

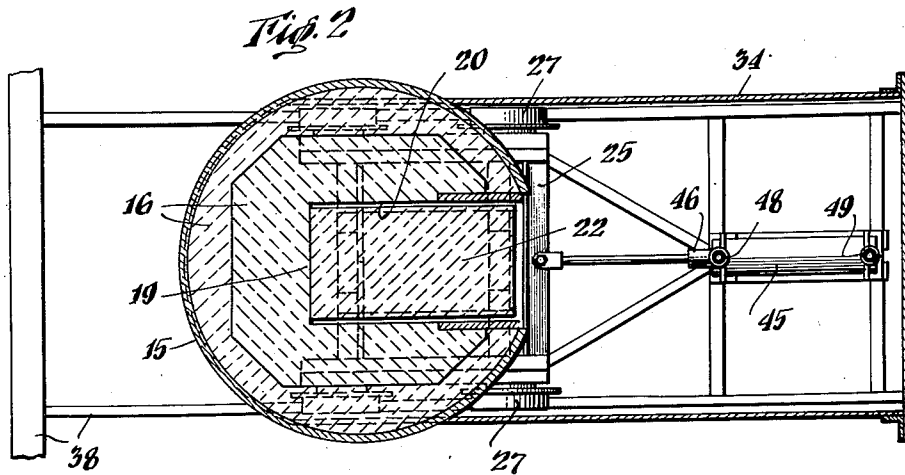
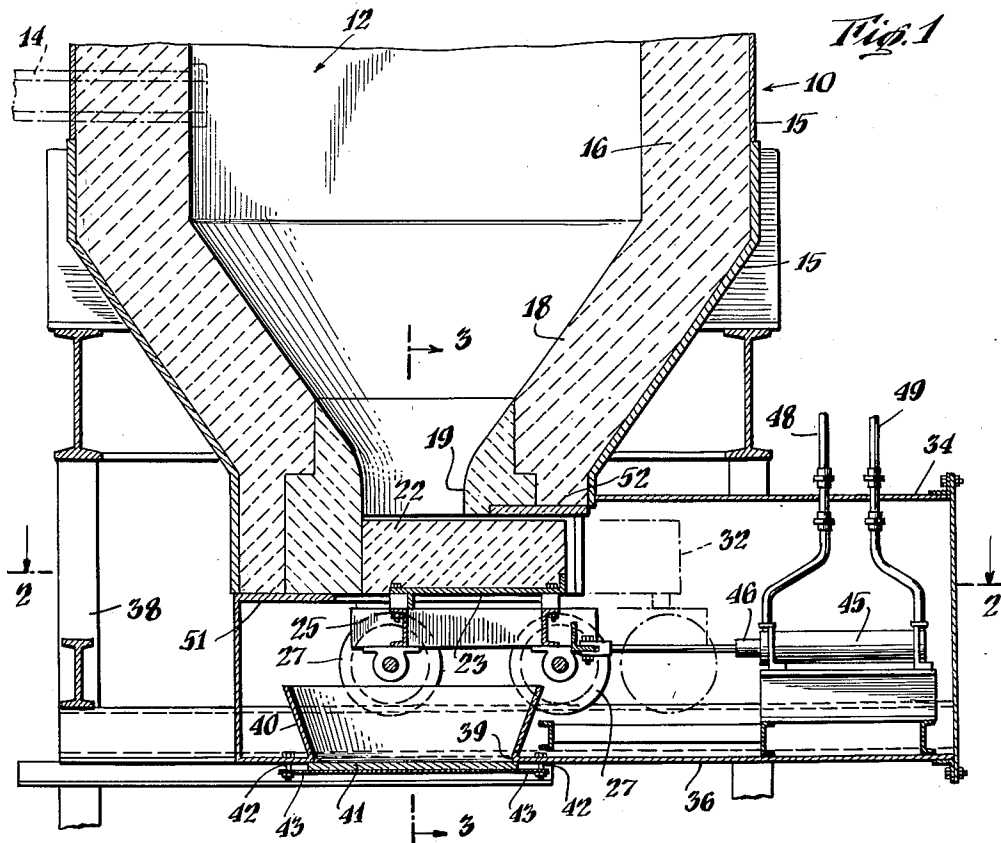
Jan. 1, 1952

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FURNACE DISCHARGE APPARATUS

2,580,700

Filed Sept. 21, 1950

4 Sheets-Sheet 1



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FURNACE DISCHARGE APPARATUS

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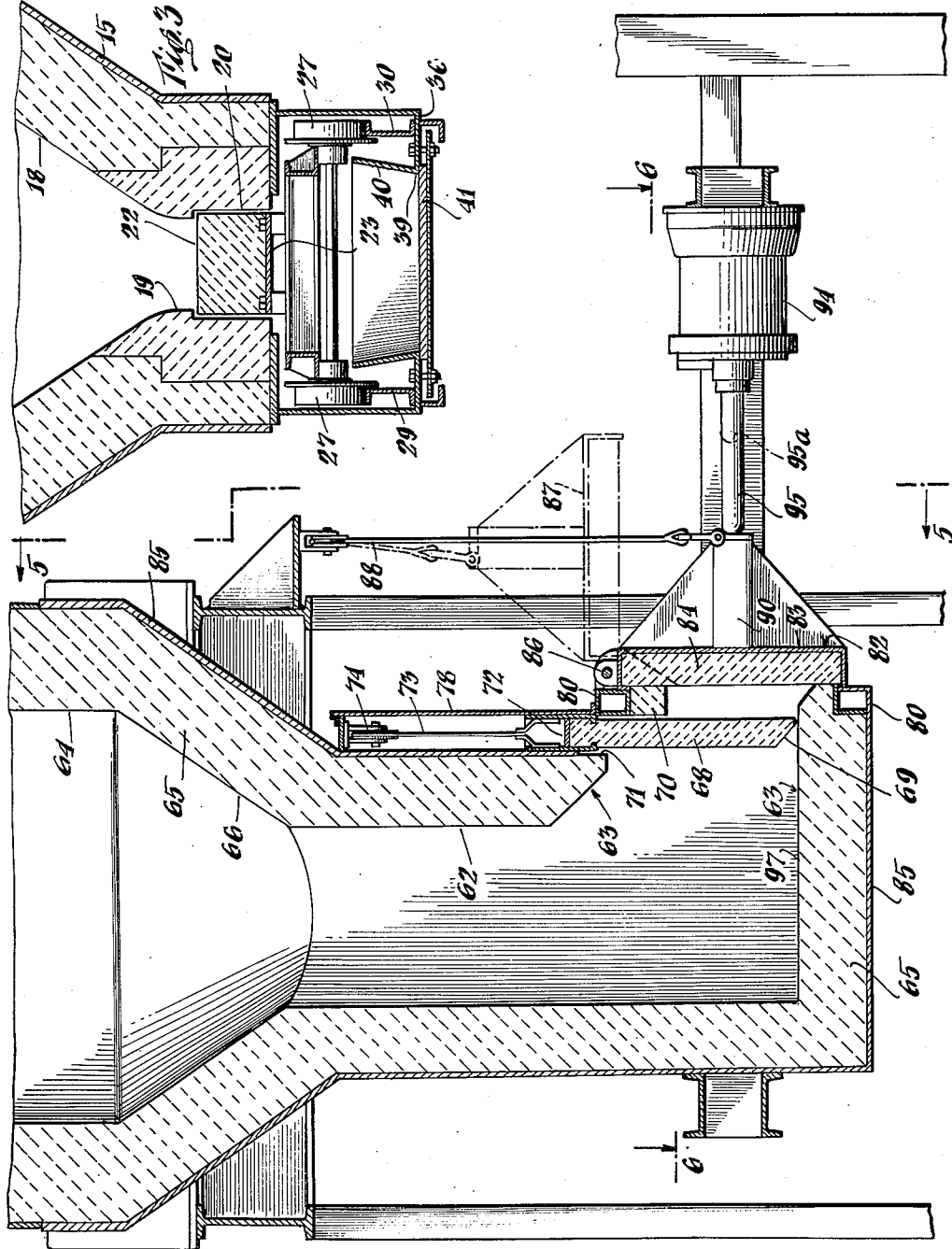


Fig. 1

60

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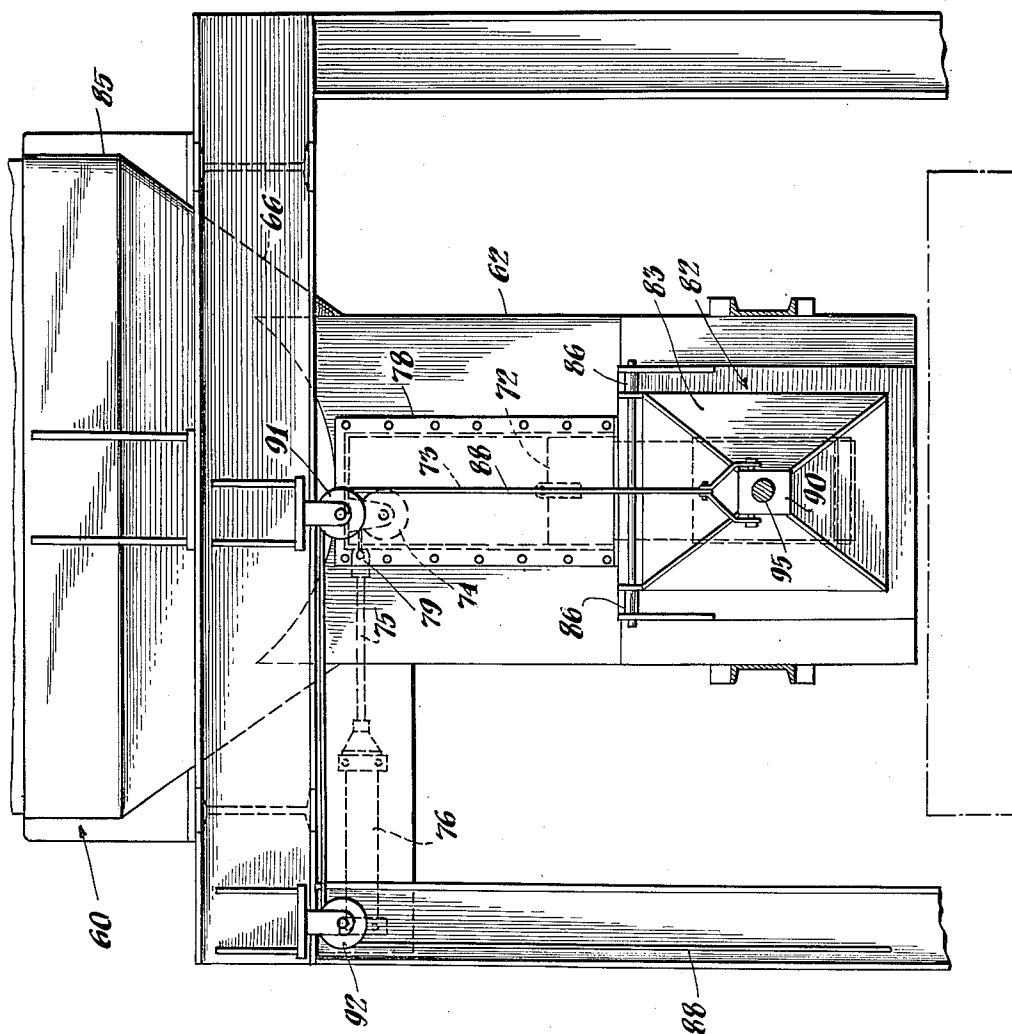
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Fig. 5



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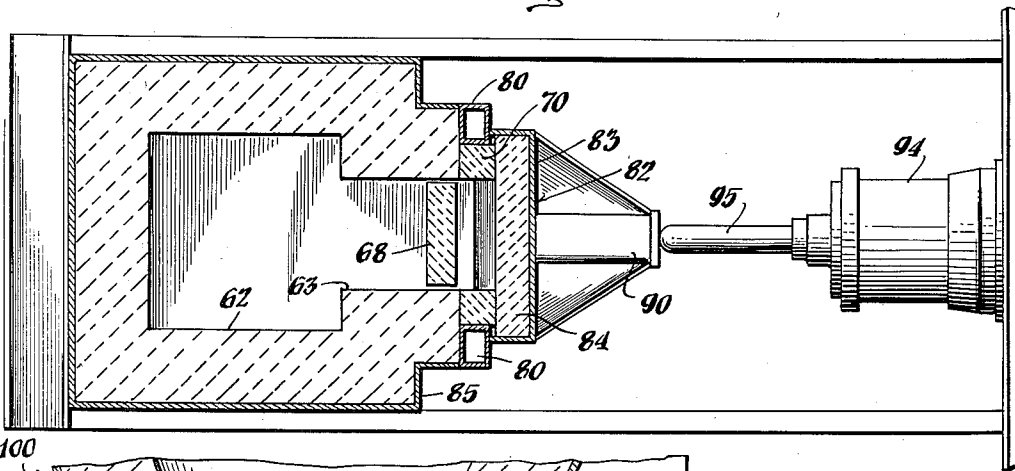
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FURNACE DISCHARGE APPARATUS

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Fig. 6



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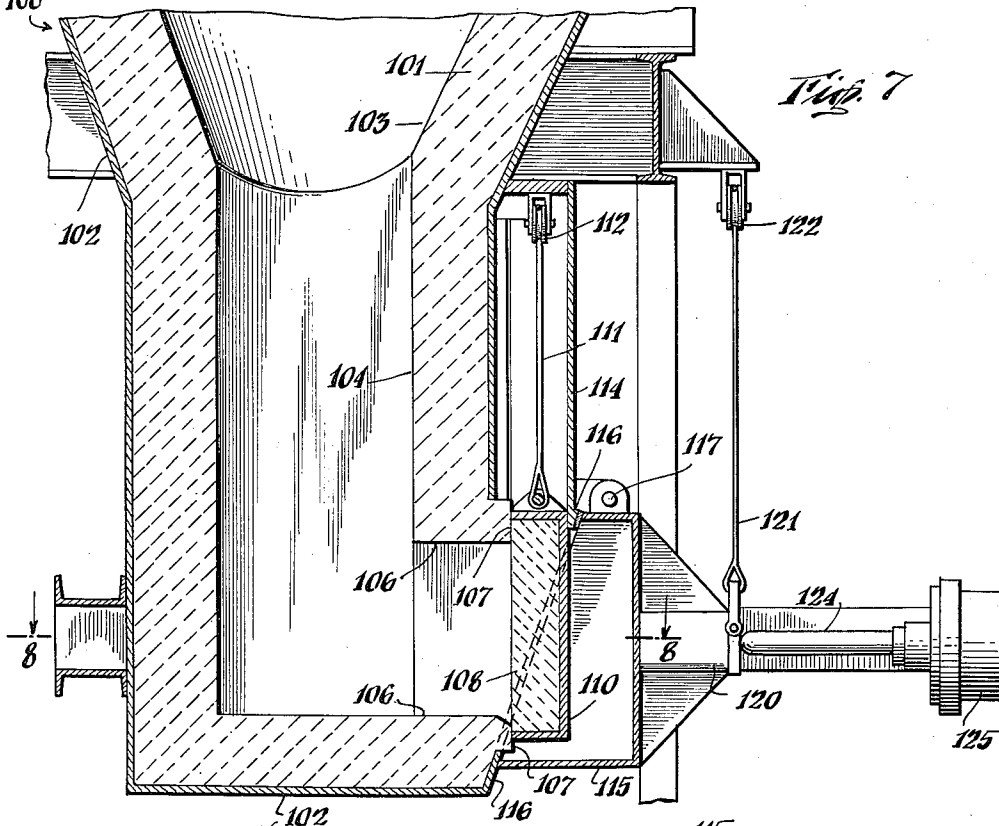
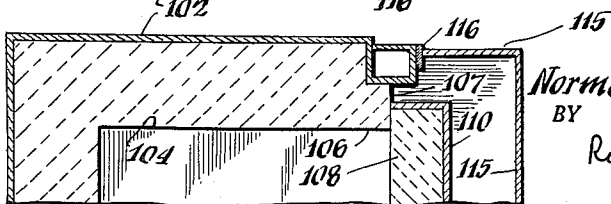


Fig. 7

Fig. 8



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# UNITED STATES PATENT OFFICE

2,580,700

## FURNACE DISCHARGE APPARATUS

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Application September 21, 1950, Serial No. 185,948

15 Claims. (Cl. 23—277)

1

This invention relates to furnaces for handling particulate solids, and more particularly to apparatus for effectuating discharge of such solids, for example in a highly heated condition, from the furnace and in a manner such as to avoid damage or deterioration of the structure. In a still more specific sense, the invention is concerned with furnaces wherein treatments are effectuated with corrosive materials or under conditions, as by the employment of corrosive gases or the use of pressures different from atmospheric, such that the furnace must be normally sealed against communication with the atmosphere and such that the solids (for instance as discharged from time to time) have a heated or other active condition that tends to be deleterious to metallic or like structural parts.

While apparatus of the improved character herein described is applicable to furnaces of other types and for the treatment of other materials, special realization of the various advantages are obtained in furnaces for the treatment of coke or like carbonaceous material with chlorine gas at a high temperature to effectuate the removal of metallic impurities. In essence, such operation involves the passage of chlorine gas through a body of material such as coke or anthracite coal for a suitable period of time, e. g. several hours or more, and under a temperature, of the reacting mass which may range upwards of 1400° C., as in accordance with a process having certain novel characteristics representing a separate invention that is not here directly concerned. In the practice of such and like procedures it has been found desirable to employ a vertical shaft furnace, appropriately lined with refractory material but having an external metallic shell, e. g. of steel, iron or the like, arranged to provide an enclosed structure essentially sealed against communication with the atmosphere, i. e. except as may be required for charging and discharging the furnace. The furnace may include appropriate means for heating the charge, as by electrodes spaced to effect flow of electric current through the carbonaceous material constituting such charge. Through appropriate conduits respectively near the bottom and top, chlorine gas may be continuously introduced to the interior of the furnace, and spent gases removed, it being understood that the chlorine reacts with metal-containing impurities so as to reduce the content of the latter by conversion to volatile chlorides, e. g. of iron, silicon and titanium, which are carried away in gaseous form. The furnace is advantageously kept filled with the coke or anthra-

2

cite coal at all times, at least to a predetermined high level, and at frequent intervals further quantities of untreated coke or coal may be introduced at the top of the furnace (as through suitable means with which the present invention is not concerned), while at the same or other times, corresponding quantities of the product, i. e. the purified carbonaceous material must be discharged from the bottom or lower end of the furnace. Such a furnace thus operates on a semi-continuous basis, the successively introduced portions of charge being disposed at the head of the contained column, while material from the foot is periodically removed, any given portion of the material thus requiring an extended period of time to pass downwardly through the treatment zone, and the entire movement of the coke or coal (which remains throughout in the form of granules, pieces or lumps, say of an average mean diameter of one-fourth inch to one inch) being effectuated, when needed, by gravity.

Since the discharging carbonaceous solid particles from such a furnace are at a relatively high temperature (whether the operation is at the value of 1400° C. or more as indicated above, or whether it is at some lower temperature, although usually at least of the order of 1000° C.) and since the space within the furnace is permeated by highly corrosive chlorine gas, the discharge of the solid product involves unusual problems. In the first place, except at times of actual outflow of the product, the furnace must be kept well sealed, to prevent escape of chlorine gas in quantities that might be hazardous to attendant personnel, or damaging to exterior metallic structures or equipment. Furthermore, even at the time of discharge, it is desirable to keep steel, iron or other metallic structures as remote from immediate, facing relation to the furnace interior as possible. In the second place, the extremely hot particulate product (perhaps especially in the presence of even small quantities of corrosive gas) has been found to cause objectionable damage or deterioration of metallic structures or surfaces, e. g. steel or iron frames, doors and guides, when it continually strikes them or passes across them in the course of its flow. Finally, the discharge apparatus must be convenient to operate and should provide an effective and controllable closing operation so that no more than a desired quantity of the product need be discharged at a given time.

Accordingly, important objects of the present invention are to provide furnace discharge apparatus wherein the foregoing problems are satis-

3

factorily solved or overcome, and specifically, to provide improved and novel discharge means satisfying one or more of the foregoing criteria, as may be desired for satisfactory operation with a given furnace.

A further object is to provide new and effective discharge apparatus for furnaces handling particulate solids, whereby the furnace may be kept sealed at times of non-discharge and whereby the stated solids may be removed in desired quantities, with at least reasonably minimum deterioration with respect to the necessary structural parts.

Another, significant object is the provision of discharge apparatus, including closure means which can be easily operated at desired times, preferably by remote control and which is adapted to afford removal of only a measured or readily measurable quantity of the particulate solids, e. g. a quantity which may be very minor relative to the total charge in the furnace. Additional objects are to provide such apparatus: which is of relatively simple yet effective construction; which is peculiarly durable and rugged, in regard to the weight and temperature of the discharging material and with respect to otherwise severe conditions of service; which may be operated repeatedly over long intervals of time with little or no attention for repair or replacement of structural parts; and which is specially designed, while accomplishing one or more of the other objects herein set forth, to deliver desired, successive quantities of the particulate solids by gravity flow directed in a controlled manner for deposit of the material at a convenient locality below or beside the furnace.

To these and other ends, important and presently preferred features of the invention relate to means providing a sealable closure for the furnace, as at the bottom or other lower part when the material advances through the furnace by gravity and is similarly to be discharged, such means including provision for an opening through the furnace wall, the opening being conveniently faced with refractory material, i. e. material substantially less susceptible to deterioration than steel, iron or like metallic parts. The opening is advantageously arranged so that, for gravity discharge, the heated solids will flow through the opening and fall to a desired locality without making contact with the metallic shell of the furnace or other relatively non-resistant structure. For direct closure of this opening, a gate is provided which can be adjustably positioned to control the rate of discharge and which likewise comprises refractory material, as defined above, in such relation that the discharging solids, flowing past the gate in its open position, do not make appreciable contact with any non-resistant parts of the gate. When closed, the gate prevents escape of the furnace charge, the refractory material of the gate then preferably abutting the refractory facing of the opening and also covering the area of the gate which is disposed inwardly of the furnace. A further element of the complete apparatus is sealing structure disposed exteriorly of the gate and arranged, for example, in cooperation with the steel furnace shell or the like, to provide an effective seal against undesired release of furnace gases, i. e. in that by reason of the material or arrangement of the gate, its separable interface with the structure providing the opening may not be sufficiently tight to prevent outlet of gas even

4

though the furnace charge is satisfactorily retained.

The sealing structure essentially comprises a sealing door, arranged to close around or exteriorly of the gate, and preferably spaced outwardly of the gate, the door comprising steel, iron or like non-porous material at least in the form of a shell. The door is arranged to close tightly against suitable frame or like structure which may be deemed to define a second or further opening (i. e. relative to the steel shell of the furnace); in at least some cases, the door-receiving structure may be associated with or embodied in the furnace shell, the door and associated receiving and enclosure parts thus constituting the sealing structure that cooperates with the shell to prevent escape of furnace gases, i. e. when the gate is closed. If desired, a relatively soft gasket may be interposed between the edges of the door and the door-receiving frame, to provide a more complete seal between these metallic parts, which then afford an effective seat for such a gasket. Being at a relatively cool locality, the gasket may be of any suitable material, although preferably of a composition resistant to deterioration by heat or chemical attack.

Supplemental or further features which may advantageously be embodied in the apparatus, include provision for moving the gate transversely across the opening, i. e. so that the gate may be slid or shifted in a plane that intersects the path of discharging material. The gate-displacing means may be of a remotely controlled character, at least in part contained within the sealing structure, which is preferably so arranged as to enclose the gate in all of its positions, e. g. even in its most open relation. The door may likewise have movable or releasable means whereby it is normally secured in sealed or closed position but may be swung or otherwise shifted to open relation, where it is at least entirely clear of the path along which the opening-defining means in the furnace wall is adapted to guide the discharging, mobile material. Such further instrumentalities of the outer door arrangement are also disposed in spaced relation to the path of the discharging material, and may include, if desired, powered operating means, e. g. for holding the door closed at desired times. In presently preferred embodiments of the invention, the metallic structural parts may conveniently be arranged so that they are not only clear of contact with the outflowing furnace product but are at least somewhat remote in the sense of reducing the effects of heat radiation on such parts from the product.

By way of example, certain useful embodiments of the invention are illustrated in the accompanying drawings, in which:

Fig. 1 is a central, vertical section, at the lowest part of a furnace, showing one embodiment of the improved port;

Fig. 2 is a horizontal section on line 2—2 of Fig. 1;

Fig. 3 is a fragmentary vertical section on line 3—3 of Fig. 1;

Fig. 4 is a central, vertical section, corresponding generally to Fig. 1, but illustrating another embodiment of the invention;

Fig. 5 is a front elevation, taken along line 5—5 of Fig. 4;

Fig. 6 is a horizontal section on line 6—6 of Fig. 4;

Fig. 7 is another central, vertical section, gen-

erally corresponding to Figs. 1 and 4, but showing a still further embodiment; and

Fig. 8 is a fragmentary horizontal section on line 8—8 of Fig. 7.

Referring first to Figs. 1 to 3, the illustrated furnace 10 is of the upright shaft type, for example having the shape of a vertically extending cylinder and providing a like, cylindrical furnace cavity 12. As noted, only the lowermost part of the furnace is illustrated in this and other views; the furnace wall structure thus actually extends upward above the portion shown in Fig. 1 for a considerable distance and includes appropriate closure and charge-introducing means at the top, suitable heating instrumentalities, and provision for inlet and outlet of gas, usually in counter-current relation to the downward travel of the charge material, all of said instrumentalities being omitted, for simplicity, from the drawings, except for a diagrammatic indication at 14 of a gas conduit, which may be the chlorine inlet in the case of a coke-treating process but which may, if desired, be at a higher level of the furnace than is embraced in these views. The furnace structure includes an exterior, steel shell 15, arranged to provide an effective seal for the furnace as explained above, and lined with refractory material 16, which may be a suitable mineral material, usually a substance that comprises predominantly or substantially wholly aluminum silicates. The refractory 16 may be in the form of bricks, tile or other composite or monolithic arrangement, defining in effect the inner wall for the furnace.

At the lower end of the structure of Fig. 1, the furnace tapers inwardly and downwardly, at 18, to a vertically extending passage or opening 19, through which the charge (not shown but always filling the cavity 12 throughout the illustrated regions) may be allowed to fall, in amounts of desired extent, from time to time. The passage 19 is similarly faced, and indeed constructed, of refractory material as shown, being conveniently of similar nature to the main portions of the furnace wall as described above. While it is ordinarily greatly preferred that the refractory substances constituting or otherwise lining the furnace, passage, and closure gates and doors, be of the inorganic type (such as aluminum silicates or other oxidized compounds), furnaces for the treatment of carbonaceous material may sometimes be conveniently faced or lined with carbon (for example, as to obtain certain advantageous results in accordance with the principles of another recent discovery, made separately of the present invention), and in consequence the term "refractory material" is for the special purposes of identification herein and in the appended claims, intended to include carbon (e. g. purified carbon from coke or the like) and graphite as well as inorganic refractories. Although carbon is considerably less resistant to wear and deterioration than the inorganic refractories, especially when it is even for short times exposed to the atmosphere in a heated condition, it may be suitable in some cases for the passage, gate and other structure. Indeed a particular feature of the arrangements shown in all of the drawings is that the refractory parts may be readily replaced when needed, without replacing or substantially altering the metallic supporting and sealing elements.

As shown also in Figs. 2 and 3, the lowermost part of the passage 19 is shaped to provide a horizontally extending passage 20 which receives

a horizontally movable gate consisting essentially of a block or tile of refractory material 22. The refractory gate 22 includes an underlying frame or plate 23 to which the block is secured and which is mounted on a carriage 25 having two pairs of flanged wheels 27 that ride on spaced, parallel rails 29, 30. The rails are disposed somewhat below the bottom of the furnace and very substantially spaced at opposite sides of the passage 19, the rails extending in a direction parallel to the slot 20 so that the refractory gate 22 carried by the car may be moved crosswise of the passage 19, i. e. toward an open position as fragmentarily indicated by the broken lines 32.

An enclosure or housing designated 34 and constructed of steel plate or sheet, is disposed around the lower end of the furnace, so that the latter projects into the housing and so that the walls of the housing are connected in sealed relation to the shell 15 of the furnace. The housing includes a floor portion 36, which carries the rails 30 as shown, as well as other structure presently to be described. It will be understood that the housing 34, if desired, may be principally supported by suitable frame structure 38 embodied in the support for the furnace proper. Directly below the opening 19, the housing 34 has an opening 39 in its floor 36, which if desired may be bounded by an upwardly and outwardly flaring hopper or chute section 40 to prevent stray particles of the discharge solids from lodging on the floor 36. The opening 39 is closed by a movable door 41, here consisting essentially of a steel plate or the like. While other means, such as hinges may be employed, if desired, for movably mounting the door and for cooperation to hold it in a normally closed and sealed condition against the frame constituted by the periphery of the opening 39 in the floor 36, the arrangement of Figs. 1 to 3 embodies a simple series of releasable bolts 42, for fastening peripheral flanges 43 of the door to the adjacent part of the floor 36. As indicated above, a suitable gasket (not shown) may be disposed at the junction between the door and the metal frame or like structure against which it closes, here and also in the embodiments of Figs. 4 to 8 described below.

While other means may likewise be employed for actuation of the gate 22, a convenient device is the double-acting, fluid-pressure operated cylinder 45 having the conventional piston (not shown) to drive a piston rod 46 which is connected to the carriage 25, the cylinder 45 being actuated by air or other fluid, such as water or oil. For example, the illustrated apparatus involves an air cylinder 45, from which the air supply lines 48, 49 to the opposite ends of the cylinder extend through the housing 34, for connection with a suitable source of air at pressure and an appropriate controlling valve means of conventional nature. Thus by driving the piston rod 46 in one direction or the other, e. g. to the right or left as seen in Fig. 1, the carriage is correspondingly rolled along the rails 29, 30 and the gate 22 moved away from or toward the indicated, closed position.

The operation of the device of Figs. 1 to 3 is essentially simple. Normally the gate 22 and door 41 are closed as shown, so that the charge is fully contained in the furnace chamber 12 and the housing 34 is sealed against escape of furnace gases which may leak past the gate 22, the latter, by reason of the nature of the abutting materials at its joint with the passage 19, present-

ing a closure which may not be gas tight. When it is desired to discharge a portion of product from the furnace, the door 41 is first opened, in this instance by removing it and placing it at one side of the path through the opening 39. Then the air cylinder 45 is actuated to move the carriage 25 and gate 22 to the right (Fig. 1) to a desired distance, i. e. opening the passage 19 either wholly or partially as may represent a desired rate of flow of the particulate solids. Such solids, i. e. the product material, then drops down through the passage 19 and the opening 39, to suitable receiving means (not shown) below the latter, it being understood that if desired, water or other coolant may be sprayed on the passing material as it emerges from the opening 39. When a desired quantity of the product has fallen through the opening 19, the air cylinder 45 is actuated in the reverse direction, moving the gate 22 back to closed position and cutting off the flow of solids. When the product material thus stops falling through the opening 39, the door 41 is replaced and locked in sealed relation to the housing 34. It will be noted that all metallic structures are substantially spaced from the flow of heated product, i. e. from the path along which or into which the discharge passage 19 guides or directs such flow. Thus the underlying structure 23 of the gate is well spaced from edges that may be swept by the product, the closing surfaces of the gate being wholly of refractory material, and the portions 51, 52 of the furnace shell that may underlie the bottom of the furnace being likewise spaced from the actual opening 19. The carriage 25, wheels 27 and rails 29, 30 are similarly arranged to lie well outside the path of falling product, for all positions of the carriage, while the periphery of the opening 39, being much wider than the opening 19 with which it registers, is likewise essentially clear of the passing material, e. g. the highly heated granules or pieces of purified carbon that constitute the product and that were originally fed to the top of the furnace as coke or anthracite coal.

In the arrangement of Figs. 4 to 6, which will be understood to be embodied at the lower end of a shaft furnace 60, otherwise identical with the furnace described in connection with Fig. 1, there is provided a discharge chamber 62 that embodies a sidewise discharge passage 63. As in Fig. 1, all of the interior of the furnace including the part defining its upper cylindrical chamber 64, is lined or constructed with refractory material 65, such material thus extending throughout the downwardly tapered region 66 and the lower chamber 62 with its opening 63. Here the gate 68, similarly comprising a slab or tile of refractory material having a tapered lower edge 69 for better interception of discharging product, is mounted to reciprocate in a vertical plane across the opening 63. Indeed the refractory structure providing the opening 63 may extend outwardly of the gate as shown, to an outer region 70, while providing a slot 71 at the top through which the gate may be hauled up. The refractory slab 68 is carried by a frame 72 across its top edge and is suspended by a cable 73 passing over a pulley 74 for connection to the piston rod 75 of a suitable, double-acting, air or other fluid-operated cylinder 76, which is disposed at one side of the assembly. Thus by control of fluid supply to the cylinder 76, the gate 68 may be raised or lowered through the slot 71, from and toward the fully closed position shown.

The outer housing or sealing structure for the discharge arrangement may include a steel housing or guide 78 enclosing the upper part and path of the gate 68, and likewise the pulley 74, a suitable gland 79 being provided for passage of the cable through the side wall of the housing 78. The sealing structure also includes a steel frame 80 around the projecting refractory portion 70 of the discharge opening, and thus essentially constituting a second or exterior opening which is closed by abutment of the edges of the door 82, specifically by abutment of the edges of the shell 83 for the door. In this embodiment, the inner face of the door may be composed of refractory material 84, for further protection of the metallic parts against damage. The housing portion 78 and frame 80 may be arranged in sealed relation to the furnace shell 85 as shown, the sealing structure being completed by the door 82 in its closed position.

The door 82 is conveniently hinged, as on pivot supports 86 along its top edge, so that it may be swung upward, and radially away from the furnace opening, to the dotted line position 87, as by means of a cable 88 connected to an outwardly projecting structure 90 on the door. The cable 88 may pass over pulleys 91, 92 and extend to a suitable winch or other device (not shown) whereby the door may be raised or lowered. While other means such as bolts or toggles may be employed to hold the door in closed and sealed relation, the illustration shows a fluid pressure actuated ram 94 or like device, comprising a cylinder and a plunger rod 95 adapted to be thrust powerfully against the projecting element 90 of the door 82. Thus to release the door, the air cylinder 94 is actuated to withdraw its rod 95, e. g. to the position 95a.

The operation of the apparatus of Figs. 4 to 6 will now be essentially self-evident. Assuming that the furnace 60 is filled with heated material, which extends down into the chamber 62 and up against the gate 68, and assuming that it is desired to discharge a portion, the door 82 is first opened by backing off the rod 95 and hauling on the cable 88 to swing the door out and up to the position 87 (Fig. 4). Thereupon the air cylinder 76 is actuated to elevate the gate 68 to a desired position, depending on the rate of gravity discharge of solids desired. The product, e. g. heated particles of carbon, then flows out of the opening between the bottom edge of the gate and the refractory floor 97 of the chamber 62. Thus guided by the described structure, over the lower beveled edge of the refractory opening frame 70, the material pours out and down, well beneath the door 82 in its raised position 87, to appropriate collecting means (not shown), and through suitable cooling influence if desired. When the intended quantity of solids has been discharged, the gate is dropped to its closed position by reverse actuation of the cylinder 76 and thereupon the door is swung down around the axis of its hinge 86 to closed position, the cylinder or ram 94 then being energized to drive the rod 95 against the structure 90 and to maintain the rod in such position thereafter. The edges of the door shell 83 are thus effectively reseated and sealed against the metallic frame 80, completing the seal of the supplemental housing, against escape of furnace gases. It will again here be noted that all metallic parts are disposed well outside the path of discharging solid, while the charge-retaining gate is arranged to provide faces of refractory in regions where it adjoins the

refractory-faced passage and also wherever it faces the furnace chamber. Indeed, as stated, the gate itself may be essentially a single, rectangular tile of refractory material.

The embodiment shown in Figs. 7 and 8 may in many details be essentially identical with the structure of Figs. 4, 5 and 6, and likewise more generally with the apparatus of Figs. 1 to 3, especially being disposed at the foot of a furnace 100 which is lined with refractory material 101 and enclosed in a steel sealing shell 102. Below the tapered portion 103 the present structure includes a discharge chamber 104 embodying a discharge passage 106, facing laterally, like the parts 62 and 63 of Fig. 4. Here the refractory facing or bounding structure of the passage 105 terminates in a vertical plane 107, where the opening is overlapped at all sides by the refractory slab or tile 108 which is held by an outer steel shell 110, constitutes the gate. Suspended from its top edge by a cable 111, which may pass over an upper pulley 112 and extend to appropriate driving means such as the air cylinder 76 in Fig. 5 (not here shown), the gate 108 can thus be moved up from or down to its fully closed position as illustrated. A steel or other metallic housing 114 encloses the upper path of the gate and the pulley 112 in the same manner as the housing portion 78 of Figs. 4 and 5.

The outer door 115 consists essentially of a heavy steel shell, of somewhat box-like configuration as shown, and arranged to engage a door frame 116 (which thus defines an outer opening) along a plane extending upwardly and outwardly at a substantial angle to the vertical. The door is hinged by suitable pivoting means 117 to swing radially outward from the frame 116, i. e. to an upper position in the same fashion as the door 82 of Fig. 4. For such purpose, an outwardly projecting structure 120 on the door 115 may be centrally connected to a cable 121 which passes over an upper pulley 122 and thence (for instance as in Fig. 5) to appropriate actuating means. To keep the door closed, with its diagonal or slanting edge tight against the frame 116, the plunger rod 124 of a suitable air or other cylinder 125 may be thrust against the projecting structure 120, in a manner similar to the corresponding arrangement of Fig. 4.

The operation of the apparatus of Figs. 7 and 8 is essentially identical with that shown in Figs. 4 to 6 and hence need not be described in detail. To discharge solid material, the door 115 and gate 108 are opened in the order named, the latter being slid upwardly to provide an actual opening of desired width. When the measured or otherwise controlled amount of particulate solid has flowed by gravity out of the furnace and downwardly over the lower edge of the refractory-faced opening 106, the gate and door are successively shifted to closed position. It will be noted that the structure of Figs. 7 and 8 is particularly simple and effective, representing certain advantages over that of Fig. 4, especially with respect to an economy of parts and to provision for keeping the sealing structure, notably the portion of the door frame that underlies the discharge flow, in a position back from the projecting lower edge of the refractory opening 106. The provision of the door sealing frame or flange at a substantial angle or diagonal is particularly useful in keeping this part from being fouled (particularly at the bottom) by the falling charge. It will be noted too that the devices of Figs. 4 to 7 have a number of characteristics in

common that represent some advantage of present preference over the structure of Fig. 1, again with respect to simplicity and ease of operation, and notably in provision for sidewise discharge of the product, avoiding excessive rapidity of flow and permitting better quantitative control.

It will now be seen that the several illustrated embodiments amply satisfy the various objects and purposes of the invention as explained above, and afford a convenient, rugged and easily operated means for the discharge of material from a furnace (indeed useful for other mobile material than particulate solids), in any regulated amount, whether small or large. While the specific apparatus in the drawings shows provision for initially guiding the gravity-flowing material in either a truly vertical or truly horizontal direction, the equipment may be readily designed to afford egress in other directions, as at an intermediate or other acute angle to the vertical. In all cases, effective provision is made both for retaining the charge in the furnace and for sealing the system against escape of gas or against other communication with the atmosphere, as where a pressure higher or lower than atmospheric must ordinarily be maintained in the furnace chamber. Indeed for the described chlorination of coal or coke it is sometimes desirable to provide a slightly increased or reduced pressure, as to suit the requirements of chlorine gas supply and spent gas removal. Finally, while metallic structures are employed for effective sealing purposes, and especially for closure joints (or indeed, if desired, to carry gaskets at such joints), all of such parts are well spaced from the hot flowing material, so as not to be fouled by contact and so as to be impaired as little as possible, even by radiant heat. All passage-forming, guiding and closure surfaces located at the discharge opening and adapted to meet the hot furnace product are faced with refractory material, an inorganic refractory being unusually suitable for this purpose, in its resistance to deterioration by mechanical, thermal or oxidizing agencies.

It is to be understood that the invention is not limited to the specific devices herein shown and described but may be embodied in other forms without departure from its spirit.

I claim:

1. In a furnace, apparatus for discharge of mobile material therefrom, comprising refractory-faced means providing a gate opening, a gate removably closing said opening and comprising a body of refractory material adapted to face the interior of the furnace and to adjoin the refractory facing of said first-mentioned means when the gate is in closed position, said gate being movable away from the opening, metallic structure exteriorly enclosing said first-mentioned means and said gate in closed position, to seal the opening against communication with the atmosphere, said metallic structure comprising door-receiving means sealed to the furnace around the first-mentioned means, and a door disposed in registration with the opening, and normally closed in sealed relation with said door-receiving means, said door being shiftable to an open position, and said door-receiving means being substantially spaced from the path of material to be discharged through the opening, in all directions transversely of said path.

2. In a furnace, apparatus for discharge of mobile material therefrom, comprising refractory-faced means providing a discharge opening

for the furnace and adapted for discharge of the material into a predetermined path from said opening, a movable gate comprising refractory material facing the interior of the furnace, to close said opening, and supplemental sealing means exterior of the gate, to prevent communication between the outside atmosphere and the interior of the furnace through said opening, said sealing means comprising a door normally closed across said path and movable to a position clear of said path, and frame means sealed to the furnace and engageable in sealed relation by the door in its closed position, said frame means being spaced away from and clear of the aforesaid path.

3. In a furnace, apparatus for discharge of mobile material therefrom, comprising means providing a discharge opening for the furnace and adapted for discharge of the material into a predetermined path from said opening, a movable gate to close said opening, and supplemental means exterior of the gate, to provide a sealed enclosure for the opening when the gate is closed, said sealing means comprising door means normally closed across said path and movable to a position clear of said path, and door-receiving means defining an opening substantially larger than said path and substantially entirely spaced outwardly therefrom, said door-receiving means being engageable in sealed relation by the door means in the closed position of the latter.

4. In a furnace, apparatus for discharge of mobile material therefrom, comprising refractory-faced means providing a discharge opening for the furnace and adapted to guide the material to discharge from said opening along a predetermined path, a movable gate comprising refractory material adjoining said first-mentioned means, to close the opening, and supplemental sealing means providing an outer opening in registration with the first opening and including a movable door disposed over said second opening exteriorly of the gate, for sealing the first opening against communication with the atmosphere, said sealing means comprising metallic structure disposed relative to said opening so that when the door is opened away from said outer opening all of the metallic structure of the sealing means is substantially outwardly spaced from and clear of the aforesaid path of discharging material.

5. In a furnace, apparatus for discharge of mobile material therefrom, comprising refractory-faced means providing a discharge opening for the furnace and adapted for discharge of the material into a predetermined path from said opening, a gate normally closing said opening and comprising a body of refractory material which faces the interior of the furnace and is adapted to adjoin the refractory facing of said first-mentioned means, said gate having means mounting it for movement transversely of the opening in linear direction to successive open positions for adjusting the size of aperture of said opening, and means comprising metallic structure exteriorly associated with the furnace, for normally sealing the first-mentioned opening against communication with the atmosphere, said last-mentioned means comprising a door normally closed across said path and movable to a position clear of said path, and frame means for receiving the door in closed position in sealed relation, said frame means thereby defining a second opening having its periphery spaced outwardly of said path in all directions.

6. Apparatus as described in claim 5, wherein

the first-mentioned refractory-faced means is disposed to provide a downwardly-leading opening, for direct, vertically downward discharge of material, said metallic structure comprising a housing disposed around and extending below said first opening, said frame means defining said second opening in said housing at a position spaced vertically below the first opening, the periphery of said second opening being substantially wider than the first opening in all directions with respect to a common vertical axis traversing the first and second openings.

7. Apparatus as described in claim 6, in which the gate mounting means includes rolling means enclosed in said housing, for displacement of the gate horizontally away from and toward closed position, and remotely controllable means for actuating said rolling means.

8. Apparatus as described in claim 6, in which the gate mounting means comprises a carriage for the gate, having supporting wheels, and horizontal rails for the wheels, substantially spaced from the downward path of discharging material at opposite sides thereof, said carriage and rails being disposed within said housing.

9. Apparatus as described in claim 5, wherein the first-mentioned means comprises refractory-faced structure having a lateral slot through which the gate is adapted to slide for displacement away from and into closed position, said last-mentioned structure including means extending outwardly of the gate and defining a refractory-faced boundary around the opening outside of the gate, the aforesaid door-receiving frame means being disposed radially outward of said last-mentioned refractory-faced means, and said door comprising means disposed to overlap said last-mentioned refractory means at all localities around the first-mentioned opening when the door is closed.

10. Apparatus as described in claim 9, wherein the first-mentioned opening-providing means is disposed to afford an opening leading in a lateral direction and includes refractory-faced means providing a floor for support of the material traveling to discharge through the opening, and said door including means pivoting the door on a substantially horizontal axis spaced above the opening, so that the door may be opened by swinging it outward about said axis and to an open position above the material discharging laterally from the opening.

11. Apparatus as described in claim 5, wherein the first-mentioned refractory-faced means is disposed to provide an opening leading laterally from the furnace, and wherein the gate mounting means comprises means for drawing the gate upward across the opening to successive open positions, said door-receiving frame means being disposed to define the second opening in a plane which lies outwardly beyond the gate in the direction of material discharge at the top and which extends beneath the gate and below the refractory facing of the first-mentioned means at the bottom, said refractory facing thereby at the bottom extending into said second-mentioned, defined opening, so that the frame means at the bottom is spaced rearwardly of the path of laterally and downwardly discharging material by a lower edge of said refractory facing.

12. Apparatus as described in claim 11, wherein the door comprises a metallic shell recessed to surround at least part of the gate when the latter is in closed position and adapted at its edges to abut the aforesaid frame means, said door hav-

13

ing associated means pivoting the door on a substantially horizontal axis above the door, so that it may be swung outward about said axis to an open position above the discharging material.

13. In a sealed, refractory lined furnace, apparatus for discharge of particulate solids, comprising refractory-faced means providing a discharge opening for the furnace, a removable gate for said opening, comprising refractory material adapted to face the opening and to adjoin the refractory facing of said first-mentioned means when the gate is in closed position, and metallic structure disposed around the gate exteriorly of the furnace, for normally sealing the aforesaid opening against communication with the atmosphere, said metallic structure having an opening therein in registration with the first-mentioned opening, the periphery of said second opening being substantially spaced outwardly of the path of discharging solids, and said metallic structure including a door for said second opening, removably closed in sealed relation thereto.

14. In a sealed, refractory lined furnace, apparatus for discharge of particulate solids, comprising refractory-faced means providing a laterally-facing gate opening and adapted to discharge the solids along a predetermined path extending initially laterally, a substantially upright gate removably closing said opening and comprising a body of refractory material adapted to face the interior of the furnace and to engage the refractory facing of said first-mentioned means when the gate is in closed position, said gate having means mounting it for endwise movement in a substantially vertical direction across the opening to successive open positions for adjusting the size of aperture of said opening, and supplemental sealing means exterior of the gate, to prevent communication between the outside atmosphere and the interior of the furnace through said opening, said sealing means comprising a door normally closed across said path and movable to a position clear of said path, and frame means sealed to the furnace and engageable in sealed relation by the door in its closed position, said frame means being spaced away from and clear of the aforesaid path.

14

15. In a sealed, refractory lined furnace, apparatus for discharge of particulate solids, comprising refractory-faced means providing a laterally-facing gate opening and adapted to discharge the solids along a predetermined path extending initially laterally, a substantially upright gate removably closing said opening and comprising a body of refractory material adapted to face the interior of the furnace and to engage the refractory facing of said first-mentioned means when the gate is in closed position, said gate having means mounting it for endwise movement in a substantially vertical direction across the opening to successive open positions for adjusting the size of aperture of said opening, metallic structure exteriorly enclosing said first-mentioned means and said gate in closed position, to seal the opening against communication with the atmosphere, said metallic structure comprising door-receiving means sealed to the furnace around the first-mentioned means, and a substantially upright door disposed in registration with the opening and normally closed in sealed relation with said door-receiving means, said door having associated means above it, pivoting the door on a substantially horizontal axis, so that the door may be swung outward about said axis to an open position clear of discharging solids, and said door-receiving means being substantially spaced from the path of solids to be discharged through the opening, in all directions transversely of said path.

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