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(54) **Tapping and pouring system for molten metals.**

(57) System (2) for tapping a high-temperature molten material, especially a molten metal, from a bath (8) and pouring it into a mould, comprising a mobile container (6) capable of moving with respect to an element (26) in such a way as, on the one hand, said container

(6) may be plunged into the bath (8) to take some liquid and, on the other hand, lift the container (6) above a particular level for forcing the liquid to fall down with gravity through an aperture (10) along the wall. The system (2) does not imply high costs and allows to pour accurate volumes of molten material.

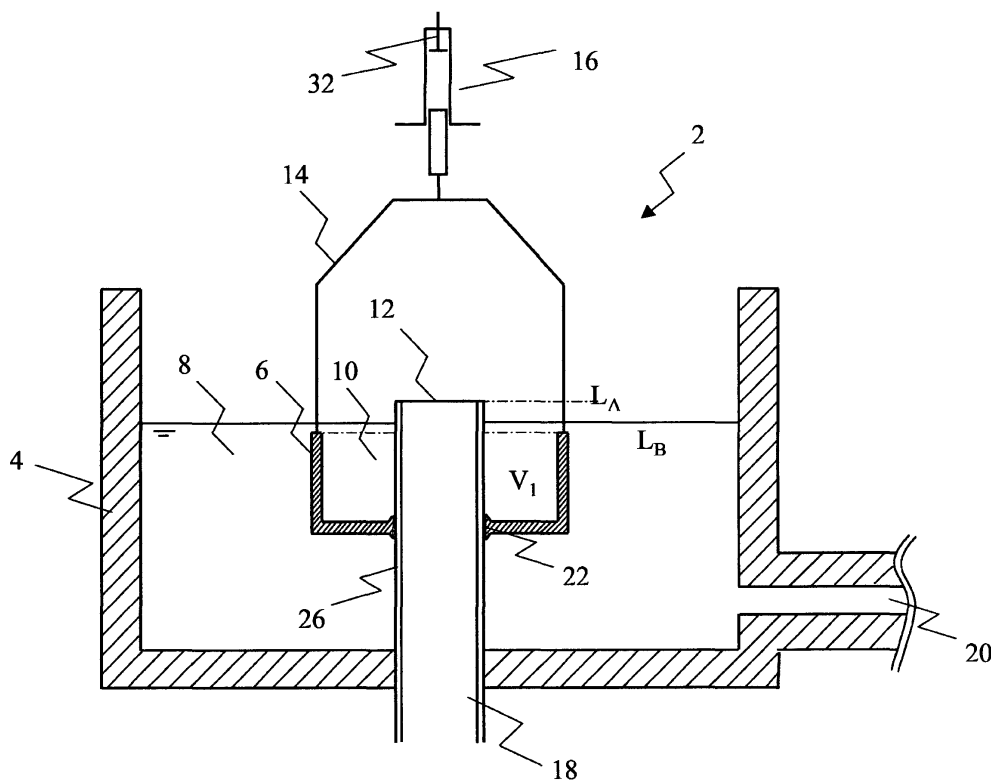


Fig.1a

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Description

Field of the invention

[0001] The invention relates to a system for tapping and pouring high temperature molten material, comprising a first container and a second container capable of being introduced into the first container.

Prior art

[0002] Many systems are known in the art to tap a particular amount or volume of high temperature molten material from a furnace and pour it, for instance into a mould for use in metal die-casting operations.

[0003] One way to perform this operation is to make use of a ladle capable of being plunged into a bath of molten material, and further capable of taking out a particular amount of said molten material, transporting it for instance on top of a mould to be filled and pouring the molten material into the mould, either by tilting the ladle and by letting the molten material going through a spout or by opening a valve and letting the molten material to drain away through said valve.

[0004] A system using the above principle is the "Hodler system", as illustrated in Fig. 219 of page 126 of "Technologie de la Fonderie en Moules Metalliques, Fonderie sous pression", Edition techniques des industries de la fonderie, Paris 1968. In said system, a container is plunged into a crucible which contains molten metal. Said container is then filled up with molten metal. The container is then removed from the crucible by mechanical means and carried to a place above a mould or a channel leading to a mould. A valve located on the bottom of the mobile container is opened to let the liquid drain away towards the mould.

[0005] When these systems are used with important amounts of high-temperature molten material and while they are required to tap and pour very accurate amounts of such material they often cannot be manually driven and require elaborate mechanisms to plunge the container into the crucible, move said container to carry the material and open a valve or to tilt said container if needed. These mechanisms are expensive to make, install and maintain and present safety hazards, such as the risk of molten material dripping.

Summary of the invention

[0006] It is an object of the invention to provide a system for tapping and pouring an accurate amount or volume of high-temperature molten material, especially a molten metal, the system being less expensive to make, install and maintain and being safer.

[0007] To this end, the system is characterized in that the second container is arranged inside the first container and, in operation, remains inside and in contact with the first container, the first and second container share

a common element comprising an exit for letting the molten material flowing out of the system, and the system comprises means for moving the second container in respect to the common element to and fro a filling position for filling the second container with molten material present in the first container and a pouring position for pouring molten material from the second container through the exit.

[0008] The system according to the invention is such that, in operation, the first container is filled with molten material. Moreover, the second container is arranged inside the first container and executes in operation a movement inside the first container, i.e. the second container remains inside the first container, thus not causing dripping of molten material outside the system and causing less alteration of the molten material, for instance less oxidation and contamination of the molten metal. This is a first advantage over the systems known in the prior art in which molten material often drips from the mobile container, which results in needless loss of material and safety problems. This is the case of the "Hodler system" which also presents the propensity to cause important alteration to the molten material, due to the relatively long transportation time mainly outside the crucible. The system according to the invention significantly improves this situation since the transportation of the molten material before pouring is simplified in a significant way.

[0009] A second advantage of the system according to the invention is that pouring can easily be controlled and stopped by reversing or stopping the movement of the second container without loss or risk of alteration of the molten material since the molten material which is not poured remains inside the second container and thus inside the first container.

[0010] A third advantage is that the system is very compact, since the second container does not leave the first container. It means, firstly, that the occupied area on the floor is smaller and, secondly, that the system is much cleaner since the elements of said system are concentrated in a relatively smaller volume, thus requiring less protecting means to constrain to a particular area the high temperatures, the heat radiation, the polluted atmosphere, the molten material ejection and the like.

[0011] A fourth advantage is that the heat remains substantially inside the system up until the metal is actually poured, because no molten metal is transported outside the first container until it is poured. In the "Hodler system" of the prior art, the mobile container is transported away from the crucible in such a way as to lead to a larger loss of energy and to subject a larger area to safety hazard.

[0012] A fifth advantage of the system according to the invention is that only relatively small and simple movements are involved in the tapping and pouring operations since the second container remains inside the first container. No complex movement is required since

the second container moves with respect to the common element and thus the movement is at least to some extent guided, i.e. for instance only a certain type or certain types of movement, such as a translation or a rotation of the second container with respect to the first container, are possible. Moreover, the system may be totally automatized without complex mechanisms thanks to its simplicity.

[0013] Thus a simpler more compact system is obtained, which means less expensive as well. Since the system is simpler and more compact and since there is less heat loss and less risk of molten material dripping, contamination and safety hazard, the system is easier to install and maintain. Furthermore, since the implied movement is quite small and can be executed in a simple way, the movement can be controlled more accurately, thus leading to a more accurate amount of poured molten material.

[0014] Thus the characteristics of the invention provide an at least partial solution to the mentioned problems of the prior art tapping and pouring systems, said problems being very specific to high-temperature molten materials. Indeed, the circumstances in which these systems are used are very particular, due to the extreme temperatures, the intense radiation, the polluted surrounding atmosphere, the molten metal ejections and so forth. Many normal material and devices cannot be used in these circumstances and any new improvement must be designed keeping in mind the specific context involved.

[0015] In particular, it should be noted that the system according to the invention is simpler, more compact, cleaner, less expensive and easier to install and maintain but yet provides for greater accuracy in pouring amounts of molten material, surprising though it may seem.

Short description of the drawings

[0016] These and further aspects of the invention will be explained in greater detail by way of example and with reference to the accompanying drawings in which :

Fig. 1a shows a schematic cross-section representation of an example of the system according to the invention, in operation, while the second container is entirely plunged into the first container bath;

Fig. 1b shows the system of Fig. 1a while the second container liquid level is slightly above the overflow limit, but while the molten material does not overflow yet;

Fig. 1c shows the system of Fig. 1a while the second container liquid level is above the overflow limit and while the exceeding molten material is flowing over the brim of an aperture;

Fig. 1d shows a top view of the system of Fig. 1c;

Fig. 2a shows a schematic cross-section representation of an example of the system according to the invention, while not in operation, i.e. without any molten material in the containers;

Fig. 2b shows the second container of the system of Fig. 2a, while said second container is completely separated from the first container;

Fig. 3a shows a schematic cross-section representation of another example of the system according to the invention, in operation, while the second container liquid level is above the overflow limit and while the exceeding molten material is flowing over the brim of an aperture;

Fig. 3b shows a top view of the system of Fig. 3a; and

Fig. 4 shows a schematic cross-section representation of yet another example of the system according to the invention, in operation, while the second container is at the pouring position.

[0017] The figures are not drawn to scale. In general, like references numerals refer to like parts.

Detailed description of preferred embodiments

[0018] According to a first aspect, the invention concerns a system (2) for tapping and pouring high-temperature molten material, for instance for tapping molten metal from a crucible (4) and pouring it into a mould.

[0019] Fig. 1a shows a schematic cross-section representation of an example of the system (2) according to the invention, in operation, while the second container (6) is entirely plunged into the first container bath (8). In operation, the first container (4) or crucible contains indeed a bath (8) of molten material, for instance a molten metal, which communicates through a first channel (20) for instance with another crucible, although it will be clear for the person skilled in the art that such a communication channel (20) is neither essential nor compulsory to the invention.

[0020] A second channel (18) or hollow inner tube is located substantially inside the first container (4) and extends from above the level L_B of the first container bath (8) to below the bottom of the first container (4), thus forming a inner wall (26), common to both the first container (4) and the second container (6). In said common inner wall (26) delimiting the second channel (18) from the first container (4) and the bath (8) contained therein, there is an aperture (12) or exit of which the lower level L_A has to be above the level L_B in order to prevent the molten material of the bath (8) from flowing through the aperture (12) into the second channel (18). Said second

channel (18) may have a cylindrical shape and may be surrounded by the liquid bath (8).

[0021] A second container (6) is arranged inside, i.e. fit in, the first container (4) in such a way as, first, to be substantially in contact through a joint (22) or not with the wall (26), secondly, to extend around the second channel (18), for instance to form a cylindrical shape around said channel (18) if said channel (18) has a cylindrical shape, and, thirdly, to be capable of moving vertically only. In order to produce the vertical movement of the second container (6), i.e. in order to lift it and to lift it down, some means for lifting the second container (6) are provided. In Fig. 1a, a jack (16) is represented and controls the second container's (6) movement via some rods (14). Nonetheless, it will be clear for the person skilled in the art that some other means may be used without departing from the invention.

[0022] The term "inside" in "the second container (6) remains inside the first container (4)" must be understood broadly, i.e. it means that the second container (6) stays in operation in or slightly above the first container (4) in such a way as, on the one hand, the movement of the second container (6) when in operation can be operated by a relatively simple mechanism and, on the other hand, the second container (6) stays in the vicinity of the first container (4), thus causing a relatively small heat loss.

[0023] Fig. 1b shows the system (2) of Fig. 1a while the second container liquid level is slightly above the overflow limit, i.e. the level L_A . In other words, Fig. 1b is a schematic representation of the system (2) of Fig. 1a at an instant just before some liquid of the second container liquid bath (10) goes through the aperture (12). Or, in still another words, while Fig. 1a shows the second container (6) at the filling position, Fig. 1b shows said second container (6) at the pouring position, just before the pouring step actually occurs.

[0024] Fig. 1c shows the system (2) of Fig. 1a while the second container liquid level is above the level L_A and while the exceeding molten material (24) is flowing over the brim of the aperture (12). It will be clear from the person skilled in the art that there may be no aperture (10) and that the exceeding molten material (24) may flow through an overflow outlet system, over the brim of the top of the second channel (18) or via any means of letting the liquid flow without departing from the invention.

[0025] Fig. 1d shows a top view of the system (2) of Fig. 1c. Both containers (4, 6) are shown and the exceeding molten material (24) is also shown when falling with gravity through the second channel (18). The dashed line A represents the plan according to which the cross-section of Fig. 1c is made. The means (16) for lifting the second container (6) is not shown in Fig. 1d in order to keep said figure as clear as possible.

[0026] So, the successive steps shown in the Fig. 1a, 1b and 1c illustrate an example of a way of operating the system (2) according to the invention in order to tap

a particular amount or volume of molten material from the bath (8), lift it in a second container (6) and pour it through an aperture (12) in a channel leading for instance to a mould. By lifting the second container (6) until it reaches particular level, the volume it is capable to hold is reduced and depends on said particular level. Subsequently, the overflowing molten material (24) that will may be poured into the mould depends on the level to which the second container (6) is lifted. This is an important advantage, for instance in die-casting operation but also on other applications, since, on the one hand, the accuracy of the volume of molten material delivered to a mould is an important requirement in order to waste as less metal as possible, and, on the other hand, the system (2) may be used for tapping and pouring different volumes or quantities without having to alter the components of said system (2). In other words, in operation, the molten material that is poured into e.g. a mould may consequently be controlled by the level to which the second container (6) is lifted.

[0027] In order to lift the second container (6) at a particular level and deliver an accurate volume, means for stopping the means (16) for lifting the second container (6) may be provided. For instance a jack (16) with a carriage stop (32) may be used. Said means for stopping the lifting movement, for instance an adjustable carriage stop (32), may be such that it is possible to adapt said means in order to change the volume of liquid to be poured. In other words, by controlling the movement of the jack (16) for instance, it is possible to control the volume to be poured. As explained above, this is an important advantage over the tapping and pouring systems as known in the art.

[0028] One notable advantage of the embodiment of the system (2) shown in Fig. 1a, 1b and 1c is that, during the operation, the molten material stays, at least for some time heated by the molten material surrounding the inner tube (18), thus creating less heat and less contamination.

[0029] Fig. 2a shows a schematic cross-section representation of an example of the system (2) according to the invention, while not in operation, i.e. without any liquid in the containers (4, 6). In particular, a first maximum volume V_1 is shown, this is the volume that can be contained by the second container (6) while fit into the first container (4). The volume V_1 is delimited by the wall (26), the walls of the first container (6) and the dashed line that would be the level of liquid in the second container (6) if it was full to the brim, for instance at the filling position.

[0030] In contrast, Fig. 2b shows the second container (6) of the system (2) of Fig. 2a, while said second container (6) is completely separated from the first container (4), but, nonetheless, in the same orientation and configuration as the orientation and configuration shown in Fig. 2a. By the expression "in the same configuration", it should be understood that for instance no valve has been opened between the second container of the sys-

tem shown in Fig. 2a and the second container of the system shown in Fig. 2b. In particular, the second maximum volume V_2 is represented and is the volume that can be contained by the second container (6) while completely separated from the first container (4). The second maximum volume V_2 is different from the first maximum volume V_1 . In particular, in the case illustrated in Fig. 2a and 2b, the volume V_2 is smaller than volume V_1 and the volume V_1 is larger than 0. The difference of volume highlighted here is a characteristic of a class of systems (2) according to the invention, the class of systems (2) in which, in operation, the second container (6) only translates with respect to the common element, i.e. the wall (26). In operation, during the process of lifting the second container (6) out of the bath (8), from a certain moment on, the volume that can be contained by the second container (6) is not anymore equal to V_1 and decreases towards V_2 .

[0031] In addition to the volumes V_1 and V_2 , the volumes V_3 and V_4 may be defined. The third volume V_3 is defined as the maximum volume of molten material which can be contained into the second container (6) while the means (16) for moving said container bumps into the adjustable carriage stop (32) when said carriage stop (32) is at its highest position.

[0032] The fourth volume V_4 is shown on Fig. 1c and 4 and is defined as the maximum volume of molten material which can be contained into the second container (6) while the means (16) for moving said container bumps into the adjustable carriage stop (32), said carriage stop (32) being in a particular intermediate position.

[0033] Subsequently, the difference between the first maximum volume V_1 and the third volume V_3 and the difference between said first maximum volume V_1 and the fourth volume V_4 represent, for a particular system according to the invention, the maximum volume of exceeding molten material that may exit the containers, respectively while the carriage stop (32) is at its highest position and while the carriage stop (32) is at a particular intermediate position. However, in order to calculate the accurate exceeding volumes that may exit the containers as explained, one must subtract from these differences of volume the possible small quantity of molten material which may leak through the joint (22), said quantity being controlled and independent of the level of molten material L_B of the first container (4). This shows the role of the adjustable carriage stop (32) and illustrates one of the advantages of the system (2) according to the invention, i.e. that an accurate volume of molten material may be poured even if the level of liquid of the first container (4) varies slightly up or down with respect to its initial level.

[0034] It should be noted that the second container (6) shown in Fig. 2b is disassembled from the system (2) according to the invention. Indeed, as explained above, in operation, the system (2) according to the invention is such that the second container (6) is arranged

inside the first container (4) and remains in it throughout the entire operation of tapping and pouring.

[0035] In one embodiment of the system (2) according to the invention, the second maximum volume V_2 is substantially equal to zero.

[0036] In yet another embodiment of the system (2) according to the invention, in operation, the exceeding molten material (24) flows through an exit in a third channel (28), which starts in an inner wall common to the first container (4) and to the second container (6), said exit being formed by a brim, an edge or a part of an edge of said wall, the means (16) for moving being then for moving the second container (6) up and down said wall. A schematic cross-section representation of said system (2), in operation, is shown in Fig. 3a. The second container liquid level is above the overflow limit and the exceeding molten material (24) is flowing through the third channel (28). The second container (6) is fit into the first container (4) in such a way as to be substantially in contact via the joint (22) with said first container (4), to be capable of moving vertically in respect to the first container (4) and to be also capable of holding a bath of liquid (10). In this particular embodiment of the system (2) according to the invention, the second container (6) has a shape which may be generated by the rotation of a "L" around an vertical axis, even though it will be clear for the person skilled in the art that the second container's (6) shape may be different without departing from the invention.

[0037] Fig. 3b shows a top view of the system of Fig. 3a. The dashed line B represents the plan according to which the cross-section of Fig. 3a is made. The means (16) for lifting the second container (6) is not shown in Fig. 1d in order to keep said figure as clear as possible.

[0038] One notable advantage of the embodiment of the system (2) shown in Fig. 3a is that the construction is simple, i.e. there is no need of installing an inner tube (18) in the first container (4).

[0039] It will be clear for the person skilled in the art that the volumes V_1 , V_2 , V_3 and V_4 and their meaning also apply to the embodiment of the system according to the invention as illustrated in Fig. 3a and 3b.

[0040] In another embodiment of the system according to the invention, in operation, in the second container (6) executes a rotation with respect to a rotation axis linking both containers. The rotation axis is the common element mentioned above. The characteristic stating that the common element (26) comprises an exit must be understood by the following meaning: said exit may be formed in the common element (26) or located in the vicinity of said common element (26) with departing from the system (2) according to the invention.

[0041] Fig. 4 shows another embodiment of the system (2) according to the invention while the exit (12) is an aperture in the inner wall (26). This embodiment is very similar to the system (2) shown in Fig. 1a, 1b, 1c and 1d.

[0042] In yet another embodiment of the system (2)

according to the invention, in operation, the high-temperature molten material is a molten metal, such as aluminium, tin, lead or any other metal or alloy of metals. It may also be a molten glass.

[0043] By high-temperature molten material, it must be understood that the concerned material has a melting point above about 0 Celsius degrees, although this meaning must not be considered as a limitation and the application of the system to molten material having a melting point below 0 Celsius degree must also be considered as being part of the invention.

[0044] In yet another embodiment of the system (2) according to the invention, the material is a metal or an alloy of metals having a melting point comprised between 0 Celsius degrees and 1000 Celsius degrees. The alloy is, in a particular embodiment, an alloy of metals having a low melting point.

[0045] In yet another embodiment of the system (2) according to the invention, the molten material is a molten metal and the joint (22) is generally entirely plunged in the bath (8) at any time of the operation of tapping and pouring molten material. Moreover, according to a preferred embodiment, in operation, the system (2) is such that the level L_A is only slightly higher than the level L_B . This slight difference between the level L_A and the level L_B guarantees that the difference between the pressure at the vicinity of the joint (22) in the second container (6) and the pressure at the vicinity of the joint (22) in the first container (4) stays relatively small, thus reducing the pressure on said joint (22) and the quantity of molten material leaking through said joint (22).

[0046] It will be clear for the person skilled in the art that the system (2) according to the invention may be used for getting samples of molten material without departing from the invention.

[0047] In short, the invention can be described as follows: System (2) for tapping a high-temperature molten material, especially a molten metal, from a bath (8) and pouring it into a mould, comprising a mobile container (6) capable of moving with respect to an element (26) in such a way as, on the one hand, said container (6) may be plunged into the bath (8) to take some liquid and, on the other hand, lift the container (6) above a particular level for forcing the liquid to fall down with gravity through an aperture (10) along the wall. The system (2) does not imply high costs and allows to pour accurate volumes of molten material.

Claims

1. System (2) for tapping and pouring high temperature molten material, comprising
a first container (4) and a second container (6) capable of being introduced into the first container (4);

characterized in that
the second container (6) is arranged inside

the first container (4) and, in operation, remains inside and in contact with the first container (4);

the first (4) and second container (6) share a common element (26) comprising an exit (12) for letting the molten material flowing out of the system (2); and

the system comprises means (16) for moving the second container (6) in respect to the common element (26) to and fro a filling position for filling the second container (6) with molten material present in the first container (4) and a pouring position for pouring molten material from the second container (6) through the exit (12).

2. System (2) according to claim 1, **characterized in that** the common element (26) is a common inner wall (26) to the first container (4) and the second container (6).
3. System (2) according to claim 2, **characterized in that** the common inner wall (26) is formed by a vertically oriented hollow inner tube (18) arranged inside the first container (4), the inner tube (18) having near a free end the exit (12), **in that** the second container (6) is arranged around the inner tube (18), and **in that** the means (16) for moving are for moving the second container (6) along the inner tube (18).
4. System (2) according to claim 2, **characterized in that** the common inner wall is formed by an inner wall of the first container (4) and the exit is formed by a brim, edge or a part of an edge of said wall, and the means (16) for moving are for moving the second container (6) up and down said wall.
5. System (2) according to any one of claims 2 to 4, **characterized in that**, the first container (4) and the second container (6) are in contact at a point which remains in operation plunged into the bath (8).
6. System (2) according to any one of claims 2 to 5, **characterized in that**, the first container (4) and the second container (6) are in contact at a point near which there is a joint (22).
7. System (2) according to any preceding claims, **characterized in that** it further comprises means for stopping the means (16) for moving the second container (6) at a particular level.
8. System (2) according to claim 7, **characterized in that** the means for stopping the means (16) for moving the second container (6) is an adjustable carriage stop.
9. System (2) according to any one of the preceding claims, **characterized in that** the molten material

is a metal or a alloy of metals.

10. System (2) according to claim 9, **characterized in that** the material has a melting point comprised between 0 Celsius degrees and 1000 Celsius degrees. 5

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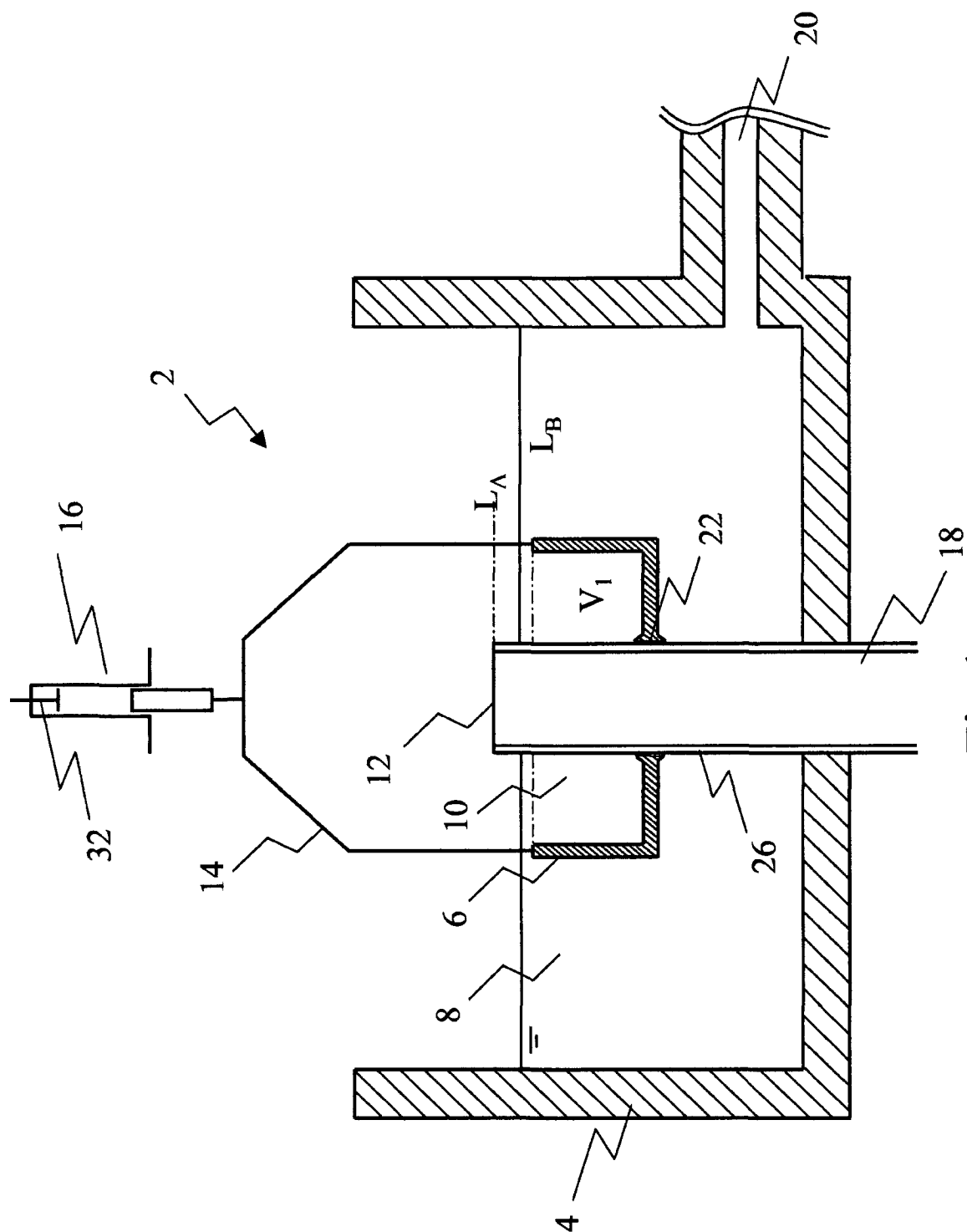


Fig.1a

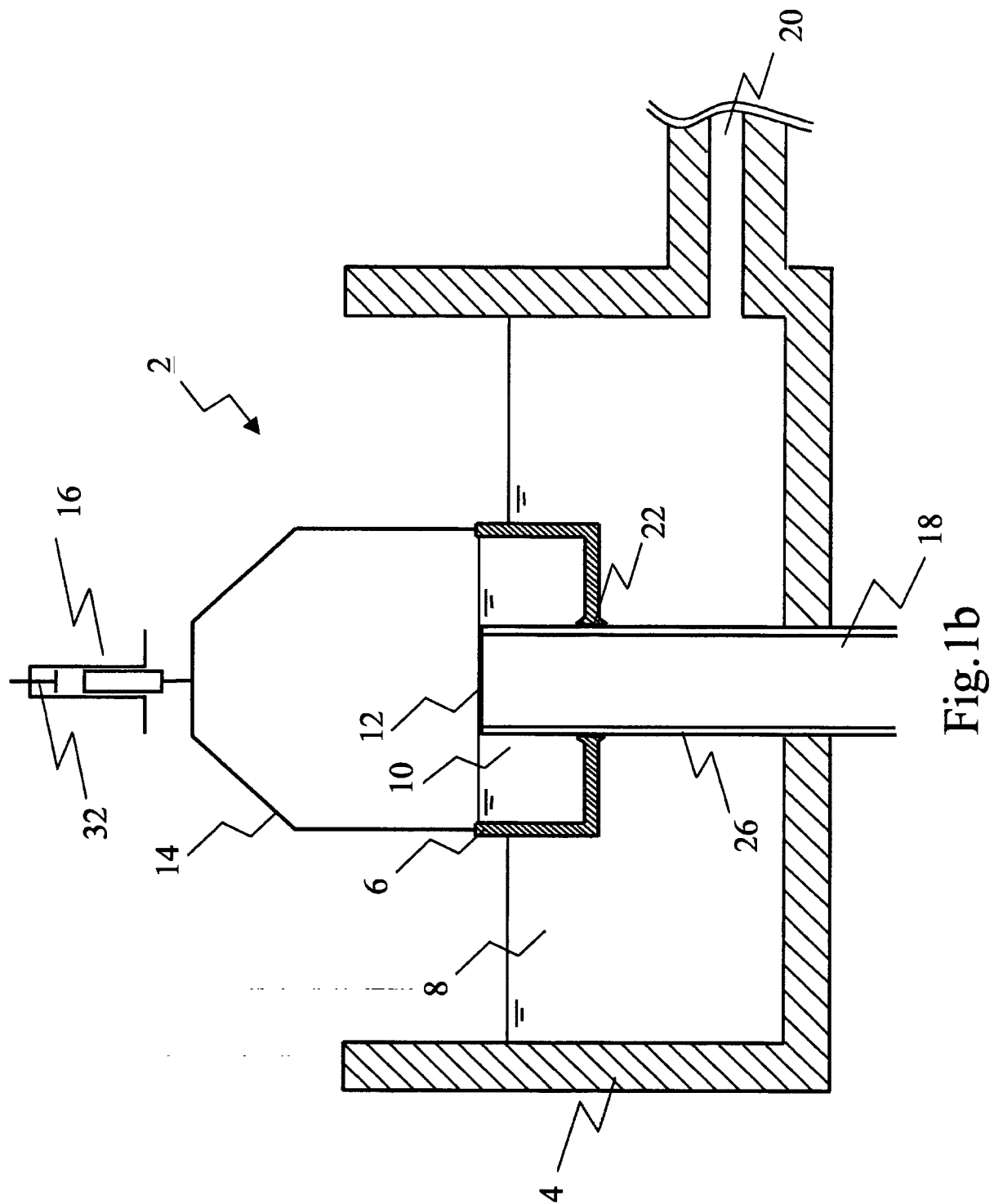


Fig.1b

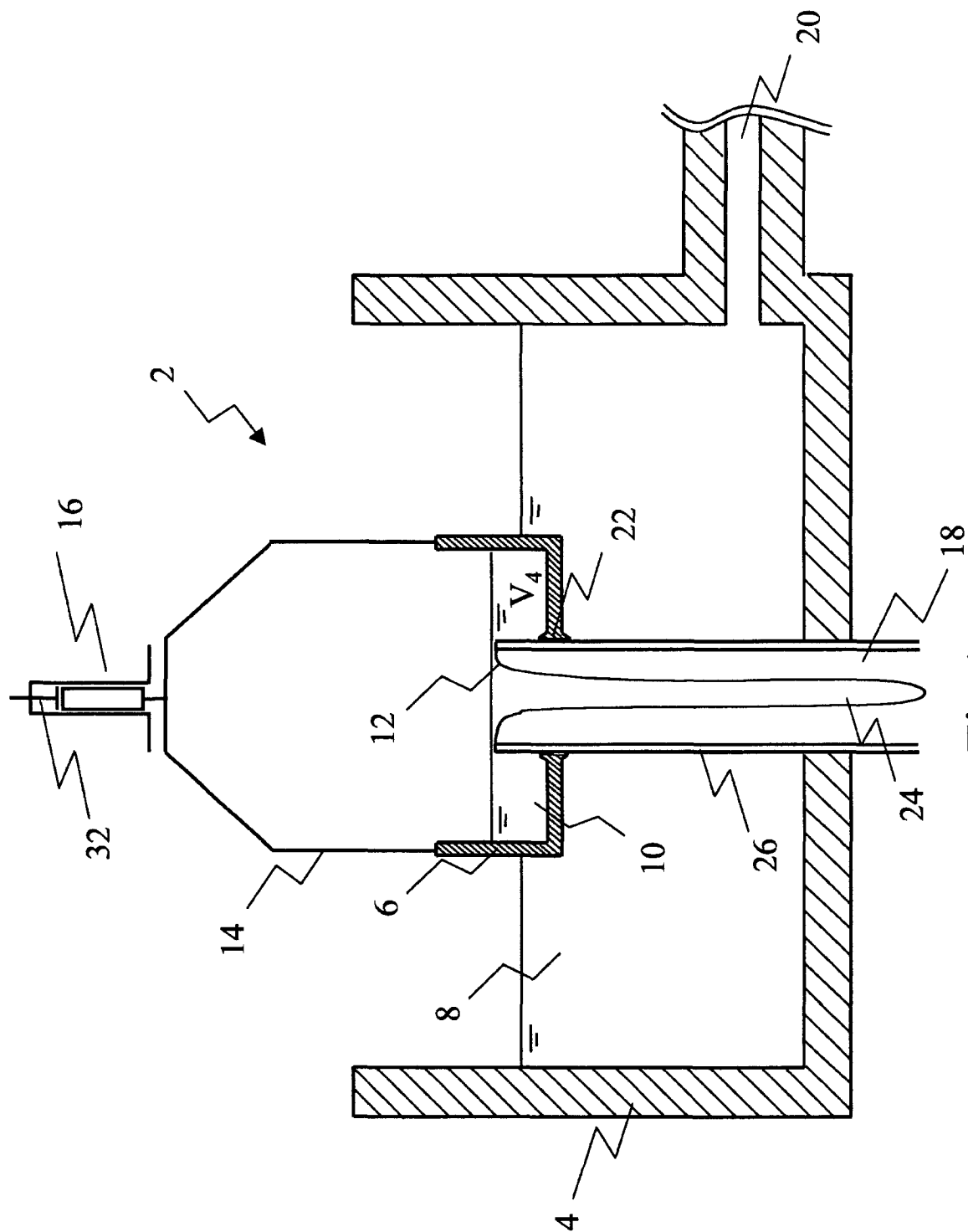


Fig.1c

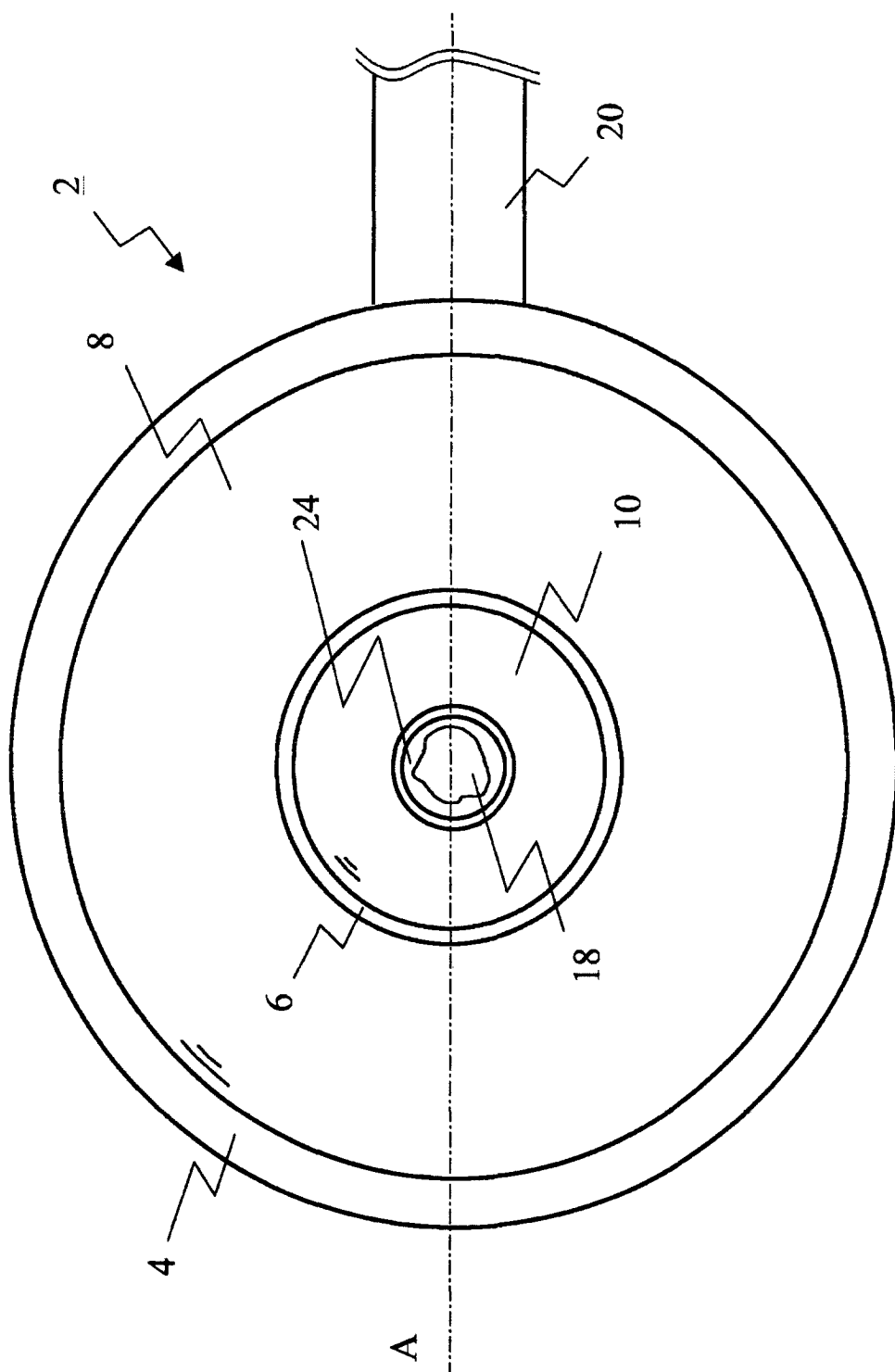


Fig.1d

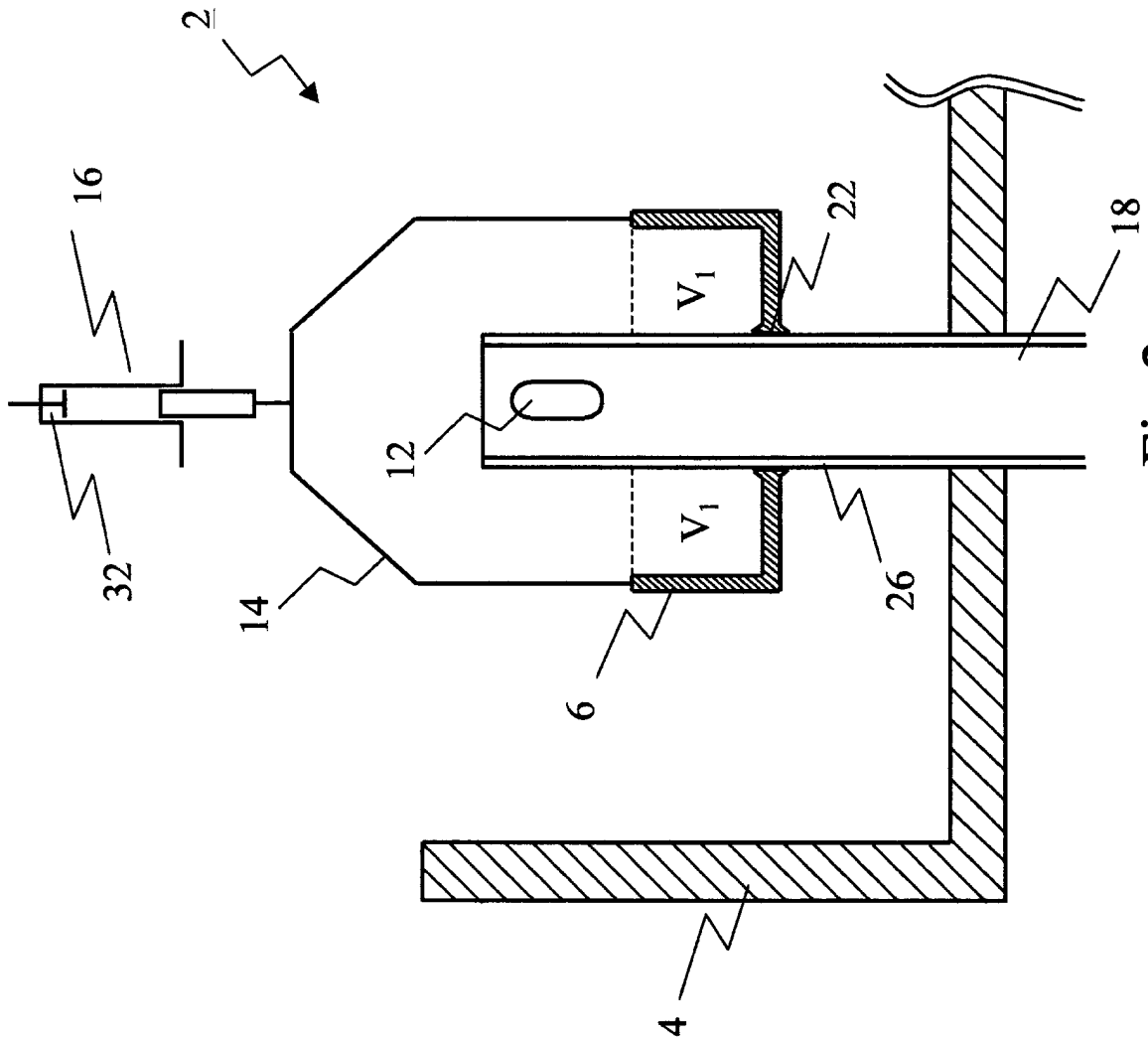


Fig. 2a

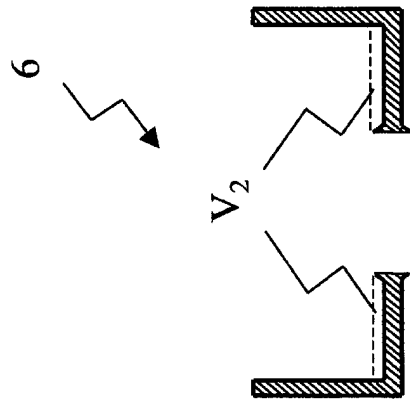


Fig. 2b

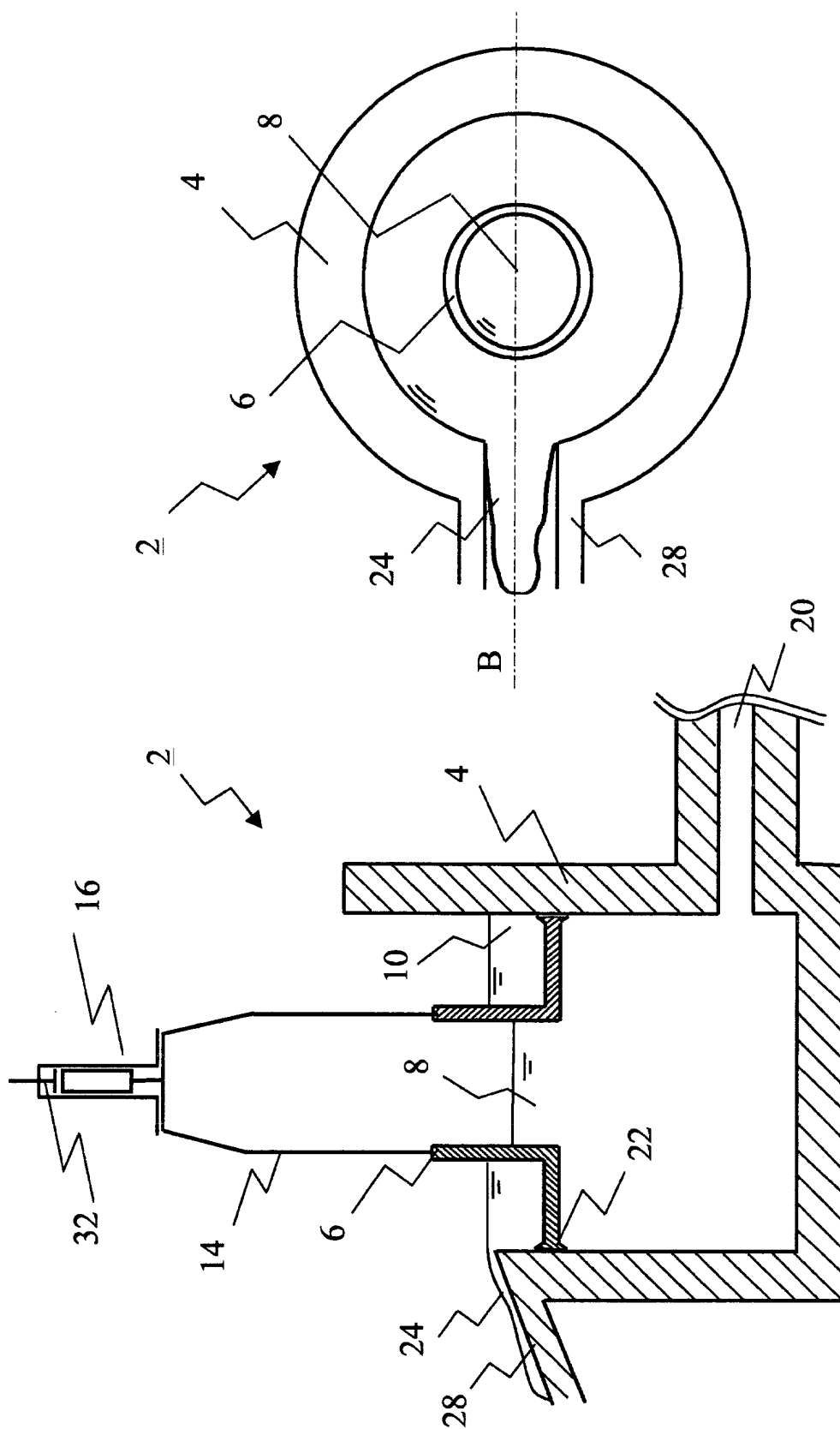


Fig.3a

Fig.3b

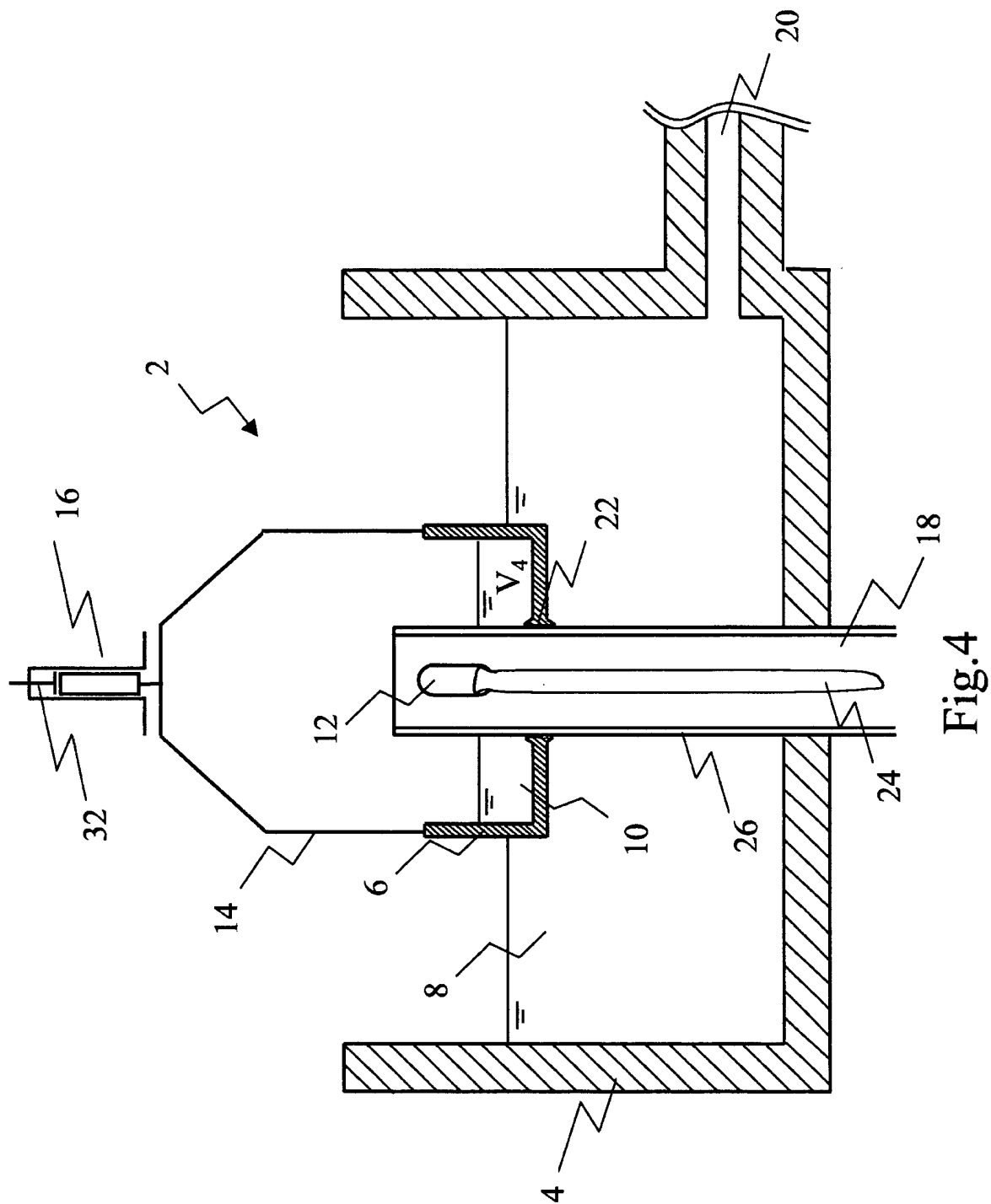


Fig.4



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 10 1083

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	GB 1 375 520 A (GERHARD SCHUSTER) 27 November 1974 (1974-11-27) * column 2, line 32 - column 3, line 91; figures 1-3 *	1	B22D17/30 B22D39/02 B22D41/00
A	GB 2 323 804 A (RYOBI LTD) 7 October 1998 (1998-10-07) * abstract; figure 1 *	1	
A	US 4 174 190 A (CRAIG EDWIN R ET AL) 13 November 1979 (1979-11-13) * abstract; figure 1 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 09, 30 September 1996 (1996-09-30) & JP 08 117972 A (HITACHI METALS LTD), 14 May 1996 (1996-05-14) * abstract *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 017, no. 275 (M-1418), 27 May 1993 (1993-05-27) & JP 05 008017 A (KUBOTA CORP), 19 January 1993 (1993-01-19) * abstract *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) B22D
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 26, 1 July 2002 (2002-07-01) & JP 2001 239357 A (AISIN SEIKI CO LTD), 4 September 2001 (2001-09-04) * abstract *	1	
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 29 August 2003	Examiner Baumgartner, R
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