March 26, 1935. J. D. PUGH 1,995,941

METALLURGICAL FURNACE

Filed June 14, 1933 2 Sheets-Sheet 1

FIG. 1.

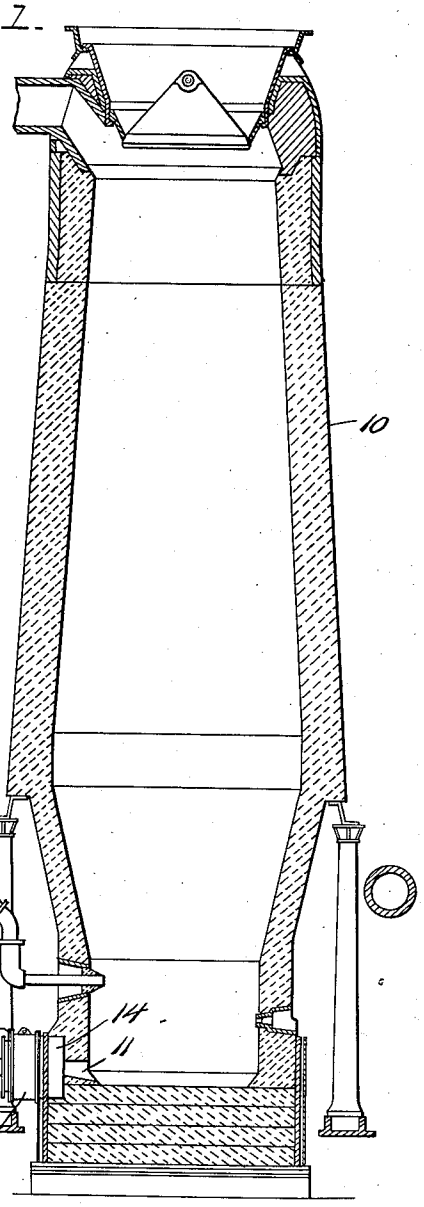


FIG. 3.

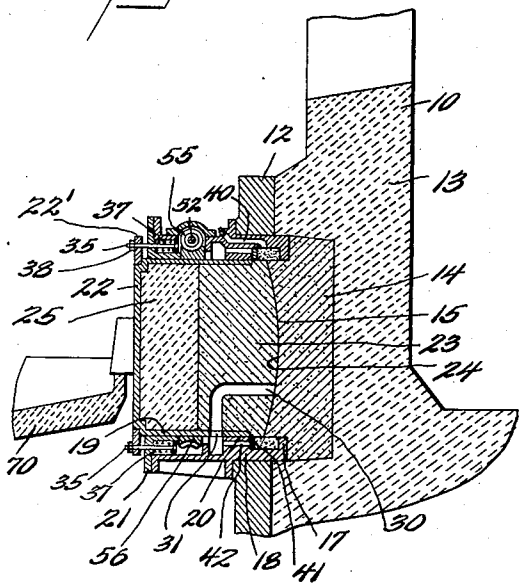


FIG. 3a.

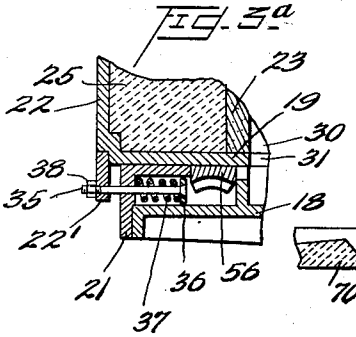
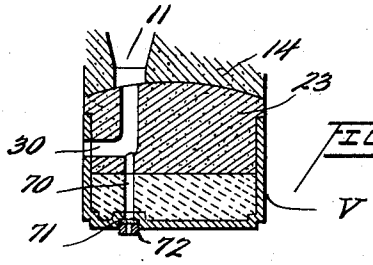


FIG. 12.



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METALLURGICAL FURNACE

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FIG. 2.

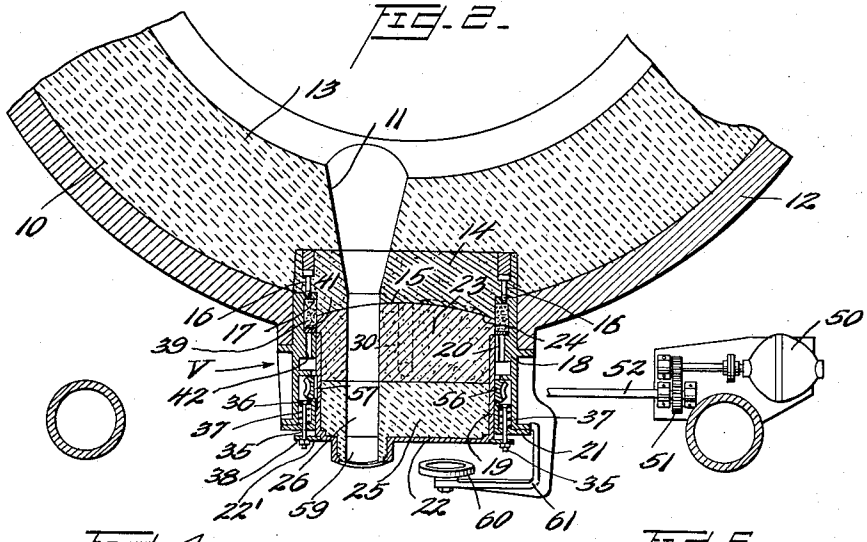


FIG. 4.

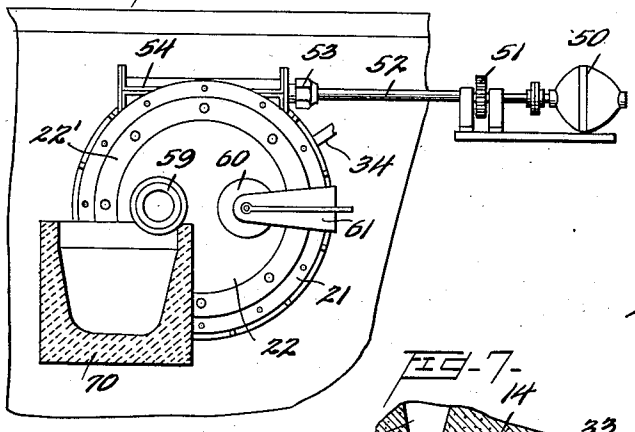


FIG. 5.

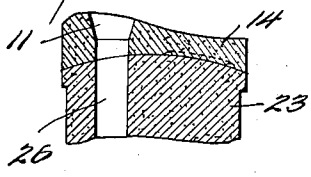


FIG. 6.

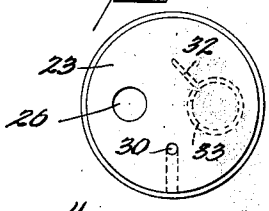


FIG. 7.

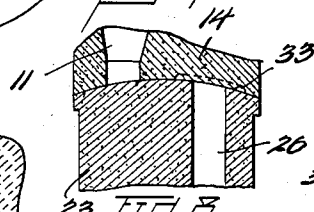


FIG. 9.

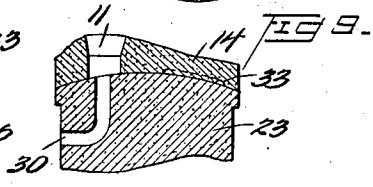


FIG. 11.

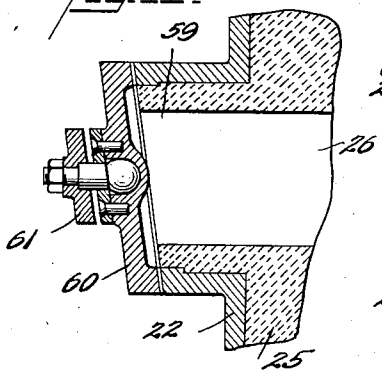


FIG. 8.

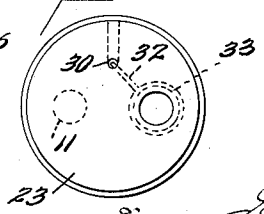
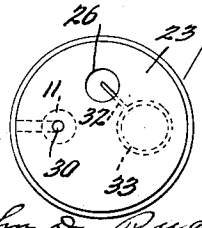


FIG. 10.



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UNITED STATES PATENT OFFICE

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METALLURGICAL FURNACE

John D. Pugh, Baltimore, Md.

Application June 14, 1933, Serial No. 675,853

10 Claims. (Cl. 266—42)

This invention relates to metallurgical furnaces and particularly to mechanism for facilitating the tapping or discharging of the molten contents of such furnaces.

Throughout the metallurgical industry it has heretofore been generally customary to retain molten material within furnaces or other containers by plugs of refractory material such as clay, material of this character being inserted into the discharge orifices or "tap holes" of such furnaces in plastic condition and then allowed to harden so as to form, in effect, an integral portion of the furnace retaining wall. When it is desired to withdraw the molten material from the furnace, the refractory plug must be broken and removed, whereupon the metal flows freely through the tap hole, the flow continuing until the molten material has wholly escaped. For instance, this method of tapping has been practiced for many years past in connection with blast and open hearth furnaces, as is well-known. As is also well known, the operation of removing a refractory plug from the tap hole of a blast or open hearth furnace is an extremely hazardous one despite improved mechanism which has been provided the workers for this purpose. Considerable time must necessarily be spent in breaking up the plug, the workers are under great tension, and serious accidents occasionally occur. It is furthermore impossible to control the rate of flow of the discharging material through the tap hole and likewise impossible to interrupt the flow once it has begun, should this be desired.

The present invention contemplates an improved mechanism, which may be broadly designated a valve mechanism, for controlling the discharge of molten materials from a furnace, such as a blast furnace or open hearth furnace, or for controlling the flow of molten materials from almost any type of container for such materials in which the molten material is maintained in freely flowing condition.

Broadly considered, the invention comprises essentially a movable valve or gate member mounted so as to have sliding relationship to a portion of the furnace or container wall in the vicinity of the tap hole, together with means for operating this member under the close control of an attendant and means for preventing leakage of molten material past the valve member when the tap hole is closed thereby. The invention further contemplates means for maintaining the material in the vicinity of the tap hole in freely flowing molten condition by effecting, whenever necessary, combustion of some of the ingredients of the bath in the vicinity of the tap hole, thus elevating the temperature of this portion of the bath.

While the invention is of general applicability, it will be found particularly useful when employed in connection with blast furnaces, and for the purpose of illustration an embodiment of the invention, designed particularly for use in connection with blast furnaces, will be hereinafter disclosed. Such embodiment is illustrated in the accompanying drawings, in which:

Figure 1 is a vertical axial section through a blast furnace to which the novel discharge control mechanism has been applied;

Figure 2 is a horizontal section through a portion of the furnace at the tap hole and through the flow controlling apparatus associated therewith;

Figure 3 is a section on line 3—3 of Figure 2;

Figure 3a is a similar section upon a somewhat larger scale;

Figure 4 is a section on line 4—4 of Figure 1;

Figures 5–10, inclusive, are rather diagrammatic illustrations showing the valve member in various positions relatively to the tap hole, Figures 5, 7, and 9 being horizontal sections through the tap hole and associated valve and Figures 6, 8, and 10 showing the valve device in front elevation;

Figure 11 is an enlarged sectional view of a detail; and

Figure 12 is an axial section through the valve device showing the improved means for permitting direct visual inspection of the molten material within the furnace, at a point below the surface thereof.

The blast furnace is indicated at 10, and inasmuch as it is not in itself novel, its detail will not be specifically set forth. It is provided with the usual charging means, tuyères, cinder notch, and tap hole, the tap hole being indicated at 11. The molten iron which results from the smelting and reducing operations carried out in the furnace, of course collects at the bottom of the shaft or upon the floor of the furnace adjacent the tap hole 11. As has been heretofore pointed out, it has been customary practice to obstruct the tap hole with a clay plug which was allowed to remain in position until the desired quantity of molten metal collected at the bottom of the shaft and to thereafter remove this plug by instruments applied externally, thus freeing the tap hole and permitting the entire molten contents of the blast furnace to escape. Thereafter a

fresh plug was reinserted and the process continued.

In accordance with the present invention, a valve member, generally indicated at V, is associated with the furnace at the tap hole, which member can be manipulated by the attendant to open and close the tap hole as desired. The furnace jacket is indicated at 12, this jacket being built up of metallic members, and the furnace lining is indicated at 13. The tap hole 11 is formed partially in lining 13 and partially in a block 14 of material such as graphite, this block being stationary with respect to the furnace and suitably retained in position, fitting tightly against the refractory lining 13. Preferably the block is circular in vertical transverse section and has a concave spherical outer face indicated at 15. Block 14 is preferably connected by bolts 16 to an annular member 17 which comprises an integral inwardly projecting annular portion of a cylindrical metallic opening of substantially the same diameter formed in the wall of the jacket 12. Casing 18 supports interiorly thereof the valve V.

The valve V includes a metallic drum having a cylindrical wall 19 coaxial with casing 18 and rotatably supported therein on bearings comprising flange 20, integral with the casing, and annular angle member 21 secured thereto, the outer end of drum 19 being closed by a circular disc 22. Drum 19 carries within it a cylindrical block of refractory material 23, preferably of graphite, the inner face 24 of which is shaped to closely engage the outer face 15 of block 14, and also carries intermediate block 23 and end closure 22 a second body of refractory material, indicated at 25. Extending through blocks 23 and 25 is a cylindrical port 26 of substantially the same diameter as the outer end of tap hole 11, the conduit 26 being to one side of the axis of the valve member V so that, by rotating this valve member within the casing 18, conduit 26 may be either brought into register with tap hole 11 to permit free flow of molten material from the furnace or may be moved out of register with the tap hole, thus closing the tap hole and preventing or terminating this flow of material.

Also formed in block 23 is a passage 30 for air, the air entering this passageway after passing through an opening 31 in the drum 19 and being conducted thereby inwardly and rearwardly to a discharge orifice formed in the inner face 24 of this block. In one position of the block 23, for instance in the position in which it is shown in Figures 3, 5, and 6, the discharge orifice of air channel 30 is closed by the stationary block 14. In a second position of block 23, however, the discharge port of channel 30 registers with the end of a short channel 32 formed in the face of stationary block 14, which channel in turn communicates with an annular channel 33 also formed in this block and so located as to encircle the inner end of conduit 26 in the valve member when that conduit has been moved to a position 180° from the tap hole 11, as shown in Figures 7 and 8. In a third possible position of adjustment of the valve member, the discharge port of the air channel is brought into alignment with the tap hole, as shown in Figures 9 and 10.

Air under pressure is conducted to an aperture formed in the wall of casing 18 by a compressed air conduit 34, and the air so supplied is under a pressure sufficiently great to insure passage of the air into the tap hole and thence into the bath of the furnace, against the static pressure of the bath, when the valve device is turned to the position in which it is diagrammatically shown in Figures 9 and 10, with the air discharge port opposite the tap hole. Air under such pressure is always maintained in the annular space intermediate drum 19 and casing 18, and suitable packing devices are provided to prevent its escape.

Preferably the end disc 22 and drum 19 are formed in one piece as shown, and, where these members join, an external annular groove is formed within which rests the inner edge of an annular collar indicated at 22'. Collar 22' is perforated for the passage of a plurality of bolts 35 having heads 36 positioned in the annular space intermediate casing 18 and drum 19, helical springs 37 encircling the bolts respectively, each spring having one end abutting against the associated bolt head 36 and its other end abutting against the annular angle member 21 through which the bolts slidably extend. The springs 37 are kept under compression, and the thrust which each exerts may be regulated by adjusting the external nut 38 on the end of the bolt associated therewith. It is the function of the mechanism just described to exert an inward pull at all times upon the valve member V to insure that its inner convex face 24 tightly engages the outer concave face 15 of plug 14.

It will be noted that the casing 18 defines, with the cylindrical outer surfaces of blocks 14 and 23 adjacent the mutually abutting faces of these blocks, an annular pocket 39. In this pocket is maintained a body of pulverulent material which may be introduced in the form of a paste through an aperture 40 and which material is thereafter dried by heat, the moisture escaping through this same channel. It is the function of the pulverulent material in chamber 39 to prevent the escape of any molten material which might tend to leak outwardly between the contacting surfaces of blocks 14 and 23. This pulverulent material is kept under constant pressure by the action of the compressed air trapped intermediate drum 19 and casing 18, an annular ring 41 which encircles block 23 being located at the outer end of pocket 39 and air under pressure having access to the outer face of this annular ring through ducts 42 formed in flanges 20 of casing 18. If desired, the pulverulent material may be dispensed with and seepage or leakage of molten material into pocket 39 prevented only by compressed air, which is kept at a pressure sufficiently high to accomplish this function.

Any suitable means may be chosen for effecting rotation of the drum, but I preferably provide a power mechanism such as illustrated in Figures 2 and 4, this mechanism including the electric motor 50, reduction gearing 51, and drive shaft 52 which extends through a suitable packing gland 53 into a cylindrically shaped housing 54 which in reality comprises a portion of casing 18. Shaft 52 has fixed thereon, within the housing 54, a worm 55 which meshes with a worm wheel 56 splined at 57 upon the outer surface of drum 19 so that it may have a slight movement on the drum axially thereof but is nevertheless at all times constrained to rotate with the drum. The motor 50 is reversible so that, by the manipulation of the customary switches, the valve device V may be rotated to any desired position of adjustment. At its outer end, conduit 26 passes through a cylindrical extension 59 of end disc 22, the outer edge of extension 59 being positioned in an inclined plane so that, when the valve device V is turned from the position in which it is shown in Figure 2 to the position in which it is shown

in Figures 7 and 8, extension 59 will freely pass in rear of a closure disc 60 adjustably mounted upon the outer end of a bracket 61 fixed on casing 18. This construction is more clearly shown in Figure 11, and it is the function of cover plate 60 to close the outer end of conduit 26 against the escape of compressed air which might leak into this conduit at its inner end. As will be appreciated from an inspection of Figure 11, the closure disc 60 is mounted to have a slight universal movement relative to the bracket 61 so that it may readily find a true seating position against the outer end of the tubular extension 59.

It is apparent from the above description that the leakage of molten metal between the relatively movable parts of the mechanism is well guarded against. The seal of pulverulent material in the cavity 39, which is kept under constant compression by the pressure of the air against ring 41, prevents escape of such material from between the blocks 14 and 23, at the outer edges of their mutually contacting surfaces, at all times. The springs 37 maintain relatively tight contact between the abutting faces of the blocks, and when the valve member V is in the position shown in Figures 7 and 8, the presence of compressed air in the groove 33, which encircles conduit 26, prevents leakage of metal from the tap hole 11 to conduit 26. The air is maintained under pressure so long as the furnace is in use and, as has heretofore been pointed out, may be utilized to maintain in highly liquid condition the molten material within the furnace structure which lies in the vicinty of the tap hole. Thus, by turning the valve device V into the position diagrammatically shown in Figures 9 and 10, a desired quantity of air under compression may be injected into the metallic bath, whereupon a portion of this bath will be oxidized and consumed and its temperature raised. As a matter of fact, this operation may be carried on continuously to a limited extent, or air introduced in this manner may be intended for refining purposes only. It will be obvious also that some other gas might be substituted for air in the event that certain refining operations are to be carried out.

The metal may be discharged conveniently into the customary runner indicated at 70 in Figures 1 and 4 and, by means of the runner, may be conducted to a ladle, hot metal car, molds, or the like. By the use of a valve mechanism constructed in accordance with the invention, it is possible to effect the release of the molten contents of a furnace or other container in a minimum of time and without the slightest danger to the operator, who may be positioned at a distant point. Should a small portion of the bath by any chance solidify in the tap hole, the valve device can be turned to the position in which it is shown in Figure 2 and the customary opening operation by means of a blow-torch carried out. The invention may be utilized in conjunction with numerous types of furnaces but will be found especially useful in connection with blast furnaces.

In Figure 12 the means for permitting visual inspection of the molten contents of the furnace, below the level of the bath surface, is illustrated. A tubular aperture 70 is formed in the valve V, one end of which opens into the air channel 30 and the other end of which is provided with an eye piece comprising a transparent disc 71 of glass or the like and a perforated retaining plug 72. The furnace operator, by placing his eye adjacent the aperture in plug 72 and in alignment with the tubular aperture 70, may look directly at the metal on the hearth of the furnace, the entire view aperture being maintained clear of metal by the action of the compressed air. Obviously a viewing device of this kind may be applied to any kind of furnace wherever compressed air is available for the purpose of maintaining the viewing aperture clear of metal and is not limited to use with a valve structure such as shown.

Obviously numerous changes in the design and arrangement of the component elements of the invention may be effected without departure therefrom in adapting the same to various types of furnaces and containers employed in the metallurgical field.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A container for molten material having a discharge aperture formed in the wall thereof and means for controlling the flow of molten material through said aperture, said means comprising a supporting casing, a valve member movably supported within the casing and having an aperture which may be brought into or moved out of register with the aforesaid discharge aperture, means for maintaining said valve member in close engagement with the wall of the container at all times, and means for maintaining a body of compressed air between the container wall and valve member and intermediate the container and valve apertures, when said apertures are out of register, to prevent passage of molten material therebetween.

2. The combination with a container for molten material having a discharge port, a ported valve member slidably bearing against the container wall adjacent the said discharge port, a compressed air channel formed in one of the mutually abutting faces of said container and member, and means for maintaining air under pressure in said channel to prevent passage of molten material between said faces.

3. The combination with a container having a discharge port of a slidably mounted ported valve member which may be moved to bring said ports into register or out of register, and means for maintaining air under pressure in the port of said valve member when said ports are out of register.

4. The combination with a container having a discharge port of a slidably mounted ported valve member which may be moved to bring said ports into register or out of register, and means for maintaining air under pressure in the port of said valve member when said ports are out of register, said means including a closure for the outer end of the port in said valve member, which closure is mounted upon the container.

5. The combination with a container having a discharge port of a slidably mounted valve member in constant contact therewith, said member having means for introducing air or other gas under pressure into said discharge port when moved to one position of adjustment.

6. A container for molten material having a discharge aperture therein and a valve mechanism for controlling the flow of molten material through said aperture, said valve comprising a member revoluble about an axis offset from the tap hole and having an aperture which may be brought into or out of register with said tap hole by rotation of said member, said member having at all times sliding engagement with the con-

tainer wall, means normally urging said member against the wall of the container to maintain at all times close engagement of said member and wall, a chamber encircling said member, the interengaging faces of the member and wall being so located at all times relatively to the chamber that any molten material leaking outwardly between said faces would enter said chamber, and means within said chamber to resist such leakage.

7. A container for molten material having a discharge aperture therein and a valve mechanism for controlling the flow of molten material through said aperture, said valve comprising a member revoluble about an axis offset from the tap hole and having an aperture which may be brought into or out of register with said tap hole by rotation of said member, said member having at all times sliding engagement with the container wall, means normally urging said member against the wall of the container to maintain at all times close engagement of said member and wall, a chamber encircling said member, the interengaging faces of the member and wall being so located at all times relatively to the chamber that any molten material leaking outwardly between said faces would enter said chamber, and means for maintaining a body of gas under pressure in said chamber to resist and prevent such leakage.

8. A container for molten material having a discharge aperture therein and a valve mechanism for controlling the flow of molten material through said aperture, said valve comprising a member revoluble about an axis offset from the tap hole and having an aperture which may be brought into or out of register with said tap hole by rotation of said member, said member having at all times sliding engagement with the container wall, means normally urging said member against the wall of the container to maintain at all times close engagement of said member and wall, a chamber encircling said member, the interengaging faces of the member and wall being so located at all times relatively to the chamber that any molten material leaking outwardly between said faces would enter said chamber, and a closely packed body of pulverulent material in said chamber to resist such leakage.

9. A container for molten material having a discharge aperture therein and a valve mechanism for controlling the flow of molten material through said aperture, said valve comprising a member revoluble about an axis offset from the tap hole and having an aperture which may be brought into or out of register with said tap hole by rotation of said member, said member having at all times sliding engagement with the container wall, means normally urging said member against the wall of the container to maintain at all times close engagement of said member and wall, a chamber encircling said member, the interengaging faces of the member and wall being so located at all times relatively to the chamber that any molten material leaking outwardly between said faces would enter said chamber, a body of pulverulent material in said chamber, and means for maintaining said pulverulent material under pressure for the purpose of preventing such leakage.

10. A container for molten material having a discharge aperture therein and a valve mechanism for controlling the flow of molten material through said aperture, said valve comprising a member revoluble about an axis offset from the tap hole and having an aperture which may be brought into or out of register with said tap hole by rotation of said member, said member having at all times sliding engagement with the container wall, means normally urging said member against the wall of the container to maintain at all times close engagement of said member and wall, a chamber encircling said member, the interengaging faces of the member and wall being so located at all times relatively to the chamber that any molten material leaking outwardly between said faces would enter said chamber, a body of pulverulent material in said chamber, a movable piston-like member within said chamber and having one side bearing upon said material, and pneumatic means for exerting pressure upon the other side of the said piston-like member to cause the same to press upon the said material.

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