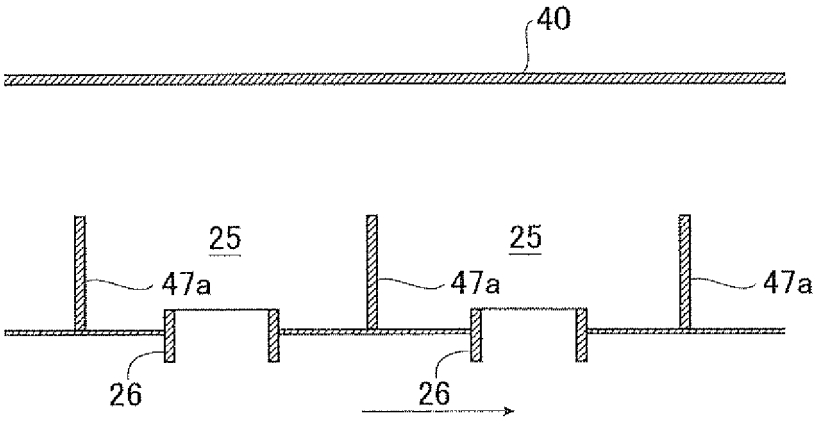
FIG. 6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47a
47a
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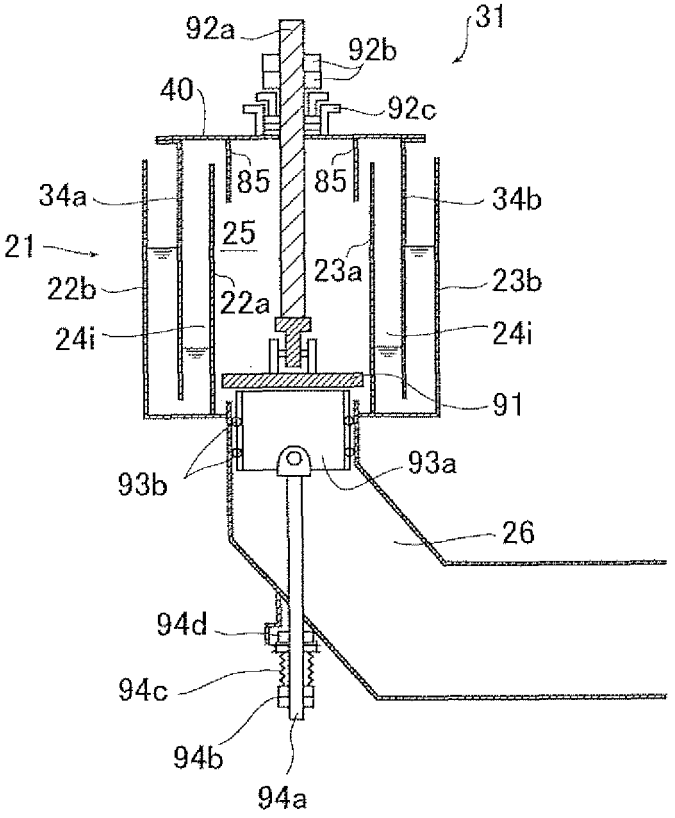
26
26

FIG. 7


92a
92b
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92c
85
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34b
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21
23a
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22b
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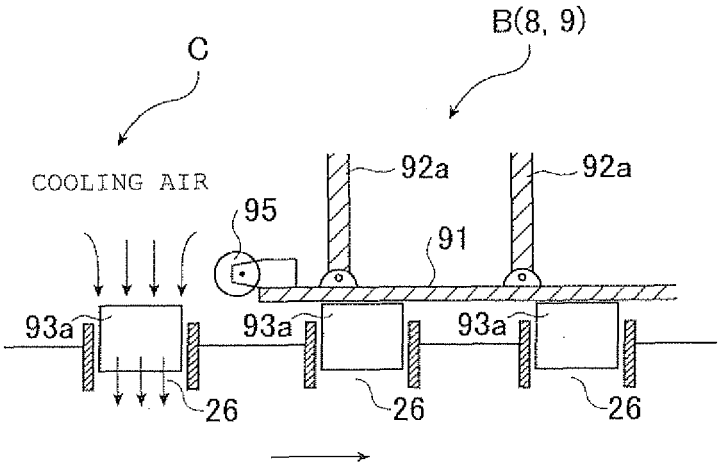
24i
24i
91
93b
93a
26
94d
94c
94b
94a

FIG. 8


C
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COOLING AIR
92a
92a
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93a
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93a
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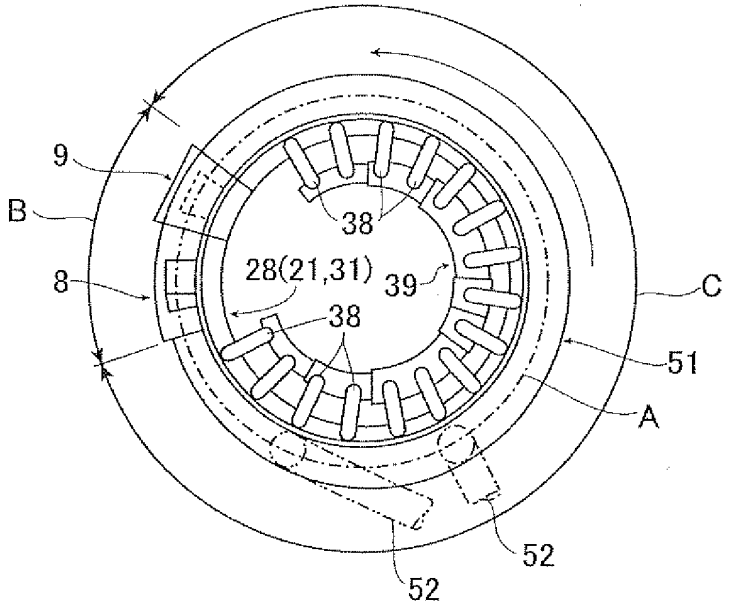
26
26

FIG.9



A: CARRIAGE PATH
B: FEED AND DISCHARGE ZONE
(8: MATERIAL FEED ZONE, 9: MATERIAL DISCHARGE ZONE)
C: COOLING ZONE

FIG.10

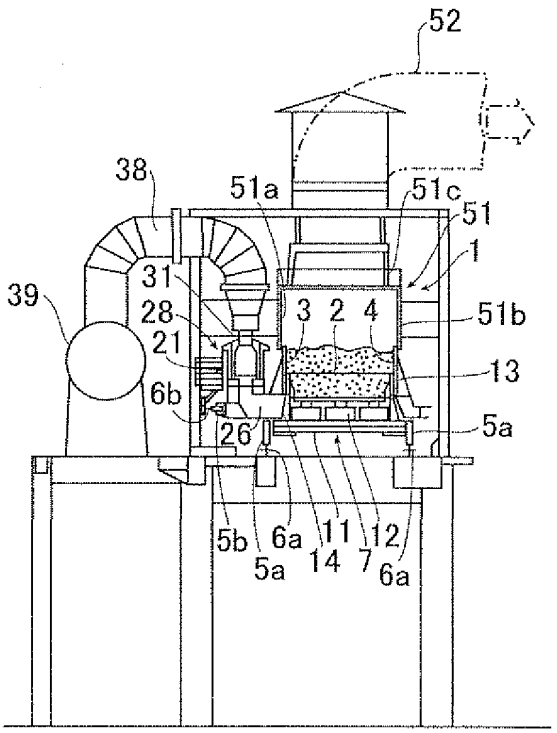
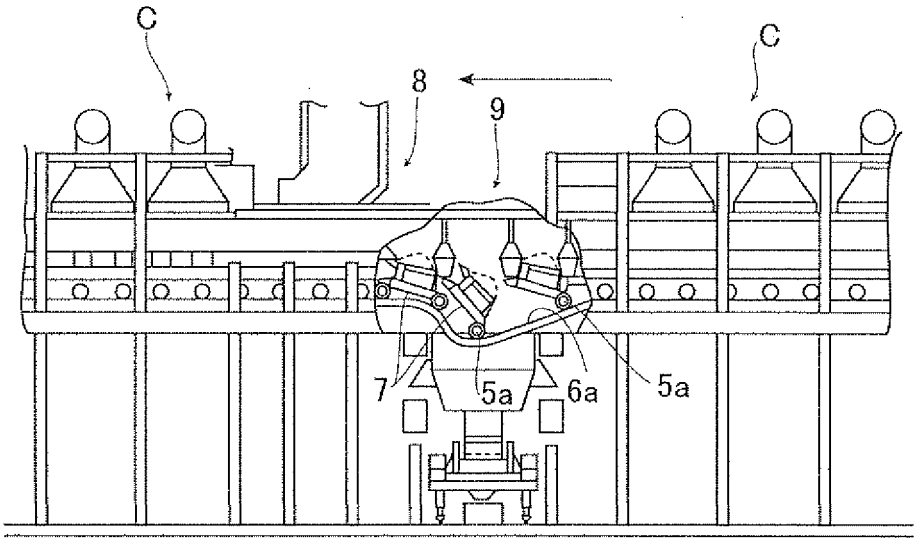


FIG.11


C
C
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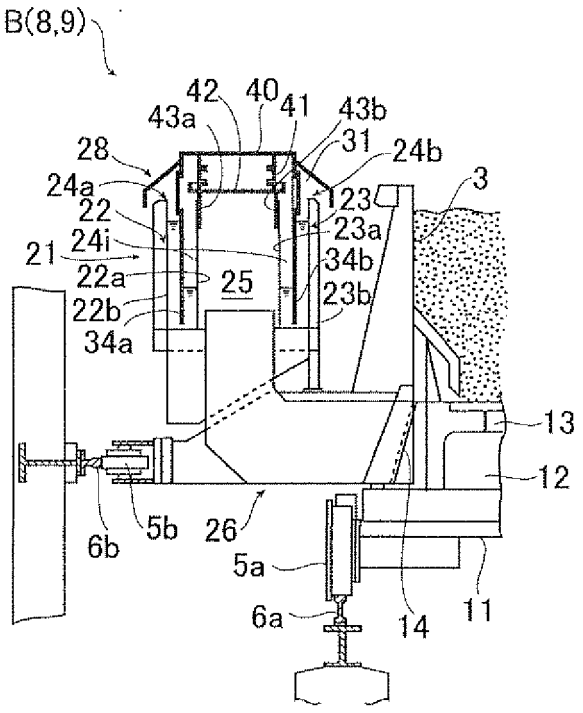
9
7
5a
6a
5a

FIG.12


B(8,9)
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43b
43a
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24b
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24a
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23
3
23a
24i
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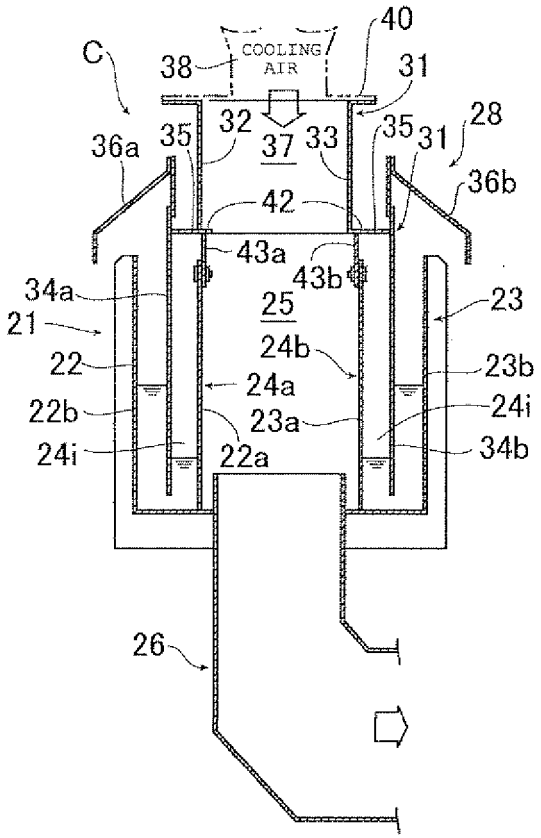
5b
26
6b
5a
6a
14
11

FIG.13


C
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28
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36b
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43a
43b
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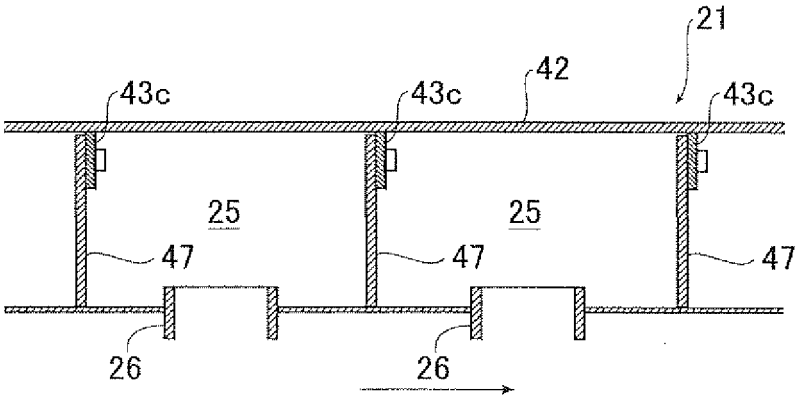
24i
24i
22a
34b
26

FIG.14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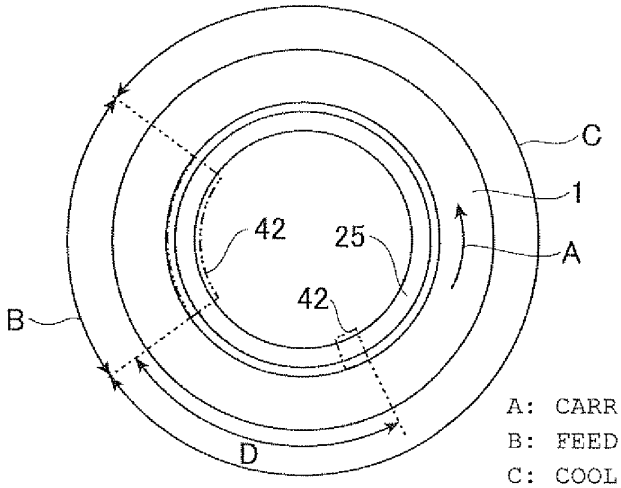
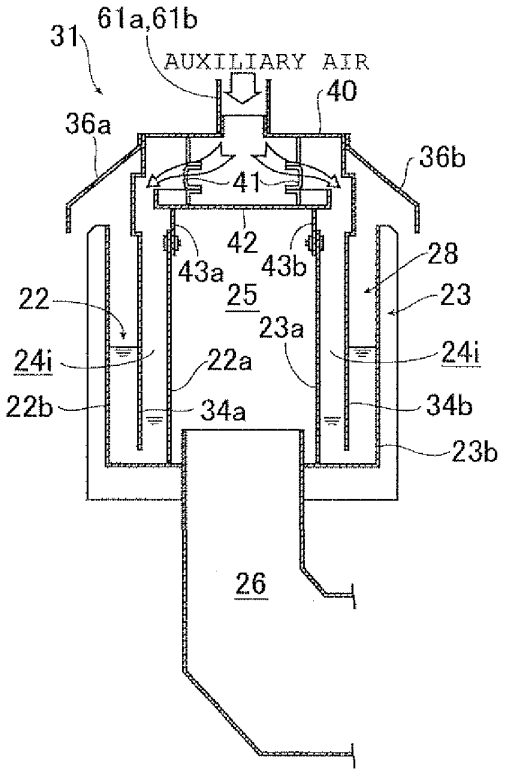
26

FIG.15



A: CARRIAGE PATH
B: FEED AND DISCHARGE ZONE
C: COOLING ZONE
D: WASTE HEAT RECOVERY ZONE

FIG.16



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/060816

A. CLASSIFICATION OF SUBJECT MATTER
F27B21/00(2006.01)i, C22B1/26(2006.01)i, F27D15/02(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)
F27B21/00, C22B1/26, F27D15/02

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 1996-2009
Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

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	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 102478/1990(Laid-open No. 061296/1992) (Hitachi Zosen Corp.), 26 May, 1992 (26.05.92), Page 11, lines 2 to 14; page 12, lines 5 to 12; page 12, 3rd line from the bottom to page 13, line 7; Figs. 1 to 4 (Family: none)	1-10

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

* Special categories of cited documents:
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"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)
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 August, 2009 (19.08.09)	01 September, 2009 (01.09.09)
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/JP2009/060816

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 04-139380 A (Hitachi Zosen Corp.), 13 May, 1992 (13.05.92), Page 5, lower right column, lines 5 to 16; Figs. 1 to 3, 6 & US 5148687 A & DE 4122751 A & DE 4122751 A1 & AT 220293 A & AT 196091 A & IT 1249698 B & BR 9104178 A & PH 31357 A & CN 1060351 A	1-10
A	JP 06-257955 A (NKK Corp., Hitachi Zosen Corp.), 16 September, 1994 (16.09.94), Par. No. [0022]; Figs. 1 to 3 (Family: none)	1-10
A	JP 2000-310489 A (Hitachi Zosen Corp.), 07 November, 2000 (07.11.00), Par. Nos. [0023], [0025] to [0027]; Figs. 1 to 6 & TW 429302 B & KR 10-2000-0056967 A	1-10
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 102480/1990(Laid-open No. 061298/1992) (Hitachi Zosen Corp.), 26 May, 1992 (26.05.92), Fig. 2 & US 5148687 A & DE 4122751 A & DE 4122751 A1 & AT 220293 A & AT 196091 A & IT 1249698 B & BR 9104178 A & PH 31357 A & CN 1060351 A	1-10
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 174531/1983(Laid-open No. 081311/1985) (Mitsubishi Heavy Industries, Ltd., Ryomei Giken Kabushiki Kaisha), 05 June, 1985 (05.06.85), Page 5, lines 5 to 12; Fig. 2 (Family: none)	1-10

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 4139380 A **[0013]**
- JP 6257955 A **[0013]**
- JP 2000310489 A **[0013]**