Oct. 8, 1946. A. MOHR, JR., ET AL 2,408,945

BLAST FURNACE CHARGING SYSTEM

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Fig. 2.

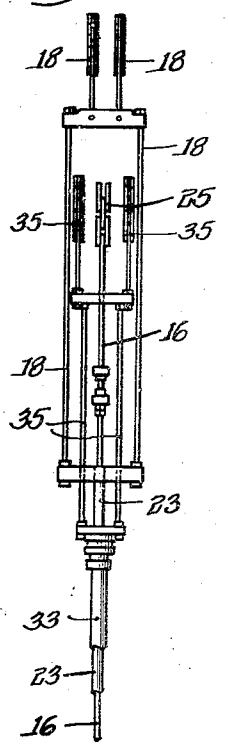


Fig. 1.

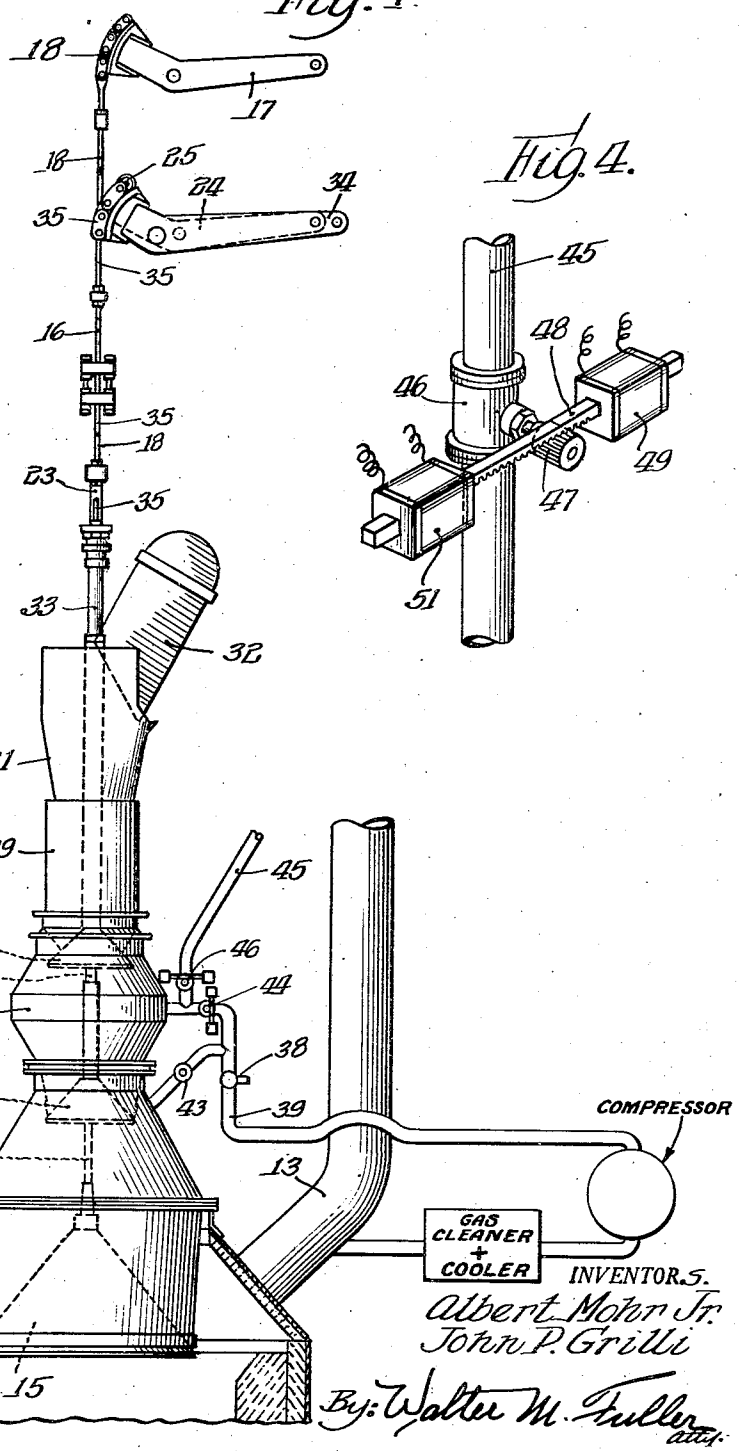


Fig. 4.

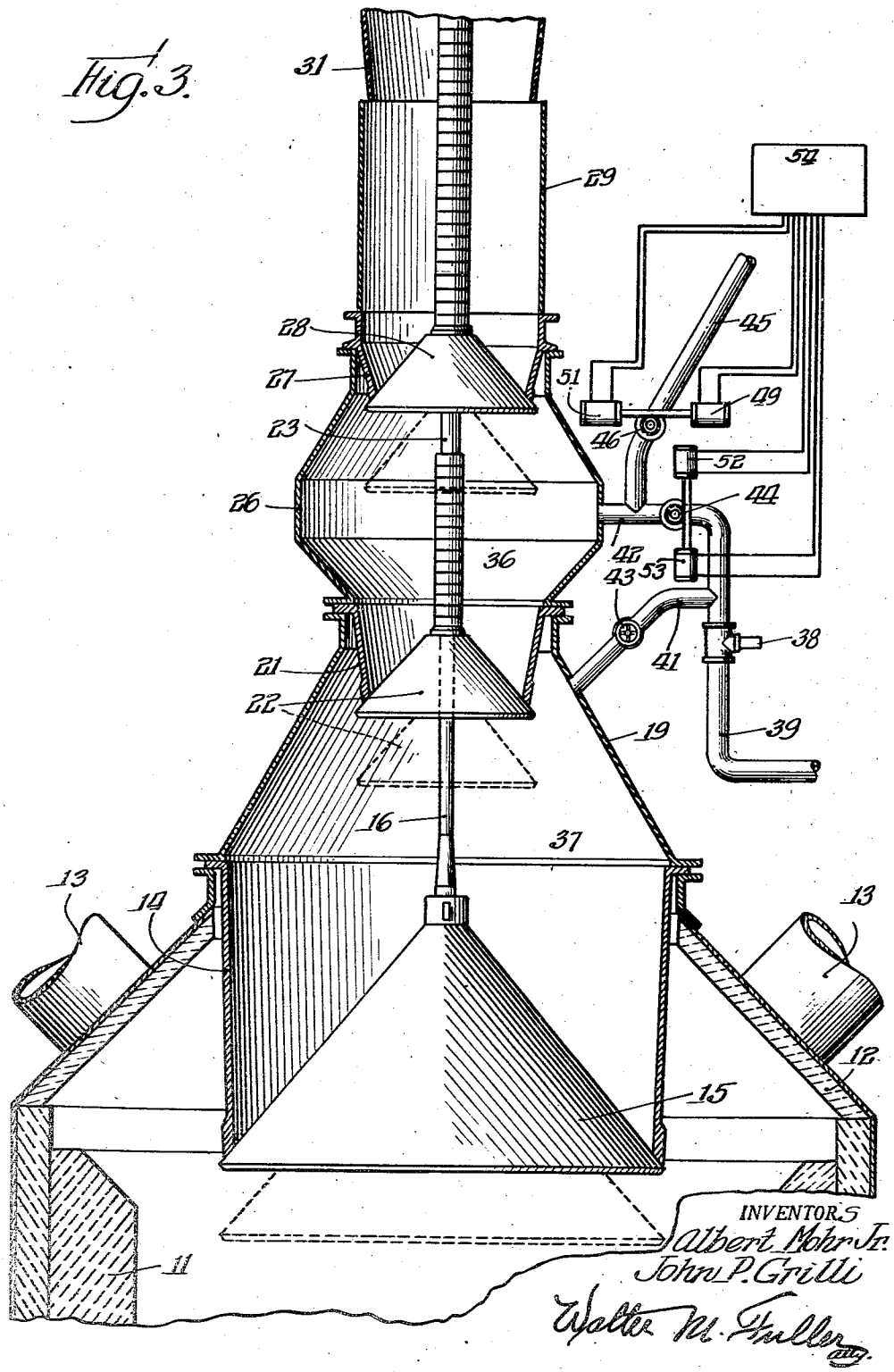
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Fig. 3.



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BLAST-FURNACE CHARGING SYSTEM

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8 Claims. (Cl. 266—27)

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Heretofore, iron blast-furnaces have incorporated an upper, material-receiving and distributing-hopper, its companion conical bell intermittently closing and opening the bottom of such hopper, automatic means to actuate such bell, a lower larger discharge-hopper at the top of the furnace adapted to receive the material delivered to it from such upper hopper and to dump it into the top of the furnace, a similar bell coacting with such large hopper, and means to open the bell intermittently automatically for the delivery of the material into the furnace, such a furnace ordinarily operating at an internal pressure in its upper portion of about one-half pound to about one and one-half pounds per square-inch.

Recently, it has been discovered that the functioning of such a blast-furnace can be materially improved by increasing the gas pressure in the top portion of the furnace to from about 10 lbs. to 20 lbs. per square-inch, but, when it was attempted to work such old style blast-furnace at the indicated higher pressure, the conditions of operation were so changed, due in part to the gases and to the large amount of extremely abrasive dust in them, that it was impossible to have the furnace perform satisfactorily.

The outstanding difficulties encountered were in large measure due to the warping of the lower, big discharge-hopper and of its companion bell, cutting of the coacting seating-surfaces of such hopper and its bell, and, due to the damage and warping of these seating-surfaces, gas-leakages developed between the bell and hopper making it practically impossible to dump the material effectively off the small bell of the upper hopper on to the lower large bell.

In some cases, a gas connection was installed to equalize the gas pressures below and above the big bell, which equalizer line would be closed to shut off the supply of gas and automatic means were provided to relieve the pressure between the small bell and the large bell, whereupon it was then possible to open the small bell and dump the contents of its hopper into the lower hopper, which dumping action consumes about ten seconds, then the bell is held in its dumping position for about the succeeding ten seconds in order that all material may slide off the upper hopper, and then the bell is closed consuming an additional ten seconds.

In the course of a day the small bell of a blast-furnace is opened and closed approximately 1152 times consuming about 576 minutes of the day, and, during these periods, the seating-junction between the large bell and the large hopper is subjected to a differential pressure of about 10 lbs. or more per square-inch.

From calculations, any openings, passages or leakages between such large bell and its hopper are scoured with heavy abrasive hot gases traveling at a speed of about 1200 ft. per second and it

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will be readily appreciated that this dirty gas can cut and injure steel, such as that of the hopper and bell, almost as rapidly as a cutting torch.

Supplementing the above-mentioned difficulties of these earlier systems are those due to the large and irregular sections of the big bell and hopper which cannot be designed and constructed of a uniform metal thickness due to their great size and weight, these large bells being from about 14 ft. to 15 ft. in diameter and varying in thickness from six inches to two inches, the complementary large hoppers ranging in diameter from 13 ft. to 15 ft. and being approximately 10 ft. to 13 ft. high.

As these large and heavy castings are subject in operation to varying unpredictable temperature cycles, their shapes are constantly changing, and also, as a result of these temperature modifications, the bell and associated hopper are not expanding and contracting symmetrically with each other and therefore their seating-surfaces are never tight.

In view of all of the above damaging factors and difficulties, it was impossible to have an operating period of the furnace of longer than five days without shut-downs for repairs and minor changes to equipment, and finally, the furnace top charging-apparatus reached such a stage of damage and injury that it was necessary to take the furnace off and make major repairs to the charging-equipment.

The present innovatory, improved and advantageous charging-system constituting the subject matter of this invention, on the other hand, is capable of operating for relatively-long periods of time with none of the serious difficulties which were heretofore experienced.

In order that those skilled in this art may have a full understanding of such invention, both from structural and functional standpoints, a present preferred embodiment of the invention is disclosed in the novel construction and system illustrated in the accompanying drawings, forming a part of this specification, and to which reference should be had in connection with the following detailed description, and, for simplicity, like reference numerals have been employed to designate the same parts of the structure throughout the several views.

In these drawings:

Figure 1 is an elevation of the novel blast-furnace charging-system;

Figure 2 is a side view of the upper portion only of the structure illustrated in Figure 1;

Figure 3 is a larger-scale, fragmentary, vertical section through the portion of the charging-equipment incorporating the present invention; and

Figure 4 illustrates one of the means for auto-

matically operating the valves of the new part of the system.

The upper portion of the blast-furnace has been designated by the reference numeral 11, its cone top by the numeral 12, and the discharge-flues for the hot abrasive gases have been denominated 13, 13.

The bottom of the huge, lower discharge-hopper 14 is normally closed by the massive conical-bell 15, the contacting bottom edge of the hopper and the marginal portion of the upper surface of the bell constituting the pressure-sealing means between those parts, such bell, as is usual, being automatically, intermittently lowered and raised to open and close it, respectively, by a rod 16 secured to the top of the bell and actuated by a lever 34 and connecting mechanism 25 all of usual and ordinary construction and mode of operation.

The top of such hopper 14 is normally closed by a truncated conical-shell 19, an intermediate hopper 21 and its bell or valve 22, raised and lowered at intervals, as indicated by dotted lines in Figure 3, by a hollow rod 23, accommodating the rod 16 inside of it, such rod 23 being actuated in well known manner up and down by a lever 17 and connecting means 18.

Above hopper 21 is a shell 26 at the top of which is an upper, rotary, receiving and distributing hopper 27, the bottom of which is ordinarily closed by a companion conical-bell 28, such hopper and shell being in pressure-tight relation with one another, and over hopper 27 is another shell 29 receiving material from above through a hopper 31 into which the skip-tub 32 intermittently and automatically delivers its charges or loads of material.

Such bell 28 is moved up and down, to close and open it, and it also rotates intermittently with its hopper, such vertical movement being brought about by its hollow supporting rod 33 actuated by its levers 24 and connecting means 35, all of such mechanism being well known in the art.

As will be readily understood, the space between the bells 22 and 28 constitutes an upper chamber 36 and the space between the large lower bell 15 and the intermediate bell 22 comprises a lower chamber 37.

By means hitherto in common use, shown diagrammatically in Figure 1, at least some of the hot, abrasive and grinding gases leaving the furnace through the outlet conduits 13, 13 are washed to free them from their scraping and rasping constituents and are cooled and are then compressed to about one pound greater pressure per square-inch than the specified gas pressure in the top portion of the furnace. Such cleaned, cooled, compressed gas is delivered through a pipe 39 and a pressure regulator 38, which maintains the gas at such one pound superpressure, into branched pipes 41 and 42. The former is lead into the top portion of chamber 37, and the latter connecting with the interior of chamber 36, pipe 41 being supplied with a manually-operated normally-open valve 43 which is closed only in case the furnace is shut down or under emergency conditions. Pipe 42 is equipped with an electrically opened and closed valve 44, and also fitted with the discharge pipe 45 to the external atmosphere, and provided with an electrically-operated valve 46.

Valve 46 is opened and closed by its gear 47 meshing with a rack 48 equipped with complementary electro-magnets 49 and 51, the one when

active opening the valve, and the other when supplied with current closing the valve.

Valve 44 is of like construction having its pair of companion magnets 52 and 53.

The rotation of hopper 27, the operation of its bell 28, and the actuation of the larger bell 15 are all brought about by the commonplace method employing the well-known electric equipment including correct timing means represented in general or conventionally by the part characterized 54 in Figure 3.

Inasmuch as the opening and closing of the new intermediate bell 22 is effected by like or comparable means, it is unnecessary to illustrate it since it is in common use in the art in association with other bells and those skilled in this industry will encounter no difficulty in providing it.

In addition, the two valves 44 and 46 are operated by electric-currents controlled as to their actions and timing by the same known and conventional relay mechanism 54, although in its broadest aspect the invention includes any manner of actuating the valves as referred to hereinafter.

The cycle of operation of this new and improved furnace charging-system is as follows:

The material to be fed or delivered into the furnace at intervals is carried up to the top of the furnace in the skip-bucket 32 which dumps it into the topmost introductory-hopper 31 from which it falls by gravity into the then bell-closed receiving and distributing hopper 27 which is thereupon rotated a fixed number of degrees, for example 60°, and then stops.

By the automatically-operated electric means referred to, the previously-open valve 44 is then closed and valve 46 is opened, this causing an equalization of the pressures in hopper 27 and in chamber 36 allowing the distributor small-bell 28 to be opened, which takes place, and the contents of hopper 27 dumped into hopper 21 on top of its closed bell 22.

Valve 46 now closes and valve 44 opens thus equalizing the pressures above and below bell 22 whereupon the latter opens and delivers the contents of its hopper 21 on to the closed bell 15 in the lower hopper 14, it being remembered that the gas pressure in hopper 14 is always about one pound greater than that in the top of the furnace into which its contents are discharged.

After having thus dumped the material in hopper 21 into hopper 14, bell or valve 22 closes ready to receive its next load during the subsequent opening of bell 28.

Usually eight skip-loads of material are thus charged and delivered sequentially on the large bell 15 in different angular locations thereon before such large bell is opened to discharge such plurality of accumulated skip-loads into the top of the furnace.

As can be well appreciated from what has been stated above relative to the cycle of operations, the space enclosed by the large bell 15 and its hopper 14 is always at a slightly greater clean and cool gas pressure than that in the furnace. By reason of any poor or defective seating between the large bell and its hopper, the downward gas-leakage will be relatively-cool, non-abrasive, inert gas into the furnace whereby comparatively hot abrasive gas will, therefore, not come into contact with any of the charging-equipment and abradant-uncontaminated compressed gas only will leak into the furnace. This prevents injury to, or destruction of, the pressure-sealing surfaces between the bell and hopper of

the final dumping structure. The gas used for this purpose being inert prevents combustion from taking place in the spaces between the bells and in the top part of the furnace.

In this connection it may be noted that no two of the three hopper bells are open at the same time.

Those acquainted with this art will readily understand that the present invention, as defined by the appended claims, is not necessarily limited and restricted to the precise and exact details of structure and function described and illustrated, and that reasonable modifications may be availed of without departure from the heart and essence of the invention and without the loss or sacrifice of any of its material benefits and advantages.

We claim:

1. In a blast-furnace charging-system having an upper receiving-hopper internally at atmospheric-pressure, its cooperating bell, actuating-means opening and closing said bell intermittently, a lower delivery-hopper and its bell discharging into the top of the furnace, operating-means opening and closing said delivery-hopper bell intermittently, a conduit connecting said hoppers together, and means to feed charging material into said receiving-hopper intermittently, the novel improvement of the combination of means including a valve-construction in said conduit dividing said conduit into an upper chamber and a lower chamber, the latter including said delivery-hopper, means to open and close said valve-construction intermittently, means to feed substantially-nonabradant inert gas under pressure into said lower chamber and maintain the gas-pressure in said lower chamber at all times greater than the gas-pressure in the top portion of the furnace, means to feed substantially-nonabradant inert gas under said specified pressure into said upper chamber, means controlling said gas fed into said upper chamber to maintain equalized gas-pressures on opposite sides of said valve prior to and during the open condition of the latter, means connecting said upper chamber to the external-atmosphere, and means controlling the passage of gas from said first chamber to the atmosphere to provide atmospheric-pressure in said upper chamber on the underside of said receiving-hopper bell prior to and during the open condition of said bell.

2. The novel combination in a blast-furnace charging-system set forth in claim 1, in which said valve-construction includes an intermediate-hopper and its bell discontinuously receiving the charging material discharged from said receiving-hopper and interruptedly dumping it into said delivery-hopper.

3. In the charging-system of a blast-furnace operating under a gas-pressure in its top portion of from about 10 lbs. to about 20 lbs. per square-inch, said charging-system having an upper receiving-hopper internally at approximately atmospheric-pressure and its bell, actuating-means intermittently opening and closing said bell, a lower delivery-hopper and its bell discharging into the top portion of the furnace, a conduit connecting said hoppers together, and means to feed charging material intermittently into said receiving hopper, the novel improvement of the combination of an intermediate-hopper and its bell in said conduit between said hoppers and dividing said conduit into an upper chamber and a lower chamber, the latter including said delivery hopper, said intermediate-hopper and its bell acquiring its material from said receiving-hopper and discharging it into said delivery-hopper, means to intermittently open and close said intermediate-hopper bell, means to deliver substantially-nonabradant inert gas at about one-pound pressure per square-inch greater than that in the top portion of the furnace into said lower chamber and maintain said specified gas-pressure therein during the operation of the furnace, means to feed substantially-nonabradant inert gas under said specified one-pound excess pressure into said first chamber, means to control the feed of said gas into said first chamber to equalize the pressures on the opposite sides of said intermediate-hopper bell prior to its opening and while it remains open, means connecting said upper chamber to the external-atmosphere, and means controlling the passage of gas therethrough to the atmosphere to provide substantially atmospheric gas-pressure in said first chamber prior to the opening of said receiving-hopper bell and while the latter is open.

4. The novel improvement in a blast-furnace charging-system set forth in claim 3, in which said one-pound excess pressure gas is hot abrasive gas from the top portion of the furnace freed from its abrasive media, cooled and compressed.

5. In a blast-furnace charging-system of known type having an upper receiving-hopper and its bell, actuating-means opening and closing said bell intermittently, a lower delivery-hopper and its bell discharging into the top of the furnace, and operating-means opening and closing said delivery-hopper bell intermittently, the novel improvement of means for continuously maintaining the interior of said delivery-hopper with substantially-nonabradant inert gas at a super-atmospheric pressure at least equalling that in the top of the furnace during the operation of the latter.

6. The novel improvement in a blast-furnace charging-system set forth in claim 5, in which said gas under pressure is hot abrasive gas from the top portion of the furnace freed from its abrasive properties, cooled and compressed.

7. In a blast-furnace charging-system of known type having an upper receiving-hopper and its bell, actuating-means opening and closing said bell intermittently, a lower delivery-hopper and its bell discharging into the top of the furnace, and operating-means opening and closing said delivery-hopper bell intermittently, the novel improvement of means for continuously maintaining the interior of said delivery-hopper with substantially-nonabradant inert gas at a super-atmospheric pressure at all times greater than the gas-pressure in the top portion of the furnace during operation of the latter.

8. In a blast-furnace charging-system of known type having an upper receiving-hopper and its bell, actuating-means opening and closing said bell intermittently, a lower delivery-hopper and its bell discharging into the top of the furnace, and operating-means opening and closing said delivery-hopper bell intermittently, the novel improvement of means to maintain at all times a pressure in said delivery-hopper with substantially-nonabradant inert gas at a pressure about one pound greater per square-inch than the super-atmospheric pressure per square-inch in the top portion of the furnace during the operation of the latter.

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