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54 **Moulding apparatus.**

57 Moulding apparatus (10) for use in pressure slip casting of ceramic items. The apparatus (10) includes a two part cylindrical porous plastics material mould (12) defining an inner moulding cavity (14). Inlet tubes (16A,16B) extend into the cavity (14) to permit entry of slip, air and pressure therein. The mould (12) is co-axially located in a steel cylinder (20) with a small clearance. An inflatable rubber bag (22) is provided around the inside of the cylinder (20). Inflation of the bag (22) clamps the two parts of the mould (12) together to permit pressure slip casting to be carried out.

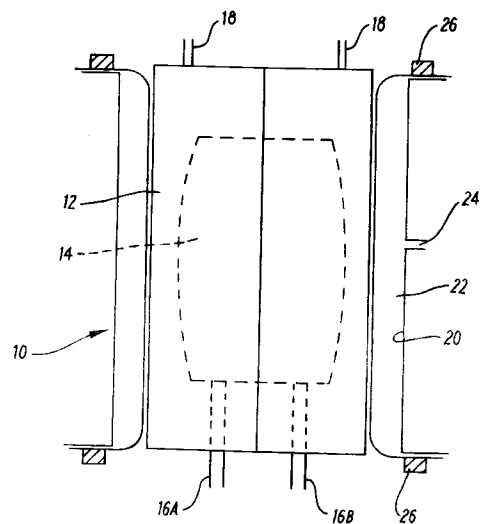


Fig. 1

This invention concerns improvements in or relating to moulding apparatus, and particularly but not exclusively moulding apparatus for use in pressure slip casting of ceramic articles.

In pressure slip casting a mould is filled with slip and pressure is applied to the slip. Pressure casting provides for a number of advantageous features relative to conventional slip casting. However, in pressure casting particular attention must be paid to clamping together the parts of the mould. The current method of clamping together pressure casting moulds uses hydraulic rams. This method demands very expensive machinery, and for high casting pressures also demands very rigid and hence expensive support frames for the mould. Whilst attempts have been made to use multi part moulds, the closing of moulds by hydraulic rams is commercially still limited to two part moulds. Such moulds may be used to form lavatory basins or simple tableware shapes. Even for small shapes the clamping of multi part moulds with hydraulic rams tends to be prohibitively expensive and/or too cumbersome to be viable.

The term "inflatable" when hereinafter used in this specification is to be understood as referring to a closed flexible member which can be filled and thus expanded with a fluid, whether it be liquid or gas.

According to the present invention there is provided moulding apparatus comprising a rigid support member, a plurality of mould pieces cooperable together to define a closed mould with means permitting the mould to be filled with fluid, the mould pieces being locatable between opposing parts of the support member, and an inflatable member locatable between at least one of the mould pieces and the support member such that the inflatable member can be filled with fluid to clamp the mould pieces together.

The support member is preferably shaped to at least partially surround the mould pieces. The support member can desirably encircle the mould pieces.

The support member may include end portions. Corresponding inflatable members may be provided for each end portion.

The apparatus may comprise means which permit the mould pieces to be tilted.

The apparatus may be arranged such that mould pieces can be moved into position between the opposing parts of the support member.

One or more of said opposing parts may be selectively movable to permit movement of the mould pieces to between said opposing parts. Said one or more of the opposing parts may be pivotally movable.

The support member may comprise a movable base support upon which the mould pieces are locatable. A track may be provided along which said base support is movable. A plurality of base supports may be provided to enable mould pieces to be placed on a one thereof whilst moulding takes place in mould pieces located on another thereof. The track may ex-

tend from opposite sides of the support member so that base supports from opposite sides may alternately comprise part of the support member.

The base support may comprise a sprung wheel means arrangement constructed such that when a predetermined downward force is applied thereto the arrangement retracts such that the whole of said force is not borne thereby.

The inflatable member may be shaped to substantially line the inside of the support member.

The support member may comprise an open frame with the inflatable member engagable against an engagement surface provided on the frame.

A plurality of inflatable members may be provided.

Alternatively the support member may be cylindrical and the inflatable member may comprise a cylindrical sleeve.

Alternatively, the inflatable member may comprise an elongate member which may be wrapped around the mould pieces or around the inside of the support member.

The mould pieces are preferably made of a porous plastics material and desirably polymethylmethacrylate.

Also according to the present invention there is provided pressure slip casting moulding apparatus according to any of the preceding thirteen paragraphs.

Still further according to the present invention there is provided a method of pressure slip casting a ceramic item, the method comprising using apparatus according to any of the preceding fourteen paragraphs, locating the mould pieces together between the opposing parts of the support member, locating the inflatable member between the support member and at least one of the mould pieces, filling the inflatable member with fluid under pressure to clamp the mould pieces together, filling the mould with slip, and applying pressure to the slip.

The force produced by the hydrostatic pressure of the slip is preferably not greater than the clamping force produced by the inflatable member.

Embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings, in which:-

Fig. 1 is a diagrammatic cross sectional side view of a first embodiment of the present invention in use;

Fig. 2 is a similar view of a second embodiment according to the present invention;

Fig. 3 is an end view of a further embodiment according to the invention;

Fig. 4 is a view along the line X-X in Fig. 3;

Fig. 5 is a cross-sectional end view of a similar apparatus to Fig. 3 but with a more complex item being moulded; and

Fig. 6 is a view along the line Y-Y in Fig. 5.

Fig. 1 shows moulding apparatus 10 for use in pressure slip casting of ceramic items. The apparatus 10 comprises a two part cylindrical mould 12 defining an inner moulding cavity 14. The mould 12 is made for example of a porous plastics material such as polymethylmethacrylate.

Inlet tubes 16A and 16B extend through the mould 12 into the cavity 14 to permit entry of slip, air and pressure thereto. A network of pipes (not shown) extends through each of the mould parts 12 which connect with pipes 18 extending from the mould parts 12 for connection to pressurized air for releasing a cast item from the mould 12.

The mould 12 is coaxially located in a steel cylinder 20 with a clearance of approximately two centimetres. The cylinder 20 is capable of withstanding internal pressures of in the order of 300 psi. An inflatable rubber bag 22 is provided around the inside of the cylinder 20. A pipe 24 leads into the bag 22 to permit pressurized fluid to be supplied thereto. The bag 22 is held on the cylinder 20 by retaining rings 26.

In use, the two parts of the mould 12 are strapped together and placed inside the cylinder 20. Pressurized fluid, which may be air or water, is then pumped into the bag 22 to clamp the mould parts 12 together within the cylinder 20. The mould 12 is then filled with casting slip through tube 16A and pressure is applied thereto. After a required interval of time the slip pressure through the tube 16A is released and air is blown through the pipe 16B while the slip drains and for a further time to firm up the cast. The bag 22 is then allowed to deflate permitting the mould 12 to be removed from the cylinder 20 for demoulding.

The cast is demoulded by connecting the tubes 18 an air supply. Air is applied to one half of the mould at the same time as the mould is parted. This causes a thin film of water to be formed at the mould cast interface and promotes release of the first mould half. The cast is then removed from the second half by application of air to the second mould half.

If required, a further mould could be placed in the cylinder 20 and the process repeated whilst the demoulding continues with the original mould 12. The fluid pressure in the bag 22 is preferably at least as great if not greater than the fluid pressure of slip in the cavity 14. If required, the cylinder 20 may be pivoted as required during casting or draining.

Fig. 2 shows moulding apparatus 30 usable for example in slip casting a pitcher with a foot. A similar arrangement could also be used for a WC. In this instance a four part mould 32 is used, comprising two side portions 34, a top portion 36 and a base portion 38 which define a inner mould cavity 40. Again a cylinder 20 is provided with a bag 22. However, in this instance a top retaining plate 42 is provided across the top of the cylinder 20 with a corresponding bag 44, and also a base retaining plate 46. The top plate 42 and bag 44 could be replaced by a flexible bellows

clamp or other clamping arrangement. Suitable tubes and pipes are again provided extending into the mould 32 and cavity 40.

Figs. 3 and 4 show further moulding apparatus 50 usable in pressure slip casting of ceramic items. In the present instance a wash basin 52 is being cast.

The apparatus 50 comprises a rigid open metal frame 54 capable of withstanding considerable force. The frame 54 comprises a substantially square base 56 from which extends side walls 58 and end walls 60. The end walls 60 are pivotally mounted to the side walls 58 by pivots 62 which permit the end walls to be opened to allow loading of the apparatus. Locking pins 64 are provided for securing the end walls 60 in a closed position.

The base 56 is mounted on a ground engaging support 66. The base 56 is mounted on one side to the support 66 by a pivotal mounting 68 and on the other side by a pair of hydraulic rams 70. A track 72 extends through the frame 54 and beyond each end thereof. The track extends immediately above the base 56. One or more trolleys 74 is mountable on the track 72. The trolleys 74 have a flat support surface 76 upon which moulds can be supported. A plurality of sprung wheels 78 are provided on the underside of the trolley 74 engageable on the track 72.

Plattens 80 are provided on each end wall 60 and an air bag 82 is provided overlying a one of the plattens 80. Two horizontal cross members 84 extend between the tops of the side walls 58.

In use, a multi-part mould such as the two part mould 86 shown in Figs. 3 and 4 is placed on the support surface 76 of the trolley 74 whilst the trolley 74 is located towards one end of the track 72. A respective one of the end walls 60 is opened and the trolley 74 is pushed into the frame 54 and the respective end wall 60 is closed. The air bag 82 is then inflated clamping the parts of the mould 86 together. Pressure slip casting can then take place. If required, the rams 70 can be actuated to tilt the frame 54 and hence trolley 74 to provide the required angle for the mould to ensure correct slip drainage.

After casting, if required the rams 70 are lowered and the air bag 82 is emptied. Either one of the end walls 60 is then opened and the trolley moved out of the frame 54 for demoulding. The provision of the track 72 extending from each end of the frame 54 means it would be possible for two or more trolleys 74 to be used, with trolleys 74 being fed in from alternate ends thereby permitting demoulding and loading of the moulds on to the trolleys 74 to be carried out whilst casting is taking place.

Figs. 5 and 6 show a similar apparatus 96 but being used with a more complicated multi-part mould 88 usable for making a W.C. In this instance a platten 90 is provided on the underside of the cross members 84. Further plattens 92 are also provided on each of the side walls 58. Respective air bags 94 are provided

for each of the plattens 90, 92. Casting will take place in a similar manner with the extra air bags 94 holding the various parts of the mould 88 together.

A further feature of the apparatus 96 is that the wheels 78 of the trolley 74 are sprung such that when a predetermined downward force is applied thereto by for example the respective air bag 94 engaging against the platten 90 the wheels 78 contract. In such an instance the underside of the trolley 74 engages directly against upstanding projections 98 provided on the base 56.

There is thus described moulding apparatus which permits mould parts to be firmly clamped together during pressure casting. The apparatus is of relatively simple construction and can thus be inexpensively and robustly manufactured. This apparatus readily lends itself to use with moulds comprising more than two parts. The apparatus permits relatively large items to be cast and with regard to the first type of apparatus described cylinders with a diameter of one metre or so could readily be used. The cost of providing a cylinder of this size is much less than that for providing the relatively large rams that would be required otherwise.

The apparatus also readily lends itself to automation of the various stages. The use of the support members described frees the top and bottom of the mould for easy application of an axial clamping force thus permitting further mould parts to be used, thereby enabling relatively complex shapes to be cast. A single support member could be used for casting many different shapes. This arrangement would permit experimental multi part mould systems to be developed relatively cheaply. This apparatus is complementary to the present pressure casting battery machines.

Various other modifications may be made without departing from the scope of the invention. For example, whilst the described examples have been involved with relatively large articles, similar apparatus could be used to make relatively small articles such as tableware and in particular handles. Apparatus according to the invention could in fact be used with a wide range of ceramic products and particularly the whole range of sanitary ware. Instead of inflatable bags, elongate inflatable members could be used which could either be wrapped around the moulds or wrapped around the inside of the support member. The inflatable bags or members can be inflated with air or other gases, or liquids such as water.

The apparatus is usable with plaster of paris moulds as well as plastic moulds. The support members may have shapes other than those described and could be made from for example reinforced concrete. The apparatus and particularly apparatus of the type shown in Figs. 3 to 6 could be used simultaneously with a plurality of moulds, the moulds being stacked side-by-side or on top of each with the re-

spective inflatable member or members clamping the moulds together and closed. In the case of moulds for W.C.s a plurality could be stacked together by a single air bag with individual air bags for the top of each mould and/or the sides thereof.

Whilst endeavouring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

Claims

1. Moulding apparatus (10, 50, 96) comprising a rigid support member (20, 54), a plurality of mould pieces (12, 34, 36, 86, 88) cooperable together to define a closed mould (12, 32, 86, 88) with means permitting the mould to be filled with fluid, the mould pieces being locatable between opposing parts of the support member, characterised in that the apparatus comprises an inflatable member (22, 82, 94) which is locatable between at least one of the mould pieces and the support member such that the inflatable member can be filled with fluid to clamp the mould pieces together.
2. Apparatus according to claim 1, characterised in that the support member (20, 54) is shaped to at least partially surround the mould pieces (12, 34, 36, 86, 88).
3. Apparatus according to claims 1 or 2, characterised in that the support member (20, 54) includes end portions (36, 38, 56, 84).
4. Apparatus according to claim 3, characterised in that corresponding inflatable members (44, 94) are provided for each end portion (36, 38, 56, 84).
5. Apparatus according to any of the preceding claims, characterised in that the apparatus (50, 96) comprises means (70) which permit the mould pieces (12, 34, 36, 86, 88) to be tilted.
6. Apparatus according to any of the preceding claims, characterised in that the apparatus (10, 50, 96) is arranged such that mould pieces (86, 88) can be moved into position between the opposing parts of the support member (54).
7. Apparatus according to claim 6, characterised in that one or more of said opposing parts is selectively movable to permit movement of the mould

- pieces (86, 88) to between said opposing parts.
- 8.** Apparatus according to any of the preceding claims, characterised in that the support member (54) comprises a movable base support (74) upon which the mould pieces are locatable. 5
- 9.** Apparatus according to claim 8, characterised in that a track (72) is provided along which said base support (74) is movable. 10
- 10.** Apparatus according to claims 8 or 9, characterised in that a plurality of base supports (74) are provided to enable mould pieces (86, 88) to be placed on a one thereof whilst moulding takes place in mould pieces located on another thereof. 15
- 11.** Apparatus according to claim 10, characterised in that the track (72) extends from opposite sides of the support member (54) so that base supports (74) from opposite sides may alternately comprise part of the support member. 20
- 12.** Apparatus according to any of claims 8 to 11, characterised in that the base support (74) comprises a sprung wheel means arrangement (78) constructed such that when a predetermined downward force is applied thereto the arrangement retracts such that the whole of said force is not borne thereby. 25 30
- 13.** Apparatus according to any of the preceding claims, characterised in that the inflatable member (22) is shaped to substantially line the inside of the support member (20). 35
- 14.** Apparatus according to any of the preceding claims, characterised in that the support member comprises an open frame (54) with the or each inflatable member (82, 94) engagable against an engagement surface (90, 92) provided on the frame. 40
- 15.** Apparatus according to any of the preceding claims, characterised in that a plurality of inflatable members (22, 82, 94) are provided. 45
- 16.** Apparatus according to any of the preceding claims, characterised in that the inflatable member comprises an elongate member which may be wrapped around the mould pieces (12, 34, 36, 86, 88) or around the inside of the support member (20, 54). 50
- 17.** Apparatus according to any of the preceding claims, characterised in that the mould pieces (12, 34, 36, 86, 88) are made of a porous plastics material. 55
- 18.** Pressure slip casting moulding apparatus (10, 50, 96), characterised in that the apparatus is according to any of claims 1 to 17.
- 19.** A method of pressure slip casting a ceramic item, characterised in that the method comprises using apparatus (10, 50, 96) according to any of claims 1 to 18, locating the mould pieces (12, 34, 36, 86, 88) together between the opposing parts of the support member (20, 54), locating the inflatable member (22, 82, 94) between the support member and at least one of the mould pieces, filling the inflatable member with fluid under pressure to clamp the mould pieces together, filling the mould with slip, and applying pressure to the slip.
- 20.** A method according to claim 19, characterised in that the force produced by the hydrostatic pressure of the slip is not greater than the clamping force produced by the inflatable member (22, 82, 94).

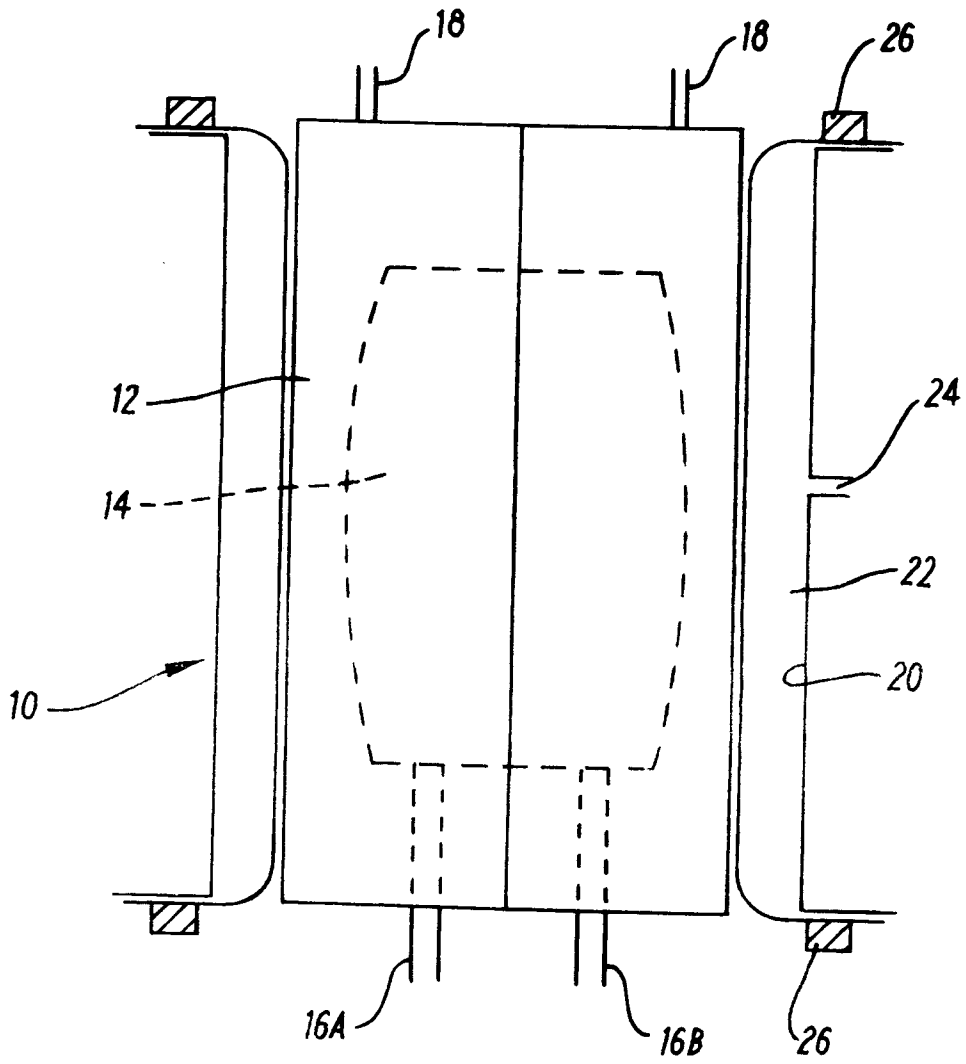


FIG. 1

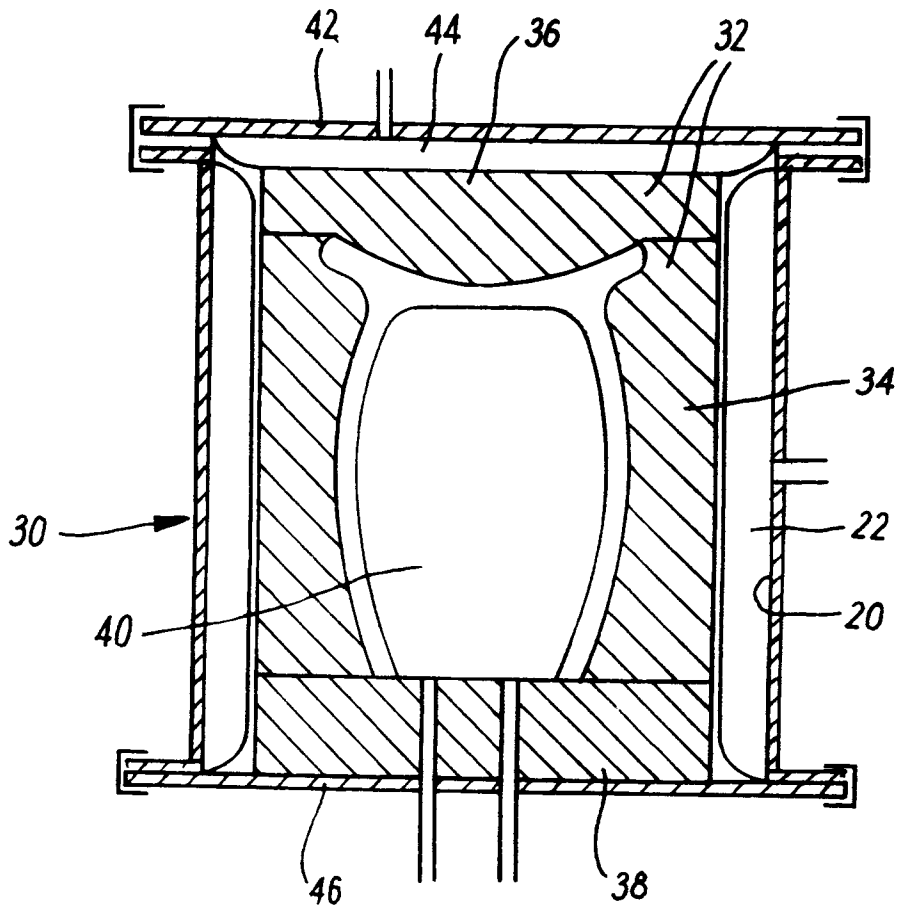


FIG. 2

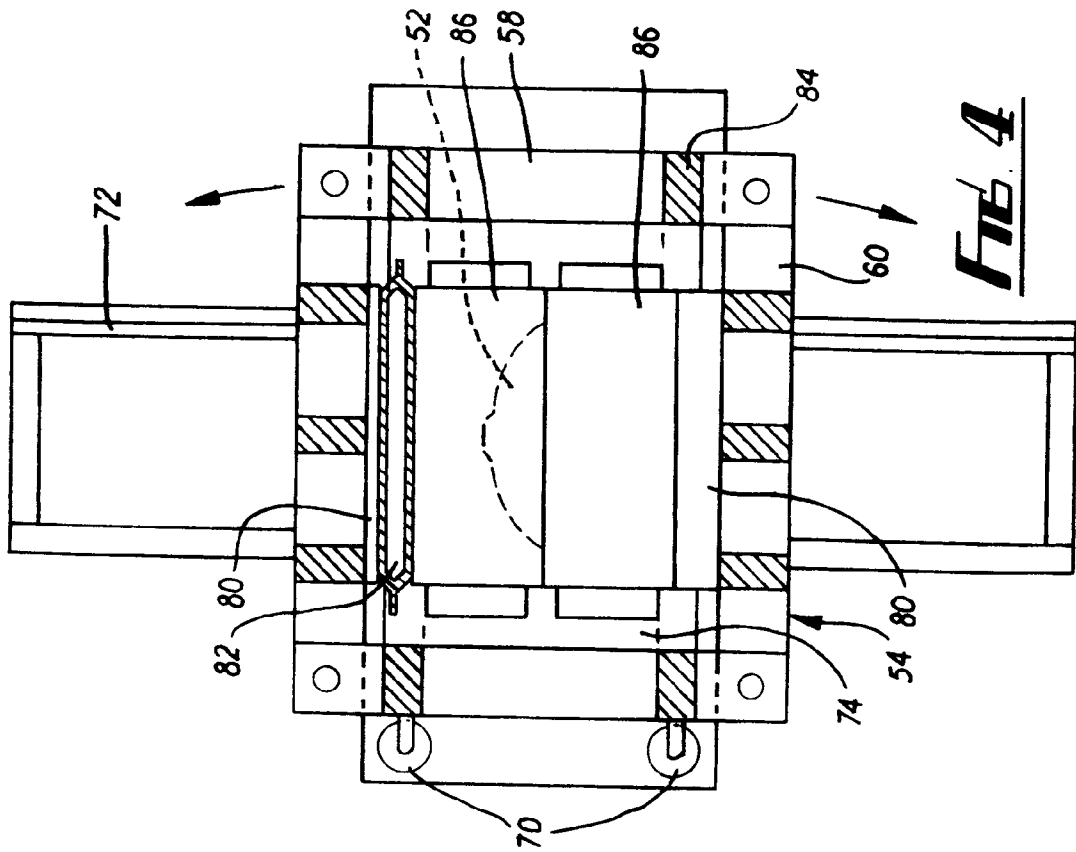


Fig. 4

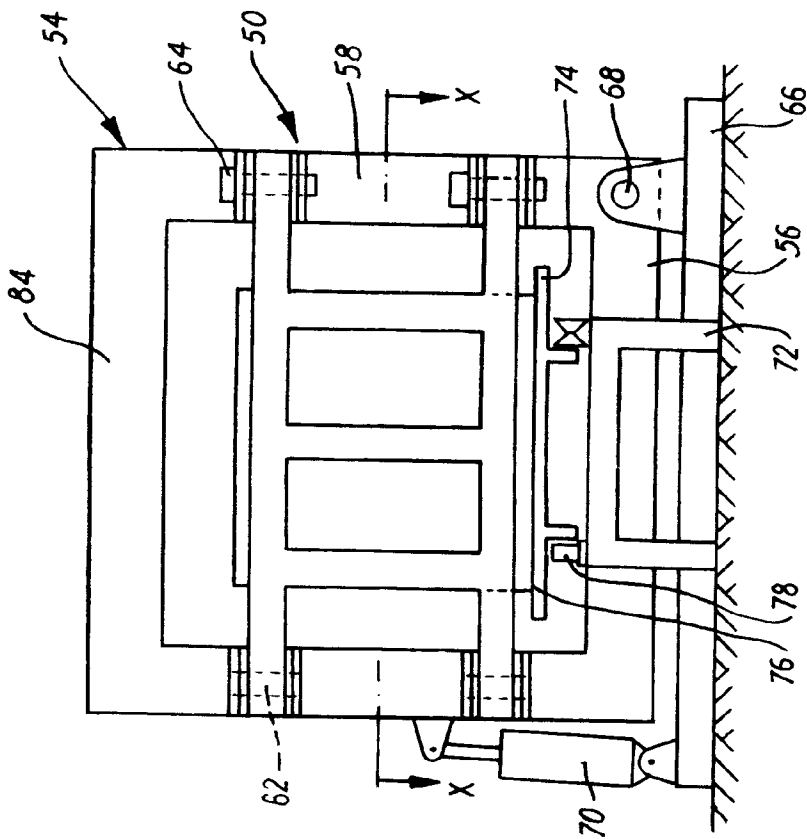


Fig. 3

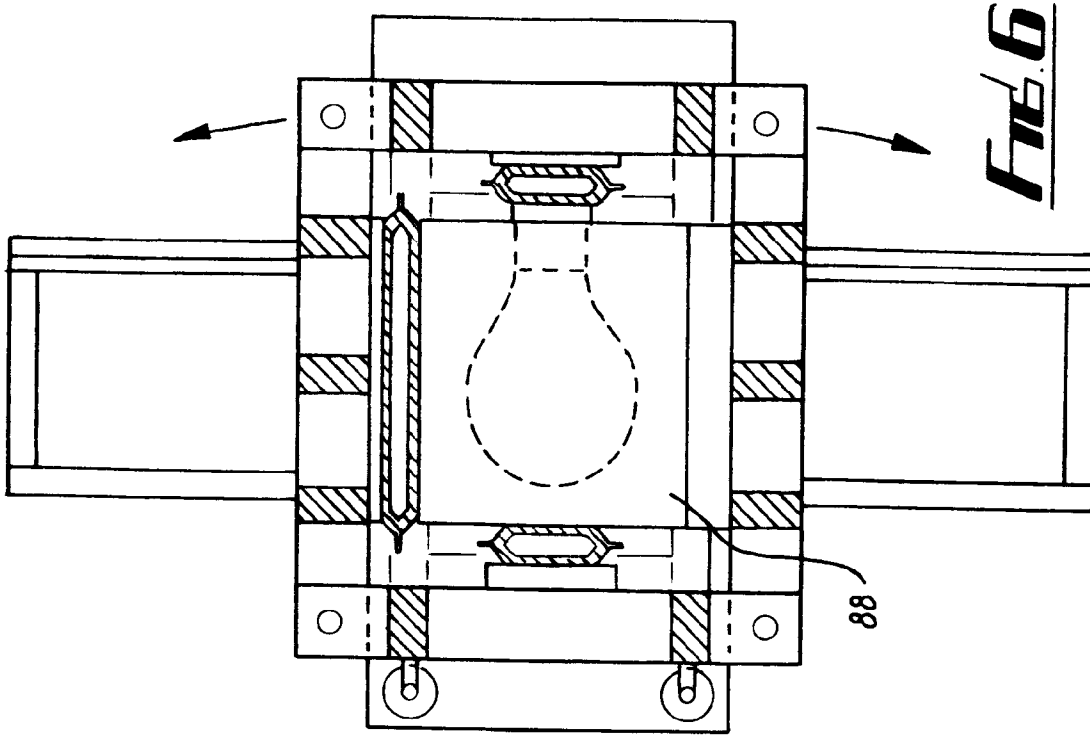


Fig. 6

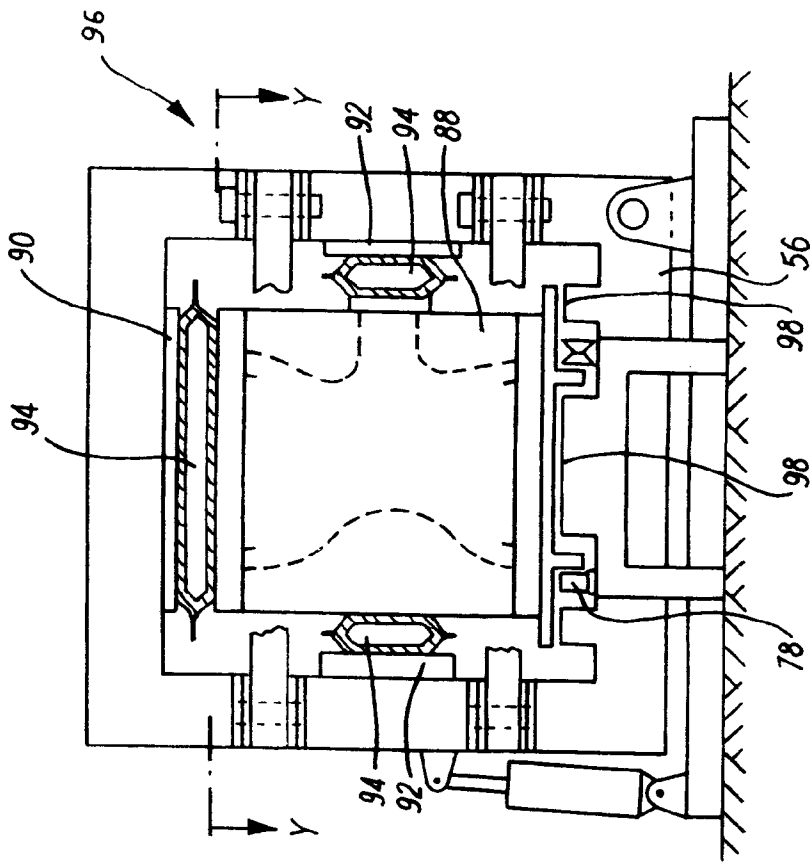


Fig. 5



European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 93 30 1988
Page 1

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	FR-A-2 602 452 (TOTO LTD.) * the whole document *	1-3, 6-12, 14, 15, 17-20	B28B7/00 B28B1/26
A	---	4	
X	EP-A-0 317 720 (DORST MASCHINEN UND ANLAGENBAU O. DORST UND W. SCHLEGEL GMBH & CO.) * the whole document *	1, 6, 14, 17-20	
A	---	5	
X	US-A-4 259 279 (J. S. GREENBERG) * the whole document *	1, 5-7, 14, 15, 17-20	
A	---	16	
X	US-A-4 954 062 (J. J. WILLING) * the whole document *	1, 6, 14, 17-20	
A	---	5	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	DE-A-3 508 892 (STANZTECHNIK GMBH R + S) * the whole document *	1-4, 13, 15, 16	B28B B29C
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A	AT-A-327 077 (R. GERSTL) * the whole document *	1, 2, 13	

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 08 JUNE 1993	Examiner GOURIER P.A.
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 93 30 1988
Page 2

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 120 (M-217)25 May 1983 & JP-A-58 038 118 (TOYODA GOSEI KK) 5 March 1983 * abstract * -----	1,16	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 08 JUNE 1993	Examiner GOURIER P.A.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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