Nov. 10, 1953 W. L. DAWBARN 2,658,636

METHOD OF CONTROLLING PRESSURE BETWEEN BELLS OF BLAST FURNACES

Filed June 14, 1949 2 Sheets-Sheet 1

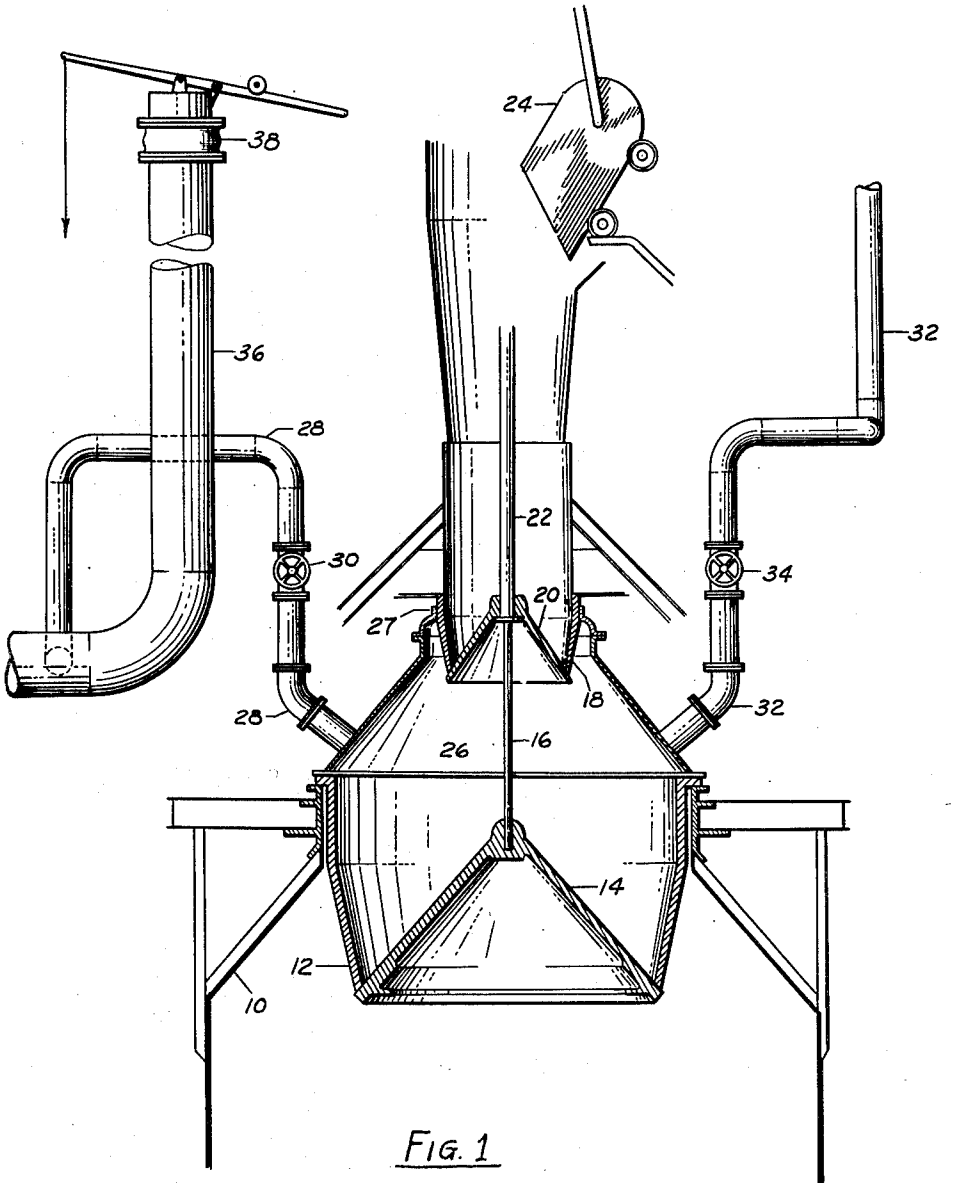


FIG. 1

INVENTOR.
WARING LENNOX DAWBARN
BY Frank M. Houghton
Agent

Nov. 10, 1953 W. L. DAWBARN 2,658,636

METHOD OF CONTROLLING PRESSURE BETWEEN BELLS OF BLAST FURNACES

Filed June 14, 1949 2 Sheets-Sheet 2

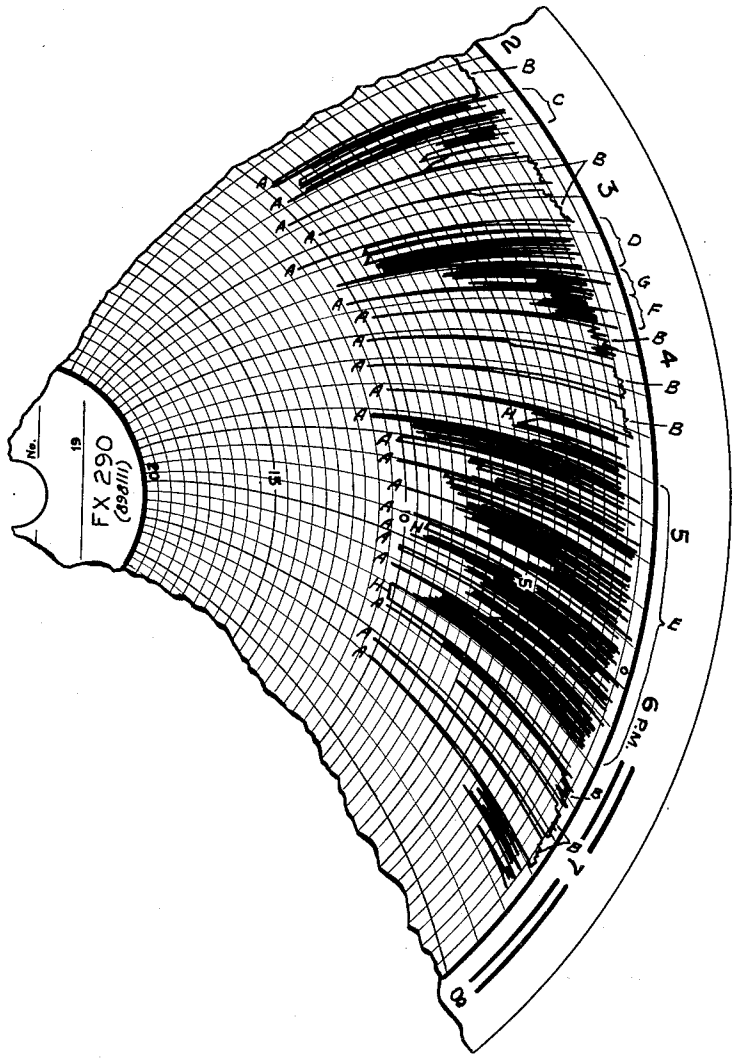


FIG. 2

INVENTOR.
WARING LENNOX DAWBARN
BY Frank M. Houghton
Agent

Patented Nov. 10, 1953

2,658,636

UNITED STATES PATENT OFFICE

2,658,636

METHOD OF CONTROLLING PRESSURE BETWEEN BELLS OF BLAST FURNACES

Waring Lennox Dawbarn, Winchester, Mass., assignor to Arthur D. Little, Inc., Cambridge, Mass., a corporation of Massachusetts

Application June 14, 1949, Serial No. 98,938

2 Claims. (Cl. 214—152)

1

This invention relates to blast furnaces, and more particularly to controlling the pressure within the chamber between the bells of furnaces which are operated under high top pressure in in accordance with the teachings of Avery U. S. Patent 2,131,031.

When operating a furnace under high top pressure, it is obviously necessary to make the pressure within the chamber between the bells substantially equal to that in the furnace top, to permit dropping the lower bell to discharge its load; and it is similarly necessary to make the pressure within that chamber substantially equal to that of the atmosphere to permit dropping the upper bell to discharge its load. Various proposals have been made to accomplish these ends, as shown in particular in U. S. Patent 2,200,488 to Clemmitt and Hayes, and U. S. Patent 2,411,487 to Whitcomb. These systems, however, operate upon the assumption that when the big bell is closed, it makes a substantially air-tight seal against the base of the lower hopper.

This assumption, however, is not correct. The heat of the furnace tends to warp the contacting surfaces of the lower bell and hopper out of round; the charge, and also escaping abrasive-laden gases, tend to scour these surfaces unevenly; and pieces of charge tend to lodge between these surfaces as they come together. For any one or more of these reasons, a good, tight seal is ordinarily almost impossible of accomplishment over more than a short period of operation. A piece of charge about ½ inch in diameter lodged between the contacting surfaces of the lower bell and hopper will permit the pressure in the chamber between the bells to equalize with that in the furnace top very rapidly—in say 2 or 3 seconds—provided that said chamber is sealed off from the atmosphere or from other areas of lower pressure. But the prior practices fail to provide such sealing.

To be sure, special constructions or procedures may be employed to strengthen the bell against warping, or to harden or otherwise treat the surfaces which are subject to abrasion. It might also be possible to provide means for the removal of pieces of the charge which lodge between the contacting surfaces. However, the use of the present invention makes it possible to provide for efficient and satisfactory operation of furnaces under high top pressures, whether or not any of such special constructions or procedures are used. In other words, the present invention is well adapted for use in furnaces having conventional construction of bells and hoppers.

2

While the present invention is primarily of value in the operation of furnaces under high top pressure—e. g. from about 5 p. s. i. to several atmospheres, gauge—it may also be used to advantage with furnaces operating at normal top pressures, since even with a top pressure of about 2 p. s. i. gauge, the pressure differential between the opposite sides of either bell may be sufficient to prevent its dropping readily.

The system of the present invention provides a simple and easily operated method and arrangement for supplying gaseous pressure to, and removing it from, the chamber between the bells, independently of whether or not the lower bell seats tightly against its hopper. This system substantially eliminates abrasion of the contacting surfaces of the lower bell and hopper by escaping abrasive-laden gases, and also reduces the discharge of dirty gas to the atmosphere. The abrasion of these contacting surfaces becomes a serious problem when operating the furnace under high top pressure, since it causes these surfaces to wear away very rapidly, thus not only requiring frequent costly replacement but also, unless the furnace top is especially constructed, venting gases to the atmosphere with consequent hazard to personnel and spreading of dust into the atmosphere.

A more complete understanding of the present invention may be had from the accompanying drawings of which Fig. 1 shows more or less diagrammatically a side elevational view, largely in section, of the top of a blast furnace with associated bells, hoppers, and conduits for gases, and Fig. 2 shows a portion of a pressure chart. In Fig. 1, numeral 10 represents the furnace top, which is provided with lower hopper 12, which is normally closed by lower bell 14 supported by rod 16. Above the lower hopper and bell is positioned the upper reeciving hopper 18, which is adapted to rotate in the usual maner and is normally closed by upper bell 20 supported by rod 22. These bells are raised and lowered by their associated rods in the usual manner, and are charged by skip 24, also conventionally. Between the two bell-and-hopper pairs aforesaid is chamber 26, which is provided around its top with annular sealing means 27 against the escape of gases from the chamber 26 to the atmosphere through the narrow space between the chamber top and the sides of the rotating hopper 18. Communicating with the chamber 26 is equalizer line 28 controlled by equalizer valve 30. Also communicating with said chamber 26 is relief line 32 controlled by valve 34. There may be one or more of

each of lines 28 and 32, but for brevity and convenience only one of each is shown. Equalizer line 28 leads from a conduit 36, which conducts cleaned washed gas from a conventional gas washer (not shown) and vents said gas to the atmosphere via bleeder valve 38—which is set to open at a predetermined pressure—thereby discharging clean gas (rather than dirty gas, as is customary) during surges of pressure resulting from slips and rolls during the furnace operations, whenever these surges result in pressures exceeding that at which bleeder valve 38 is set. A more detailed showing of this operation of conduit 36 may be found in the copending application of LeViseur and Larson, Serial No. 771,870, filed September 3, 1947, now U. S. Patent 2,585,800, but is not necessary for a complete understanding of the present invention. Suffice it to say that equalizer line 28 is provided with a supply of cleaned washed gas at very nearly the same pressure as that of the gas within the top of furnace 10. The difference in pressure between the furnace top gases and those in conduit 36 is due merely to the loss of energy of the gases in moving from the furnace top through the dust catcher, wet washer, and associated conduits; this pressure difference is usually about 1 p. s. i., and in any event not more than about 1.5 p. s. i.

Valves 30 and 34 are shown as conventional valves. While they may be operated manually, in practice they are operated by pulleys or other connections running to a control station at the base of the furnace, from which station the bells are also operated. In accordance with modern blast furnace practice, the operation of the bells and of the valves is carried out and controlled from this control station. By making suitable changes in the control mechanism at that station, the sequence and timing of the valve and bell operations may be changed to suit desired conditions. Since various types of control mechanism for these purposes are well known, they need not be detailed here.

The operation of the above-described apparatus is as follows, starting with both bells empty and in closed position, and both equalizer valve 30 and relief valve 34 closed; Hopper 18 is charged from skip 24, and rotated as necessary; relief valve 34 is then opened, thereby equalizing the pressure between chamber 26 and the atmosphere, and then the upper bell 20 is immediately lowered to dump its load into lower hopper 12. Bell 20 is then raised to seat against hopper 18, and relief valve 34 is closed, substantially simultaneously. This sequence is repeated as often as necessary (say 6 to 8 times) to provide an adequate body of charge in lower hopper 12. If, during this sequence, lower bell 14 is seated tightly against its hopper 12, the pressure within chamber 26 will remain substantially at atmospheric pressure. However, if lower bell 14 is not tightly seated, the pressure within chamber 26 will rise quickly, after each closing of bell 20 and relief valve 34, to substantially that within the top of furnace 10. Under such circumstances, said pressure will be reduced to atmospheric each time valve 34 is opened, thereby venting gas to the atmosphere. While this gas was originally dirty, the coarser dirt will have settled during the time valve 34 is closed, so that the gas discharged will not be as dirty as that from conventional bleeding operations wherein the gas comes directly from within the furnace top.

As soon as there is an adequate body of charge in lower hopper 12, equalizer valve 30 is opened, relief valve 34 remaining closed. If the seating between lower bell 14 and its hopper 12 is poor, substantially no gas will flow into chamber 26 from equalizer line 28 as the pressure in the latter will be substantially the same that in the former and that in the top of the furnace. However, if said seating is good, cleaned washed gas will flow into chamber 26 from line 28 to equalize the pressure between chamber 26 and that in the top of the furnace. Bell 14 is then immediately lowered, to drop its charge into the furnace, and then raised, after which equalizer valve 30 is closed. The pressure within chamber 26 is then, of course, substantially the same as that in the top of the furnace. The foregoing entire cycle is then repeated throughout the operation of the furnace.

The advantages of the procedure of this invention over the presently-used sequence of operations, which are exemplified by Whitcomb, supra, are made even more evident by the data shown on the pressure chart of Fig. 2. This chart was prepared by attaching a recording pressure gauge to the bell chamber 26 to record the pressures therein when operating in accordance with the present invention. On the chart, time divisions are shown by curved radii, and pressure divisions by circles starting with zero gauge at the circumference of the chart and rising uniformly to 20 p. s. i. gauge at the inner circle. The chart covers a representative operating period of about 5½ hours, in a furnace operating at 10 to 11 p. s. i. gauge top pressure and with a cycle of seven dumpings of the upper bell for each dumping of the lower bell. As is evident from the chart, by the peaks designated A, the pressure in chamber 26 is at the pressure within the furnace top—i. e. 10 to 11 p. s. i. gauge—at each dropping of the lower bell (which as seen from the chart averages about once every 14 minutes). When the lower bell is closed, and seated tightly against its hopper, the pressure in chamber 26 remains at substantially atmospheric pressure during the cycle of upper-bell dumpings between dumpings of the lower bell—as shown by the relatively constant-pressure lines at the places designated B, at approximately the 1 p. s. i. line. On the other hand, when the lower bell seats poorly, the pressure in chamber 26 rises to substantially that in the furnace top between each dumping of the upper bell. This is shown clearly in areas C, D and E of the chart. Thus, after the 2:14 dumping of the lower bell, the seating was poor due no doubt to the lodging of a chunk of charge between the contacting surfaces of the lower bell and its hopper. This poor seating resulted in substantial equalization of pressure between the furnace top space and chamber 26, which pressure was relieved at each opening of relief valve 34 and reestablished at each closing of said valve, as shown by the pressure lines in area C. A similar situation occurred at the 3:10 dumping of the lower bell (area D), and at several dumpings beginning with that at 4:50 (area E). Had relief valve 34 remained open at these times, as in present practice, the abrasive dust-laden gases from the furnace would have poured out continuously through relief valve 34, thereby rapidly eroding the facing surfaces of lower bell 14 and its hopper 12, as well as valve 34 and line 32.

That these conditions as shown at areas C, D and E were a result of lodgement of charge between the contacting surfaces of the lower bell

and its hopper, and not because of any wearing or out-of-roundness of either bell or hopper, is evident from the fact that at areas B, the lower bell and hopper seal was substantially perfect.

The seal may also be intermediate between good (areas B) and poor (areas C, D and E)—as for example at area F, where the seal may have been fairly good but not perfect, and at area G, where the seal may have been poorer but not as bad as at C, D and E. On the other hand, intermediate pressures in chamber 26 such as those shown at areas F and G may occur when the lower bell seats poorly, and at the same time there is undesirable leakage from the chamber 26 to the atmosphere—e. g. because of ineffective sealing at the seal 27 between the chamber top and the rotating upper hopper 18.

The periods of dwell shown at points H are due to longer-than-usual times between successive dumpings of the upper bell.

Although the present invention has been described in its preferred embodiment, modifications within the scope of the appended claims will be evident to those skilled in this art.

I claim:

1. The method of charging a blast furnace which is operating under high top pressure, said furnace being provided with a top having a single bell chamber provided with a single upper bell and a single lower bell, which comprises the steps of supplying charge to said upper bell, equalizing the pressure between said chamber and the atmosphere and then while said pressure is equalized immediately opening the upper bell to discharge its load into said chamber, then closing said bell and substantially simultaneously shutting off communication between said chamber and the atmosphere, entrapping within said chamber gases escaping from the furnace top into said chamber through any cracks and worn places in the seat between said lower bell and its hopper when both of said bells are closed, repeating said steps until an adequate body of charge has accumulated in said chamber, said lower bell remaining closed during the aforementioned steps, then, immediately prior to opening the lower bell and while the upper bell is closed, putting said chamber into communication with a source of gas at a pressure substantially equal to, but not greater than, the pressure in the furnace top, opening the lower bell to discharge its load into the furnace while maintaining said communication open and said upper bell closed, closing said lower bell and thereafter cutting off said communication with said source of gas, and thereafter repeating the entire series of steps hereinabove set forth.

2. The method of claim 1 wherein the gas in said source of gas is clean washed gas from the furnace top.

WARING LENNOX DAWBARN.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,727,100	Edwards	Sept. 3, 1929
2,131,031	Avery	Sept. 27, 1938
2,192,885	Avery	Mar. 12, 1940
2,200,488	Clemmitt et al.	May 14, 1940
2,408,945	Mohr et al.	Oct. 8, 1946
2,411,487	Whitcomb	Nov. 19, 1946
2,516,190	Dougherty et al.	July 25, 1950

FOREIGN PATENTS

Number	Country	Date
502,942	Great Britain	Mar. 28, 1939

OTHER REFERENCES

J. H. Slater: "Blast Furnace Practice Under High Pressure Operation" Steel, June 9, 1947, pages 102–104, 106.