

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>5</sup> : <b>B22D 41/14</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 92/12815</b> (43) International Publication Date: 6 August 1992 (06.08.92)</p>
<p>(21) International Application Number: PCT/GB92/00080 (22) International Filing Date: 14 January 1992 (14.01.92)</p> <p>(30) Priority data: 9101172.6 18 January 1991 (18.01.91) GB 9125698.2 3 December 1991 (03.12.91) GB</p> <p>(71) Applicant (for all designated States except US): FOSECO INTERNATIONAL LIMITED [GB/GB]; 285 Long Acre, Nechells, Birmingham B7 5JR (GB).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only) : WALLIS, Roger [GB/GB]; 87 Old Retford Road, Sheffield 13 (GB).</p> <p>(74) Agent: MOORE, J., H.; Fosco International Limited, Group Patents Department, 285 Long Acre, Nechells, Birmingham B7 5JR (GB).</p>		<p>(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), CS, DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC (European patent), MG, ML (OAPI patent), MN, MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, RU, SD, SE, SE (European patent), SN (OAPI patent), TD (OAPI patent), TG (OAPI patent), US.</p> <p><b>Published</b> <i>With international search report.</i></p>
<p>(54) Title: VESSEL OUTLET</p>		
<p>(57) Abstract</p> <p>A rotary valve for use in the release of a molten solid from a vessel comprises a valve member (34) having a passage (42), inlets (44) to the passage being present in the head of the member. The valve member mates with a wall (32) of a seating member (16), the wall having a taller first section (48) and a lower second section (46) selected to close off or open the inlets (44), respectively. The wall portions (46, 48) are shaped relative to the surfaces of the member (34) to avoid metal freezing and the parts sticking. The passage (42) includes ribs (101) to cause the stream to emerge with parallel sides.</p>		

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VESSEL OUTLET

This invention relates to the casting of molten metal and in particular to vessels for molten solids, e.g. molten metal, and to outlets for said vessels.

Problems occur when molten solids are poured through an outlet from a vessel, for example when pouring molten metal. In a foundry, it is known to fit an outlet through the floor of a vessel for molten metal, e.g. a foundry ladle, and to provide a so-called stopper rod above the vessel. The rod is lowered or raised to close or open the outlet. The rod comprises a metal shaft surrounded by a refractory sleeve. This arrangement has disadvantages. For example, the rod becomes distorted in use; if it is used as a throttle, the stream of metal breaks up affecting the quality of the casting; and there is a relatively long turn around period when changing the refractory sleeve of the stopper rod.

An alternative device is a so-called sliding gate valve. This is mounted externally below the bottom outlet and is used on bulk steel ladles where the liquid metal is discharged in a few pours. In the foundry, however, the outlet is opened and closed a greater number of times and there can be long intervals between

one opening and the next. When the sliding gate valve is closed, a slug of metal forms in the outlet above the closed valve and is unable to circulate, even though it is communication with the bulk of the molten metal, and the slug tends to freeze if the time between successive pours is too great. This causes metal to freeze on the sliding gate valve which is thus not suitable for use with foundry ladles. The sliding gate valve is also not without problems in relation to liquid steel which is particularly prone to this "freezing-off" and there is thus a serious risk of valve blockage.

It has been realised that there should be advantages in having a rotary valve mechanism instead of a stopper rod system or a sliding gate valve system. The mechanism comprises a valve in a seating therefor in the vessel outlet. A passage is present in the valve member which has inlets in the head portion thereof. A drive mechanism is present outside the vessel and used to rotate the valve member with respect to the seating member therefor, the seating member being shaped so that when in one position the inlet is closed off and in another open. Such a system is disclosed in WO88/05355 published in July 1988; in GB-A-2226263 published in June 1990; and in WO 90/14907 published in December 1990. More specifically, GB-A-222623 discloses an outlet comprising a rotary valve member and a seating therefor, the valve member having at least one passage for conducting molten solid from inside to outside the vessel, the valve member sealing

with a wall of the seating member, the wall having a first section sufficiently high that when the valve member is rotated to align an inlet end of the passage therewith the passage is closed by the first section, the wall having a second section of less height so that if the valve member is rotated to align the inlet end of the passage therewith, the inlet end is open. The outlet is normally installed so that the top of the second section of the wall is level with the inside surface of the floor of the vessel. The first section does not extend round the periphery of the wall significantly further than necessary to close the outlet. The majority of the valve member is therefore exposed so that, in contrast to the conditions when a sliding gate valve is closed, the molten metal is able to circulate around the closed valve member and there is no slug of trapped metal liable to freeze between pours.

In each of these prior disclosures, insufficient attention has been paid to the practical problems of operating such a rotary valve mechanism. It has now been discovered that in order to reliably and repeatedly rotate the valve member it is necessary to shape the sealing faces as described herein and arrange the valve so that there are no dead zones wherein molten solid can be trapped; and preferably also shape the exit portion of the passage so that the stream of molten solid emerges in a predetermined shape.

In one aspect the invention provides an outlet for a vessel containing a molten solid, the outlet comprising a rotary valve member and a seating member therefor, the valve member having at least one passage to conduct molten solid from inside to outside the vessel, the valve member sealing with a wall of the seating member, the wall having a first section sufficiently high so that when the valve member is rotated to align an inlet end of the passage therewith the inlet is closed by the first section, the wall having a second section of relatively reduced height so that when the valve member is rotated to align an inlet end of the passage therewith the inlet end is open to allow molten solid to pass into and along the passage characterised in that the first section of the wall is shaped to allow molten solid to pass freely in the region of the second section when the inlet is closed.

Preferably the first section provides upstanding side walls for the second section which defines the base of a channel of generally open cross-sectional shape. Because the second section has the shape of an open channel, i.e. no roof is present, there is reduced risk of creating a dead zone in which molten solid can settle to solidify. Preferably the sidewalls of the second section lie along planes which diverge outwardly away from the valve member to avoid a restriction of the flow of molten solid and to discourage any bridging which might otherwise lead to a solidification of the molten solid.

In accordance with an alternative or additional aspect of the invention, the outlet has a branched passage which has a plurality of outlet ends spaced from each other so as to be aligned with the second section of the wall in different rotational positions of the valve member, the inlet ends communicating with a common outlet end of the passage. If, in use the valve member is always rotated in the same direction, both to open and close the passage, each of the inlet ends will be used in turn, so reducing the wear and tear on each and increasing the life of the outlet.

The dimensions of the sections depend on the number of inlets and whether they are to be used singly or together. Where there is a single inlet and a single second section, the first section preferably comprises from about 19% to about 81% of the length of the wall. Where there are two inlets and two second sections the first section preferably comprises from about 38% to about 62% of the length of the wall. Where there are two inlets and a single second section so that the inlets are used individually preferably the first section comprises from about 69% to about 81% of the length of the wall. The number of inlets may exceed two. The dimensions given are preferred in the case of casting articles of steel in a foundry, and other values may be appropriate when the molten solid is different, e.g. or another metal such as iron, or steel when processed in a steelmill or a

non-metallic material.

In the known outlets the valve member and the seating member have conical surfaces which mate to form a seal. In use the valve member tends to 'stick' leading to the need for large forces to rotate it, which leads to wear. In accordance with yet another alternative or additional aspect of the invention, the surfaces are convex in a plane including the axis of rotation of the valve member. This prevents the jamming experienced with conical members reducing the force required to rotate the valve member and generally decreasing wear and thus increasing robustness. Also, if the sealing surfaces are hemispherical the same benefits accrue and the valve assembly can tolerate slight misalignments of the refractory parts. This will be of considerable benefit in industries where unskilled labour is employed, e.g. in the steel and iron industries.

A suitable material from which to form an outlet intended for a metallurgical vessel, is graphitised alumina and the valve member and seating member are preferably made by isostatic pressing. Although a preferred embodiment of the invention is utilised in a vessel for molten metal, the invention can be applied to a vessel for any molten solid which is liable to freeze blocking the outlet.

It is a much preferred feature of the invention that the flow of

molten metal emerging from the down pipe be coherent, i.e. having substantially parallel sides, irrespective of the extent of opening of the inlet. To ensure this, in a further feature of the invention, means to control the shape of the stream are present in the passage. Most preferably the means comprises elongate generally parallel straight sided ribs, radially spaced about the passage. Preferably at least two such ribs are present.

The invention also extends to a vessel for molten solids having a floor having an opening containing an outlet as defined in this invention, the top of the second section of the wall of the outlet being approximately level with that of the surface of the floor inside the vessel.

One embodiment of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a plan view of an outlet embodying the invention;

Figure 2 is a side view of the outlet of Figure 1;

Figure 3 is a side view in section of the outlet, at right angles to that of Figure 2;

Figure 4 is a view from below of Figure 3;

Figure 5 is a section on arrows V-V of Figure 2 showing the outlet installed in a foundry ladle;

Figure 6 is a view from underneath the foundry ladle shown in Figure 5;

Figures 7A, 7B and 7C are plan views of three different configurations of outlet; and

Figure 8 is a transverse sectional view of the nozzle.

Referring to the drawings, a vessel comprises a foundry ladle 2 (Figures 5 and 6), having an outer metal shell 4 defining a side wall 6 and a floor 8. The shell has a refractory lining 10. A hole 12 having a conical taper extends through the floor 8 of the shell and of the lining. An outlet 14 has a seating member 16 which has an exterior frustoconical surface matching that of the hole 12, is retained therein by an annular plate 18. The plate 18 has three arms 20 projecting radially therefrom. A cup 22 is mounted at the end of each arm 20. The plate 18 is located by bosses 26 which depend from the floor 8 of the ladle, and which extend through central holes through each cup 22. A wedge (not shown) is driven through a slot 28 in each boss to retain the seating member 16 tightly in the hole 12.

A tapered hole 30 opens through the seating member 16 into the ladle 2 so that the seating member defines a wall 32 about the hole 30. A valve member 34 has a side surface 36 which mates sealingly with the tapered hole 30 at its inner end. The valve member 34 is retained in, and is rotatable by, a mechanism generally indicated at 38. The wall 32 and the mating surface 36 of the valve member are convex in a plane including the axis of rotation of the valve member. This reduces the tendency to stick which would occur if the surfaces were conical.

At its lower end, the valve member 34 provides a nozzle 40, of reduced section, having a central passage 42 which communicates branches at the upper end to communicate with a plurality of inlets 44. In the example illustrated there are two inlets 44 in opposite side surfaces of the valve member 34.

The wall 32 is of non-uniform height. A second section 46 of the wall is of such a height that its top is approximately level with the top of the lining 10 on the floor of the ladle. When the valve member is rotated to the position illustrated in Figures 3 and 5, the inlet end 44 of the passage is open so that molten metal may flow from the ladle. Another (first) section 48 of the wall 32 is taller and of such a height that when an inlet end of the passage is aligned therewith, the inlet is closed thereby. This condition may be seen on the left-hand side of Figures 3 and

5 so that only one of the inlets is open. The section 48 of the wall extends round sufficient of the periphery of the wall that, when the valve member is rotated to a position at 90 degrees to that shown in Figures 3 and 5, both inlets 44 are closed. As can be seen in Figure 1, the walls of the taller section 48 define the sidewalls of the channel 99 whose base is defined by the top of the lower section of wall 46. The channel 99 is of generally open cross-sectional shape, i.e. having no roof. The sidewalls 49 of the channel lie along planes which diverge apart away from the valve member 34. In other words, the shape of the second section 46 is open and free of walls or shoulders which could provide blind alleys or dead zones.

In a variation, not illustrated, the passage has only one inlet end opening through its side surface 36. In such a case the higher section 48 extends around at least 19% of the periphery of the wall. In the case illustrated, the higher section 48 must extend round more than 69%, sufficient to close both inlets together. In either case, it is preferred, for robustness, that the higher section extends round as much of the wall as practicable, and more preferably that the lower section 46 extends along the periphery of the wall approximately the same distance as the inlet end 44 of the passage.

In the example illustrated, the section 46 extends round only a small portion of the periphery of the wall sufficient that the

inlet can be completely uncovered. When the inlets are closed, despite the fact that the section 48 extends round the majority of the wall, molten metal is able to circulate under the effect of convection currents around all the exposed surfaces of the valve member 34 so reducing the tendency of metal to freeze on the valve member. (Contrast this with the situation if instead of the wall 32 having a low section 46, the wall was formed with a through hole bound by walls all round, for example similar to the arrangement disclosed in WO 88/05355. Although in the latter case molten metal would flow satisfactorily through the hole when the valve was open, when the valve was closed, there would be a slug of metal trapped in the hole and, although in communication with the bulk of the molten metal, the slug would be unable to circulate into the bulk, and additionally the area of cooling surface is greater so that the molten metal would tend to freeze by heat loss due to conduction through the valve member).

In contrast to the prior stopper rod arrangement the outlet illustrated may be partially closed, to throttle the flow of molten metal, without the stream dividing. The operator has improved control over the pouring rate, and the nozzle size may vary up to the full bore to suit the size of the product. The ladle may be covered to reduce temperature losses (because there is no top apparatus to move the stopper rod) and metallurgical treatment may be conducted without the risk of melting a stopper rod. In contrast to a sliding gate arrangement there are no dead

zones in which metal may solidify prematurely.

Another advantage of the invention is that it is possible to control or regulate the flow of the liquid from the outlet and maintain stream integrity.

The mechanism 38 comprises an annular ring gear 50 mounted for rotation by three V-section rollers 52 each of which is rotatably mounted on the plate 18 by a shaft 54 and spaced from the plate by a spacer 56. The V-section rollers are received by a V-section slot 53 in the periphery of the ring gear so allowing the gear to rotate. The lower face of the ring gear is formed with bevelled gear teeth 58 which engage a bevel gear 60 mounted on a shaft journalled in a bracket 62, mounted on the plate 18, for rotation by a handwheel 64. Rotation of the handwheel 64 thus drives the ring gear to rotate.

Referring to Figure 4, above a shoulder 70, the valve member is formed with a plurality of indents 66 around its periphery. An annular pressure plate 68 is formed with a recess 72 to receive the shoulder 70. The pressure plate 68 is urged against the shoulder 70 by a plurality (six are illustrated) of spring loaded pressure pins 74 which extend from respective bores in the ring gear 50 so urging the valve member into its sealing engagement with the seating member 16. The pressure plate 68 has a plurality of teeth (not shown) which extend inwardly into the

recess 72 so as to engage in the indents 66 so that rotation of the ring gear causes rotation of the valve member. The indents 66 extend axially of the valve member (see Figures 2 and 3) a sufficient distance that no axial thrust is transmitted to the valve member by the teeth so avoiding high local pressures.

In order to withstand the temperatures associated with molten metals or alloys, the valve member and seating member are both formed of a refractory material, eg graphitised alumina which may be formed by isostatic pressing.

In the embodiment of Figure 7A, the valve member 34 has a single inlet 44 and the high wall section may range across an arc of from  $70^{\circ}$  to  $290^{\circ}$ , corresponding to a length from 19% to 81% of the perimeter of the seating member 16. In the embodiment of Figure 7B, the valve member 34 has two inlets 44 which are used together, and there are two second sections 46; the section 48 makes up from 38% to 62% of the perimeter of the seating member 16. In the embodiment of Figure 7C, the valve member 34 has two inlets 44 but these are used individually and the first section 48 makes up from 69% to 81% of the length of the perimeter of the seating member 16.

As can be seen in Figure 8, four radially spaced apart ribs 101 are present in the passage 42. The ribs are straight sided, extend parallel to the longitudinal axis of the passage and are

and spaced about 90° apart. By virtue of these ribs the stream of molten metal emerging from the passage is substantially parallel sided, so reducing the risk of splashing etc.

It will thus be seen that because the sealing faces of the valve member and the seating member therefor are shaped as illustrated the force required to turn the valve member is small and there is little chance of binding or jamming of the refractory parts. Also, the valve is designed so that there are no dead zones and molten solid has free access around the valve and is not trapped in blind alleys in which it could cool and solidify. As a result, the valve member may reliably be rotated without the risk of sticking of mating parts and causing freezing of molten metal which would stop relative rotation completely. Because of the ribs in the passage the flow of molten metal is coherent irrespective of the extent to which the valve is throttled.

The invention is not limited to the embodiments shown. For example there may be more than two inlets. The dimensions of the first and second sections may vary when the molten solid is other than steel poured in a foundry.

CLAIMS

1. An outlet (14) for a vessel (2) containing a molten solid, the outlet (14) comprising a rotary valve member (34) and a seating member therefor (16), the valve member (34) having a passage (42) to conduct molten solid from inside to outside the vessel (2), the valve member (34) sealing with a wall of the seating member (16), the wall having a first section (48) sufficiently high so that when the valve member (34) is rotated to align an inlet end (44) of the passage therewith the inlet end (44) is closed by the first section (48), the wall having a second section (46) of relatively reduced height so that when the valve member (34) is rotated to align an inlet end (44) of the passage therewith the inlet end (44) is open to allow molten solid to pass into and along the passage characterised in that the first section (48) of the wall is shaped to allow molten solid to pass freely in the region of the second section (46) when the inlet (44) is closed.
2. An outlet according to Claim 1 characterised in that the first section (48) provides upstanding side walls for the second section (46) whereby the second section (46) provides

the base of generally open channel cross-sectional shape (99).

3. An outlet according to Claim 2 characterised in that the opposite sidewalls (49) lie along planes which diverge away from the valve member (34).
4. An outlet according to any of Claims 1 to 3 characterised in that the first section (48) comprises from about 19% to about 81% of the length of the wall (32) and the valve member (34) has a single inlet (44).
5. An outlet according to any of Claims 1 to 3 characterised in that the first section (48) comprises from about 69% to about 81% of the length of the wall (32) and the valve member (34) has two inlets (44) which are used individually.
6. An outlet according to any of Claims 1 to 3 characterised in that the first section (48) comprises from about 39% to about 62% of the length of the wall (32) and there are two inlets (44) which are used together.
7. An outlet according to any preceding Claim characterised in that the opposite surfaces of the valve member (34) and the wall (32) of the seating member (16) therefor which mate are shaped and dimensioned to reduce sticking in use.

8. An outlet according to Claim 7 characterised in that the opposite surfaces are convex in a plane including the axis of rotation of the valve member (34).
9. An outlet according to any preceding Claim characterised in that the passage (42) includes means (101) to ensure that the stream of molten solid leaving the outlet is substantially parallel sided.
10. An outlet according to Claim 9 characterised in that the means (101) comprises radially spaced apart ribs extending along generally parallel to the longitudinal axis of the passage (42).
11. A vessel (2) having a sidewall (4) and a floor (8) including a hole (12) characterised in that the hole contains an outlet according to any of Claims 1 to 10, the top of the second sections (46) of the wall of the outlet being approximately level with that of the surface of the floor (8) inside the vessel (2).
12. A method of releasing molten from a vessel in a controlled manner, the method comprising placing the molten metal in a vessel according to Claim 11, and moving the valve member (34) relative to the seating member (16) to adjust the rate

of flow whereby molten metal may be poured and the valve (34) moved to close off the flow, without causing sticking of the valve member (34) and the seating member (16) therefor.

13. A method according to Claim 12 characterised in that means (101) are present in the passage (42) to ensure that the molten metal is released in a stream having substantially parallel sides.

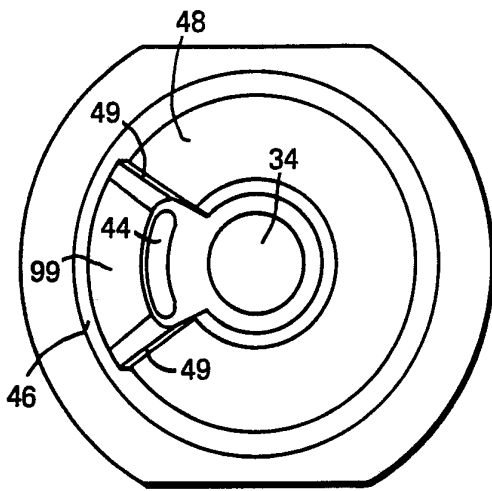


FIG. 1

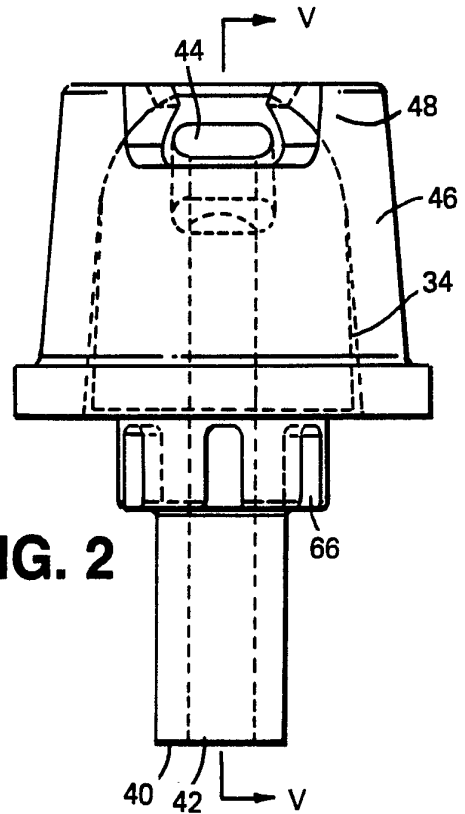


FIG. 2

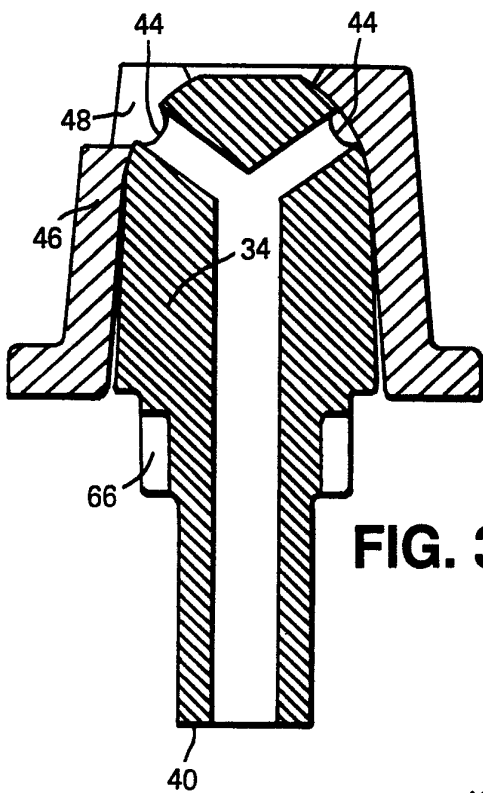


FIG. 3

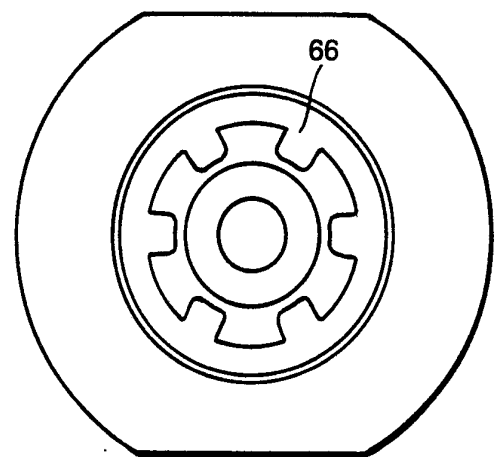


FIG. 4

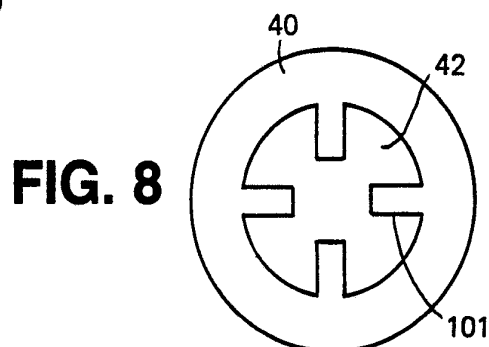


FIG. 8

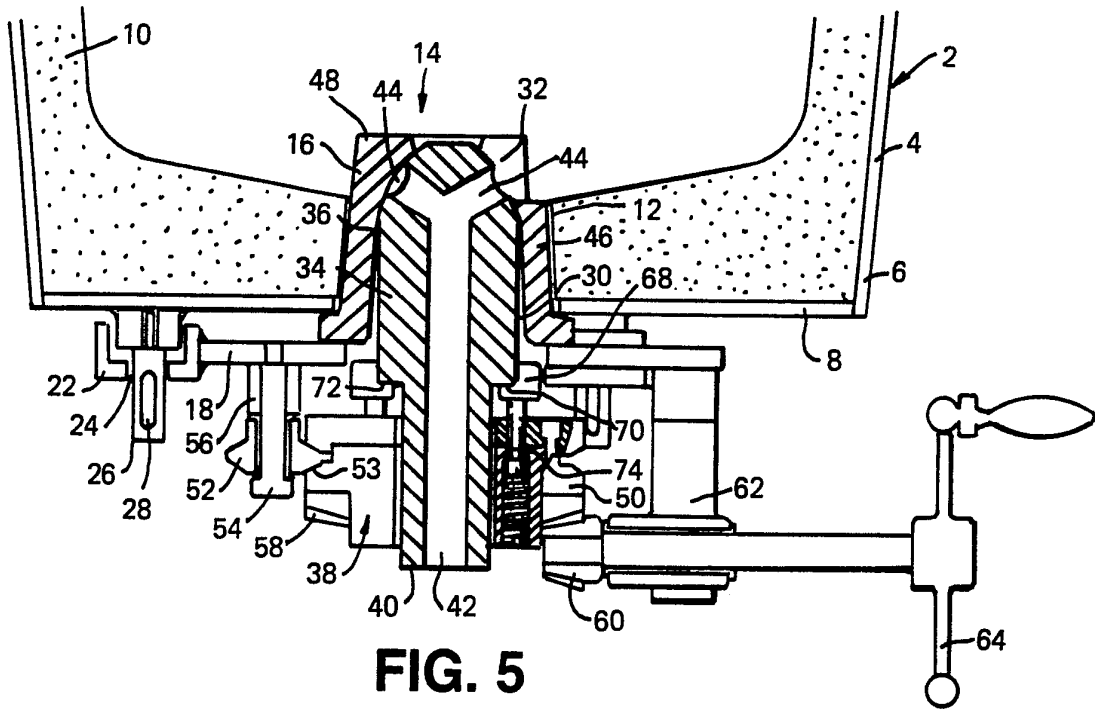


FIG. 5

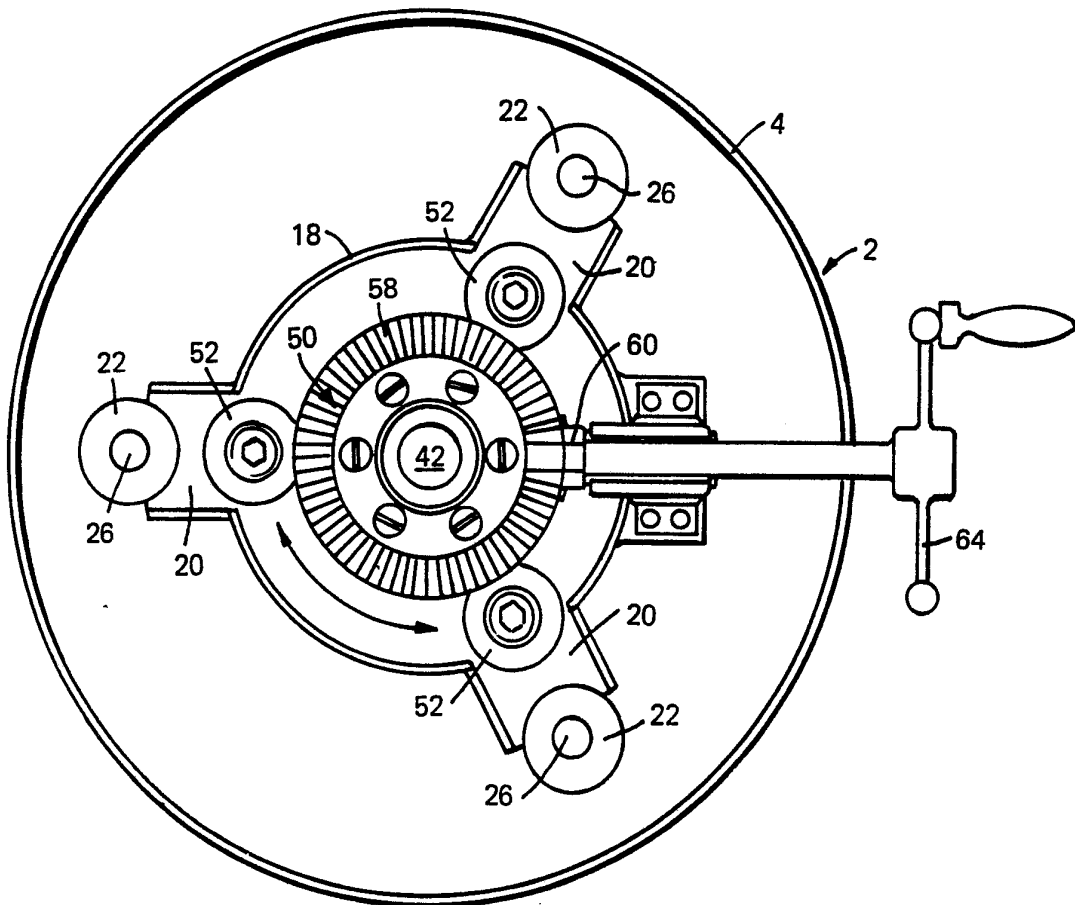
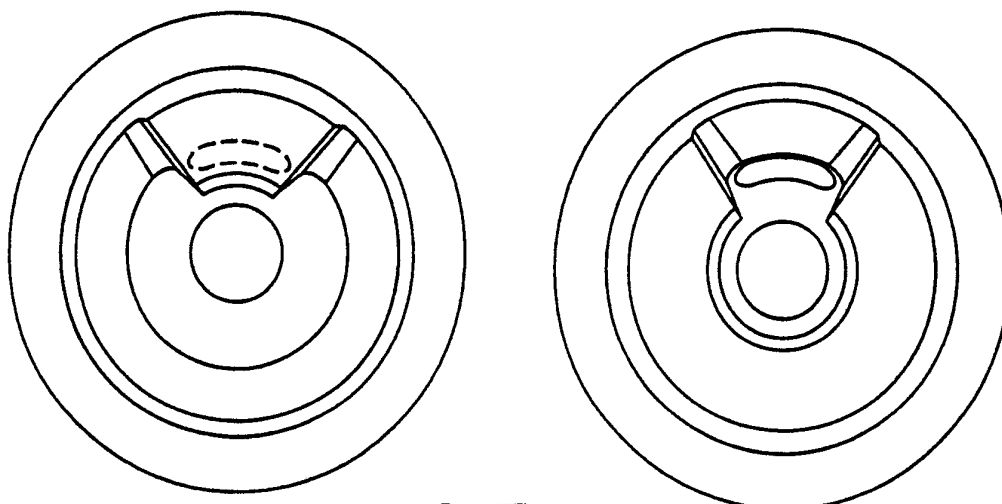
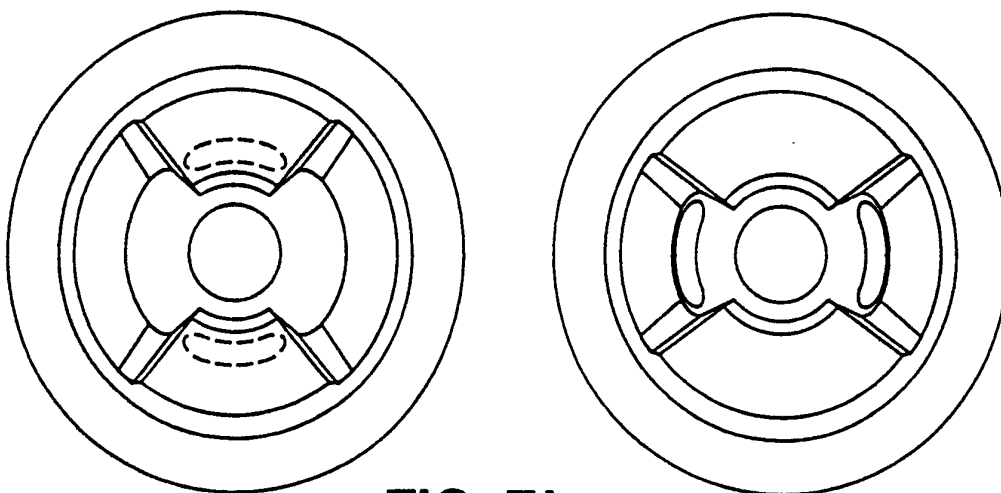


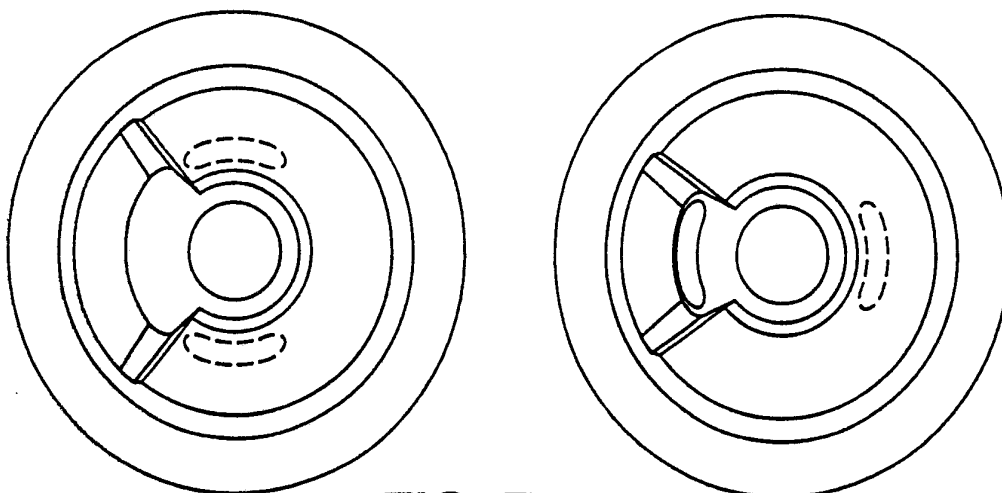
FIG. 6



**FIG. 7a**



**FIG. 7b**



**FIG. 7c**  
SUBSTITUTE SHEET

# INTERNATIONAL SEARCH REPORT

PCT/GB 92/00080

International Application No

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5 B22D41/14		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	B22D ; C21C ; F27D	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>o</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X	WO,A,9 014 907 (SHINAGAWA REFRACTORIES CO) 13 December 1990 see abstract; figures 1-4,9-13	1-6,11, 12  7-10,13
Y	---	7
Y	FR,A,2 140 597 (BIERI H.) 19 January 1973 see figures 1,2	7,8
Y	---	9,10,13
Y	AT,A,165 292 (J.FISCHLSCHWEIGER) 10 February 1950 see figures 1-4	1
Y	---	1
A	DE,C,631 753 (H.BRINKMANN) 25 February 1938 see the whole document	1
A	DE,A,3 743 383 (RADEX DEUTSCHLAND AG) 6 July 1989 see column 4, line 44 - line 48; claims 20,21	1
A	---	1
-/--		
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>o</sup> Special categories of cited documents :<sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
16 MARCH 1992	24. 03. 92	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	MAILLIARD A.M.	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		Relevant to Claim No.
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 48 (M-793)(3396) 3 February 1989 & JP,A,63 256 265 ( NKK CORP ) 24 October 1988 see abstract ---	1
A	DE,A,3 842 121 (HORNING K.O.) 29 June 1989 see the whole document ---	1
A	EP,A,0 310 296 (FOSECO INT LTD) 5 April 1989 see abstract; figures 1-7 ---	1

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO. GB 9200080  
SA 55384**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 16/03/92

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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