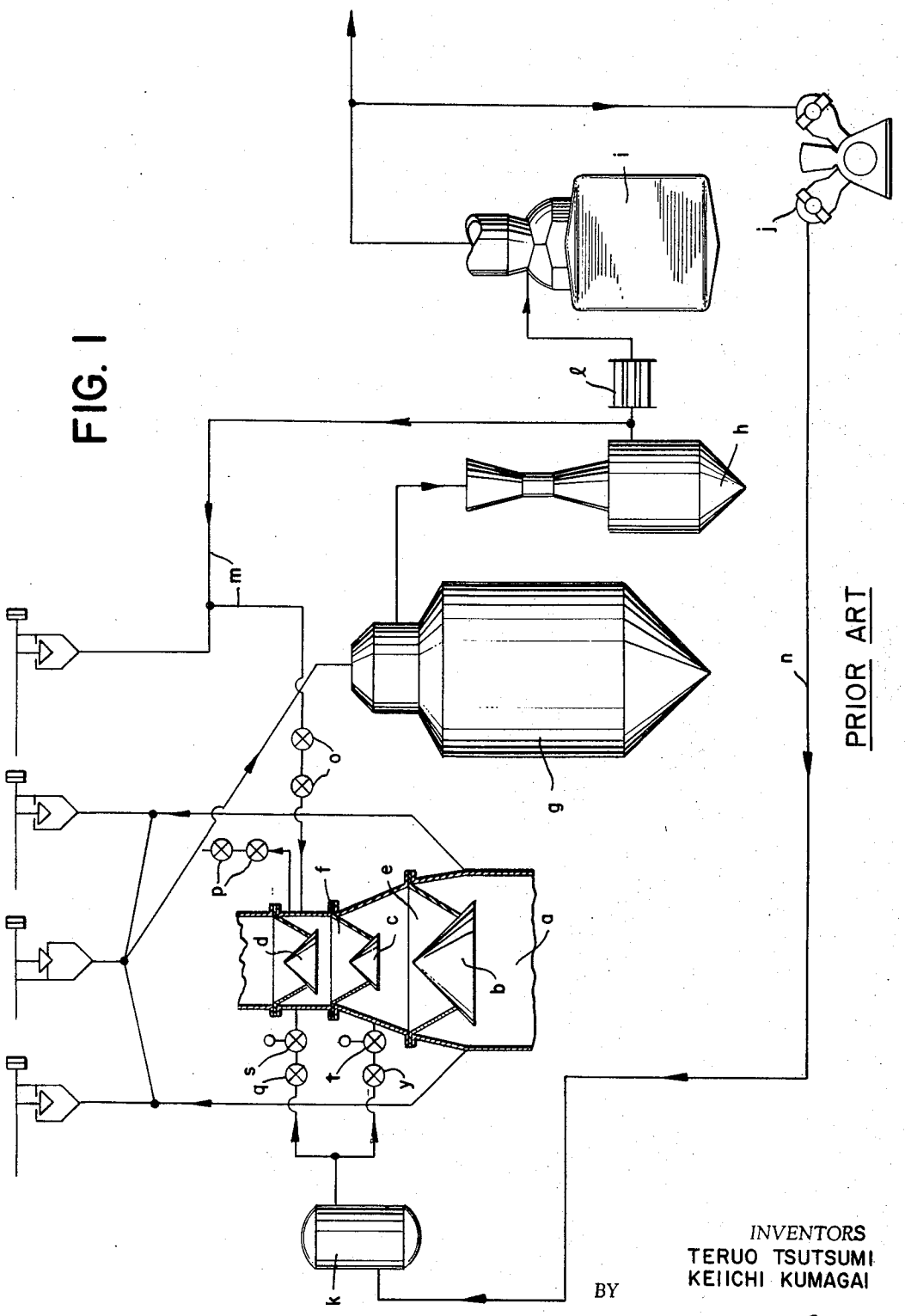
Sept. 26, 1967 TERUO TSUTSUMI ET AL 3,343,825

PRESSURE EQUALIZER AND DISCHARGER OF A BLAST FURNACE

Filed Oct. 1, 1964 2 Sheets-Sheet 1

FIG. 1



PRIOR ART

INVENTORS
TERUO TSUTSUMI
KEIICHI KUMAGAI

BY

Nolte and Nolte
ATTORNEYS

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Filed Oct. 1, 1964 2 Sheets-Sheet 2

FIG. 3

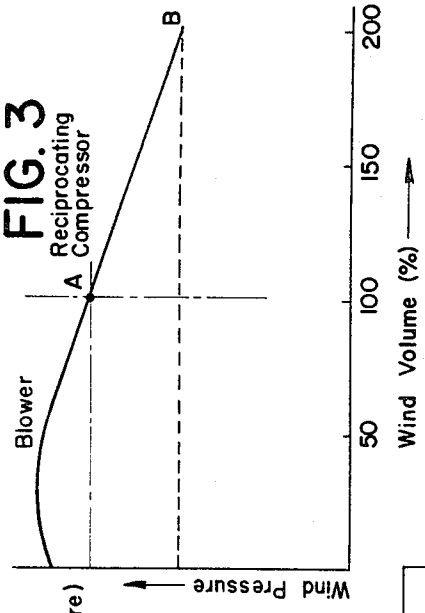


FIG. 2

INVENTORS
TERUO TSUTSUMI
KEIICHI KUMAGAI

BY

Nolte and Nolte
ATTORNEYS

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PRESSURE EQUALIZER AND DISCHARGER OF A BLAST FURNACE

Teruo Tsutsumi, Yokohama-shi, and Keiichi Kumagai, Kawaguchi-shi, Japan, assignors to Ishikawajima-Harima Jukogyo Kabushiki Kaisha, Tokyo-to, Japan, a company of Japan

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10 Claims. (Cl. 266—27)

ABSTRACT OF THE DISCLOSURE

An axial-flow or centrifugal turboblower with a discharge pressure control means installed between the primary dust catcher and the bell hopper apparatus of a blast furnace to prevent a fluctuation of a gas leakage from a contact surface of the bell cup. Futhermore, a new method of controlling the primary equalizer valve and the secondary equalizer valve to introduce a great deal of the unboosted gas from the primary dust catcher into the bell hopper and to prevent it from flowing wastefully to the side of the primary dust catcher, is described.

Of late, the so-called "high top pressure" operation, in which the pressure in the furnace top is kept high, has been introduced. In the said operation, when the burden is charged into the furnace, the blast gases half filtered by means of the primary dust catcher fill the large bell hopper between the large bell and the small bell positioned above said large bell, making the pressure in the hopper equal to that in the furnace, before the said large bell is opened. This process is known as the pressure equalization. At this time, the pressure of the said gases is lower than the pressure at the furnace top (the pressure below the large bell) owing to the pressure loss in the primary dust catcher. As the result, such troubles are experienced as follows:

(i) The pressure below the large bell being higher by 500 to 2000 mm.Aq. (mm' Water Column) than the pressure above it, the hot gases (200° to 500° C.) at the furnace top, which contain the dust of about 20 gr. per 1 Nm^3, flow upward into the large hopper through the gap between the large bell and the cup, causing the continual frictional erosion on the seats of the large bell and cup.

(ii) As generally known as the "pressure discharge," the gases in the large bell have to be discharged into the atmosphere to make the pressure in the large bell hopper equal to that of atmosphere before the small bell is lowered. During the process, the pressure difference above and below the large bell becomes equal to that between the pressure at the furance top (usually 0.7 to 1.0 kg./cm.^{2}G.) and the pressure of atmosphere (0 kg./cm.^{2}G.). As the said gases flow through the gap between the large bell and the cup into the large bell hopper as fast as, or a little slower than, the sound, the seats of the large bell and the cup are subjected to the severe frictional erosion, the period of such erosions lasting as long as about ¼ of one input cycle.

To remove such troubles as are mentioned in (i) and (ii), a reciprocating compressor has been employed so as to boost the filtered gases through the secondary dust catcher, and the boosted gases are ushered to the furnace top for the cancellation of the said pressure difference, or as an alternative the pressure above the large bell is raised a little by some means or other. Thus, the large bell is saved from said erosion. Still further known alternative has been devised as shown in FIG. 1, in which the three bells are equipped so as to avoid completely the pressure above the large bell getting reduced to that of atmosphere,

and thus it becomes possible by means of the pressure equalizer and discharger to prevent the said frictional erosion on the seat of the large bell and the cup.

The operation of the said pressure equalizer and discharger will be explained with respect to FIG. 1. In the drawings

FIG. 1 is the schematic representation of the conventional pressure equalizer and discharger applied to the triple bell distributor.

FIG. 2 is the schematic representation of the new pressure equalizer and discharger according to the invention, as applied to the triple bell distributor.

FIG. 3 shows the relation between the pressure and volume of the blast air when the reciprocating compressor and the turbo blower are employed.

In FIG. 1, *a* shows the blast furance; *b*, large bell; *c*, middle bell; *d*, small bell; *e*, large hopper; *f*, middle hopper; *g*, dry dust catcher; *h*, primary dust catcher; *i*, secondary dust catcher; *j*, reciprocating compressor; *k*, gas receiver; *l*, septum valve; *m*, primary equalizer pipe; *n*, secondary equalizer pipe; *o*, primary equalizer valve; *p*, discharge valve; *g* and *y*, secondary equalizer valves; *s* and *t*, pressure control valve.

The gases of the blast furnace *a* purified by means of the secondary dust catcher *i* are compressed to the extent of 7 kg./cm.^{2} by the reciprocating compressor *j* and stored in the receiver *k*, which is positioned near the furnace top. To drop the burden, which is charged on to the small bell *d* from the hoisting equipment, (not shown) on to the middle bell *c*, the primary equalizer valve *o* (ON-OFF valve) for the middle hopper *f* is at first closed so as to stop the charge of the high pressure gases, and then the discharge valve *p* is opened to blast out the gases from the middle hopper *f* into the atmosphere, removing the pressure difference above and below the small bell *d*, before the said small bell *d* is opened.

Then, after the discharge valve *p* is closed, the primary pressure equalizer valve *o* is opened; the gases half purified through the primary dust catcher *h* are ushered into the middle hopper *f* to fill it until the pressure in the said middle hopper *f* reaches that of the half purified gases (lower than that of the furnace top by 500 mm.Aq. to 2000 mm.Aq.); and the primary pressure equalizer valve *o* is closed. Then, the secondary equalizer valve *q* (ON-OFF valve) for the middle hopper *f* is opened to usher the high pressure gases from the receiver *k*, and after adjusting by means of the pressure control valve *s* the pressure in the middle hopper to that in the large hopper *e*, the middle bell *c* is lowered to drop the burden on to the large bell *b*. The said equalizer valve *q* is kept open till the small bell *d* is lowered, while the control valve *s* continues its function to maintain the pressure in the middle hopper *f* at the same level as that of the large hopper *e*. The pressure equalizer valve *y* for the large hopper *e* is kept open during the above mentioned process, so the pressure control valve *t* for the large hopper *e* induces the high pressure gases into the large hopper *e* and continues to regulate the pressure in the large hopper *e* to the level of the furnace top pressure or a little higher.

The pressure equalizer valve *y* for the large hopper *e* is closed when the large bell *b* is lowered to charge the burden into the furnace *a*, and after this the pressure equalizer valve *y* for the large hopper *e* is opened again, and the control valve *t* carries out its function.

When the pressure equalizer and discharger is applied to the triple bell distributor as shown in FIG. 1, the pressure in the large hopper *e* is constantly adjusted to that of the furnace top or a little higher than the latter and the purpose to protect the large bell *b* against the gases of the furnace top is attained as has been described above; however, some problems still remain to be solved.

(i) The gas leakage from the seats of the bells or the cups of the furnace can not be prevented because of their structure. Owing to the advance of the friction caused by the passing burden and by the gas cut, the gas leakage increases progressively, consequently the reciprocating compressor, which supplies gases, cannot keep pressure in the large or the middle hopper high enough to compensate an eventual excessive leakage, and a great pressure difference results above and below the large or the middle bell. Thus, the large or the middle bell can not be opened, and finally the charging operation must be suspended.

(ii) The reciprocating compressor, due to its structure, is sensitive to the moisture and the dust contained in the gases; therefore, the highly compressed half purified gases, usual pressure 0.8 kg./cm.^{2} to 0.5 kg./cm.^{2} must be boosted as high as that of purified gases usually below the level of 500 mm.Aq., to draw them in. Moreover, the volume of the sucked gases per unit weight is so large that the power and accordingly the consumption of the compressor must be proportionately increased.

(iii) As the filtered gases are compressed to 7 kg./cm.^{2} by the reciprocating compressor and reduced to the level of about 0.5 kg./cm.^{2} to 1.0 kg./cm.^{2} by the control valve to be charged to the large and the middle hoppers, the amount of gas leakage varies as previously mentioned; therefore, it is hard to assure satisfactory regulation by the control valve of the particular size, and the range of the pressure fluctuation in the said hoppers is excessively large.

(iv) As the pressure of the filtered gases, which are stored in the receiver, is kept as high as at 7 kg./cm.^{2} in order to shorten the period of said pressure equalization above and below the middle bell before the bell is lowered, though the pressure about 0.5 to 1.0 kg./cm.^{2} is adequate to fill each hopper, an extra power is wanted.

The purpose of the present invention is to eliminate such shortcomings that accompany the use of the reciprocating compressor as well as the provision of highly reliable pressure equalizer and discharger for the high top pressure operation of the blast furnace at low cost.

Now in the following description an example of the present invention is explained with respect to FIGS. 2 and 3.

FIG. 2 shows one embodiment of the present invention applied to the blast furnace with the triple bell distributor. In the said figure, **1** refers to the blast furnace; **2**, large bell; **3**, middle bell; **4**, small bell; **5**, large hopper; **6**, middle hopper; **7**, dry dust catcher; **8**, primary dust catcher; **9**, secondary dust catcher; **10**, turbo-blower; **11**, septum valve; **12**, butterfly valve; **13**, primary equalizer pipe; **14**, secondary equalizer pipe; **15**, primary equalizer valve; **16**, discharge valve; **17** and **18**, secondary equalizer valve; and **19**, bypass pipe.

The turbo-blower **10** draws in with little pressure loss the high pressure half filtered gases which have just passed through the primary dust catcher **8**, and after boosting their pressure as high as or a little higher than that of the furnace top pressure, compresses them through the secondary pressure equalizer pipe **14** into the large and the middle hoppers **5** and **6**.

On the other hand, the butterfly valve **12** is fitted in the bypass pipe **19**, which is installed to connect the outlet of the turbo-blower **10** with that of the primary dust catcher **8**. The said butterfly valve **12** being controlled by a control means (not shown) which detects the pressure in the outlet of the turbo-blower **10** maintains by opening and closing the pressures in the large and the small hoppers **5** and **6** at the prescribed level.

While each bell is closed, the secondary equalizer valve **18** for the large hopper **5** and the secondary equalizer valve **17** for the middle hopper **6** are open, and the pressures in respective hoppers **5** and **6** are maintained at the same level as, or a little higher than, that of the furnace top by means of the closed valves **16** and **15** and by means

of the previously mentioned butterfly valve **12** in the bypass pipe **19**.

To lower the small bell **4**, the secondary equalizer valve **17** for the middle hopper **6** is closed first, and subsequently the discharge valve **16** is opened in order to make the pressure of the middle hopper **6** equal to that of the atmosphere. Then, the discharge valve **16** is closed and the primary equalizer valve **15** is opened to fill the middle hopper **6** with the half purified gases through the primary equalizer pipe **13**. The said primary equalizer valve **15** is so controlled as to close before the pressure in the said middle hopper **6** exceeds that of the half filtered gases (lower than that of the furnace top by 500 to 2000 mm.Aq.). The secondary equalizer valve **17** for the said middle hopper **6** opens simultaneously with, or a little later than, the said primary equalizer valve **15**, and leads the gases boosted by the turbo-blower **10** into the said middle hopper **6** to make the pressure in the said middle hopper **6** equal to that of the large hopper **5**. Then, the middle bell **3** is lowered to drop the burden on to the said large bell **2**. The functions of the primary equalizer valve in concert with the secondary equalizer valve and discharge valve is accomplished by a control device (not shown) which controls the entire operation schedule of the charging device for the blast furnace.

The secondary equalizer valve **18** for the large hopper **5** which controls the gases passing through the said turbo-blower **10** into the large hopper **5** opens and closes independently of the operation of the middle and the small bells **3** and **4**. Subsequently the said large bell **2** is operated to drop the burden into the furnace.

It is a matter of choice to apply the present invention to the double bell distributor devoid of the small bell by connecting the primary equalizer valve with the large hopper, and to use the secondary equalizer valve only for the large hopper.

The effects of the present invention are listed below:

(I) As the turbo-blower, which is insusceptible of and enduring against the dust and moisture of the gases, is adopted, maintenance and inspection can be made easy, dependability is increased, and the gas receiver and the pressure control equipment can be dispensed with.

(II) Due to the reason given in I, it is enough to boost the half purified gases through the primary dust catcher by 500 to 2000 mm.Aq., which is equal to the pressure loss in the primary dust catcher, or to the difference between the pressures of the primary dust catcher and the filtered gases. The theoretical pneumatic force of about 4.5 kw. for the gas volume of 1 m.^{3}/min. is required for the gases to be boosted by 7 kg./cm.^{2}, while the boosting of the high pressure half filtered gases to that of the furnace top or a little higher requires only 0.3 kw.; therefore, it is possible to cut down the costs of the installation and operation drastically.

(III) By controlling the pressure at the outlet of the blower by the butterfly valve, the pressure control valves for the large and the small hopper become unnecessary, which simplifies the structure thereof, and cuts down the cost of the equipment. Besides, as the pressure difference between the upper and the lower streams of the butterfly valve for controlling the pressure at the outlet of the blower is small (about 500 mm.Aq. to 2000 mm.Aq.), more effective adjustment of the pressure can be attained, and the range of the pressure fluctuation of the large and the small hopper can be reduced.

(IV) The reciprocating compressor has no change in the output, regardless of the change in pressure if the change of the volumetric efficiency is neglected; while, with the blower, if the pressure is lowered to that of inlet from Point A where the pressure and the volume of gas output are of given value, the amount of gas output increases up to Point B, 200% as compared with that at Point A. This means that a stable operation can be maintained over a wide fluctuation of the gas leakage in the case of the blower, because the permissible variation of

gas leakage from the seat of the bell and the cup doubles that in the case of the reciprocating compressor.

What we claim is:

1. In a blast furnace system comprising: a blast furnace to be charged with charging material; a bell hopper charging apparatus attached to the top of said blast furnace and having downwardly ararnged consecutive first, second and third hoppers each with an independently controlled bell whereby said second hopper is connected via a discharge valve with the outer atmosphere; a dry dust catcher the input of which is connected to said blast furnace; a primary dust catcher the input of which is connected to the output of said dry dust catcher and the output of which is connected via a primary equalizer valve with said second hopper; and a pressure equalizer and discharger comprising a turbo-blower the output of which is connected via secondary equalizer valves with said second and third hopper and the input of which is connected with the output of said primary dust catcher, pressure control means installed in a bypass pipe connecting the outlet of the tubo-blower with the primary dust catcher, charging operaton control means which controls the entire operation schedule of said primary equalizer, discharge and secondary equalizer valves.

2. In the blast furnace system according to claim 1 wherein said turbo-blower is an axial flow turbo-blower.

3. In the blast furnace system according to claim 1 wherein said turbo-blower is a centrifugal turbo-blower.

4. In the blast furnace system according to claim 1 wherein said pressure control means comprises a butterfly valve, whereby said butterfly valve is controlled by a control device sensitive to the pressure of the second and the third hopper.

5. In the blast furnace system according to claim 1 wherein said charging operation control means are adjusted to open the primary equalizer valve simultaneously with or a little earlier than the secondary equalizer valve and to close it before the pressure in the said bell hopper exceeds that of the output of the said primary dust catcher.

6. In a blast furnace system comprising: a blast furnace to be charged with charging material; a bell hopper charging apparatus attached to the top of said blast furnace and having downwardly arranged consecutive first and second hoppers each with an independently controlled bell whereby said second hopper is connected via a discharge valve with the outer atmosphere; a dry dust catcher the input of which is connected to said blast furnace; a primary dust catcher the input of which is connected to the output of said dry dust catcher and the output of which is connected via a primary equalizer valve with said second hopper; and a pressure equalizer and discharger comprising a turbo-blower the output of which is connected via a secondary equalizer valve with said second hopper and the input of which is connected with the output of said primary dust catcher, pressure control means installed in a bypass pipe connecting the outlet of the turbo-blower with the primary dust catcher, charging operation control means which controls the entire operation schedule of said primary equalizer, discharge and secondary equalizer valves.

7. In the blast furnace system according to claim 6 wherein said turbo-blower is an axial flow turbo-blower.

8. In the blast furnace system according to claim 6 wherein said turbo-blower is a centrifugal turbo-blower.

9. In the blast furnace system according to claim 6 wherein said pressure control means comprises a butterfly valve, whereby said butterfly valve is controlled by a control device sensitive to the pressure of the second hopper.

10. In the blast furnace system according to claim 6 wherein said charging operation control means are adjusted to open the primary equalizer valve simultaneously with or a little earlier than the secondary equalizer valve and to close it before the pressure in the said bell hopper exceeds that of the output of the said primary dust catcher.

References Cited

UNITED STATES PATENTS

2,516,190	7/1950	Dougherty	214—36
2,585,800	2/1952	Le Viseur	266—27 X
2,599,334	6/1952	Latham	214—36
2,602,027	7/1952	Old	75—41
2,658,636	11/1953	Dawbarn	266—27 X
2,715,575	8/1955	Coutant	75—41
2,765,935	10/1956	Schuman	214—36
3,139,472	6/1964	Evans	266—27
3,152,703	10/1964	Slagley	266—27 X
3,198,623	8/1965	Evans	266—27 X
3,221,906	12/1965	Melcher	266—27 X

JOHN F. CAMPBELL, *Primary Examiner.*

R. F. DROPKIN, *Assistant Examiner.*