United States Patent

[11] **3,574,341**

[72] Inventors **Hans Reinhard Fehling**
Zug, Switzerland;
Hans-Joachim Winkler, Krefeld-Uerdingen; Karl Modler, Krefeld-Linn, Germany

[21] Appl. No. **786,980**
[22] Filed **Dec. 26, 1968**
[45] Patented **Apr. 13, 1971**
[73] Assignee **Didier-Werke A. G.**
Wiesbaden, Germany
[32] Priority **Dec. 30, 1967**
[33] **Great Britain**
[31] **59289/67**

[54] **VALVE CLOSURE FOR LADLES AND THE LIKE**
6 Claims, 3 Drawing Figs.

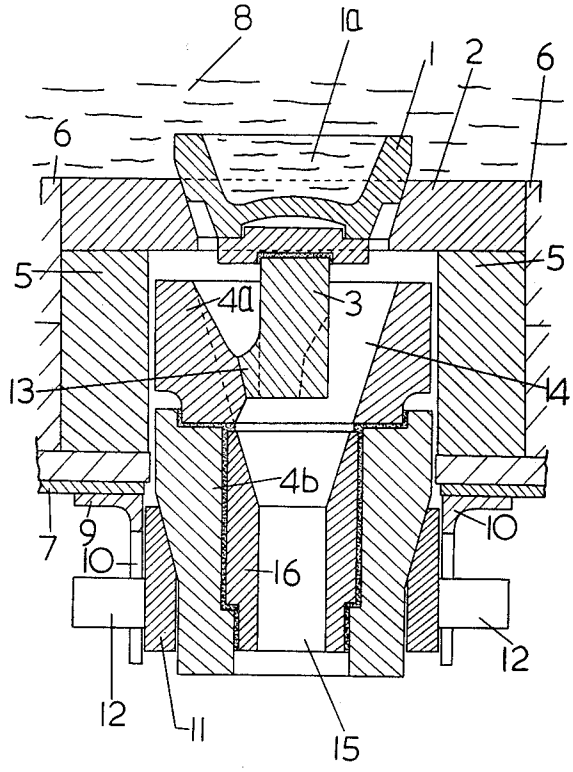
[52] **U.S. Cl.** **251/319,** 251/144, 251/368, 266/38
[51] **Int. Cl.** **F16k 1/00,** F27d 3/14
[50] **Field of Search** 137/1; 251/368, 144, 333, 319; 4/203, 204; 266/38

[56] **References Cited**
UNITED STATES PATENTS

2,689,959	9/1954	Holycross, Jr. et al.	4/203
3,386,633	6/1968	Nadrich et al.	251/144X
2,863,189	12/1958	Back	266/38X

Primary Examiner—William R. Cline
Attorney—Brumbaugh, Graves, Donohue and Raymond

ABSTRACT: In a valve closure assembly for controlling the discharge of molten material from the base of a container (e.g. the discharge of molten steel from a casting ladle) in which the flow takes place downwards through a valve seat controlled by an axially-movable valve head, the valve head is supported on a movable support member which is disposed in a flow passage through a valve body and is supported from the latter by a plurality of circumferentially-spaced struts. The valve body is movable upwards, to open the valve, by raising the valve head through the mechanism of the support member and the downward flow from the valve seat is divided by the struts in the flow passage into a plurality of streams passing the support member.



PATENTED APR 13 1971

3,574,341

SHEET 1 OF 2

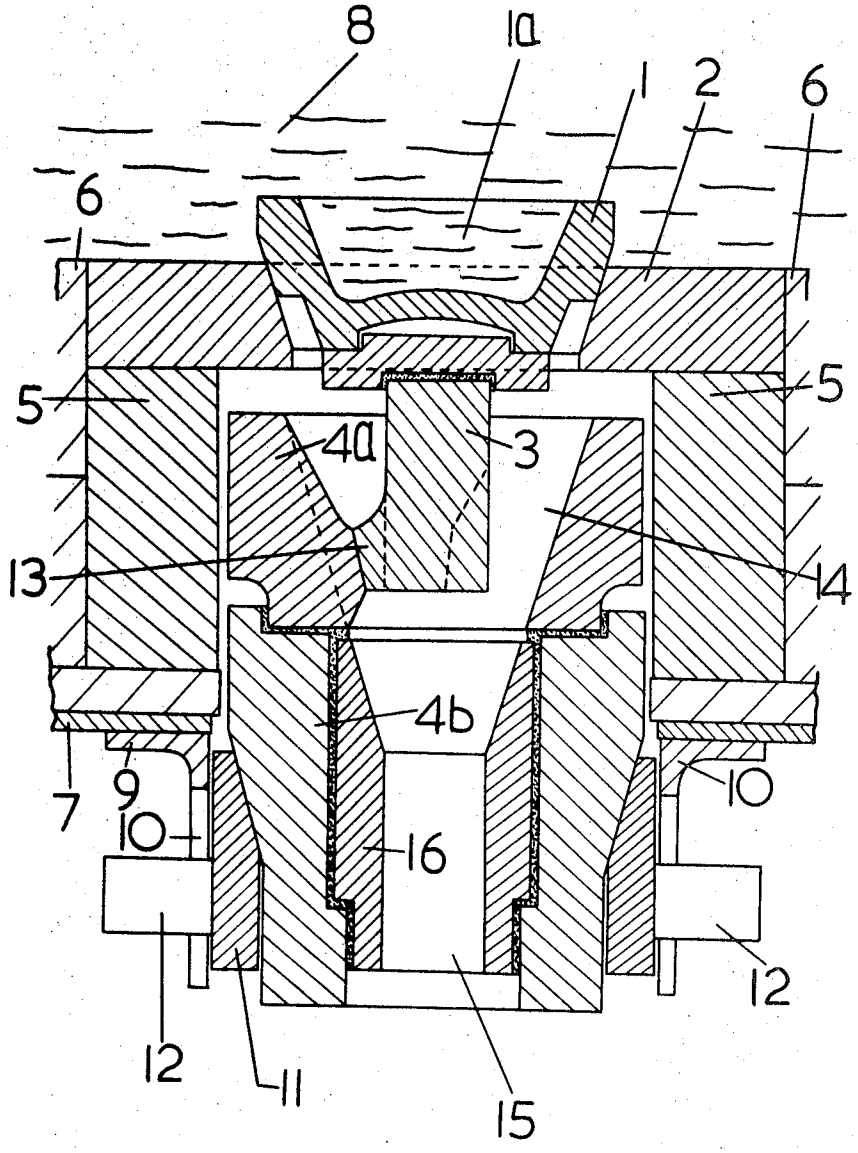


FIG. 1.

HANS REINHARD FEHLING
HANS JOACHIM WINKLER
KARL MODLER
INVENTORS

BY
Brumbaugh, Graves, Donohue & Raymond
THEIR ATTORNEYS

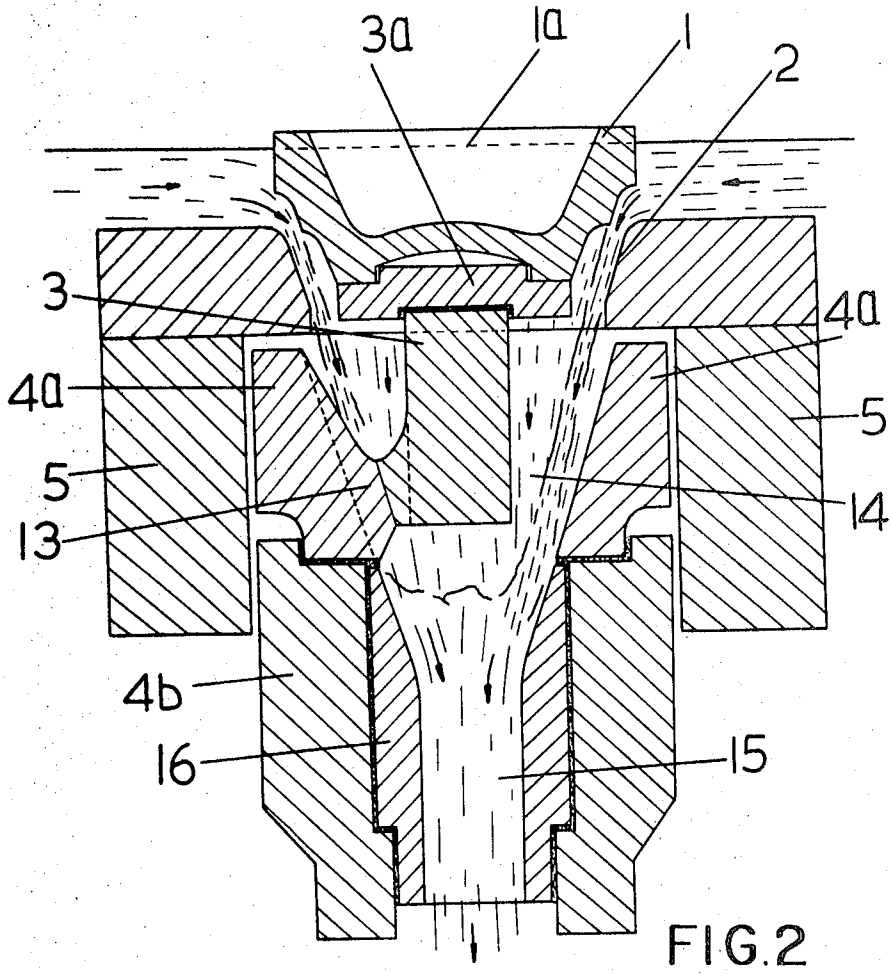


FIG.2

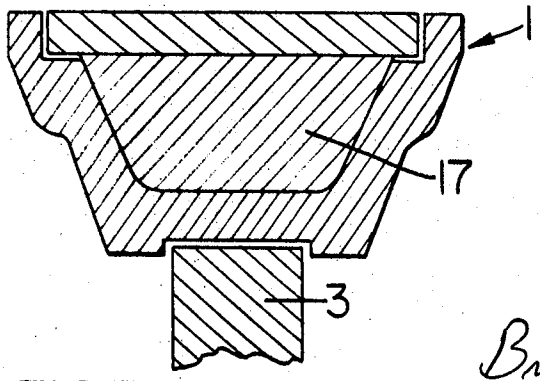


FIG.3

HANS REINHARD FEHLING
HANS JOACHIM WINKLER
KARL MODLER
INVENTORS

By
Brumbaugh, Graves, Donohue & Raymond
THEIR ATTORNEYS

VALVE CLOSURE FOR LADLES AND THE LIKE

CROSS-REFERENCE TO RELATED APPLICATIONS

Reference is made to British Pat. application No. 5,928,967 of Dec. 30, 1967, Didier-Werke A.G. from which priority is claimed.

The invention relates to a method and apparatus for controlling the flow of molten materials dispensed or discharged from containers, particularly from casing ladles and the like in the steel industry.

It has been proposed to use for this purpose closure means consisting of two apertured refractory plates arranged below the bottom of the container, one sliding over the other in the manner of a slide valve. This method has a number of drawbacks. As the plane at which the relatively sliding plates intercept the flow is inevitably at a considerable distance from the bottom of the container the temperature of the plates during closure periods drops below the melting point of the hot metal in the ladle so that the metal solidifies in the duct leading from the bottom of the ladle to the plate shutting off the flow.

Another drawback is severe erosion of the plates round their apertures, particularly in the throttling position when the centers of the two apertures do not match. This erosion strongly handicaps the serviceability and reliability of this device, and shortens its useful life.

It is the object of the present invention to overcome these drawbacks.

The present invention therefore provides a valve closure assembly for controlling the discharge of molten material from a container, comprising a valve seat, an axially-movable valve head which seats in the seat to cut off flow therethrough and which is axially movable upwards away from the seat to permit downward flow through the latter, a support member supporting the valve head, an axially movable valve body affording through its interior a flow passage for downward flow of the molten material, and means whereby the valve body supports the support member at a plurality of circumferentially-spaced locations and whereby the downward flow is divided into a plurality of streams passing the support member, up and down movement of the valve head being effected by up and down movement of the valve body. Preferably, the said streams are reunited after passing the support member. It is further preferred that the flow passage is of downwardly convergent form, thereby assisting in accelerating the flow after passing the valve seat.

It will of course be understood that the material of those parts which are exposed to the action of the molten material or melt is such as adequately to withstand the action of the melt.

The invention also includes a method of controlling the flow of molten material or melt dispensed or discharged from a container, characterized in that it employs a shutoff valve, at the bottom of the container, comprising a stationary valve seat and an axially-movable valve head which seats in the seat to cutoff flow therethrough and is movable axially upwards away from the seat to permit downward flow through the latter, the downward flow takes place through a valve body and past at least one support member supporting the valve head and itself supported, at a plurality of locations spaced apart around it, by the valve body, the downward flow is divided, at said locations, into at least two streams passing the support member, and the movement of the valve head is effected by up and down movement of the valve body communicated to the head through the support member.

The method and apparatus according to the invention will be better understood by reference to the accompanying drawings showing, by way of example, an embodiment of the valve.

In these drawings:

FIG. 1 is a vertical cross section through the valve showing the latter, in the closed condition, installed in the base of, for example, a casting ladle;

FIG. 2 is a diagram, similar to FIG. 1 but showing the valve in the open condition;

FIG. 3 illustrates a modification.

In FIG. 1, the valve head 1 rests on the valve seat 2 and can be moved up to open, or down to close, the valve by means of the support member 3 which in turn is held by the valve body 4*a*. A cap 3*a* is interposed between the top of member 3 and the underside of head 1. The valve seat 2 and its supporting blocks 5 form part of the refractory lining 6 of the metal container 7 for the melt 8. A metal flange 9 fixed to the bottom of the container 7 has a cylindrical collar 10 within which the valve body 4*b* may be moved in substantially coaxial alignment by means of the ring 11 holding said valve body and of the two bosses 12 on which a suitable mechanical or hydraulic actuator (not shown) acts.

The valve head 1 may be, for example, generally frustoconical and rests on a valve seat of conforming shape. On closure, the flow from the container is therefore stopped in the immediate vicinity of the bottom surface of the container, and will thus remain at a temperature very close to the temperature of the melt. It is hereby assured that the melt will not "freeze" at any point above or on the seat surface and that the melt will, therefore, instantly flow on opening the valve after long periods of closure e.g. between casing operations.

In all metallurgical applications of the invention, refractory materials will have to be used which are all considerably lighter than the melt. There is, therefore, the danger that due to its buoyancy in the melt, the valve head would tend to float up in it, unless held down in a suitable manner. It will be appreciated that refractory materials are inherently weak when subjected to tension stresses and that, for this and other reasons, connecting means like threaded parts and the like are very inconvenient or impractical particularly at the very high temperatures of, for example, a steel melt.

It is, therefore, proposed according to the invention to design the valve head in such a manner, that under all normal conditions of use the hydrostatic forces of the melt and other forces acting on the valve head counteract and nullify its buoyancy so that there is no need to attach it to, or anchor it in, the support member. This is achieved by two features:

1. The wetted surface of the underside of the valve head (i.e. its substantially conical seating surface, over which the melt flows when the valve is open) is kept so small in relation to the total wetted surface of the upper side of the valve head that the resultant downward force upon it remains larger than its buoyancy under conditions where the height of the melt in the container is large compared to the thickness of the valve head (vertical distance between upper surface of the valve head and its wetted underside).

2. The upper side of the valve head has the general shape of a cup 1*a* so that when the melt has descended to a level below the rim of the valve head, some of the melt will be retained in the cup and thus ensure that the hydrostatic pressure of the melt on the upper surface of the refractory valve head will never drop below a certain value.

It will be further appreciated that in use the valve head and seat are subject to extremely severe conditions of high temperature combined with a possible chemical attack and that it is for this reason desirable to minimize the effect of these conditions by arranging that the flow past the valve seat is as low and as streamlined as possible. This is achieved by the arrangement according to the invention. At the same time the flow remains streamlined irrespective of the degree of valve opening.

Once the flow of melt has passed the valve seat, it is on the other hand desirable to accelerate it towards the point of discharge, in order to prevent any undue tendency of the stream to freeze and thereby block any passage.

The support member 3 rests on the tapered inner surface of the valve body 4*a* by means of struts or legs 13, preferably three in number. These struts may form part of the support member and/or the valve body, or may be independent distance pieces between them. In the illustrated construction

each strut is formed in part on the support member 3 and in part on the valve body 4*a*, the strut parts on member 3 having downwardly-tapering outer end surfaces engaging correspondingly downwardly-tapering surfaces of those strut parts that are formed on body 4*a*. It is within the scope of the invention to make the support member 3, its struts 13, and the valve body 4*a*, as an integral, or monolithic, component particularly in the case of small valve. Between the struts, which are kept as narrow as their required strength permits, there are wide passages 14 for the melt which on flowing down inside the valve body is split up into individual streams which reunite further down in the discharge duct 15, as is illustrated in FIG. 2. Duct 15 is formed in a part 16, or bush, housed in valve body 4*b*.

As an alternative to FIGS. 1 and 2, in the construction shown in FIG. 3, the valve head is of composite construction, e.g. a refractory body with a metal core 17, such that its specific gravity is either higher than that of the melt, or at least so much increase that the resultant of all forces acting on the valve head is directed downwards.

It is essential to choose the refractory material used for the parts exposed to high temperature and contact with the melt with great care. This is particularly true of the materials used for the valve seat and valve head, because in the closed position the area of contact between the two will be subject to a strong compressive force corresponding to the ferrostatic pressure on the valve head. This area will, therefore, have to be large enough to ensure that the maximum contact pressure does not exceed the compressive strength (creep limit) of the material at the temperature of the melt. In the case of molten steel this limit will lie between 5 and 10 kg./cm.^{2} and is attainable by using, for example, corundum refractories containing a minimum amount of clay as binder and fired at temperatures well in excess of the temperature of use.

A suitable refractory contains 80 percent Al_2O_3, 10 percent SiO_2, 3 percent ZrO_2, 0.5 percent Fe_2O_3, and about 0.8 percent alkali oxides. Even higher wear resistance is obtained with a refractory material which contains 90 percent Al_2O_3 in the form of Tabular Alumina produced by the Alcoa Co. and 9 percent SiO_2 mainly present as Mullite.

As will be seen from FIG. 1 and 2, the space between the valve seat 2 and the discharge duct 15 will not be completely filled with melt, when the latter flows through the valve. On the other hand, this space can only communicate with the atmosphere through any gap there may be between the collar 10 and the ring 11, so that no significant amount of air can infiltrate into the space while the melt is discharged. But if desirable, this space can be kept free of oxygen by flushing it with nitrogen or argon under slightly higher than atmospheric pressure. The clearances between the various parts of the valve are exaggerated in the drawings.

It usually is important to keep the maintenance time on a ladle between two casting runs to a minimum. This always involves inspection, and where necessary, replacement of the refractory parts subjected to wear. This is particularly easy in the case of the apparatus according to the invention, as all parts below the valve head can, after a run, be lowered as a complete subassembly until they can be visually inspected. If not in good condition, the whole subassembly can be taken out and replaced by a new one which can be held ready in advance.

On the other hand, the valve head and valve seat can be inspected from above and are independently accessible from the bottom of the ladle in the same manner as the refractory lining of the container itself.

It is within the scope of the invention to make the valve head integral with the support member.

We claim:

1. A valve closure assembly for controlling the discharge of molten metal from a container comprising a valve seat, an axially movable valve head made of refractory material having a generally concave upper surface so as to retain molten material therein, the valve head being axially movable toward and away from the valve seat to control the flow of molten material therethrough, an axially movable valve actuator disposed beneath the valve head, and means for imparting vertical motion to the valve actuator to control the flow of molten metal through the valve seat.

2. A valve closure assembly according to claim 1 in which the valve actuator supports the valve head by surface engagement therewith and is removable from the valve head by downward motion following engagement of the valve head with the valve seat.

3. A valve closure assembly according to claim 1 including support means for the valve head comprising at least one support member traversing the path of flow of molten metal through the valve assembly, whereby the flow of metal is divided into a plurality of streams which are reunited after passing the support member.

4. A valve closure assembly for controlling the discharge of molten metal from a container comprising a valve seat, an axially movable valve head made of refractory material and having a metal core, the valve head being axially movable toward and away from the valve seat to control the flow of molten material therethrough, an axially movable valve actuator disposed beneath the valve head, and means for imparting vertical motion to the valve actuator to control the flow of molten metal through the valve seat.

5. A valve closure assembly according to claim 4 in which the valve actuator supports the valve head by surface engagement therewith and is removable from the valve head by downward motion following engagement of valve head with the valve seat.

6. A valve closure assembly according to claim 4 including support means for the valve head comprising at least one support member traversing the path of flow of molten metal through the valve assembly, whereby the flow of metal is divided into a plurality of streams which are reunited after passing the support member.

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,574,341 Dated April 13, 1971

Inventor(s) Hans Reinhard Fehling et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 4,	"5,928,967" should read -- 59289/67 --;
Column 1, line 9,	"casing" should read -- casting --;
Column 1, line 16,	after "relatively" insert a hyphen;
Column 1, line 47,	after "downwardly" insert a hyphen;
Column 1, line 58,	"cutoff" should read -- cut off --;
Column 2, line 25,	"casing" should read -- casting --;
Column 2, line 43,	after "substantially" insert a hyphen;
Column 2, line 74,	after "and/or" insert -- of --;
Column 3, line 24,	after "and" insert -- the --;
Column 3, line 35,	"10 percent" should read -- 15 percent -
Column 4, line 47,	after "of" insert -- the --.

Signed and sealed this 16th day of November 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Pa