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Grewer et al.

[11] **3,799,367**

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[54] **DISCHARGE SYSTEM FOR A SHAFT-TYPE FURNACE**

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[52] **U.S. Cl.** ..... **214/23**, 198/67, 214/17 B, 214/18 V, 214/41

[51] **Int. Cl.** **F27b 1/20**

[58] **Field of Search** ..... 214/18 R, 18 V, 23, 24, 214/17 B; 266/27

[56] **References Cited**

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Primary Examiner—Robert G. Sheridan

Attorney, Agent, or Firm—Karl F. Ross; Herbert Dubno

[57] **ABSTRACT**

A discharge system for a shaft-type furnace comprising a table supporting a column of furnace charge at the base of the shaft-type furnace for the direct reduction of iron ore to produce sponge iron, a discharge device on this table being horizontally reciprocable to carry hot sponge iron alternately to one side and the opposite side of the table and expells the sponge iron into discharge openings provided at the opposite sides of the table. The sponge iron cascades through downwardly extending shafts or chutes of each opening, which, in turn, open downwardly into respective intermediate bins, the latter opening into dispensing hoppers which communicate via compensating connectors (e.g. bellows), with transport vessels or the like for the storage or further treatment of the sponge-iron. The transport vessel is provided with a system for flushing the interior with a nonoxidizing gas and the discharge hopper or bellows, is provided an outlet for the flushing gas. Between the bin and the hopper and between the discharge shaft and the bin, flap-type closures are provided to hermetically seal the respective openings.

12 Claims, 9 Drawing Figures

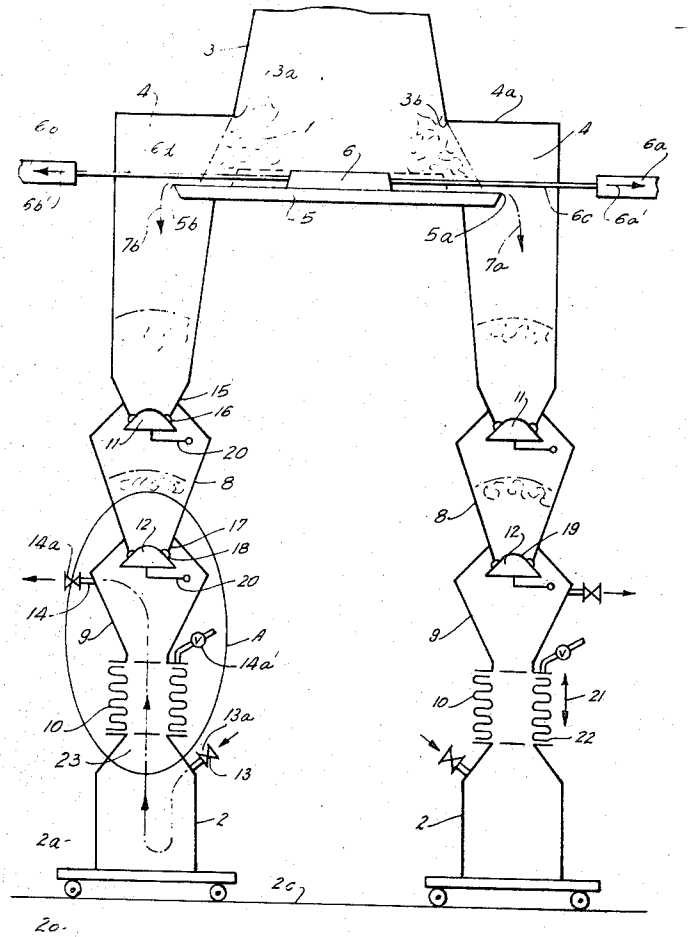
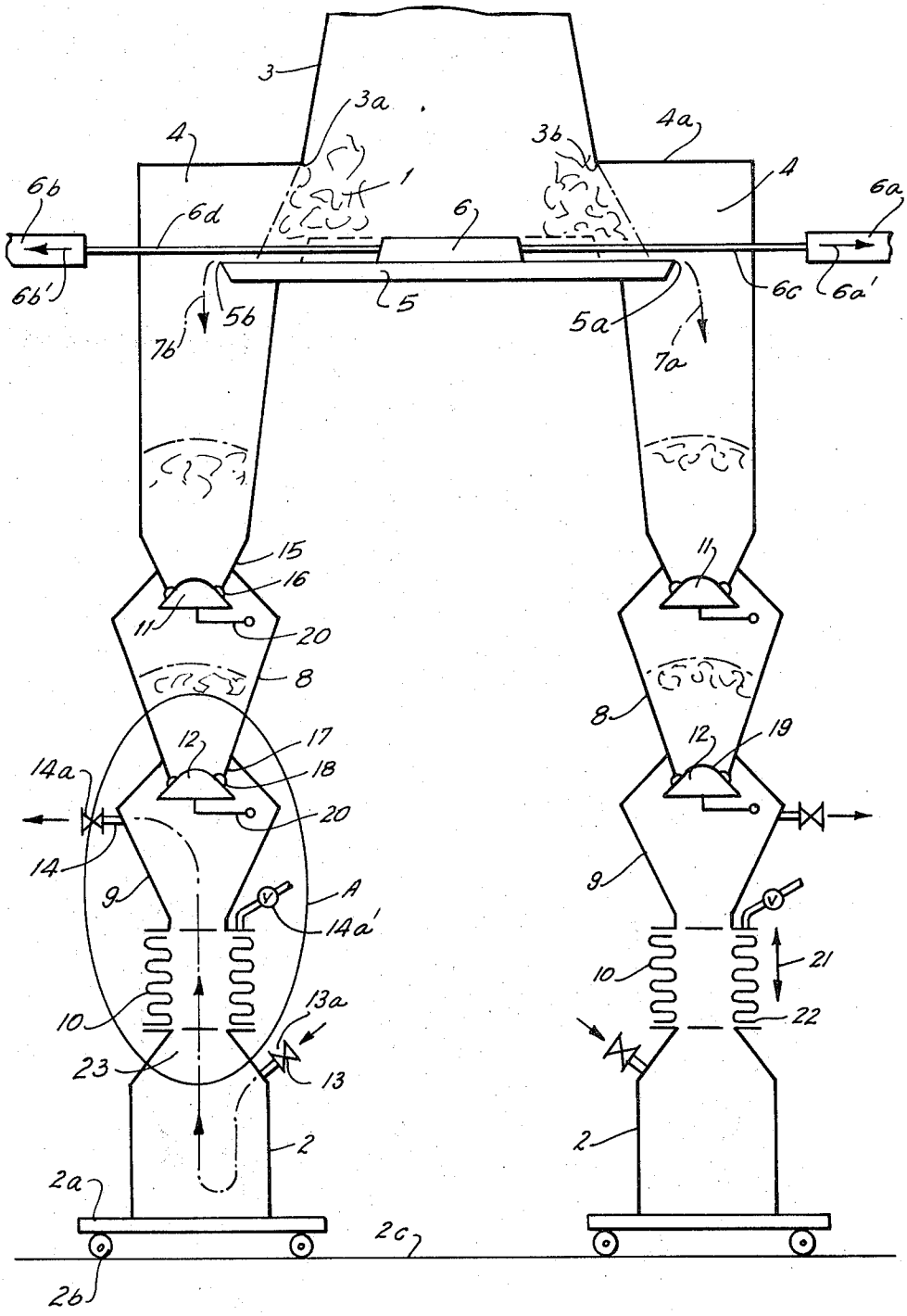


FIG. 1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3a
3b
4
4a
1
6
6a
6b
6b'
6d
6c
6a'
5
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5b
7a
7b
15
16
11
20
8
12
17
18
19
14a
14
9
A
14a'
10
13a
13
23
2
2a
2b
2c
21
22

FIG. 2

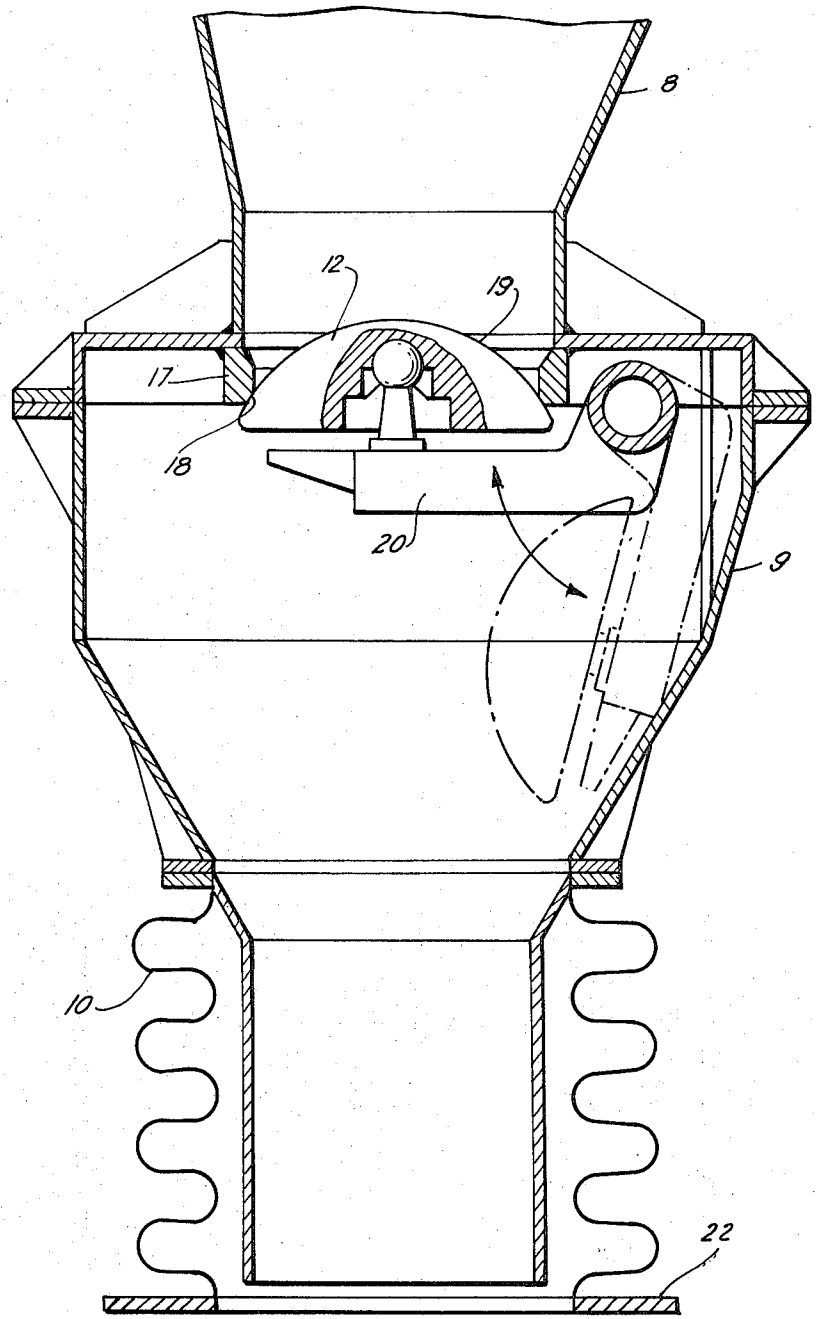
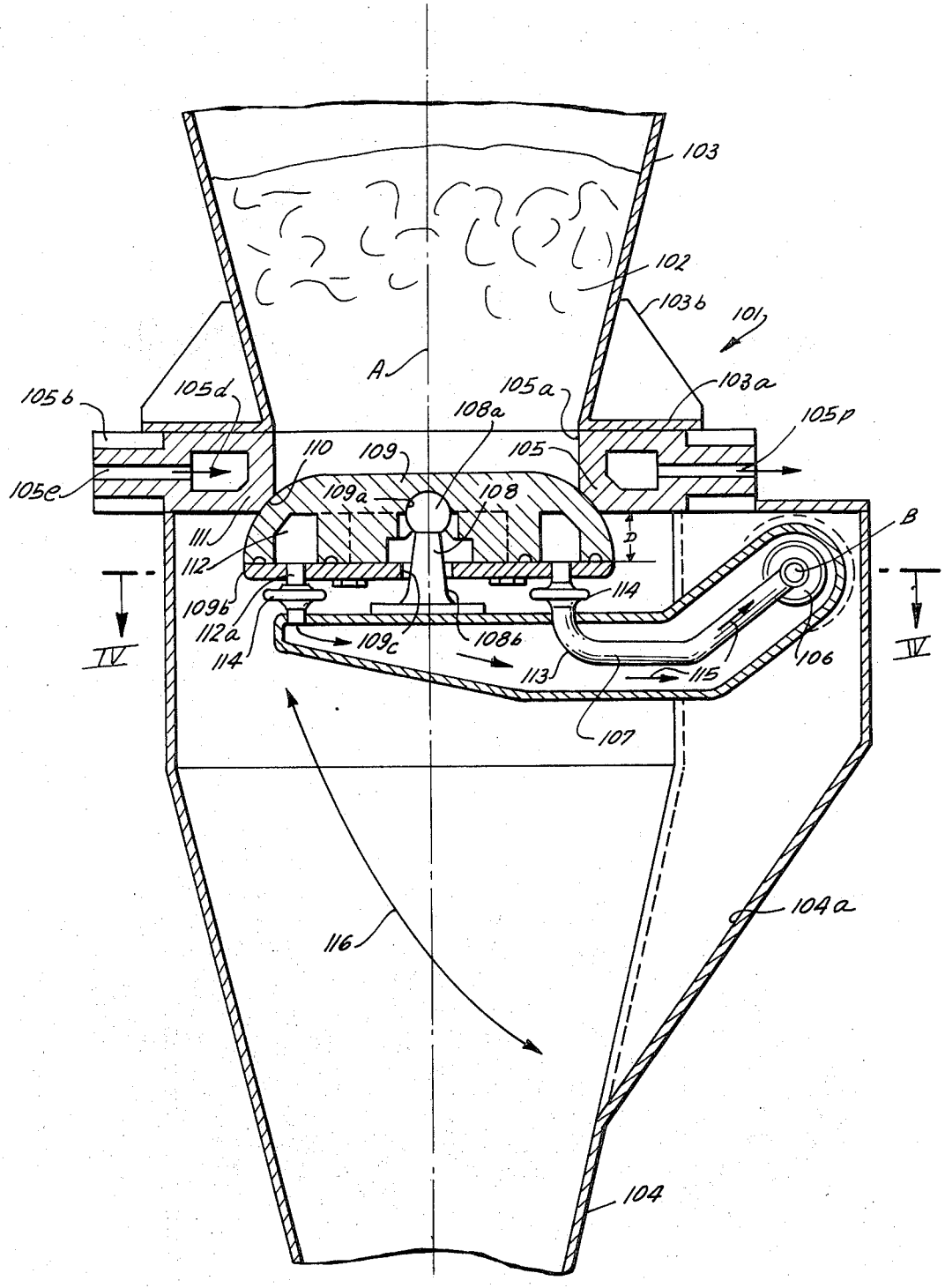


FIG. 3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102
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101
A
105b
105d
105a
103a
105c
105p
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105
109a
108
111
112
D
B
109b
112a
114
109c
108b
113
115
106
IV
IV
107
116
104a
104

FIG. 4

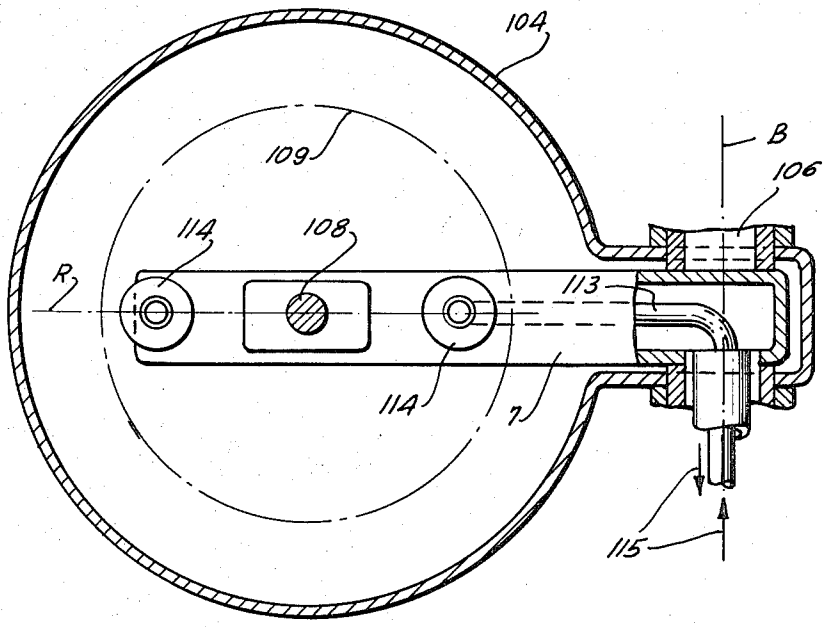


FIG. 5

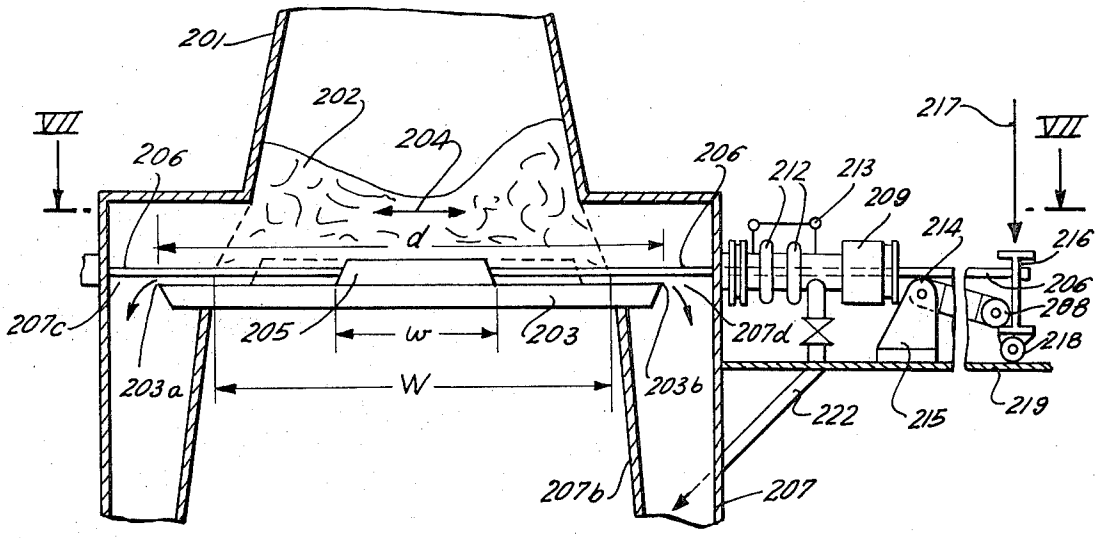
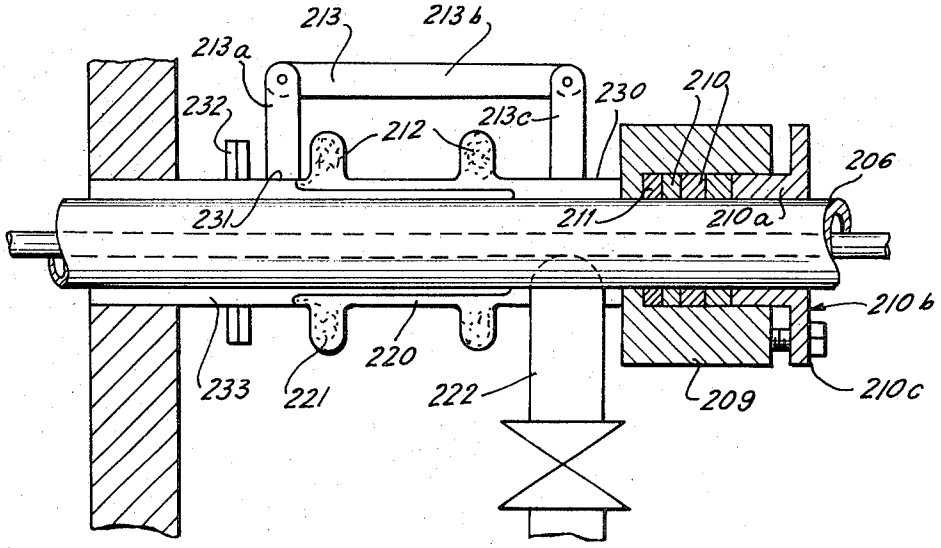

201
202
204
206
206
VII
VII
217
212
213
209
214
216
206
208
218
219
d
w
W
205
203
203a
203b
207c
207d
207b
207
222
215

FIG. 6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213b
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232
213c
212
206
231
211
210a
210b
220
233
221
222
209
210c

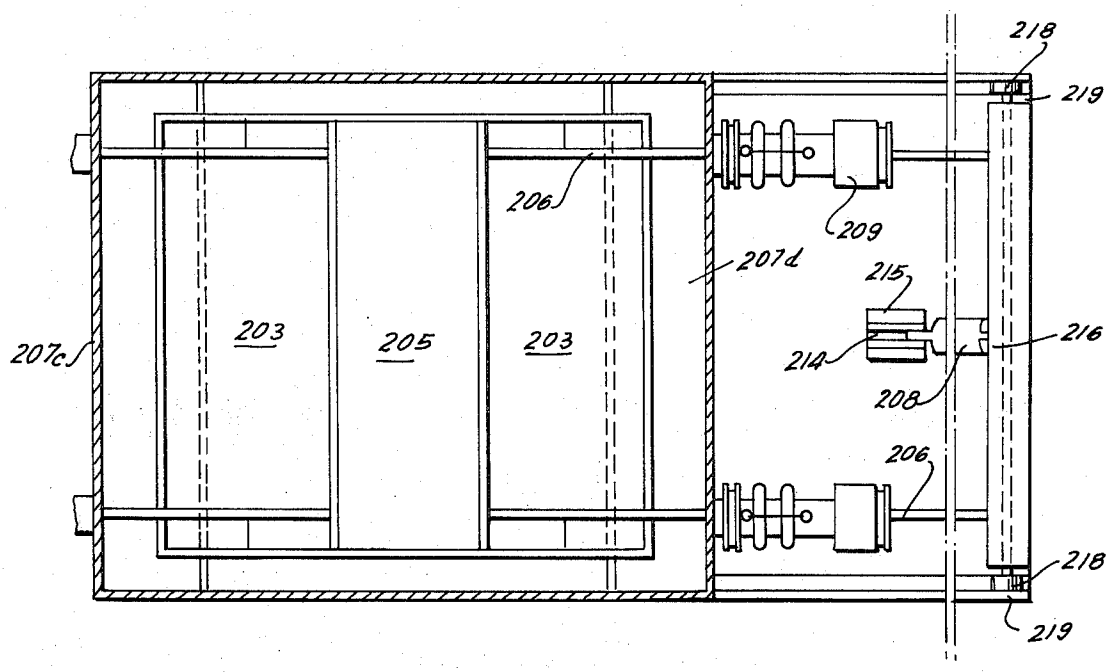
218
219
206
209
207d
215
216
214
208
207c
203
205
203
206
218
219

FIG. 7

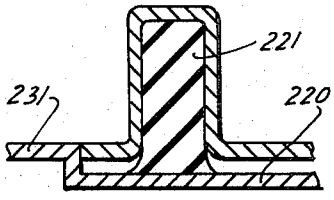
221
231
220

FIG. 9

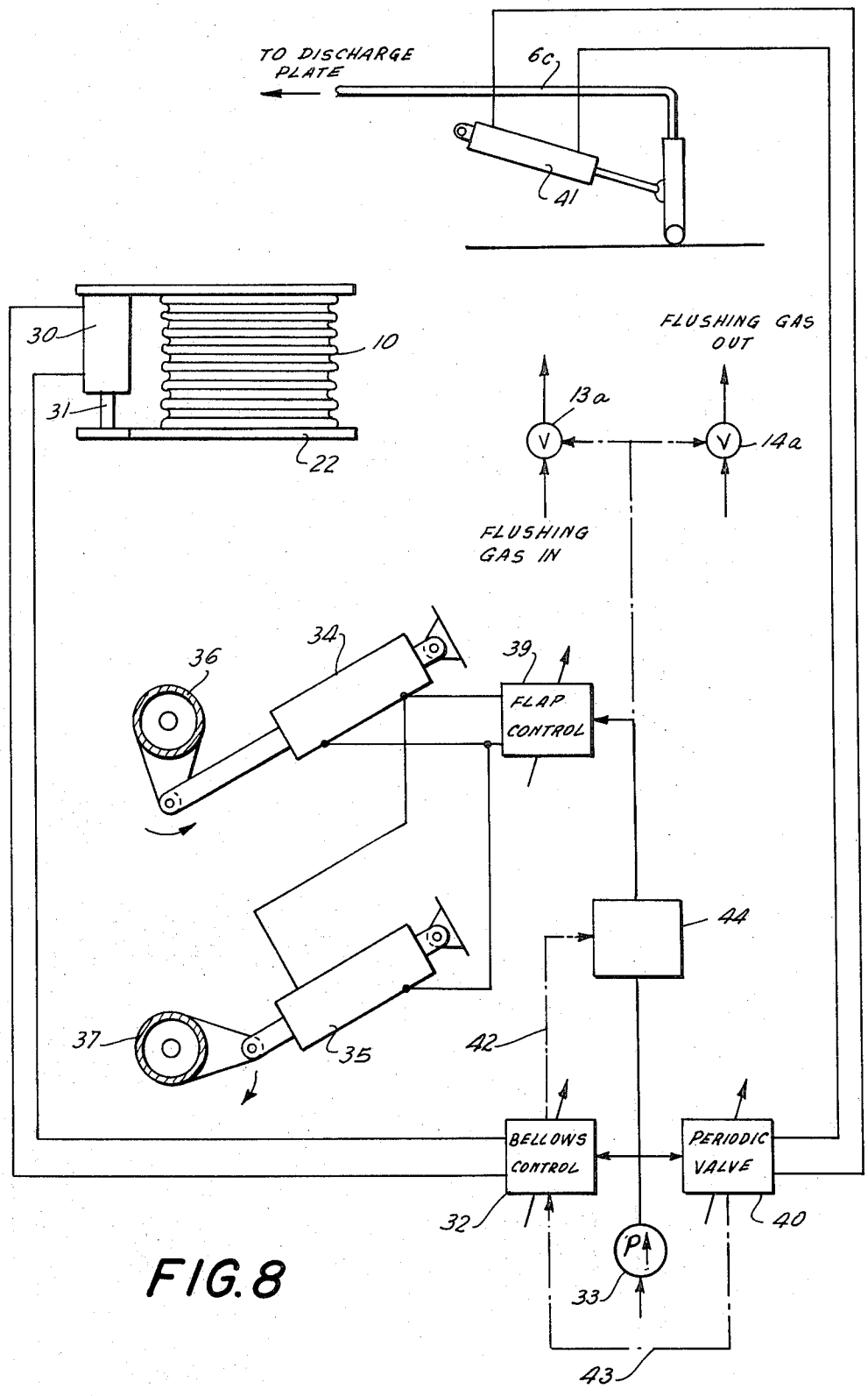
TO DISCHARGE PLATE
6c
41
30
10
31
22
FLUSHING GAS OUT
13a
14a
FLUSHING GAS IN
36
34
39
FLAP CONTROL
44
37
35
42
BELLOWS CONTROL
PERIODIC VALVE
32
40
P
33
43

FIG. 8

DISCHARGE SYSTEM FOR A SHAFT-TYPE FURNACE

FIELD OF THE INVENTION

The present invention relates to a discharge apparatus at the base of a shaft furnace for the direct reduction of iron oxides to produce sponge iron and, more particularly, to a system for discharging such furnaces into transport or storage vessels.

BACKGROUND OF THE INVENTION

A shaft-type furnace for the direct reduction of iron oxide to sponge-iron generally comprises an upstanding shaft which is charged at its top, e.g. through a closure adapted to prevent the escape or entry of gases during charging, with iron-ore pellets or briquettes which are deposited upon the top of the charge undergoing reduction with a minimum of freefall.

The charge descends in the furnace and a reducing gas containing, for example, hydrogen and carbon monoxide, is passed upwardly through the charge at a temperature sufficient to bring about a reaction between the iron oxide and the reducing gas, thereby forming metallic iron, carbon dioxide and water vapor. The metallic iron, generally at a temperature of 1,000°C or greater, but less than its melting point, is obtained as a spongy, highly active mass, generally referred to as sponge iron. The sponge iron is removed at the base of the furnace by a discharge device since the sponge iron is seldom in a free-flowing state at the furnace base.

It has been proposed to convey the sponge-iron from the base of the direct-reduction furnace to some other location for the further treatment of the spong iron, e.g. its conversion into steel in an electric-arc furnace, or to store the sponge iron until it can be utilized. Both storage and transport must be carried out with the exclusion of air, especially prior to cooling, since the high activity of the sponge iron (high ratio of surface area to mass) renders the sponge-iron particularly susceptible to reoxidization. Consequently, difficulties have been encountered in the discharging of shaft-type furnaces of the kind discussed above.

It is also desirable, with shaft-type furnaces of the aforedescribed type to obtain a substantially uniform flow of the sponge iron from the system in spite of the fact that the discharge device may act more or less intermittently (periodically) and, to this end, a double-outlet arrangement mentioned previously is employed.

OBJECTS OF THE INVENTION

The present invention has as its principal object the provision of an improved system for the discharging of a shaft-type furnace whereby the aforementioned disadvantages are obviated.

Another object of this invention is to provide an improved system for the discharging sponge iron from shaft-type furnaces which prevents reoxidization of the sponge iron in all stages from the moment it leaves the furnace outlet to the moment at which it enters a transport or storage vessel.

Yet another object of the invention is to provide an improved system for filling transport vessels with sponge iron whereby reoxidization of the sponge iron is precluded.

SUMMARY OF THE INVENTION

These objects and others which will become apparent hereinafter are attained, in accordance with the present invention, in a discharge system for a direct-reduction furnace, i.e. a storing or loading system for a transport vessel, which comprises, two discharge openings of the direct-reduction furnace (on opposite sides of a supporting table below the column of charge of the furnace and toward which a scraper or displacement bar or plate is reciprocated alternately), a downwardly extending discharge shaft or chute of converging configuration, an intermediate storage bin communicating with the downwardly opening end of each discharge shaft or chute, and a dispensing funnel or bin into which the intermediate bin opens via conically convergent walls.

Between the discharge shaft or chute and the intermediate storage bin according to the present invention, there is provided a flap-type closure forming a hermetic seal with a seating ring surrounding the opening at the lower end of each discharge shaft or chute. A similar closure is provided at the lower end of the intermediate storage bin at which it opens into the discharge hopper. The latter is provided with compensating seal means engageable with a transport vessel to provide a hermetic seal between the vessel and the hopper. Means is provided for flushing the transport vessel with an oxidization-limiting gas, the outlet for this gas being provided on the hopper or the intermediate bin.

The hopper may be connected to the transport vessel by compensating connector means, e.g. a bellows-type seal, which may be provided with the flushing-gas outlet or the latter may be formed on the discharge hopper itself.

The system described above can be embodied in various forms 1 and it has been found to be highly advantageous when the discharge chute or shaft has a converging portion of small cross section reaching into the intermediate bin and on its downwardly-facing end, having a seat or a flap-type closure forming a gas-tight fit therewith. The lower end of the intermediate bin likewise may have a reduced diameter and can extend into the charge hopper so that its lower edge forms a seat for a flap-type closure.

The flap-type closure may include a conventional flap body whose sealing surface corresponds to a surface of revolutions centered on the axis of the respective seat when the flap is in a closed position, the flap being swivelly mounted for self-centering engagement with its seat, upon an arm swingable in a plane of the aforementioned axis and operated by a horizontal shaft. The compensating connector is preferably provided with a connected flange adapted to be seated over the filling opening of a transport vessel aligned with the discharge hopper.

The system described above is highly advantageous in that it operates continuously or quasicontinuously to carry sponge iron from a shaft-type furnace in a hot state to the transport vessel, the transport vessel discontinuously carrying away the sponge iron. The discharge hoppers may work alternately and it goes without saying that the various flap-type closures of the two systems may be operated in alternation. The flushing gas is preferably turned on automatically when the compensating connector is brought into plane although a constant gushing gas flow can be maintained

in the transport vessel or a flushing gas pressure allowed to build up therein until the inlet of the vessel is properly sealed to the compensating connector.

DESCRIPTION OF THE DRAWING

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is a diagrammatic vertical cross sectional view through a sponge-iron discharge arrangement according to the present invention;

FIG. 2 is a detail view of the region II of FIG. 1 drawn to a larger scale;

FIG. 3 is a vertical cross-sectional view showing a closure arrangement according to the present invention which is representative of each of the flap-type closures illustrated in FIG. 1;

FIG. 4 is a cross-sectional view taken along the line IV—IV of FIG. 3;

FIG. 5 is a detail view of the means for reciprocating the movable discharge bar shown diagrammatically in FIG. 1;

FIG. 6 is a detail view of the region VI of FIG. 5, drawn to an enlarged scale and shown in part in axial section;

FIG. 7 is a cross-sectional view taken along the line VII—VII of FIG. 5;

FIG. 8 is a diagram of a control system of the unit of FIGS. 1 and 2; and

FIG. 9 is a detail, in enlarged section, of a portion of the seal of FIGS. 5 – 7.

SPECIFIC DESCRIPTION

In FIGS. 1 and 2, there is shown a device for discharging a shaft-type furnace represented generally at 3 and containing a column of charge represented at 1. The shaft-type furnace 3 is shown diagrammatically and, although not considered per se to be part of the present invention, will generally be formed with a downwardly diverging shell provided with means at its lower end for admitting a gas containing carbon monoxide and hydrogen and provided, at its upper end, with a waste-gas outlet and a gas-lock or closure system for admitting a charge of iron ore in pellet or briquette form with a minimum of free fall.

The waste gas drawn off from the top of the furnace may pass into recuperators for recovering any sensible heat and then into gas-generating reactors where all or part of the waste gas is reformed with hydrocarbons to regenerate carbon monoxide and hydrogen which is fed to the bottom of the shaft-type furnace in accordance with conventional practices.

The base of the furnace 3 has a pair of opposite lateral openings 3*a* and 3*b* through which the charge, after conversion to sponge iron, is alternately fed. To this end the column of charge rests upon a support table 5 upon which a scraper bar or plate 6 is reciprocable by fluid-responsive devices 6*a* and 6*b* alternately effective to drive the plate 6 in the directions represented by the arrows 6*a'* and 6*b'* respectively. The details of the discharge arrangement at the base of the furnace are shown in, and described with reference to FIGS. 5 through 7. The hydraulic or pneumatic cylinders 6*a* and 6*b* have their pistons operatively connected with rods 6*c* and 6*d*, respectively, the rods passing through the walls of a housing 4*a* enclosing the base of the furnace 3 and its outlets 3*a* and 3*b*.

Sealing devices are provided for these rods at the housing as described in FIGS. 5 through 7.

The housing device defines with the opposite lips 5*a* and 5*b* of the plate 5 respective discharge openings 4 which extend into downwardly converging discharge chutes or stacks represented at 7 which alternately receive sponge iron from the column as represented by the arrows 7*a* and 7*b*.

The assembly of the present invention, extending downwardly below the shaft furnace 1 is designed to introduce sponge iron into transport vessels 2 shown to be carried on carriages 2*a* whose wheels 2*b* ride upon rails 2*c*.

Each of the discharge openings 4 is thus associated with a gas-type discharge chute or shaft 7 communicating at its lower end with a respective intermediate storage bin 8 of downwardly converging configuration. At its lower end each intermediate storage bin 8 communicates with a discharge hopper 9, also of downwardly converging configuration, the lower end of the discharge hopper 9 being provided with a compensating connection 10 (e.g. a metal elongatable bellows) for communication with the respective inlets of one of the transport vessels.

Between the discharge chute or stacks 7 and the respective intermediate bunker and between each intermediate bunker 8 and the respective discharge hopper, there is provided a gas-tight closure 11 or 12 which is shown diagramatically in FIGS. 1 and 2 but can be constructed as illustrated in greater detail in FIGS. 3 and 4.

Each transport vessel 2 is provided with a fitting 13 and a control valve 13*a* through which a flushing gas may be introduced to remove all traces of oxygen from the vessel during, before and after filling of the latter.

The flushing gas may be any gas incapable of oxidizing the sponge iron or otherwise reacting adversely therewith and preferably is a hydrocarbon (e.g. methane), carbon monoxide or a mixture thereof, nitrogen or an inert gas such as neon or argon.

Each of the discharge hoppers 9 is provided with an outlet fitting 14 and a valve 14*a*, although it should be understood that the discharge fitting may also be provided on the compensating connector 10 as shown in FIG. 1 at 14' in the drawing.

Each of the discharge chutes or shaft 7 has a converging lower end reaching into the respective intermediate storage bin 8 and formed at the opening of the lower end 15 with a circular seat 16 for a flap-type closure 11 which forms a gas-tight seal therewith. The construction of the seat and the closure may be that described in connection with FIGS. 3 and 4.

Similarly, the downwardly convergent lower end of each intermediate 8 extends at 17 into the respective discharge hopper 9 and is provided with a lower rim forming a seat 18 for the respective flap-closure 12 forming a gas-tight closure therewith.

The flap-type closures 11 and 12, as best seen in FIG. 2, may be upwardly convex and of generally spherical configuration, at least at the annular zone thereof engageable with the generally spherical concave seat, the spherical member 12 being swivelably mounted upon the ball-shaped head of a pin extending perpendicularly to an arm 20 mounted upon a horizontal pivot shaft.

The ball-shaped portion **19** is thus self-centering in the seat **18.** The closure assembly **12** may be cooled as described below in connection with FIGS. **3** and **4.**

The compensating connectors or bellows **10** are vertically shiftable (arrows **21**) and comprise connecting flanges **22** sealing the engageable with the openings of the transport vessels **2,** the latter openings being flanged as represented at **23.**

The closure **11** between each discharge chute or stack **7** and the respective intermediate bin **8** is held open for a predetermined number of strokes of the plate **6,** thereby delivering a predetermined quantity of sponge iron to the intermediate bin **8** therebelow. During this period, of course, the closure **12** is in the closed position and sponge iron is collected in the intermediate bin **8.**

At the conclusion of this period, member **11** is closed and member **12** may be opened to discharge the collected iron through the hopper **9** into the vessel **2.** This discharge can be accomplished when the compensating connection **10** is lowered into engagement with the transport vessel, immediately or after a delay sufficient to flush all oxygen from the hopper **9,** the compensating connection **10** and the vessel **2.** Thus the closures **11** and **12** between discharge shaft **7** and bin **8** and between the bin **8** and the hopper **9** operate alternately. While one transport vessel **2** is being filled moreover, the other section of the discharge apparatus may collect sponge iron for subsequent discharge into another transport vessel.

In FIG. **8** there is shown a control system dealing with one part of the discharge system, a corresponding circuit being provided for the other half of the system. From FIG. **8** it can be seen that the compensating connector **10** has a fluid-responsive device **30** whose piston may be extended at **31** to bring the connecting flange **22** into engagement with the lip of the vessel **2.** The pneumatic cylinder **30** is operated by a control valve **32** to connect a source **33** of fluid under pressure to the cylinder, another control valve **39** operating the cylinders **34** and **35** respectively connected to the shafts **36** and **37** of the arms **20** of closures **11** and **12** to drive them in alternation, i.e. to close one when the other opens vice versa.

A periodic valve **40** connected between the source **33** and fluid-responsive cylinders **41** connected to the tie rods **6***c*, etc. for reciprocating the discharge plate **6** (FIGS. **1** and **2**). With a predetermined number of reciprocations, a signal is transmitted at **43** to the bellows control **32,** thereby lowering the compensating connector **10** into registry into transport vessel **2,** whereupon a signal is transmitted at **42** to a valve **44** operating the closure control valve **39** and the flushing-gas valves **14***a* and **13***a* as previously described. The signals may be pneumatic, electrical etc.

In FIGS. **3** and **4,** there is shown in somewhat great detail a closure structure which may be used for either or both of the closures **11** and **12** but which has been illustrated for a closure between a downwardly extending shaft **7** (FIGS. **1** and **2**), here represented at **103** and an intermediate bin **8** represented at **104** in FIGS. **3** and **4.**

The sponge iron mass **102** is retained in the funnel-shaped member **103** (hereinafter simply funnel) is provided with a horizontal flange **103***a* strengthened by radial ribs **103***b* mounted upon the top of a generally flat setting-ring structure represented generally at **105.** The latter member, which has a cylindrical opening **105***a* registering and coextensive with the opening of funnel **103,** terminates in a concave seating surface **110** conforming to a surface of revolution centered on the axis A of the ring **105.** The outer periphery of the ring **105** is fluted at **105***b* to provide ribs **105***c* increasing the surface area in contact with the surrounding atmosphere and therefore the heat dissipation from the ring **105.**

Ring **105** is also formed with an annular channel **105***d* into which a coolant can be fed through a radial bore **105***e*, the coolant being led from the system by a radial bore **105***f.* At a location diametrically opposite the bore **105***e*, channel **105***d* can be connected in a coolant circuit with the flap arm and shaft as described hereinafter.

A pivotal hollow shaft **106** has a horizontal axis B about which the shaft can be rotated by one of the cylinders **34** or **35** previously described. The shaft is journaled in the housing structure **104** and preferably is disposed so that its axis lies at a distance D beneath ring **105,** the horizontal plane through the axis B corresponding generally to the position of the center of the flap-type closure arrangement.

Shaft **106** carries a bent arm **107** which lies in a radial plane R (FIG. **4**) of the shaft **106** but an axial plane of the ring **105.** The arm **107** has a free end supporting a pin **108** which extends perpendicular to the arm and to the shaft **106.**

The upper part of pin **108** is formed with a ball **108***a* provides a swivel head for a socket **109***a* at the center of a closure disk **109** whose spherical segmental outer surface **111** is complementary to the seat **110** and corresponds to a surface of revolution centered upon the axis A.

A plate **109***b* is bolted to the underside of disk **109** and has an aperture **109***c* surrounding the shaft **108***b* of pin **108** to limit the swivel motion of closure member **109.** The opening **109***c* has a diameter less than that of ball-shaped head **108***a* so that the closure member cannot be slipped off the pin. The ball-shaped head **108***a* may be threaded onto the shaft **108***b* after the plate **109***b* is placed thereover, whereupon the disk **109** is bolted to the plate and the structure illustrated in FIG. **3** is thereupon formed.

The plate **109***b* also closes a downwardly open recess **112** which forms a coolant channel within the closure member **109,** the channel communicating with diametrically opposite ports **112***a* and **112***b* opening in the axial direction along the plane R. These ports are connected by bellows fittings (compensating connectors) at **114** to ports of the arm **107.** The arm **107** is provided with a conduit **113** (i.e. is hollow and receives the conduit **113** with clearance) which also extends with clearance through the hollow shaft **106** and opens at the port **112***b* to deliver a coolant fluid to the interior of the closure member **109.** The coolant is returned by the port **112***a* directly through the hollow arm **107** (arrows **115**) from which the fluid flows through the hollow shaft **106** around the conduit **113.** The structure **104** is provided with an antechamber **104***a* adapted to receive the arm **107** in the opened portion of device (broken-line position), the arm being swingable through the angle **116** as represented in FIG. **3.** The bellows **114** allow swivel motion of the closure **109** upon the ball-head **108***a* so that, when the device is closed as shown in FIG. **3,** member **109** is able to seat effectively against

the ring **105** in spite of thermal expansion of the latter.

FIGS. **5** through **7** disclose the system for discharging the sponge iron from the base of the charge column in somewhat greater detail. In this embodiment, the shaft-type furnace **201** receives the column **202** of sponge iron above the charge-support table **203** lying horizontally below the base of this column. Upon the table **203** there is provided a discharge plate or bar **205** from which pairs of traction rods extend at **206** in each horizontal direction.

The rods **206** pass out of the housing **207** at the base of the shaft furnace and are provided with an actuating system as shown generally at **208** (FIG. **5**) for the right-hand rods. A similar actuating system is provided at the left-hand side of the device.

As previously described, the housing **207** comprises a pair of chutes or stacks (funnels) **207***a* or **207***b* leading downwardly from the openings **207***c* and **207***d* at opposite ends of the table **203.** In operation, the plates **204** entrains a portion of the sponge iron at the bottom of the charge to the left upon movement of the plate in this direction (energization of the left-hand cylinder) and carries this portion of the charge to the edge **203***a* of the table **203.** The charge cascades over this edge through the opening **207***c* and is led via chute **207***a* to the intermediate bin as previously described.

During movement of the plate **205** to the left, the charge **202** descends by an increment according to the quantity of sponge iron discharged, thereby filling the space previously occupied by the plate **205.** When the latter is then drawn to the right, a fresh increment of the sponge iron is entrained over the edge **203***b* of the table **203** and into the chute **207***b* through the opening **207***d.*

With each reciprocation of the plate **205,** via the tension rods **206,** a corresponding quantity of sponge iron is drawn out of the column **202** and is caused to discharge through a respective chute. The tension rods pass slidably through floating packing sleeves or housings **209** which are provided with packing rings **210** (FIG. **6**) hugging the rods **206** to form a gas-tight seal.

At the axial end of the packing sleeve turned toward the housing **207,** each packing assembly includes a dust-stripper ring **211** which prevents entry of dust into the packing housing and hence prevents the dust from being entrained on the surface of the rod **206** out of the housing.

The packing rings **210** are maintained in tight-fitting but slidable relationship with the rods **206** and under pressure applied from a packing-compression boss **210***a* of a rigid flanged sleeve **210***b* whose flange **210***c* is bolted to the packing housing **209** as best seen in FIG. **6** supported by a compensating system **212** and a motion limiter **213** as will be more readily apparent hereinafter.

The housing **209** may be rigid with a tube **230** which is formed with a plurality of transverse corrugations defining an axially extendable and contractible bellows **212,** the bellows **212** being formed with yieldable heat resistant fillers **221** which closely surround the inwardly extending portion **220** of a tube **231** flanged at **232** to a pipe **233** rigid with the housing wall **207.** The movement-limiting device includes a bar **213***a* rigid with pipe **231,** a further link **213***b* articulated to the bar **213***a,* and yet another line **213***c* articulated to the link **213***b* and connected to pipe **230.**

From FIGS. **5** through **7** it will be apparent that limited movement of pipe **230** at housing **209** is possible in the plane of linkage **213** and in the plane of rod **206** which may be provided with a duct leading a cooling fluid to or removing it from plate **205** as described previously.

The drive or actuating means for plate **205,** according to the present invention, comprises a piston-and-cylinder arrangement **208** (FIGS. **5** and **7**) which is preferably hingedly mounted at one end **214** on a pair of trunnions **215** and at the other end is articulated to a traverse bar **216.** The latter is fixed to the free ends of two rods **207** at each side of the plate **205** and is provided with rollers **218** resting upon horizontal guide surfaces **219** formed by a pair of rails rigid with the housing as shown in FIGS. **5** and **7.**

The pivot of the piston and cylinder arrangement are so positioned that a downward component of force is applied by its piston and cylinder arrangement, holding the rollers **218** upon the rails **217,** the piston arrangement being energized as described in connection with FIG. **8.** The downward component of force at the traverse **216** is represented by the arrow **217.** The pivot **214** should thus be located at a point above the point of attack of the cylinder arrangement **208** upon the traverse **216.**

As previously described and as illustrated particularly in FIGS. **6** and **9,** the region between the bellows and the dust tube may be filled with a body **221** of a heat resistant elastic thermal insulation, e.g. a packing of asbestos fibers in a heat resistant elastomer. An outlet **222** is provided for collecting dust between the stripper **211** and the housing **207** along the tube **230** and feeding it back into the chute **207***b.*

We claim:

1. A discharge system for a shaft-type furnace, comprising:

discharge means at the base of said furnace for dislodging quantities of sponge iron from a column of charge in said furnace in alternate directions;

a respective discharge-shaft member communicating with and extending downwardly from said discharge means at opposite sides thereof for guiding respective quantities of sponge iron downwardly;

a respective intermediate-bin member communicating with each of said discharge-shaft members at the bottom thereof for receiving quantities of sponge iron traversing said discharge-shaft members;

a respective discharge-hopper member communicating with each of said discharge-bin members at the bottom thereof for discharging quantities of sponge iron into respective vessels disposed beneath the discharge hopper members;

respective compensating connectors adjustably mounted between each of said discharge-hopper members and the respective vessel and sealingly engageably therewith;

closure means between at least one of said members and another member communicating therewith for sealing same against passage of gas; and

means for flushing each of said vessels and at least the compensating connector communicating therewith with a gas adapted to exclude air from said

vessel and the associated compensating connector.

2. The discharge system defined in claim **1** wherein the last-mentioned means includes a gas inlet formed on said vessel and a gas outlet formed on one of said discharge-hopper member and the respective compensating connector.

3. The discharge system defined in claim **2** wherein said one of said members has a downwardly convergent lower end extending into said members and formed with a seat, a said closure means including a flap-type closure element sealingly engageable with said seat.

4. The discharge system defined in claim **3** wherein said one of said members is said discharge-shaft member and said other of said members is said intermediate-bin member.

5. The discharge system defined in claim **3** wherein said one of said members is said intermediate-bin member and said other of said members is said discharge-hopper member.

6. The discharge system defined in claim **3** wherein said element has a spheroidal surface, further comprising means for swivelably supporting said element for self-centering engagement with said seat.

7. The discharge system defined in claim **3** wherein said compensating connector is formed at its lower end with a connecting flange adapted to sealingly surround an opening formed in said vessel.

8. The discharge system defined in claim **1** wherein said discharge means includes a support table underlying and carrying said column, a discharge plate reciprocable on said table for alternately entraining said material in opposite directions into the respective discharge-shaft members, a housing enclosing said plate and the bottom of said column, a tension rod fixed to said plate and extending out of said housing, a packing body slidably receiving said rod and spaced from said housing, means floatingly mounting said packing body on said housing for at least limited relative displacement of said packing body and said housing, and activating means connected to said rod beyond said packing body for shifting said plate.

9. The discharge system defined in claim **8** wherein a pair of such rods are affixed to said plate on one side thereof and respective packing bodies are slidably engaged by said rods, said activating means including a traverse connecting said rods beyond said packing bodies, a piston-and-cylinder arrangement pivotally connected to said traverse for displacing same, rollers on said traverse, and a horizontal guide surface extending from said housing, said rollers bearing upon said guide surface, said compensating means including a bellows affixed to each of said packing bodies, a dust tube extending into the respective bellows, and a body of elastically deformable insulation filling space between each of said bellows and the respective dust tube.

10. The discharge system defined in claim **1** wherein said closure means includes an annular seat formed between said one of said members and said other member, a pivot shaft extending generally parallel to the plane of said seat and offset to a side thereof, an arm swingably mounted on said pivot shaft and extending generally radially therefrom while having a free end juxtaposed with said seat in at least one position of said arm, a pin mounted on said arm and extending generally perpendicular thereto, a closure member swivelably mounted on said pin and engageable with said seat in said direction, said seat and said closure member having complementary engaging surfaces conforming to a surface of revolution.

11. The discharge system defined in claim **10** wherein said seat is formed with a concave sealing surface, said closure member is formed with a convex sealing surface engageably with said concave sealing surface, said seat is formed with a coolant channel and means for passing a coolant through said channel, said closure member is formed with a cooling channel and means including the interiors of said pivot shaft and said arm for passing cooling gluid through said cooling channel, said arm being provided with a pin having a ball-shaped head, said closure member being formed with a generally spheroidal socket mounted on said head.

12. The discharge system defined in claim **1** wherein one such closure means is provided between each said discharge-shaft member and the respective intermediate-bin member and another such closure means is provided between each said intermediate-bin member and the respective discharge-hopper member.

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