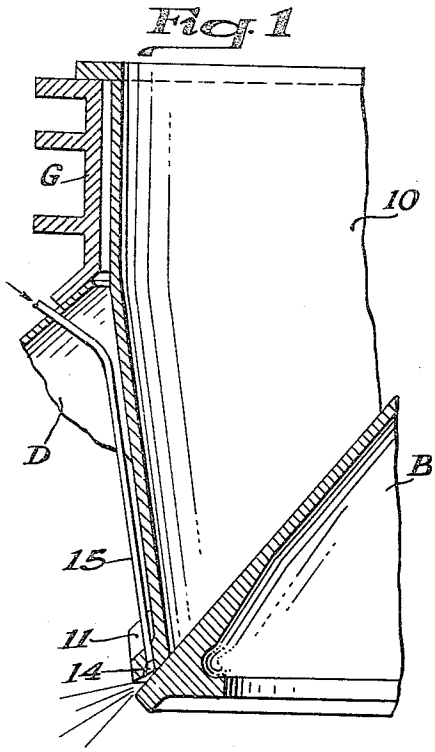
Oct. 9, 1956 L. H. SCHUMAN 2,765,935

CLEAN GAS SEAL FOR BELL AND HOPPER

Filed March 24, 1948

Fig. 1



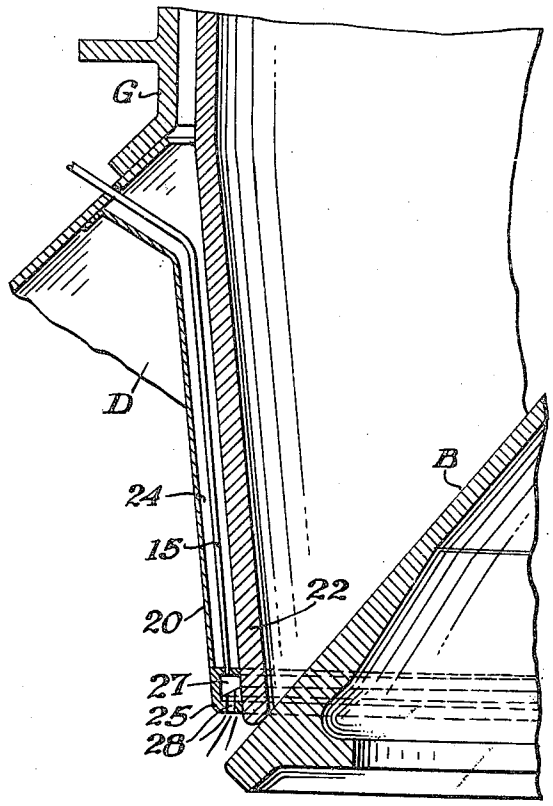


Fig. 2

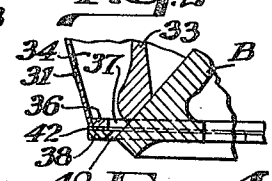


Fig. 4

Fig. 3

INVENTOR.
LOUIS H. SCHUMAN.

BY

Richey & Watts

ATTORNEYS.

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CLEAN GAS SEAL FOR BELL AND HOPPER

Louis H. Schuman, Youngstown, Ohio, assignor to Republic Steel Corporation, Cleveland, Ohio, a corporation of New Jersey

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7 Claims. (Cl. 214—36)

This invention relates generally to the blast furnace art and is particularly concerned with a new method of and apparatus for reducing erosive wear between the opposed surfaces of the hopper and large bell of a blast furnace.

A close fit between the opposed surfaces at the bottom edge of a blast furnace charging hopper and the upper surface of the large bell which closes the lower end of that hopper has been relied on heretofore to prevent the escape of dirty gases from the top of a blast furnace, these gases carrying abrasive solids such as fine iron ore, silica and the like. Accurate machining of these opposed surfaces and accurate assembly of these parts is required for an initially good sealing contact but this contact may be interfered with and passages between these opposed surfaces may be afforded when the bell and hopper seal is cracked upon opening or closing of the bell, or by warpage of the hopper or bell when heated to operating temperatures, or by solids lodging on the bell and preventing complete closing of the bell against the hopper. When any space exists between these two surfaces, gas may flow therethrough and since it carries erosive solids with it, the opposed surfaces are eroded and as they are eroded, the spaces become larger so that eventually there is a continual flow of gases between the hopper and bell. While this erosive wear is substantial in blast furnaces operating at gas pressures above the stock line of two or three pounds above atmospheric pressure, the erosive wear is much faster where the gas pressure above the stock line is higher. As the gas pressure increases from about two or three pounds up to several atmospheres, the rate of erosive wear increases very rapidly and this problem of erosive wear becomes serious. In the event it becomes necessary to replace either the hopper or the bell or both during the campaign of a furnace, such replacement is quite expensive in materials and almost prohibitively expensive because of the cost and losses due to shutting down the furnace while these parts are replaced. Accordingly, the problem of preventing erosive wear of the opposed surface between a blast furnace hopper and large bell has been a serious problem for many years and is much more serious at the present time with blast furnaces operating at pressures considerably higher than those which have been used heretofore.

In accordance with my present invention, these shortcomings of the prior art structures can be substantially overcome by a method which is easy and economical to use and apparatus consisting of few parts all of which are easily and inexpensively produced and assembled with conventional blast furnace top assemblies. My method which, broadly speaking, involves preventing furnace gases from flowing between the surfaces of blast furnace bell and hopper charging mechanisms when perfect sealing between these parts is desired but unobtainable, has the additional advantage, when used with certain forms of my apparatus hereinafter described, of protecting the portion of the hopper in the vicinity of the bell-engaging surface of the hopper from the effects of the hot furnace

gases. Thus the tendency for this portion of the hopper to warp due to temperature changes occurring in normal furnace operation in which the hopper is alternately heated by hot furnace gases and chilled by contact with the cold and moist furnace charge, is substantially minimized or completely eliminated and very effective bell and hopper sealing is, therefore, possible over long periods of furnace operation.

Briefly, the method of this invention comprises the step of delivering a gas, preferably clean washed furnace gas having a temperature of about 100° F., in a stream directed generally downwardly into the furnace and flowing in contact with the lower extremities of the bell and hopper adjacent to their engaging surfaces. Actually the flow of gas is not directly downwardly with respect to the hopper and bell, but rather away from the engaging surfaces of the lower extremities of these parts so that the tendency for furnace gases to flow through any breach in the annular seal between these parts is substantially minimized or eliminated due to the counterflow of the seal protecting gases. As will appear in the description of various types of apparatus of my invention set forth below, this gas is continuously blown into the furnace and delivered as a plurality of independent streams regularly and closely spaced around the circumference of the hopper, or in the form of a continuous stream enveloping the lower extremity of the hopper and the adjacent surface portion of the bell.

Those skilled in the art will gain a further understanding of the apparatus of this invention and the manner in which it is used for best results in accordance with the foregoing method, by referring to the following detailed description and the drawings accompanying and forming part of this specification in which:

Figure 1 is a fragmentary vertical sectional view of a large bell and hopper assembly for a blast furnace, embodying one form of this invention;

Figure 2 is a similar view of another such assembly embodying this invention in another form;

Figure 3 is a view similar to the foregoing but embodying still another form of this invention and showing additional structural details of the blast furnace dome and bell and hopper assembly; and

Figure 4 is an enlarged view of the lower extremity of the large bell and hopper of Figure 3, showing how these parts are related to the hopper enclosure which comprises a portion of the means of this invention illustrated in said Figure 3.

In all the figures the large bell, furnace dome and annular hopper-supporting girder are conventional in form and arrangement and are indicated respectively by the characters B, D and G. The hoppers are arranged in the conventional manner in the illustrated assemblies, being supported by girders G which in turn rest on the tops of domes D, and having lower ends for sealing engagement with bells B, which are disposed within but extend below the hoppers; but the hoppers differ in the form of their lower end portions.

Referring to Figure 1, the illustrated assembly comprises, in addition to the usual parts aforementioned, viz., dome D, girder G and bell B, a hopper **10** which extends downwardly into the top of the furnace through a suitable opening and is tapered toward its lower open end which is disposed to engage the lower outside surface of bell B. Around the periphery of its lower end the hopper is provided with a flange **11** having a lower surface defining a small acute angle with the opposing surface of bell B, as shown, and having a plurality of axially disposed regularly spaced apertures **14** opening adjacent to the bell-engaging surface of the hopper. A plurality of pipes **15** lead upwardly from their discharge openings within apertures **14** and generally parallel the adjacent

outer surface portions of hopper 10 to points near dome D, where the pipes are turned away from the hopper and extend outwardly through the dome to which they are secured in gas-tight contact, and communicate with a suitable source of gas under pressure outside the furnace, such a furnace gas washer equipped with a small auxiliary blower to boost gas pressures as much as desired (not shown).

In the operation of this device gas is introduced continuously into the furnace through the aforementioned pipes at all times during furnace operation so that when the hopper and bell are in engagement, as shown in Figure 1, a plurality of gas streams flow into the furnace between opposing surfaces of hopper flange 11 and bell B. Preferably the gas employed is at a relative low temperature compared to the temperatures obtaining in the upper part of the furnace where the bell and hopper are located and also preferably is clean washed furnace gas. In any case, however, the gas employed should not be one which is likely to be detrimental to the operation of the furnace or conducive to corrosion of the parts thereof with which it may come into contact, and should not be of a temperature sufficiently high to cause or permit warpage of the hopper in the vicinity of the bell-engaging surface of the hopper.

The device of Figure 2 generally resembles that of Figure 1, but in addition to the parts there shown, includes a cylindrical sheet metal shield 20 which defines with walls of dome D and hopper 22, a chamber 24 in which a plurality of pipes 15 are disposed. Shield 20 is flanged at its upper end and secured by welding or other means to the dome D adjacent to, but below, the points where pipes 15 pass through the dome. The lower end of the shield is attached to an annular flange 25 disposed on the outer surface of the lower end of the hopper. The flange 25 is a hollow ring which in transverse cross section is channel-shaped and which defines with the opposing surface of the hopper an annular chamber 27. A plurality of apertures 28 equally spaced around flange 25 in its lower wall communicate with the annular chamber and open adjacent to the lower end of hopper 22 so that gas under pressure in the chamber may escape continuously in a plurality of streams and impinge upon the opposing surface of bell B thereby to accomplish the objects of this invention set forth above. Since the number of apertures 28, rather than the number of pipes 15, determines the number of gas streams flowing into the furnace over the outside lower end of bell B, pipes 15 need not be spaced apart in any particular or critical manner and need not be provided in any critical number so long as adequate gas delivery into header chamber 27 through pipes 15 is at all times assured.

The operation of this apparatus is substantially the same as that described above in that a gas is continuously delivered into the furnace through pipes 15,, but instead of flowing directly from the pipes into the space surrounding the lower ends of the bell and hopper 22, the gas in this case is distributed by chamber 27 to insure a continuous and uniform discharge therefrom through the apertures 28. The pressure of the gas in chamber 27, and therefore in the lines serving it, is preferably substantially above the gas pressure prevailing in the upper part of the furnace so that there is constant gas flow into the furnace through openings 28. Also, as in the case of the Figure 1 apparatus, it is preferable here that the gas delivered through pipes 15 is clean washed furnace gas at about 100° F.

In the apparatus of Figures 3 and 4, a sheet metal cylinder 31 secured at its upper end to the furnace dome D and tapering therefrom to its lower open end adjacent the lower end of bell B, encloses the lower portion of hopper 33 within the furnace and defines with the dome D and hopper 33, a chamber 34 having an annular discharge opening at its lower end. At the lower end of cylinder 31 a metal ring 36 having equally spaced threaded apertures is secured to said cylinder forming a flange extending toward the bell-engaging surface of the hopper and defining with said hopper, an annular orifice 37. As illustrated more clearly in Figure 4, a second metal ring 38 consisting of a plurality of segments is secured to said ring 36 by means of bolts 39. The inner surface of the ring 38 may be bevelled, as shown in Figure 4, so that this surface lies substantially parallel to the outside surface of the lower extremity of bell B. Suitable packing material 42, preferably asbestos sheet in the form of a ring, is held firmly in position between the two rings and such packing material may be of varied thickness to obtain the desired size of orifice 40.

As illustrated, the chamber 34 is provided with gas under pressure greater than the pressure of the furnace gases in the upper part of the furnace, by means of a conduit 44 having a discharge opening 45 within the chamber 34 and communicating with a source of gas under pressure (not shown) outside the furnace. Conduit 44, like pipes 15 of Figures 1 and 2, enters the furnace through the upper portion of dome D to which it is sealed in order that gas cannot escape from chamber 34 around the conduit.

The operation of the apparatus is generally the same as described above, differing primarily in that gas is delivered into chamber 34 by means preferably of a single pipe or conduit, and in that the gas flows as a blanket, rather than a plurality of separate streams, through orifice 40 and over the lower extremities of the bell and hopper adjacent to the bell-engaging surface of the hopper. The gas employed is preferably clean washed and relatively cool furnace gas.

Having thus described the present invention so that others skilled in the art may be able to understand and practice the same, I state that what I desire to secure by Letters Patent is defined in what is claimed.

What is claimed is:

1. Apparatus for use in a blast furnace comprising a hopper to be disposed in the top of said furnace and having a sealing surface at its lower edge, a bell having a sealing surface on its outer side near its lower end to engage the sealing surface of the hopper, and means including a conduit having a discharge opening in the furnace and adjacent to the said sealing surface of the hopper for delivering a stream of clean gas into the furnace and flowing the stream in contact with the outer side of the bell below the sealing surface thereof and in a direction generally away from said surfaces while the bell is in its closed position and said sealing surfaces are engaged.

2. Apparatus for use in a blast furnace comprising a hopper to be disposed in the top of said furnace and having a sealing surface at its lower edge, a bell having a sealing surface on its outer side near its lower end to engage the sealing surface of the hopper, and means for delivering streams of clean gas into the furnace and flowing the streams in contact with the outer side of the bell below the sealing surface thereof and in a direction generally away from said surfaces while the bell is in its closed position and said sealing surfaces are engaged, said means comprising a plurality of conduits extending into the furnace and having discharge openings adjacent to the lower edge of the hopper and directed generally toward the bell.

3. Apparatus for use in a blast furnace comprising a hopper to be disposed in the top of said furnace and having a sealing surface at its lower edge, a bell having a sealing surface on its outer side near its lower end to engage the sealing surface of the hopper, and means for delivering a stream of clean gas into the furnace and flowing the stream in contact with the outer side of the bell below the sealing surface thereof and in a direction generally away from said surfaces while the bell is in its closed position and said sealing surfaces are engaged, said means comprising a manifold surrounding the hopper and

having an annular opening adjacent to the lower edge of said hopper and directed generally toward the bell, and a conduit communicating with the manifold for delivering clean gas into said manifold.

4. Apparatus for use in a blast furnace comprising a hopper to be disposed in the top of said furnace and having a sealing surface at its lower edge, a bell having a sealing surface on its outer side near its lower end to engage the sealing surface of the hopper, and means for delivering streams of clean gas into the furnace and flowing the streams in contact with the outer side of the bell below the sealing surface thereof and in a direction generally away from said surfaces while the bell is in its closed position and said sealing surfaces are engaged, said means comprising a manifold surrounding the hopper and having a plurality of spaced openings adjacent to the lower edge of said hopper and directed generally toward the bell, and a conduit partially disposed in the furnace and communicating with the manifold for delivering clean gas into said manifold.

5. In the operation of a blast furnace equipped with a charging hopper and a large bell to engage and cooperate with the hopper to form an annular seal and thereby close the hopper, the steps of bringing a gas into the furnace under pressure substantially greater than the pressure of the furnace gas in the upper part of the furnace and while the hopper is closed discharging said gas into the furnace from a location outside the hopper and below the annular seal as a stream directed generally downwardly into the furnace and against the bell and generally away from the said annular seal.

6. In the operation of a blast furnace equipped with a

charging hopper and a large bell to engage and cooperate with the hopper to form an annular seal and thereby close the hopper, the steps of continuously bringing a gas into the furnace under pressure substantially greater than the pressure of the furnace gas in the upper part of the furnace and while the hopper is closed continuously discharging said gas into the furnace from a location outside the hopper and below the annular seal as a plurality of streams directed generally downwardly into the furnace and against the bell and generally away from the said annular seal.

7. In the operation of a blast furnace equipped with a charging hopper and a large bell to engage and cooperate with the hopper to form an annular seal and thereby close the hopper, the steps of bringing clean washed furnace gas into the furnace under pressure substantially greater than the pressure of the furnace gas in the upper part of the furnace and while the hopper is closed continuously discharging said gas into the furnace from a location outside the hopper and below the annular seal as a tubular stream directed generally downwardly into the furnace and enveloping the lower extermity of the bell and flowing generally away from the said annular seal.

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