United States Patent

Nieboer

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[54] **CHARGING APPARATUS CONSTRUCTION FOR A BLAST FURNACE**

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[58] **Field of Search** 214/35, 36, 37; 266/27

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[57] **ABSTRACT**

A shaft furnace particularly a blast furnace which is operated at high pressures includes a furnace head having a top pan with a distributor bell therein which is movable upwardly to close the top pan to permit an accumulation of charging material thereover and which may be moved downwardly to provide an annular charging opening for the material to drop off the bell into the furnace. The construction includes a charging hopper which may be arranged above the furnace and located to receive a charge of material, for example, by delivery on a carriage which moves over the skip-type conveyor. The charging hopper includes a lowermost portion with a rotatable distributor pipe which has an eccentric opening to permit the rotatable distribution of charging material downwardly into a locking chamber which is arranged between the hopper and the chamber defined by the top pan of the furnace head which is closed by the distributor bell. The lock chamber includes openable and closeable flaps at its lower end which when closed permit the accumulation of a material in the chamber and it is also sealed in a gas tight manner by a displaceable valve member which is mounted on a pivot shaft so that it can be moved to a position offset from the locking chamber to permit the unhindered downward flow of the material from the lock chamber into the furnace above the distributor bell during charging periods. The top of the lock chamber is closed by a valve member which may be opened by displacing it into an offset chamber portion out of the way of the flowing material to open the passage between the hopper and the lock chamber. the inlet valve to the lock chamber, at the top thereof, is opened when the pressure in the lock chamber returns substantially to atmospheric pressure. The inlet opening and the discharge opening of the lock chamber are advantageously arranged in vertical alignment but may be offset if so desired.

9 Claims, 2 Drawing Figures

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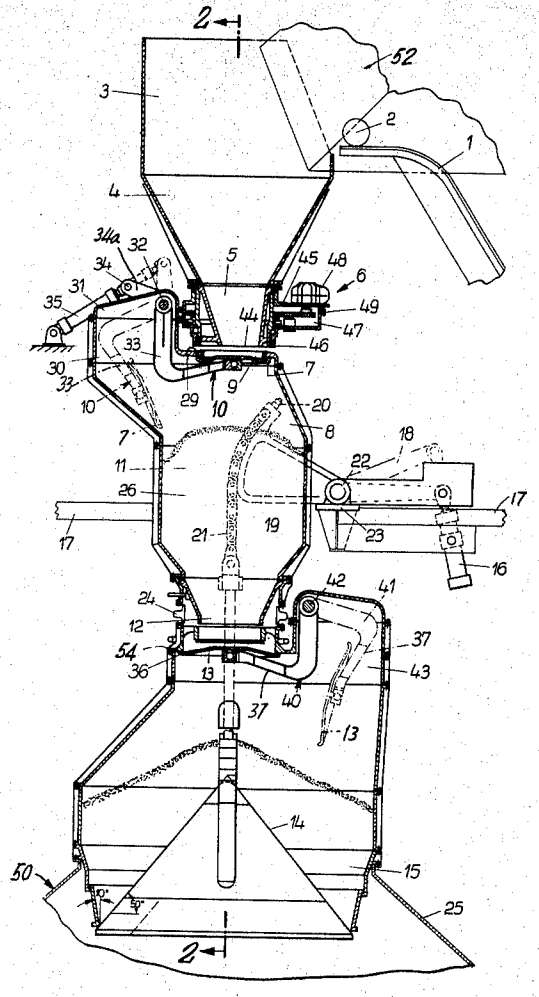

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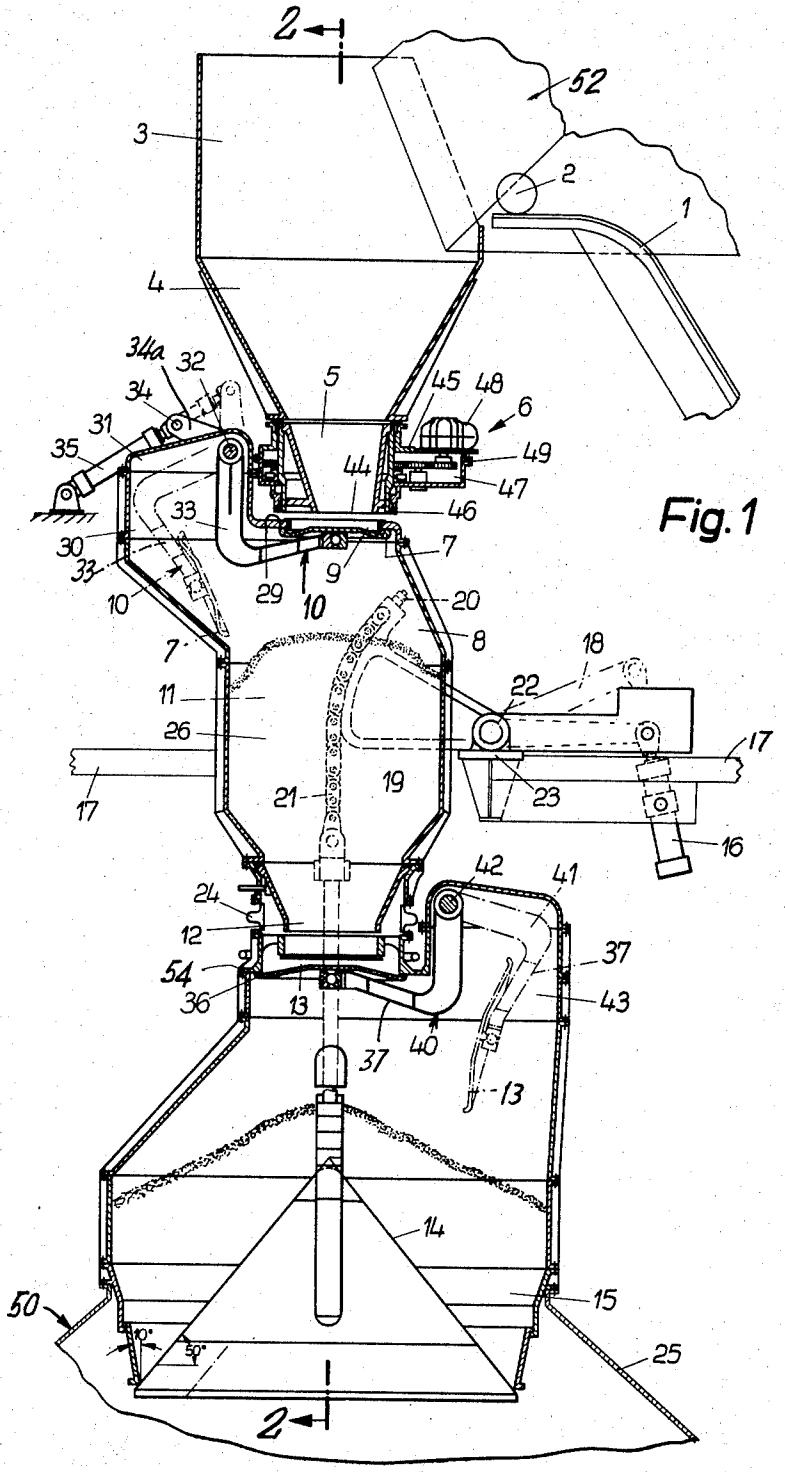

Fig. 1

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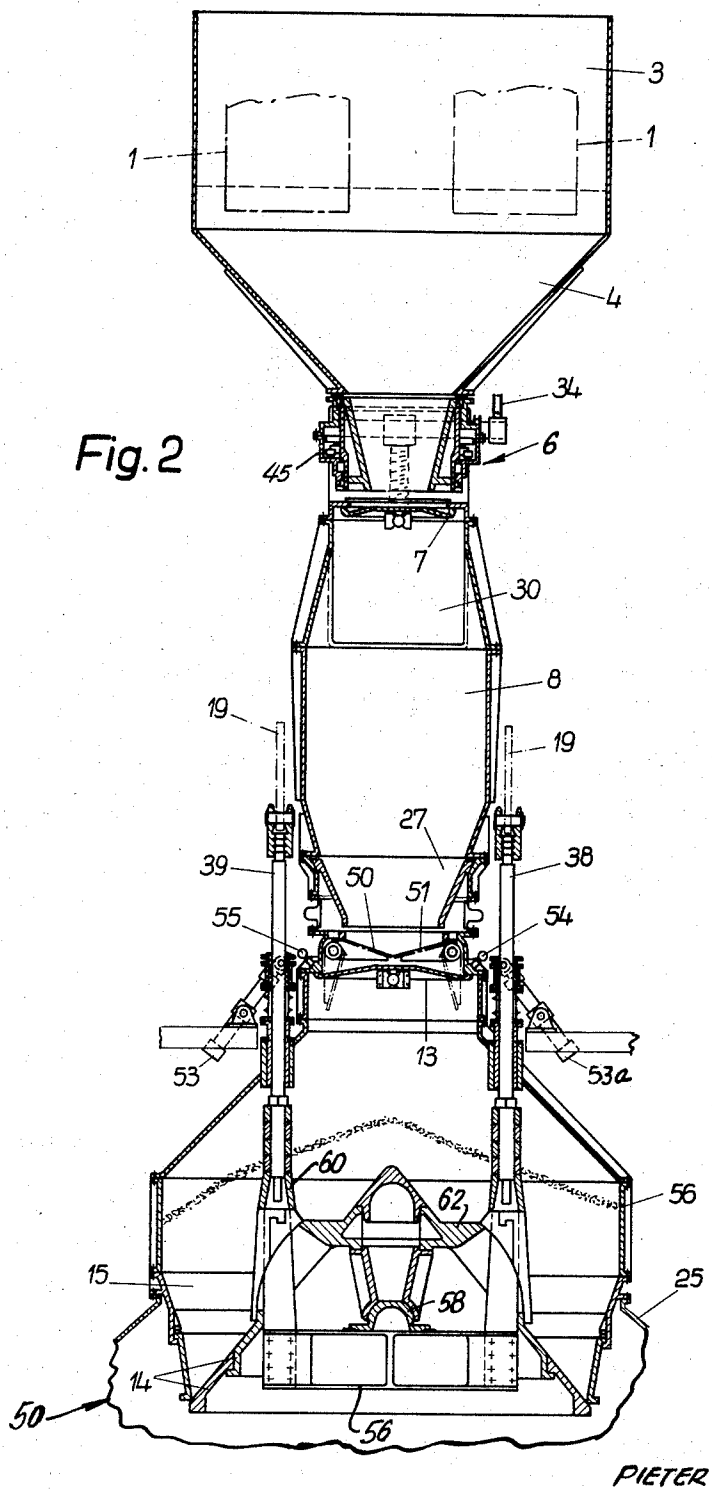
Fig. 2



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CHARGING APPARATUS CONSTRUCTION FOR A BLAST FURNACE

SUMMARY OF THE INVENTION

This invention relates in general to the construction of metallurgical furnaces, and in particular, to a new and useful shaft furnace, particularly a blast furnace which is operated by the high pressure method and which includes a hopper arranged above the furnace top and which discharges into a lock chamber arranged between the hopper and the furnace top and which includes valve means for sealing the top and bottom of the lock chamber and which may be selectively opened to permit a charge of material to enter into the chamber from the hopper through a rotatable distributing pipe.

The metallurgical reduction of iron ores is more intensive at pressures of the top gas which are higher than 0.1 to 1 excess atmospheres absolute. High top gas pressures can only be achieved by specially designed charging apparatus. As is known the conventional bell and hopper arrangements which are employed with such furnaces comprise superposed bells which close each of the bottom openings of the conical top pan of the furnace and the charging hopper. It was found however, that a gas tight fit of the bells in a closed position could be maintained only to a limited extent because of the thermal stresses and wear which are caused by the fluid dust. Additional measures were necessary to provide armoring of the bell surfaces by built up welding in order to achieve a somewhat acceptable operating arrangement. However, for high pressure operation, lock chambers are now also required. Such a lock chamber includes sealing flaps or valves which are characterized by an arrangement in which the sealing edge of the flaps as well as the sealing flap are arranged in an opened position outside the path of the charging material. The wear otherwise occuring in the bells can be avoided and a lock chamber which is equipped with sealing flaps is superior to the system of two bells cooperating with top pans.

In itself the conical form of the top pan of the furnace enhances the distribution of the charging material. But even the double cone form of the top pan and the top of the distributing bell is not sufficient to distribute the material uniformly over the bell without considerable separation into fine and coarse grains. According to the known proposals a rotatable discharge hopper is associated with the upper bell. The material conveyed over the skip gear is delivered to the hopper which provides some distribution of the material. It is known also to obtain a better distribution by a distributor with eccentric discharge ports arranged above the discharge hopper. The separation of the charging material which is to be avoided however, is generally achieved by reducing the number of impact surfaces to a minimum. A discharge hopper, a revolving chute and the like, the upper bell and the lower bell produce impact surfaces of different angles so that the separation of the material is very pronounced. The greater the number of impact surfaces which are hit by the material during its downward travel into the furnace, the more difficult it is to achieve a controlled separation. A uniform surface operation is enhanced by controlled separation. The controlled separation should take place first on the distributing gear in the furnace

chamber. An earlier separation into fine and coarse grain material is therefore a disadvantage.

The two bell system of the known bell and hopper arrangement provides a sealing effect which suffices only at the start of the furnace operation, and the top bells wear out so that they must be replaced after some time and this has an additional disadvantage. The fitted socket stands for supporting rods which are arranged centrally and concentrically of the charging bells are located in the path of the charging material. The passage of the socket stem to the lower bell acts as a distributor and requires a suspension rod arrangement which is streamlined to permit an even flow of material and which must be designed sufficiently large enough to support the great weight of the bell and the charged material. The suspension arrangement however, provides an unfavorable influence on the flow of the material at several points around the distributor head and thus separations of the material are unavoidable.

The known blast furnaces include a hopper arranged above the top including two superposed top bells which act together adjacent the top pans to form a lock chamber from which the charging material can be fed to a lower bell which acts as a distributing gear in the furnace chamber. These furnaces have two main disadvantages: First the sealing effect of the bell is insufficient and second the introduction of the charging material produces undesirable effects on the furnace operation.

In accordance with the present invention there is provided a shaft furnace which is suitable for charging material at the necessary higher pressures for meeting furnace operation requirements. The invention provides an additional distributing gear arranged in front of the inlet port of a lock chamber which is located between the charging hopper and the furnace head. The free interior of the lock chamber is provided with a lower end which tapers inwardly or includes a constriction toward the discharge port to permit the accumulation of the charging material above this location. Thus the distributing gear for the charged material is not arranged above the discharge hopper but directly in front of the inlet port of the lock chamber underneath the charging hopper. Since no bars and the like are provided for securing the distributor bell in the lock chamber, there is no discharge edge for the charged material. The material from the skip elevator which arrives in the discharge hopper is collected in the hopper and periodically discharged therefrom through the rotatable distributor gear into the lock chamber. The material may be collected in the lock chamber over the constriction thereof and, depending on the state of filling, avoids major slope angles of movement of the material. The material is subsequently directed over the distributor bell in the top pan of the furnace head and only after this does the separation of the material take place on the charging surface of the distributor bell when the latter is lowered to permit the falling of the charge into the furnace. The arrangement of the distributing gear between the hopper and the locking chamber avoids the free fall of the material from an inclined discharge edge.

A particularly favorable arrangement is obtained when the inlet and outlet ports of the lock chamber are arranged in vertical alignment. The charging material

can thus travel through the lock chamber vertically partly in free fall and partly in a type of movement characteristic of this material. No separation takes place during the free fall. Separations are also generally avoided during the vertical travel with minor transverse movements.

According to another feature of the invention, the lock chamber is provided with a lateral passage to accommodate the rotatable drive for a valve member which seals the upper inlet opening of the chamber in a closed position but which may be rotated with the gear into the offset chamber in an opened position at which all of the operating mechanism is out of the path of downward movement of the material. A similar lateral chamber arrangement is arranged in the furnace head above the top pan in order to accommodate a valving mechanism for closing the lower end of the lock chamber. The lateral compartment for the valve mechanism has two advantages:

1. The height of the total bell and the hopper arrangement may be reduced, and

2. The adjacent parts of the distributing gear can be attached closer to the inlet port of the lock chamber. In addition, the lateral compartment affords room for bringing the sealing valve member outside the path of the dropping charging material to avoid damage of the valve mechanism. The distributing gear for rotating the eccentric pipe is advantageously contained outside the hopper and above the lock chamber. The diameter of the inlet port of the lock chamber is made large enough to accommodate the rotatable path of movement of the outlet opening of the distributor pipe which is mounted for eccentric rotation. Thus, a slanted furnace column can already be influenced by the distributing gear. For example, a position of the rotatable pipe corresponding to the slanted burden column can be temporarily maintained. The charging material drops then on one side of the lock chamber to a higher amount than flows correspondingly unilaterally to the distributor bell in the furnace chamber. The invention arrangement also provides a storage possibility and the charged material can be filled into the hopper above the rotatable distributor gear. The hopper can be suitably constructed to form a wide bin for storage of the charged material at such location. The rotary drive for the distributor gear is secured on the hopper and encased by a housing in a dust proof fashion. The dust containing top gas which issues from the port of the lock chamber can therefore not get into the driving case for the distributing gear. Stress by radiant heat is likewise avoided and difficult sealing points need not be sealed such as by scavenging gas.

Accordingly, it is an object of the invention to provide an improved charging apparatus for a shaft furnace particularly blast furnaces, which includes a hopper for the charging material which discharges through a distributing gear into a lock chamber which is arranged above a furnace head and which terminates in a discharge opening at its lower end which may be sealed against the furnace by suitable valving means, the hopper including a distributing gear for distributing the material uniformly into the lock chamber and the lock chamber having means for facilitating the accumulation of the charged material therein prior to its delivery into the furnace head.

A further object of the invention is to provide a lock chamber construction having valve means at each end with rotatable parts which may be moved between opened and closed positions and which in an open position are contained in an offset chamber out of the way of the flowing charge material and which is advantageously oriented in a position between a supply hopper having a distributor gear and the charging head of the furnace.

A further object of the invention is to provide a furnace charging apparatus construction which is simple in design, rugged in construction, and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a vertical sectional view through the upper portion of a shaft furnace having a charging device constructed in accordance with the invention; and

FIG. 2 is a section taken along the line 2—2 of FIG. 1.

GENERAL DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in particular, the invention embodied therein comprises a material charging apparatus for a furnace, generally designated **50**, which includes a hopper **3** which is located above a furnace head **25** and which is supplied with material, for example, from a carriage or car **52** which is movable along the skip type conveyor **1** on wheels **2**. The charging material moves downwardly into a sloping hopper portion **4** and is delivered into a rotatable pipe **5** of a distributing gear generally designated **6**. The rotatable pipe **5** has an eccentric outlet portion **44**. The pipe **5** is mounted in a drive case **45** which is sealed at its top against the hopper portion **4** and is sealed at its bottom with the gear chamber proper **47** by means of a sealing ring **46**. A flanged-housing motor **48** is mounted on the outside of the drive cage **45** and it includes a drive shaft which operates the gearing **49**. The distributing gear **6** is advantageously fastened on the rear side of the hopper **4** so that if any repair is necessary the entire distributing gear can be removed from the hopper and exchanged very rapidly.

In accordance with a feature of the invention, a lock chamber **8** is provided between the discharge opening **44** from the hopper **3** and the inlet to the furnace head which connects into a top pan **56** which is closed at a lower conical portion **15** by a distributor bell **14** of conical configuration. The lock chamber **8** includes an inlet opening or port **9** at its top end and an outlet opening or port **12** at its lowermost end and these two openings are advantageously aligned vertically. Closing and sealing valve means are associated with each of the openings **9** and **12** and include an upper sealing valve

mechanism generally designated **10** and a lower sealing valve mechanism generally designated **40**. The upper sealing valve mechanism **10** includes a valve cover plate or closure member **7** which is carried on a lever arm **33** which is affixed to a shaft **32** for rotatable movement therewith. The shaft **32** is rotated by means of a fluid drive in the form of a fluid piston and cylinder combination **35** which is connected to a lever **34***a* at a pivot connection **34**; and which may swing the arm **33** between the solid line and dotted line positions indicated, i.e., from a closed position to an opened position. In the open position the arm **33** and the closure plate **7** are in the dotted line position at which they are contained within an offset chamber **30** defined at the top end of the lock chamber **8**. The opening of the sealing flap **7** is affected in a known manner by pressure equalization. The pressure building up in the lock chamber **8** during the charging proper of the furnace chamber is released so that atmospheric pressure prevails in the lock chamber **8** at the time that the valve member **7** is moved away from its seat. This permits the easy opening of the valve member **7** to permit the downward flow of the material from the hopper portion **4** and the accumulation of the material into a charge supply **11** above a constriction or narrowed portion **27** of the lock chamber **8**.

At the time of charging the outlet port **12** is closed by a valve member **13** of the valve mechanism **40**. The valve member **36** engages with its sealing edge **13** on an annular sealing face **54** defined at the upper end of the top pan **56**. A shaft **42** carries a cranked arm **37** which carries the valve member **13** and which is rotatable on the shaft **42** between the solid line position and the dotted line position indicated. In the dotted line opened position, the valve crank arm **37** and the valve member **13** together with the shaft **42** are all contained within an offset chamber **43** so that none of these parts will interfere with the easy downward flow of the charged material from the lock chamber **8** into the top pan **56** for accumulation in an annular form above the distributor bell **14**.

When the sealing flap **7** is closed, and repair is necessary to the distributing gear, there will be no annoyance by the exiting of any gas during the repair work. The sealing flap **7** seals the lock chamber **8** in a gas tight manner so that operating personnel can readily make any necessary repairs in this location. The shaft furnace charging device is therefore particularly safe and can be readily manipulated in case of trouble.

The volume of material which the lock chamber **8** can hold will depend on the size of the shaft furnace. For medium and large furnaces, the lock chamber can be designed to hold **12** cubic meters or more. This supply suffices to be discharged to the conical heap over the distributor bell **14**. The top pan **56** defines a chamber which is much larger than the lock chamber **8** so that two or more fillings of the lock chamber **8** can be discharged onto the top of the distributor bell **14** until the desired amount of the specific charged material is achieved which is adapted to the furnace operation. Only after this correct charging amount is accumulated above the distributor bell **14**, is the distributor bell lowered.

The distributor bell **14**, as best shown in FIG. **2**, is supported on suspension rod assemblies **38** and **39** which connect at their lower ends to respective ends of a bridge member **14a** which is retained within the hollow bell and which provides a universal joint support **58** for the bell. The suspension rods **38** and **39** advantageously enter into the bell from diametrically opposite sides adjacent the apex of the bell and protective coverings **60** for the suspension rods cooperate with projecting portions **62** of the bell to define smooth flowing surfaces over which the material may be directed. The suspension rods **38** and **39** are connected to driving mechanism for raising and lowering them which includes a fluid motor in the form of a piston cylinder combination **16** which is connected to a lever **18** having an opposite end connected to a shaft **22** which is journaled on a bearing **23** on a platform **17**. The shaft **22** carries a rocker **19** having an arcuate outer surface over which a chain **21** is directed and fastened as at **20**. In the preferred form such a rocker **19** is arranged on each side of the lock chamber **8** as can be seen from FIG. **2** and each is provided with a respective chain **21** for engagement with an associated suspension rod **38** and **39**.

A feature of the inventive construction is that the bin **3**, the charging hopper **4**, and the distributing gear **6** forms a structural unit which is arranged separate from the lock chamber **8**. The lock chamber **8** itself is connected with the upper part of the top pan **56** for vertical movement through a connecting expansion bellows **24**. The top pan **56** rests tightly on the furnace head **25**.

A characteristic of the invention is that the lock chamber **8** has a free interior **26** which has a lower part with a constriction **27** in which the charged **28** can accumulate. In the arrangement indicated in the drawings, the inlet and outlet ports **9** and **12** are aligned vertically but these ports can be staggered if desired. The sealing edge **29** of the valve member **7** can be turned easily out of the path of the charging material when the valve member **7** is moved form the closed to the opened position at which it is located within the offset chamber **30**. The wall **31** of this chamber makes a gas tight seal with the shaft **32** and the shaft **32** can be driven through the lever **34** and the hydraulic piston drive **35** which may be arranged outside of the lock chamber **8**. A similar arrangement is provided for the valve mechanism **40**. The shaft **42** for this mechanism is packed and sealed with the wall **43** of the chamber **41**.

The lower end of the lock chamber **8** includes closure flaps **50** and **51** as shown in FIG. **2**, which may be closed as indicated and which provides means for the accumulation of material within the lock chamber. One of the two sealing valve members **7** or **13** is always closed in order to keep the gas loss from the lock chamber **8** as low as possible. The flaps **50** and **51** at the lower end of the lock chamber **8** are driven separately by their own drive. The drives for the flaps **50** and **51** comprise fluid motors in the form of combination fluid pressure operated piston and cylinder combinations **53** and **53a** respectively, which are connected through toggle joints **54** and **55** to the respective shafts for the flaps **50** and **51**.

What is claimed is:

1. A charging device for a high pressure operated shaft furnace, particularly a blast furnace operating under high pressure and having a furnace head with a top pan adapted to be closed, at the interior of the fur-

nace, by a distributor bell, and a charging hopper for the charging material having a lower opening for discharging material therefrom, said device comprising a separable lock chamber vessel interposed between said charging hopper and the furnace head and having a top inlet adjacent said discharge hopper and a bottom discharge communicable with said top pan above said distributor bell, respective means operable to selectively and separately seal and open said inlet and said discharge, said lock chamber being constructed and arranged to provide for accumulation of material therein from said charging hopper when said discharge is closed and said inlet is open, and distributor means associated with said hopper and located to receive material from opening of said hopper and to distribute the material substantially uniformly into and around the interior of said lock chamber upon opening of said top inlet; said means for selectively sealing said inlet and said discharge comprising a pivotal arm member and a plate carried by said arm member for sealing said inlet, said arm member and said plate being movable between an opened and a closed position, said lock chamber defining a constriction adjacent the lower end thereof in which the charging material can accumulate.

2. A charging device, according to claim 1, wherein said lock chamber includes an upper laterally offset chamber portion, said lever arm for said valve member being pivotally mounted within said offset chamber and being positionable with said plate in an opened position within said chamber out of the path of flow of the material.

3. A charging device for a high pressure operated shaft furnace, particularly a blast furnace operating under high pressure, having a furnace head with a top pan having an upper inlet and an outlet at the interior of the furnace, said device comprising, in combination, a distributor bell adapted to close said outlet of said furnace head: a charging hopper, for the furnace charging material, having a lower opening for discharging material therefrom, said lower opening being spaced vertically a substantial distance from said upper inlet of said top pan; distributor means associated with said hopper and located to receive material from the lower opening of said hopper and to distribute the material substantially uniformly; and a separable lock chamber removably interposed between said distributor means and said furnace head, and having a top inlet alignable with said discharge hopper lower opening for uniform distribution of material into and around the interior of said lock chamber by said distributor means, said lock chamber having a bottom discharge communicable with the upper inlet of said furnace head; first sealing means mounted within said lock chamber and operable selectively, independently of said distributor bell, to seal and open said top inlet of said lock chamber; and second sealing means, mounted within said furnace head, and operable selectively, independently of said distributor bell and independently of said first sealing means, to seal and open said upper inlet of said furnace head; whereby with said second sealing means sealing said upper inlet of said furnace head, and blocking communication of said lock chamber with said furnace head, said first sealing means may be operated to open said top inlet of said lock chamber for discharge of material from said charging hopper and distribution of the material substantially uniformly into and around the interior of said lock chamber, independently of said second sealing means and said distributor bell and, when said first sealing means seals said top inlet of said lock chamber, said second sealing means may be operated to open said upper inlet of said furnace head for flow of material from said upper inlet of said furnace head for flow of material from said lock chamber through the bottom discharge thereof and into said furnace head for support by said distributor bell, with said distributor bell being independently operable, when said second sealing means seals said upper inlet of said furnace head, to discharge material from said furnace head into said furnace.

4. A charging device, according to claim 3, wherein said lock chamber inlet and said discharge are aligned vertically.

5. A charging device, according to claim 3, including means for filling said lock chamber by a rotatable distribution of the material.

6. A charging device for a high pressure operated shaft furnace, particularly a blast furnace operating under high pressure and having a furnace head with a top pan adapted to be closed, at the interior of the furnace, by a distributor bell, and a charging hopper for the charging material having a lower opening for discharging material therefrom, said device comprising a separable lock chamber vessel interposed between said charging hopper and the furnace head and having a top inlet adjacent said discharge hopper and a bottom discharge communicable with said top pan above said distributor bell, respective means operable to selectively and separately seal and open said inlet and said discharge, said lock chamber being constructed and arranged to provide for accumulation of material therein from said charging hopper when said discharge is closed and said inlet is open, and distributor means associated with said hopper and located to receive material from the opening of said hopper and to distribute the material substantially uniformly into and around the interior of said lock chamber upon opening of said top inlet; said means for selectively and separately sealing and opening said inlet and said discharge of said lock chamber including a discharge valve member, a lever arm carrying said discharge valve member, said charging device also including the top pan adapted to be located within the furnace and defining an offset chamber portion, said discharge valve lever arm being pivotally mounted within said offset chamber portion and being movable with said discharge valve member into an opened position at which said lever arm and said valve member are offset from the discharge to permit free flow of the material from said lock chamber into said top pan.

7. A charging device for a high pressure operated shaft furnace, particularly a blast furnace operating under high pressure and having a furnace head with a top pan adapted to be closed, at the interior of the furnace, by a distributor bell, and a charging hopper for the charging material having a lower opening for discharging material therefrom, said device comprising a separable lock chamber vessel interposed between said charging hopper and the furnace head and having a top inlet adjacent said discharge hopper and a bottom discharge communicable with said top pan above said

distributor bell, respective means operable to selectively and separately seal and open said inlet and said discharge, said lock chamber being constructed and arranged to provide for accumulation of material therein from said charging hopper when said discharge is closed and said inlet is open, and distributor means associated with said hopper and located to receive material from the opening of said hopper and to distribute the material substantially uniformly into and around the interior of said lock chamber upon opening of said top inlet; said distributor means comprising a rotatable pipe having an eccentrically positioned discharge opening, said pipe being rotatable to discharge the material in an annular flow pattern into said lock chamber.

8. A charging device for a high pressure operated shaft furnace, particularly a blast furnace operating under high pressure and having a furnace head with a top pan adapted to be closed, at the interior of the furnace, by a distributor bell, and a charging hopper for the charging material having a lower opening for discharging material therefrom, said device comprising a separable lock chamber vessel interposed between said charging hopper and the furnace head and having a top inlet adjacent said discharge hopper and a bottom discharge communicable with said top pan above said distributor bell, respective means operable to selectively and separately seal and open said inlet and said discharge, said lock chamber being constructed and arranged to provide for accumulation of material therein from said charging hopper when said discharge is closed and said inlet is open, and distributor means associated with said hopper and located to receive material from opening of said hopper and to distribute the material substantially uniformly into and around the interior of said lock chamber upon opening of said top inlet; said distributor means comprising a rotatable tubular member having a discharge opening which is eccentric to provide for a rotatable distribution of the material from said hopper into said lock chamber, and means for rotating said tubular member comprising a driving motor and drive gears, and a dust proof casing enclosing said motor and gears.

9. A charging device for a high pressure operated shaft furnace, particularly a blast furnace operating under high pressure and having a furnace head with a top pan adapted to be closed, at the interior of the furnace, by a distributor bell, and a charging hopper for the charging material having a lower opening for discharging material therefrom, said device comprising a separable lock chamber vessel interposed between said charging hopper and the furnace head and having a top inlet adjacent said discharge hopper and a bottom discharge communicable with said top pan above said distributor bell, respective means operable to selectively and separately seal and open said inlet and said discharge, said lock chamber being constructed and arranged to provide for accumulation of material therein from said charging hopper when said discharge is closed and said inlet is open, and distributor means associated with said hopper and located to receive material from the opening of said hopper and to distribute the material substantially uniformly into and around the interior of said lock chamber upon opening of said top inlet; including first and second pivotal flaps closing the lower end of said lock chamber, said flaps being pivotal to open said lock chamber, said means for selectively and separately sealing said inlet and said discharge including the discharge valve member in addition to said flaps, said top pan defining a furnace chamber within said furnace, said distributor bell enclosing the bottom of said top pan and permitting the accumulation of charging material over said distributor bell, suspension means connected to said distributor bell and movable upwardly and downwardly through a closed connection of said furnace chamber, and fluid drive means connected to said suspension means for shifting said suspension means upwardly and downwardly.

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