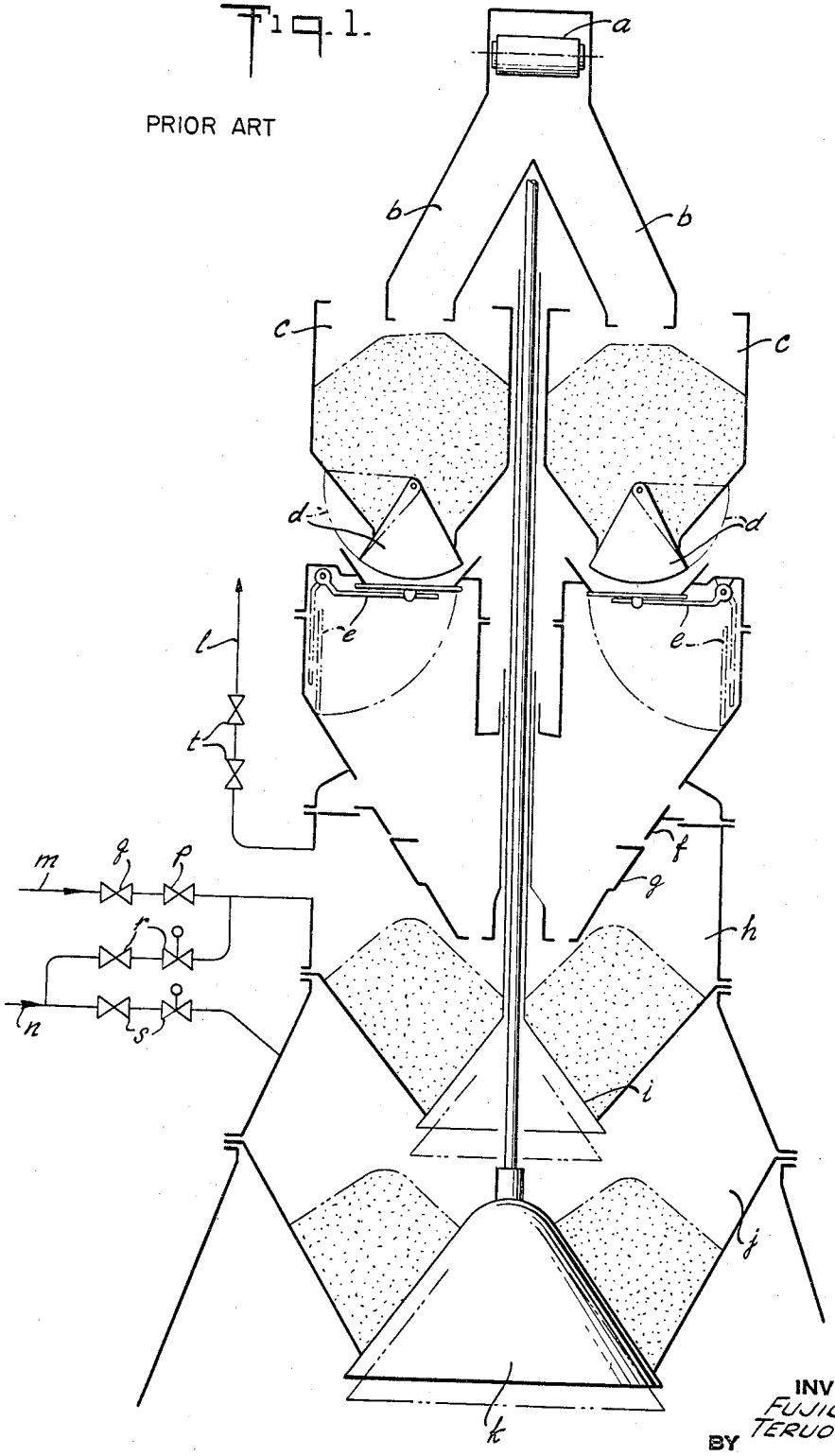
Dec. 9, 1969 FUJIO OGURI ET AL 3,482,714

FURNACE TOP CHARGING EQUIPMENT

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Fig. 1.

PRIOR ART



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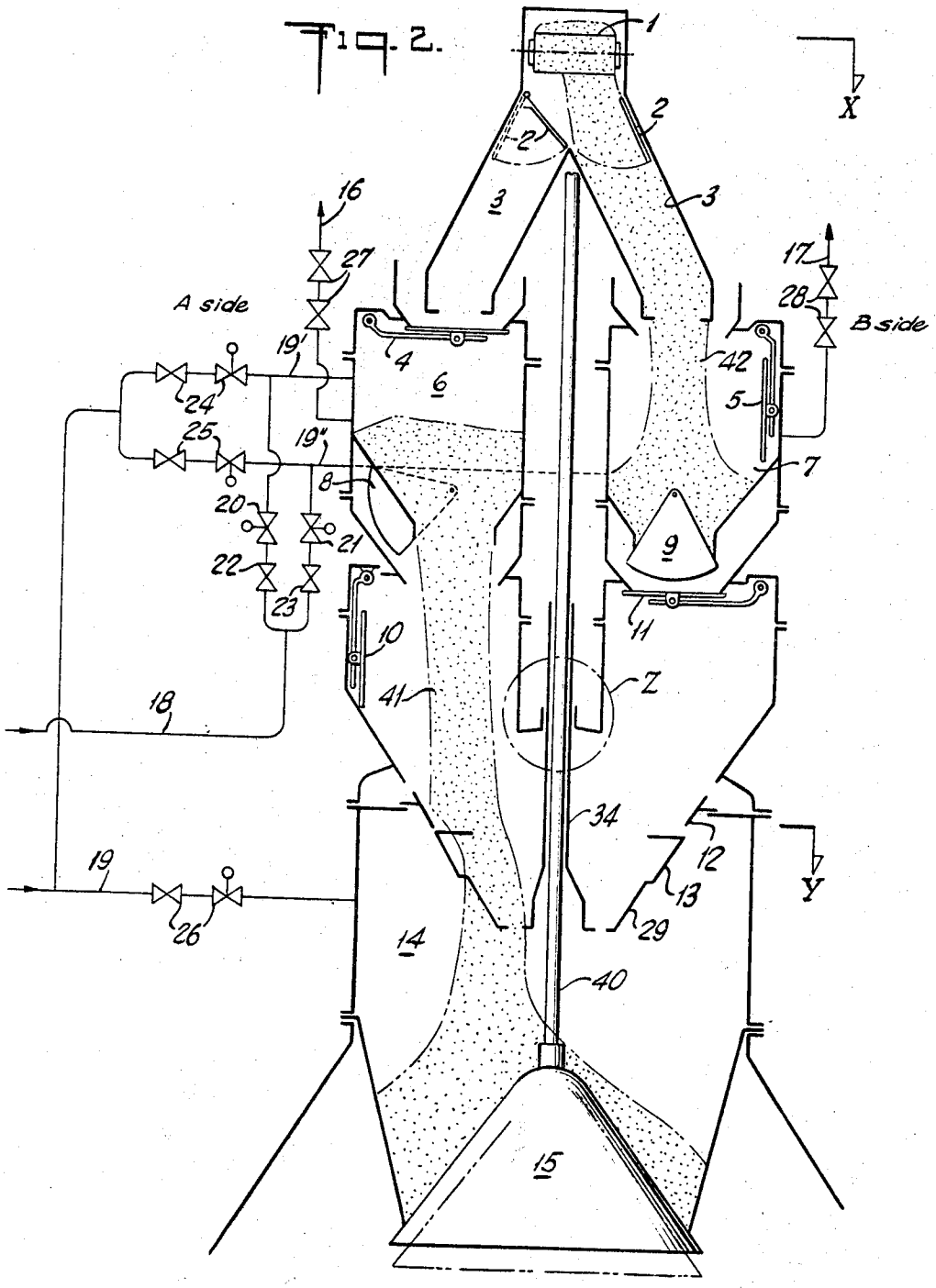
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FURNACE TOP CHARGING EQUIPMENT

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Fig. 2.



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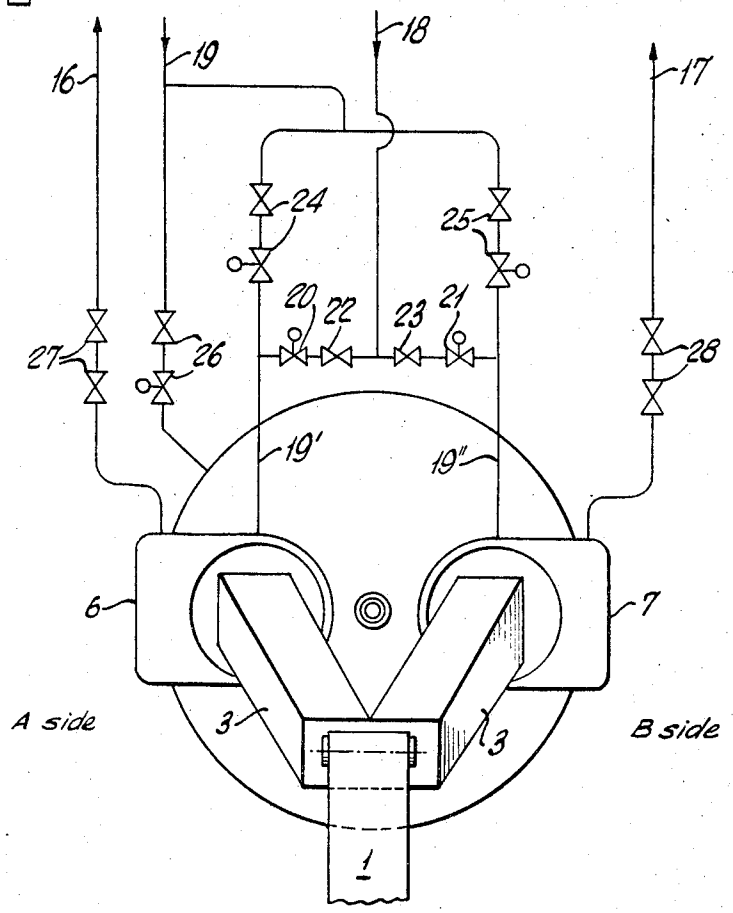
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FURNACE TOP CHARGING EQUIPMENT

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Fig. 3



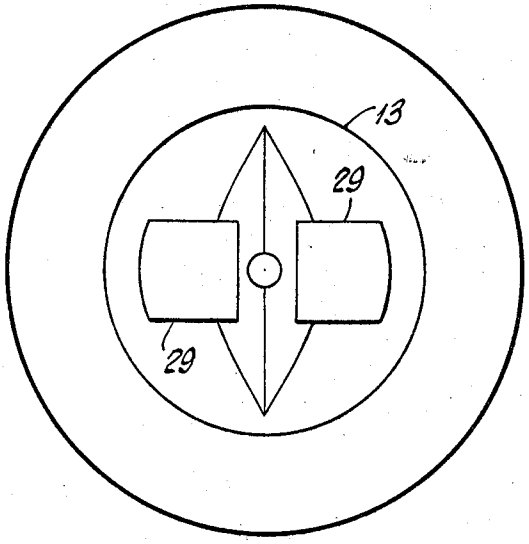


Fig. 4.

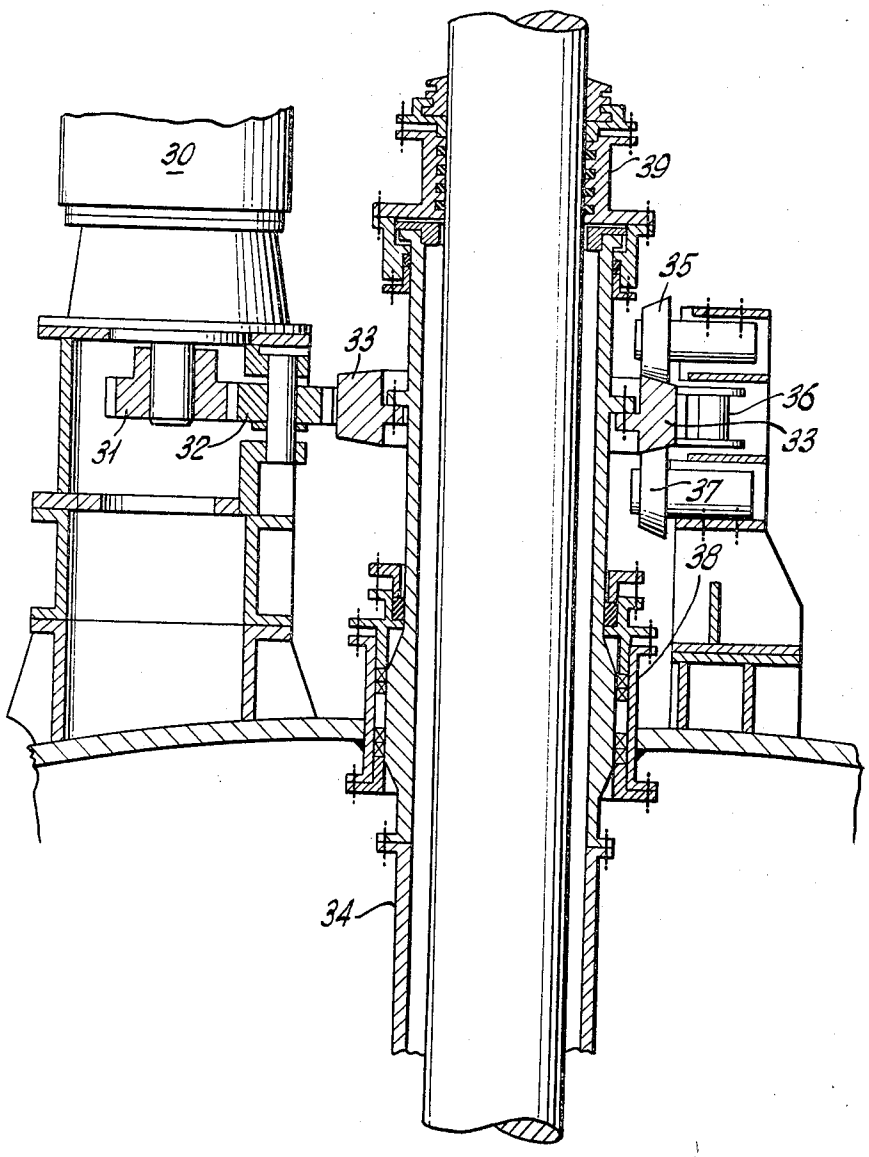
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FURNACE TOP CHARGING EQUIPMENT

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Fig. 5.



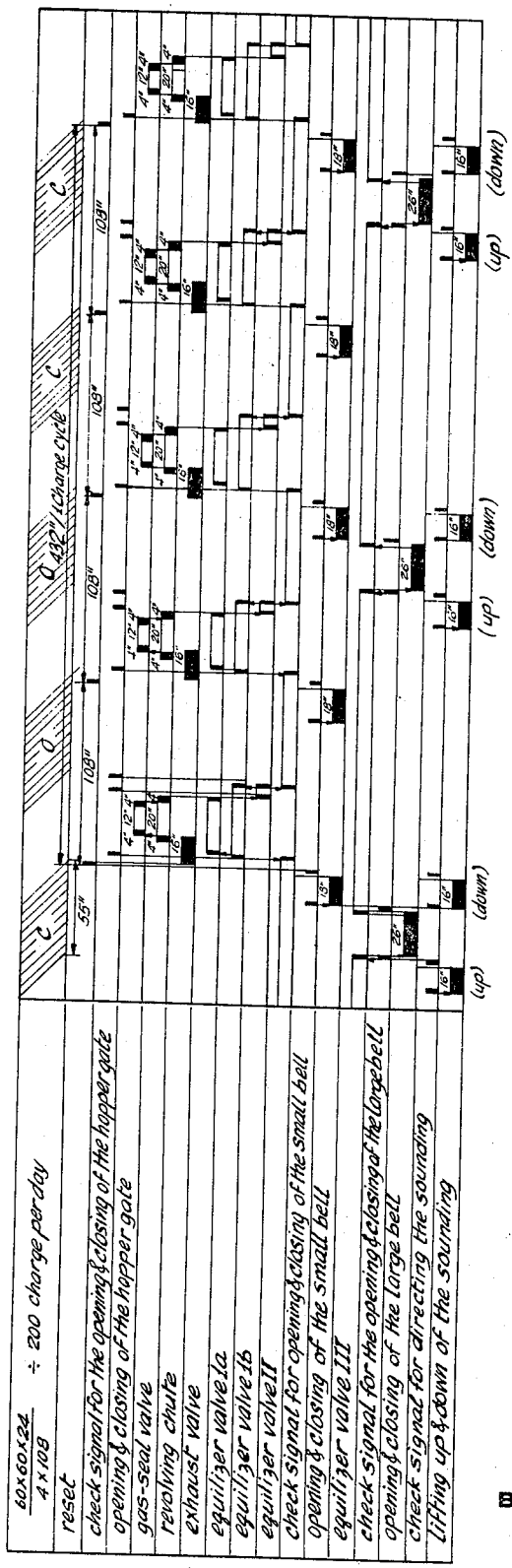
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FURNACE TOP CHARGING EQUIPMENT

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FIG. 6.
PRIOR ART



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FURNACE TOP CHARGING EQUIPMENT

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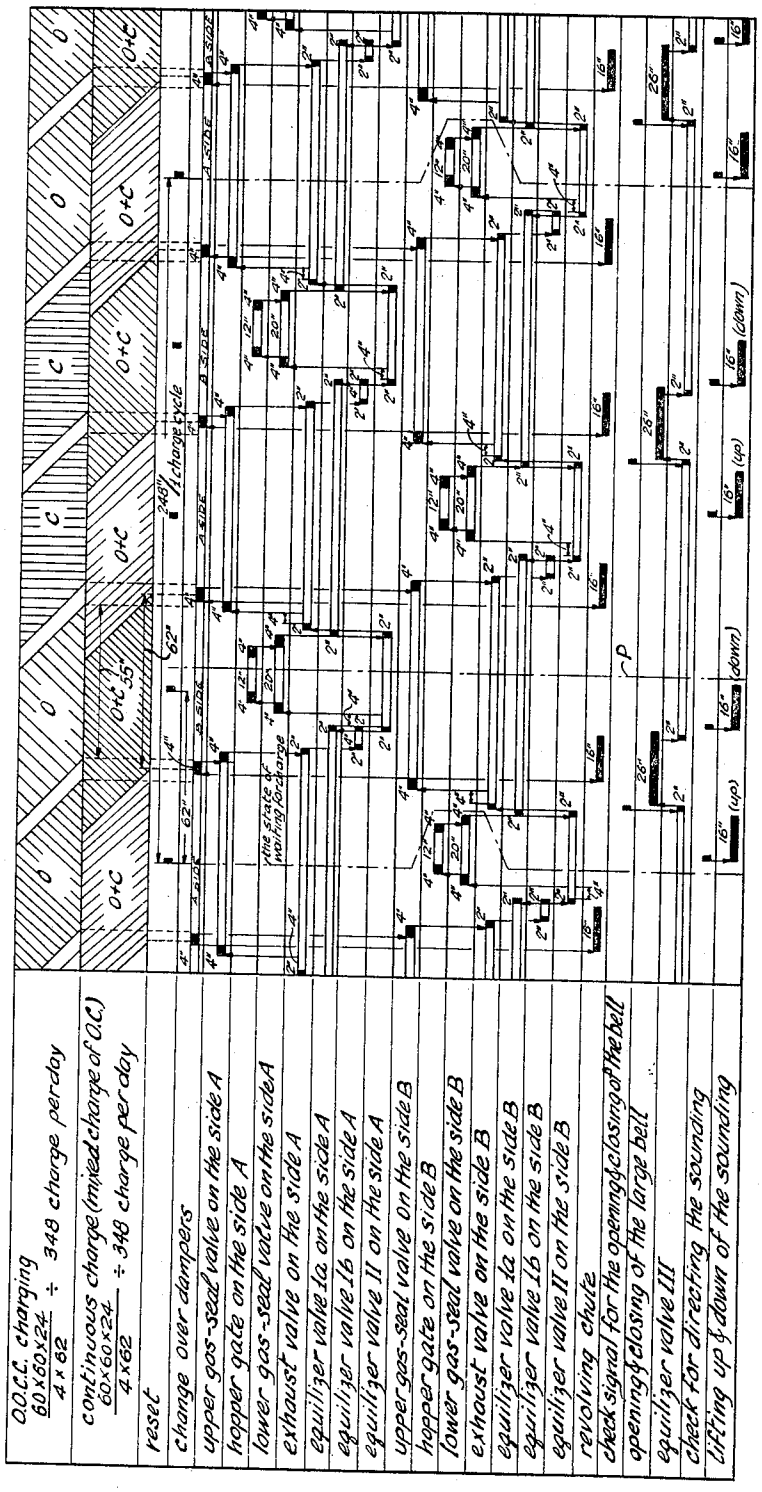


Fig. 7.

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3,482,714

FURNACE TOP CHARGING EQUIPMENT

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Int. Cl. F27b *11/12*; G01f *11/28*; B65g *47/44*
U.S. Cl. 214—37 13 Claims

ABSTRACT OF THE DISCLOSURE

A furnace top charging equipment wherein the raw-material-storing hoppers are installed above the bell hopper, and the gas-seal valves are provided at the upper inlets and the lower outlets of said raw-material-storing hoppers, said gas-seal valves being capable of opening and closing alternately to charge the bell hopper with the raw-materials and keep the pressure in the bell hopper at a given value by means of said gas-seal valves at the time of charging the bell hopper with raw-material.

BACKGROUND OF THE INVENTION

With the recent diffusion of the high-pressure operation of the blast furnace for iron manufacture the valve-seal type furnace top charging equipment is widely used, but the conventional valve-seal type furnace top charging equipment is inevitably accompanied with the following two defects.

FIG. 1 is a cross-sectional elevational view showing the structure of a conventional valve-seal type furnace top charging equipment applied to the conveyor charging system. FIG. 2 is an elevational view in cross-section showing the structure of the furnace top charging equipment constructed in accordance with the teachings of the present invention. FIG. 3 is a sectional view taken along the lines X—X of FIG. 2. FIG. 4 is a cross-sectional view of the revolving chute taken along the lines Y—Y of FIG. 2. FIG. 5 is a detailed cross-sectional view of the driving mechanism for the revolving chute shown in FIG. 2. FIG. 6 is a table showing the time schedule of the prior art furnace top charging equipment shown in FIG. 1. FIG. 7 is a table showing the operational time schedule of the furnace top charging equipment constructed in accordance with the teaching of the present invention. FIG. 6 is a table showing the time schedule of the operation of the conventional furnace top charging equipment shown in FIG. 1, wherein, *a* refers to a belt conveyor, *b* to a bifurcate chute, *c* to raw-material-storing hoppers, *d* to hopper gates, *e* to gas-seal valves, *f* to stationary hoppers, *g* to a revolving chute, *h* to a small bell hopper, *i* to a small bell, *j* to a large bell hopper, *k* to a large bell, *l* to an exhaust pipe, *m* to a primary pressure equalizer pipe, *n* to a secondary pressure equalizer pipe, *p* to a equalizer valve I*a*, *q* to a equalizer valve I*b*, *r* to equalizer valves II, *s* to equalizer valves III, and *t* to exhaust valves.

In the conventional valve-seal type furnace top charging equipment, comprising a small bell positioned above a large bell, shown in FIG. 1, the raw materials do not cause the abrasion of the seat surface of the gas-seal valves *e*, and therefore the leakage of the furnace top gas is not brought about. However, the seat surface of the small bell *i* is subject to abrasion in the path of the raw materials while they are charged. Since the said small bell *i* must serve as a valve to seal the gas within the large bell hopper *j* when the gas-seal valve *e* is opened to pour the raw materials onto the small bell *i*, once the abrasion takes place on the surface of the said bell *i* by the raw

materials, the gas leakage is brought about and, when the gas leaks out, the seat surface of the small bell *i* is shaved by the dust contained in the gas. What is more, in the recent high-pressure operation, the said gas velocity reaches generally that of sound theoretically and, in consequence, the seat surface is acceleratingly abrased. At this stage the small bell *i* can no more serve as a valve, and the raw materials are blown up by the gas leaking from the small bell *i* during the charging of the raw materials with the gas-seal valves *e* opened, and, in extreme cases, the charging of the raw materials may become impossible. The above is the first defect.

The second defect is the restricted capacity of charging the blast furnace with the raw materials. As it is evident in the time schedule shown in FIG. 6, the sequence must be so scheduled that the raw materials thrown from the conveyor *a* are temporarily stopped while the gas-seal valves *e* opened, and, consequently, the interval of the charge is naturally restricted and the maximum frequency of charge per day is limited. However, since the required amount of raw materials to be charged naturally increases in the high-pressure operation whose purpose is to increase the production of pig iron, the said limitation in the frequency of charge is a great disadvantage to a blast furnace of high-pressure operation.

The purpose of the present invention is to facilitate long term continuation of high-pressure operation by eliminating two defects described above and also to dissolve a problem of insufficient charging capacity, increasing the production of pig iron. The structure of the present invention is characterized by that the raw-material-storing hoppers are installed above the bell hopper and the gas-seal valves are arranged at the upper inlets and the lower outlets of the said raw-material-storing hoppers, the said gas-seal valves being capable of opening and closing alternately. The explanation of an embodiment of the present invention will be given below with reference to FIGS. 2 to 5 and FIG. 7.

The embodiment according to FIG. 3 is constructed in such a way that a large bell hopper **14** which receives and discharges the raw materials through the operation of a large bell **15** houses a revolving chute **13** therein, that the raw materials from a stationary hopper **12** installed above the large bell hopper **14** flow into the large bell hopper **14** through the revolving chute **13**, and that a cylindrical shaft **34** fixed to the said chute **13** is projected out of the upper part of the large bell hopper **14** by stretching upward round a large bell rod **40** and the said cylindrical shaft **34** is fixed to a ring gear **33**. The ring gear **33** is rotatably supported by lower rollers **37**, side rollers **36** and upper rollers **35** to support the load of the said revolving chute **13**. The ring gear **33** is engaged with a pinion **31** through an idle gear **32**, so that the revolving chute may be rotated by the operation of driving means **30** through the pinion **31**, the idle gear **32**, and the ring gear **33**. Above the large bell hopper **14**, a raw-material-storing hopper **6** on the side A and a raw-material-storing hopper **7** on the side B are installed, together with an upper gas-seal valve **4** on the side A and an upper gas-seal valve **5** on the side B at each of the raw materials inlets of the respective upper parts of the said raw-material-storing hopper, also with the hopper gate **8** on the side A and a hopper gate **9** on the side B at each of the raw material outlets at each of the lower parts of the said hoppers **6** and **7**, and further with a lower gas-seal valve **10** on the side A and a lower gas-seal valve **11** on the side B beneath the said hopper gates **8** and **9**.

A bifurcate chute **3** is installed, pouring the raw materials into the two raw-material-storing hoppers **6** and **7**, and the change-over dampers **2** are attachedly equipped in the bifurcate chute **3** to throw the raw materials drop-

ping from a conveyer **1** switchingly into either of the two raw-material-storing hoppers **6** and **7**. In FIGS. 2 and 3, **16** refers to an exhaust pipe on the side A, **17** to an exhaust pipe on the side B, **18** to a primary pressure-equalizer pipe, **19** to a secondary pressure-equalizer pipe, **20** to an equalizer valve I*a* on the side A, **21** to an equalizer valve I*a* on the side B, **22** to an equalizer valve I*b* on the side A, **23** to a equalizer valve I*b* on the side B, **24** to equalizer valves II on the side A, **25** to equalizer valves II on the side B, **26** to the pressure-equalizing valve III, **27** to exhaust valves on the side A, **28** to exhaust valves on the side B, **29** to two raw-material-chuting openings installed at the revolving chute **13**, **38** to the gas-seal means for the rotary chute shaft **34**, **39** to gas-seal means for the large bell rod, and **41** and **42** to the raw materials, and also in FIGS. 6 and 7, O refers to the ore, C to the coke, and further, O.O.C.C. charges show the case where the charges are carried out in the order of ore, ore, coke, and coke, O.C. mixing charges show the case where the ore and the coke are thrown together; the white rectangles in the rows concerned with valves indicate the open state, the black parts preceding the said white rectangles indicate the state from the start to the end of opening, the black parts following the said white rectangles indicate the state from the start to the end of closing respectively, and finally the black parts in the rows not concerned with valves show the states of operation corresponding to each row. The pipes **19'** and **19''** bifurcated from the secondary equalizer pipe **19** are connected to the raw-material-storing hoppers **6** and **7**.

Here is an explanation of the operation of the device shown in FIG. 2, which is the embodiment of the present invention, with respect to the time schedule shown in FIG. 7. FIG. 2 shows the state when the raw materials **42** is thrown from the conveyer **1** into the raw-material-storing hopper **7** on the side B, together with the state when the raw materials **41** is thrown onto the large bell **15** with the hopper gate **8** on the side A of the raw-material-storing hopper **6** on the side A and the lower gas-seal valve **10** on the side A open, which namely shows the state indicated by line P in FIG. 7. As for the gas pressure in each hopper in the said state, the pressure in the raw-material-storing hopper **7** on the side B is equal to the atmospheric pressure and that in the raw-material-storing hopper **6** on the side A and in the large bell hopper **14** is equal to the gas pressure in the furnace (furnace top pressure). After the raw materials **41** in the raw-material-storing hopper **6** on the side A finish dropping onto the large bell **15** and the said raw-material-storing hopper **6** on the side A is empty, the hopper gate **8** and the lower seal valve **10** on the side A are closed. Then, just before the prescribed raw materials finish falling into the raw-material-storing hopper **7** on the side B, the exhaust valves **27** on the side A are opened to adjust the gas pressure in the raw-material-storing hopper **6** on the side A to the atmospheric pressure, and then the upper seal valve **4** on the side A is opened.

When the upper seal valve **4** on side A is fully open, the change-over damper **2** is changed to the side of the raw-material-storing hopper **6** on the side A, and after the said change-over is finished the upper seal valve **5** on the side B is closed. Then, the primary equalizer valve I*b* **23** on the side B is opened to increase the gas pressure in the B side raw-material-storing hopper **7** till a little lower than the furnace top pressure and the secondary equalizer valve II **25** on the side B is opened to adjust the pressure to the said furnace top pressure. After the pressure on the both sides of the B side lower seal valve **11** are equalized, the lower seal valve **11** on the side B is opened and then the hopper gate **9** on the side B is opened so that the raw materials may be thrown onto the large bell **15**. After the raw materials are thrown onto the large bell **15** by two hopper-full quantity from each of the raw-material-storing hoppers on the sides A and B, the equalizer valve III **26** is closed, and then the said raw materials are thrown into the furnace by opening the large bell **15**.

The revolving chute **13** which has raw-material-chuting openings **29** on the both sides serves to equalize circumferentially the distribution of the raw materials in the furnace, being rotated intermittently by 60 degrees to shift the top of the pile of the raw materials thrown onto the large bell **15**.

It is optional within the scope of the present invention to add one more bell hopper with another between the rotary chute **13** and the large bell **15** in order to equalize the distribution of the raw materials, and also free to adopt other means, instead of the conveyer, to throw the raw materials into the raw-material-storing hoppers.

The furnace top charging equipment of the present invention has the structure composed of the raw-material-storing hoppers installed above the bell hopper, and the gas-seal valves equipped at the upper inlets and the lower outlets of the said raw-material-storing hoppers. The equipment of the present invention displays such advantageous effects that the high-pressure operation can be continued for the long period of time since the adaptation of the gas-seal valves instead of the small bell of the conventional valve seal type furnace top charging equipment renders no bell subject to the difference of pressure and consequently there is no worry that the gas-seal may become impossible because of the abrasion due to the raw materials and the gas-cutting, that while one of the raw-material-storing hoppers, say on the side A, is receiving the raw materials from the conveyer, the other raw-material-storing hopper on the side B can throw the raw materials into the large bell hopper by adapting such structure, in addition to the structure described above, that the raw materials thrown from the conveyer, etc., can be alternatively received by the said raw-material-storing hoppers and also the raw-material can be poured onto the bell even if the raw materials from the conveyer is in the process of charging, with the pressure in the bell hopper being maintained at the prescribed level, and that, in consequence, according to the time schedule of the embodiment of the present invention illustrated in FIG. 7, the charging frequency per day can be increased by 75% in comparison with the conventional type of the time schedule shown in FIG. 6, therefore we can cope with an increase in the production of the pig iron realized by the high-pressure operation and, the loss of time required for the restoration of the normal state at the time of abnormal decrease of stock in the furnace called "slip," can be decreased on account of an increase in the raw-material following-up capacity.

What we claim is:

1. A furnace top charging equipment comprising a housing, a raw material receiving station at one end of said housing, a raw material discharging station at the opposite end of said housing, a longitudinal member attached to said discharging station and extending through said housing toward said receiving station, a plurality of communicating raw material storing means connecting said receiving station and said discharging station, said storing means comprising a pair of substantially parallel storing hoppers positioned on opposite sides of said longitudinal member, a stationary hopper located below said storing hoppers and having said longitudinal member passing therethrough, and at least one bell hopper located below said stationary hopper and superposed on said discharging station, each of said storing hoppers comprising an inlet port and an outlet port, bifurcate conduit means intermediate said receiving station and said pair of storing hoppers, means in said bifurcate conduit means for selectively directing said raw material into alternate storing hoppers, a first pair of gas seal valves, each being disposed in a respective storing hopper proximate to the adjacent inlet port, and a second pair of gas seal valves disposed in said stationary hopper proximate to said outlet port of said storing hopper, said valves being operable for movement between an open position and a closed position,

wherein each of said first pair of gas seal valves and each of said second pair of gas seal valves are located on opposite sides of said longitudinal member, and are in open and closed positions respectively, and vice versa.

2. The furnace top charging equipment defined in claim 1 wherein said first gas seal valve in one of said storing hoppers is in said open position during said transmission of raw material from said receiving station thereto, and said first gas seal valve in said other of said storing hoppers is in said closed position.

3. The furnace top charging equipment defined in claim 2 wherein said raw material receiving station is a conveyor.

4. The furnace top charging equipment defined in claim 2 wherein said raw material discharging station is a bell.

5. The furnace top charging equipment defined in claim 2 wherein said longitudinal member is a bell rod.

6. The furnace top charging equipment defined in claim 2 wherein said outlet ports in said storing hoppers are pivotable hopper gates.

7. The furnace top charging equipment defined in claim 2 wherein said means in said bifurcate conduit means for directing said raw material alternatingly into said storing hoppers are dampers.

8. The furnace top charging equipment defined in claim 2 comprising a shaft concentric with said longitudinal member and partially coextensive therewith, a plurality of coacting gears mounted on said shaft, and a chute rotatably supported by said gears intermediate said stationary hopper and said bell hopper and communicating therewith.

9. The furnace top charging equipment defined in claim 2 comprising a plurality of bell hoppers.

10. The furnace top charging equipment defined in claim 2 comprising an exhaust pipe extending outwardly from each of said storing hoppers, and a flow-regulating valve in each of said exhaust pipes.

11. The furnace top charging equipment defined in claim 2 comprising a plurality of pressure equalizer pipes extending outwardly from said raw material storing means, and a plurality of flow regulating valves in each of said pipes.

12. The furnace top charging equipment defined in claim 2 comprising gas seal means for said longitudinal member.

13. The furnace top charging equipment defined in claim 2 comprising gas seal means for said shaft.

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