ABSTRACT

A flap-type closure for a device for the feeding of sponge iron to a transport vessel, adapted to receive the product of a furnace for the direct reduction of iron ore, comprises a substantially horizontal annular seat and a substantially horizontal pivot shaft connected to the flap by a swingable arm. A pin between the arm and the flap allows relative swiveling motion of the flap with respect to the arm, and the flap is convex toward the seat to provide self-centering positioning of the flap against the seat.

6 Claims, 2 Drawing Figures
CLOSURE FOR SPONGE IRON DISPENSER

SPECIFICATION

1. Field of the Invention

The present invention relates to a closure adapted to be interposed into the path of bulk material, especially sponge iron, between a source thereof and a receiver therefor and, more particularly, to a flap-type closure for a device for feeding or transferring sponge iron to a vessel for its further transport away from a direct-reduction furnace.

2. Background of the Invention

In the handling of sponge iron, i.e., the solid mass obtained by the direct reduction of iron ore (usually in the form of pellets or briquettes) in a shaft-type furnace with a reducing gas (generally containing hydrogen and carbon monoxide), a highly reactive product is obtained, which is transferred at the discharge side (bottom) of the furnace to transport or storage vessels which may be sealed against the atmosphere to prevent reoxidation of the highly active iron during transport or storage.

Direct-reduction shaft furnaces may have two discharge openings through which the charge is removed from the furnace, the openings operating alternately in the cadence of operation of a reciprocable device at the bottom of the furnace which carries the reduced iron to one side and another as part of the discharge movement. The discharge openings may be provided with vertical shafts, inclined chutes or the like communicating with intermediate storage bins and respective funnels and, between these storage devices or transport vessels, flap-type closures may be provided. The closures, therefore, are said to lie between the outlets of the furnace and receptacles or vessels adapted to accommodate the sponge iron, either to store the latter until it can be transported elsewhere or to receive the sponge iron for transport, e.g., by a wheeled or track vehicle system.

In such devices, the flap-type closure must be adapted to withstand considerable thermal stress since the sponge iron generally has a temperature above 1000°C. In spite of the rigorous conditions to which the closure is subjected, it must provide a tight and even hermetic seal to prevent access of air to the sponge iron until the transport vessel is aligned with the outlet, or the flap is to be opened for other reasons. Conventional closures have been incapable of withstanding such temperatures for long periods and, in fact, conventional flap-type closures have readily deteriorated under these conditions or have been incapable of maintaining the necessary gas-tight seal.

OBJECTS OF THE INVENTION

It is the principal object of the invention to provide a flap-type closure between a device for feeding sponge iron and a receptacle or vessel therefor whereby the aforementioned disadvantages are obviated.

Another object of this invention is to provide a flap-type closure for the purposes described, which has a high useful life, does not deteriorate readily and is capable of providing a satisfactory seal for long periods without breakdown.

Still another object of the invention is to provide a flap-type closure with effective sealing properties, low cost and high stability under thermal stress.

SUMMARY OF THE INVENTION

These objects and others which will become apparent hereinafter are attained, in accordance with the present invention, in a flap-type closure for a passage between a source of sponge iron and a receptacle therefor, which comprises a generally circular seat lying substantially in a horizontal plane and formed with a concave surface conforming generally to the configuration of a surface of revolution centered on the axis of the seat, a convex generally disk-shaped closure member of complementary configuration disposed below and engageable with the seat, the closure member having a convex configuration corresponding — at least in the region engageable with the seat — to a body of revolution centered on this axis, an arm carrying the closure member at an end thereof, a generally horizontal shaft supporting this arm for angular displacement thereof about the shaft axis and carrying the arm at the other end thereof, and at least one pin projecting perpendicularly to said arm and forming a swivel-type joint upon which the closure member is mounted at the first end of the arm.

The resulting structure allows substantially free movement of the closure member with at least two degrees of freedom relative to the pin and to the arm so that the closure member is self-centering with respect to the seat. It has been found, most surprisingly, that such a closure structure is capable of withstanding temperatures of 1,000°C or more, as in the handling of sponge iron, and equally is capable of accommodating the distortions which arise from the development of such temperatures and correspondingly high temperature differential across the seat and/or the closure member.

The flap-type closure of the present invention, although having generally applicability to any passage traversed by sponge iron and which in the absence of bulk transfer of this material must provide a hermetic seal to prevent entry of oxidizing gases to the passage, is preferably provided at the bottom of a pair of outlets or chutes disposed on opposite sides of a support table on which the column of sponge iron and furnace charge rests in a shaft-type furnace for the direct reduction of iron ore with reducing gases. In such furnaces, the bottom of the column may be entrained to one side and the other of the support table, alternately, thereby entraining a portion of the sponge iron to one outlet and the next portion of the sponge iron to another outlet, the chutes being formed with respective seats at the bottom thereof, as described previously. Of course, the chutes may open into respective sponge bins or a common storage bin without intermediate exposure to the atmosphere and, if the storage bins are permanently placed below the furnace outlets, the flap-type closure may be provided at an outlet of the bin or each bin, at the location at which it discharges into another receptacle, e.g., a transport vessel.

The essential elements of the present invention thus include a substantially horizontal ring-shaped flap seat, a substantially horizontal angularly displaceable shaft, a flap-carrying arm anchored at one end to this shaft and advantageously extending generally radially therefrom along a radius of the seat (in the closed position of the flap) and along a radius of the flap so that the arm is swingable in a radial plane of the shaft but an axial plane of the flap and its seat, and a convex disk
or flap of circular outline pivotally mounted on a pin perpendicular to the arm at the free end thereof. The convex flap and the flap seat have complementary surfaces corresponding to a surface of revolution centered on the common axis of the seat, the flap and the pin, when the flap is in its closed position, so that the flap may be considered to correspond to a spheroidal segment.

A flap-type closure of this character not only has been found to be capable of long-term use with a minimum downtime and repair, but also is capable of providing high sealing effectiveness between the seat and the flap.

The material from which the flap and the seat are constructed should be chosen to be capable of withstanding the high temperatures encountered by the closure and refractory steels, and tungsten or molybdenum alloys have been found to be most effective for the purposes of the present invention. However, ceramic flap members may be used with refractory-metal rings and vice versa, both the ring (seat) and the flap may be composed of ceramic or ceramic-metal compositions (cermets) and these materials may be used with refractory-metal (tungsten and/or molybdenum alloys) reinforcement to constitute the arm of the flap.

According to another feature of the invention, the seating ring is hollow and forms part of a coolant circulation path, the cooling being either water or a gas such as air or steam. Cooling can be effected, moreover, by introducing water into the seating ring and permitting the water to evaporate against atmospheric or higher pressure. The flap is likewise made hollow and means is provided, e.g. in the arm carrying the flap, for conducting a coolant of the aforementioned type to an from the plate.

It has been found to be particularly desirable to provide a coolant through both the shaft and the arm, whether or not the flap is cooled, and in a preferred embodiment of the invention, a coolant-carrying duct extends from the pivot shaft through the flap arm and to the flap, the flap arm serving as a coolant return path. Between the flap arm and the closure member, compensating connectors are provided to enable the transfer of coolant between them. The term “compensating connectors” is used herein to describe a connecting system for a fluid path which accommodates the relative motion of the flap and the arm described above. Preferably, the coolant channels of the pivot shaft, the arm and the flap are united in a common coolant circulation path.

It has been found to be advantageous, moreover, to constitute the confronting surfaces of the flap and the seating ring from refractory materials having high abrasion resistance and, where the seat and the flap are not composed of materials capable of withstanding abrasive wear at high temperatures, it is desirable to apply deposits of such materials by deposit welding, hard-facing and like techniques. Suitable materials for this purpose are tungsten carbide, applied by hard-facing techniques of the type described in U.S. Pat. No. 3,098,150, or molybdenum or tungsten alloys applied by deposition welding. It has also been found to be advantageous to make the seat somewhat softer than the flap so that a plastic deformation of the seat occurs on flap closure, thereby increasing the sealing engagement between flap and seat. Of course, the alternative arrangement, wherein the seat is slightly softer than the flap, can also be used.

**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 vertical section through a flap-closure embodying the present invention; and

FIG. 2 is a section taken along the line II — II of FIG. 1.

**SPECIFIC DESCRIPTION**

In the drawing, there is shown a system for introducing sponge iron into a vessel and for discharging sponge iron from a shaft-type furnace, the system being represented generally at 1.

The system 1 comprises a downwardly tapering funnel 3 through which the sponge iron mass 2 from a direct-reduction shaft-type furnace is adapted to cascade when a portion at the bottom of the column of charge is entrained into an opening communicating with the descending chute 3. The latter is formed at the bottom with a horizontal flange 3a strengthened by radial ribs 3b and is mounted upon the top of a generally flat seating-ring structure represented generally at 5. The latter member, which has a cylindrical opening 5a registering with and coextensive with the opening of chute 3, terminates in a concave seating surface 10 conforming to a surface of revolution centered on the axis A of the ring. The outer periphery of the ring-shaped member 5 is fluted at 5b to provide ribs 5c increasing the surface area in contact with the ambient atmosphere and therefore the heat-dissipation effectiveness of the ring 5. The latter is also formed with an annular channel 5d into which a coolant can be fed through a radial bore 5e, the coolant being led from the system by a radial bore 5p at a location diametrically opposite the bore 5e. Channel 5d can be connected in a coolant circuit with the flap, arm and shaft, as described hereinafter.

The ring 5 is mounted above a downwardly converging funnel-shaped structure 4 forming an intermediate bin for the sponge iron and communicating at its opening at the bottom of the bin (not shown) with a transport vessel for the sponge iron. The member 4, moreover, communicates with funnel-shaped structures or chutes, if required, to transfer the sponge iron to the transport vessel.

The closure arrangement further comprises a hollow shaft 6 having a horizontal axis B about which the shaft is pivotal and journaled in the housing formed by the structure 4. Preferably, the axis of the shaft lies at a distance D beneath the ring 5, the horizontal plane through this axis B corresponding to the position of the center of gravity of the flap-closure arrangement. The shaft 6 is rotatable by any conventional means, not shown, e.g., an arm affixed to the shaft at a location remote from the system shown in FIGS. 1 and 2, and a fluid-responsive cylinder connected to this latter arm.

Shaft 6 carries a bent arm 7 which lies in a radial plane R of the shaft 6 but in an axial plane of the ring 5, the arm having a free end supporting a pin 8 which extends perpendicularly to the arm and to the shaft 6. The upper end of pin 8 is formed with a ball 8a providing a swivel head for a socket 9a at the center of a clo-
sure disk 9. The latter has a spheroidally convex annular surface 11 complementary to the surface of seat 10 and also corresponds to a surface of revolution centered upon the axis A. A plate 9b is bolted to the underside of disk 9 and has an aperture 9c surrounding the shank 8b of pin 8 to limit the swivel motion of the closure member 9. This opening 9c has a diameter less than the diameter of the ball-shaped head 8a so that the closure member cannot slip off the pin. The ball-shaped head 8a may be threaded onto the shank 8b after the plate 9b is placed thereover, whereupon the disk 9 is bolted to the plate and the structure illustrated in FIG. 1 is thereupon formed.

The plate 9b also closes a downwardly open annular recess 12 which forms a coolant channel within the closure member 9, the channel communicating with diametrically opposite ports 12a and 12b opening in the axial direction along the plane R. These ports are connected by bellows fittings 14 (compensating connectors) to ports of the arm 7.

The arm 7 is provided with a conduit 13 which leads through the hollow shaft 6 with clearance and opens at the port 12b to deliver a coolant fluid to the interior of the closure member 9. The coolant is returned via the port 12a directly to the hollow arm 7 (arrows 15) from which the fluid flows through the hollow shaft 6 around the conduit 13.

The structure 4 is provided with an antechamber 4c adapted to receive the arm 7 in the open position of the device, the arm being swingable through the angle 16 as represented in FIG. 1. The bellows 14 allow swivel motion of the closure 9 on the ball head 8a so that, when the device is closed, as shown in FIG. 1, member 9 is able to seat effectively against the ring 5 in spite of any distortion of the latter.

We claim:
1. A lap-type closure for a generally vertical passage traversable by sponge iron at an elevated temperature, comprising:
an annular scar formed along said passage and lying in a generally horizontal plane transverse thereto;
a pivot shaft having a generally horizontal axis and extending generally parallel to the plane of said seat and offset to a side thereof;
an arm swingably mounted on said 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 perpendicularly thereto;
a closure member swivelably mounted on said pin and engageable with said seat in said position, said seat being formed with a concave sealing surface and said closure member being formed with a convex sealing surface engageable with said concave sealing surface, said surfaces conforming to surfaces of revolution, said closure member being formed with a cooling channel; a duct formed along said arm for feeding a cooling fluid to and removing cooling fluid from said channel; and compensator connector means between said duct and said closure member for communicating between them while permitting at least limited swiveling movement of said closure member.
2. The closure defined in claim 1 wherein said seat is formed with another coolant channel, further comprising means for feeding a coolant fluid to and removing coolant fluid from said other channel.
3. The closure defined in claim 1 wherein said arm is hollow and forms said duct.
4. The closure defined in claim 3, further comprising a conduit extending through said shaft and said arm into communication with said channel at one location, said channel communicating with the interior of said arm and said shaft at another location.
5. The closure defined in claim 4 wherein two such compensating connectors are provided, one at each of said locations.
6. The closure defined in claim 5 wherein said pin is formed with a ball-shaped head and said closure member is formed with a ball-shaped socket receiving said head.

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