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Remarks:
Claims 33 - 55 are deemed to be abandoned due to non-payment of the claims fees (Rule 31 (2) EPC).

(54) Device for forming objects

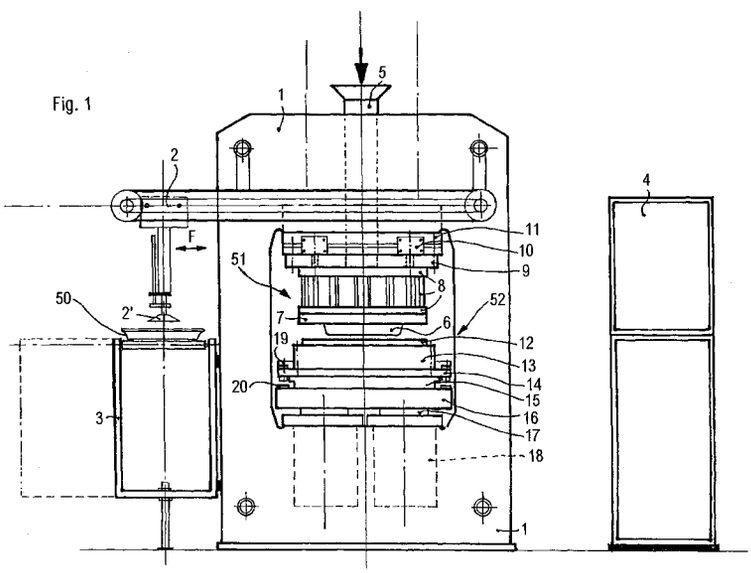
(57) A device for compacting flowable material, particularly for forming ceramic objects (50), comprises a first half mould (52) interacting with a second half mould (51) to define pressing cavity means (36'), suction means (36) associated with said first half mould (52) and suitable for assisting the entry of said flowable material into said cavity means (36'), said suction means (36) being so configured as to be operationally movable in relation to said first half mould (52).

Hopper means (41) is further provided that is suitable for delivering said flowable material to said cavity means (36'), and distribution means (26, 27, 28, 29; 46, 47, 48) arranged for enabling uniform distribution of said flowable material in said hopper means (41).

The device comprises cleaning means (24, 25) configured so as to interact cyclically with said second half mould (51), which is suitable for shaping a surface of said objects (50) intended to remain visible during use.

A device for compacting flowable material so as to form tableware (50) comprises a first half mould (52) interacting with a second half mould (51) to define cavity means (36') wherein said tableware (50) is formed, said second half mould (51) being arranged for forming a surface of said tableware (50) intended to remain visible, suction means (36) suitable for assisting the entry of said flowable material into said cavity means (36'), said suction means (36) being operationally associated with said first half mould (52).

Fig. 1



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Description

[0001] The invention concerns a process for forming by means of dry compression ceramic objects of any shape from porcelain granulate or other similar material and a device for implementing said process.

[0002] The porcelain granulate for forming tableware, like other ceramic materials, is suitably compacted by prevalently using a known isostatic pressing process.

[0003] The non-isostatic pressing process in fact causes differences in compacting or density of the granulate material that limit the use of said process to a few types of ceramic product.

[0004] In the case of isostatic forming according to the process with dry matrix, apparatuses are used that are equipped with two opposed half moulds. One of these half moulds, preferably the one used to form the back side of the object that is desired, is provided with an elastic membrane which is in contact with an uncompressible fluid that is cyclically pressurised so as to push the membrane towards the top half mould.

[0005] The application for utility model IT MI98U000041 discloses a mould for isostatic pressing of ceramic tiles, comprising an elastic membrane that is fixed to one of the two half moulds and which is interrupted by a plurality of air-removal valves, that are suitable for enabling the air initially present in the ceramic granulate to flow out through the openings with which said valves are provided. When pressing takes place, one of the two half moulds approaches the other half mould and the incompressible fluid pushes the elastic membrane against the material to be pressed. In the zones affected by the incompressible fluid, isostatic pressing therefore takes place whilst at the air-removal valves the pressing action stops when the bottom half mould, which bears the air-removal valves, arrives at its nearest position to the other half mould.

[0006] Italian utility model IT 212838 discloses a mould for pressing dishes, wherein the two half moulds that cooperate to form the dish are bordered by an external cylindrical surface on which a matrix can slide, said matrix being suitable for peripherally closing a cavity defined by the two half moulds. The matrix consists of two plates placed at a preset distance from one another, said plates defining a ring-shaped hopper wherein the ceramic granulate is inserted by means of an opening provided at a set point on the perimeter of the matrix. The ceramic granulate is facilitated in entering the cavity owing to certain suction holes made on the half mould designed to form the visible surface of the dish. Such suction holes also enable the air that is initially present in the granulate to exit during the first pressing phases. During the mould-loading phase the ring-shaped hopper made in the matrix communicates with the mould cavity in such a way that the mould cavity can be filled with the material to be pressed; subsequently the matrix is translated along the external surface of one of the two half moulds, so as to peripherally close said cavity during the pressing phase.

[0007] A drawback of the mould disclosed in IT 212838 is that, since the supply of ceramic granulate is provided at a single point of the ring-shaped hopper, non-uniform distribution of the powder inside said hopper may arise, which may risk causing non-homogenous filling of the mould cavity.

[0008] A further drawback of IT 212838 is that the suction holes are made on the half mould used to form the visible surface of the dish. Said holes may cause defects on the visible surface that will remain visible even after glazing, which significantly detracts from the quality of the product.

[0009] In known pressing devices, the half mould used to form the visible surface of the object, e.g. the top half mould, is made from stiff material that is preferably clad by a film of self-cleaning elastomer material. Although the use of self-cleaning material is desirable because it enables the cleaning of the relative half mould to be improved, it diminishes the gloss of the visible surface of the manufactured objects, which affects the final shine or brightness of said objects.

[0010] As an alternative to the half mould clad with self-cleaning elastomer material, to form the visible surface of the ceramic object a stiff half mould can be used that has no cladding in elastomer material. Said half mould nevertheless requires frequent and thorough cleaning operations in order to maintain a highly glossy surface and to form ceramic objects that are equally glossy. Said cleaning operations are responsible for decreasing the productivity of the manufacturing line.

[0011] Such qualitative or quantitative constraints, which conflict with one another, characterise current production techniques implemented with both the vertical and horizontal-axis presses and moulds of the prior art.

[0012] One aim of the invention is to improve the known devices for forming objects, particularly in ceramic material.

[0013] A further aim of the invention is to supply devices for pressing objects which enable the original material to be uniformly compacted, even when suction means is provided to facilitate pressing and/or filling of the mould.

[0014] Yet another further aim is to provide devices for pressing objects that ensure uniform filling and regular distribution of the material to be pressed within the mould cavity.

[0015] A further aim of the invention is to supply devices for pressing tableware that enable the quality of the tableware obtained to be improved by eliminating the defects on the surface that is destined to remain visible during use.

[0016] A further aim is to greatly reduce the formation of burrs due to the leak of powders from the closing zone of the half moulds.

[0017] One main objective of this invention consists in overcoming the constraints of the prior art by propos-

ing an innovative manufacturing procedure and the relative device for implementing said process, which enables maximum productivity to be associated with manufacturing objects of better quality, thereby ensuring uniform transversal compaction in addition to gloss and shininess in the pressed objects, starting from the prior art, for which ample patent documentation is available.

[0018] These and other problems can be preferably solved according to the proposed invention inasmuch as it enables a perfect instantaneous filling of the ceramic granulate in the cavity of a mould achieved through the use of a convex top punch made from a stiff material, the surface of which is completely chromed and polished. The top punch is opposite a concave bottom punch, in the form of an elastic membrane, which elastic membrane is cyclically activated by an incompressible fluid. The elastic membrane is equipped centrally with a stiff insert and semistatic autonomous pneumatic valve, connected to an external generator of a high vacuum, thereby ensuring speed and perfection in the above operations.

[0019] The procedure for actuating it can be implemented by the device consisting of a top half mould that includes said convex punch that is fixed to the stiff structure of a press with a vertical axis by means of a top punch holder that is particularly elaborated, assisted by a plane-protecting plate and a fixed crosspiece, that carries hydraulic actuators that cyclically actuate a container with attached shutter ring, arranged around said top punch and containing the ceramic granulate for the mould on one side. A bottom half mould that is axially opposite the top one comprises said concave elastic membrane with the incorporated insert and semistatic valve, hermetically housed in its own metal container provided with an element arranged under the membrane and perimeter seal ring. Said bottom mould, which is fixed to a plate that is horizontally movable on an air cushion, is translated cyclically outside the press to enable the pressed ceramic piece to be picked up and evacuated. A rotating and lubricating brushing device is fixed to said movable plate, the brushing device is translated at the same time as the bottom mould and is positioned underneath the top static punch, working against its surface and cyclically ensuring its gloss. The bottom mould is brought cyclically in contact with the top mould by means of suitable hydraulic actuators that are fixed to the structure of the press on one side and to the bottom mould on the other by means of a movable crosspiece.

[0020] In a first aspect of the invention, a device is provided for compacting flowable material, particularly for forming ceramic objects, comprising a first half mould interacting with a second half mould to define pressing cavity means, suction means associated with said first half mould (52) and suitable for assisting the entry of said flowable material into said cavity means, characterised in that, said suction means is so configured as to be operationally movable in relation to said first half mould.

[0021] The movable suction means enables better pressing of the flowable material to be obtained inasmuch as the position of the suction means in relation to the first half mould can be set at will so as to ensure good compaction even in the zones affected by the suction means.

[0022] The suction means both enables air to be eliminated from the flowable material to be compacted, by acting as an air-removal means, and the depressurisation of the cavity means during filling with flowable material, e.g. ceramic powders, and/or during pressing.

[0023] In a preferred embodiment, membrane means is anchored to the first half mould, said membrane means operationally defining chamber means suitable for receiving a fluid that can exert pressure on said flowable material.

[0024] In a further preferred embodiment, the suction means is received in the membrane means.

[0025] In yet another preferred embodiment, the suction means is associated with stiff insert means that is movable in relation to the first half mould.

[0026] During the pressing phase the stiff insert means exercises a stabilising function on the shape of the ceramic object the obtaining of which is desired.

[0027] Advantageously, the membrane means winds at least partially around the stiff insert means.

[0028] Further advantageously, the stiff insert means comprises a disc element that preferably supports the suction means in its own central region.

[0029] In one advantageous embodiment, actuating means is provided that is suitable for translating the suction means in relation to the first half mould.

[0030] Preferably, the actuating means acts on sleeve means that is integral with said disc element.

[0031] Also preferably, seal means is associated with the sleeve means.

[0032] The seal means exerts a sealing action both on the fluid acting on the membrane means and on the air aspirated by the suction means.

[0033] Guide means can also be associated to the sleeve means, said guide means being arranged for keeping said sleeve means guided during movement in relation to the first half mould.

[0034] In a second aspect of the invention, a device is provided for compacting flowable material, particularly for forming ceramic objects, comprising a first half mould interacting with a second half mould so as to form cavity means suitable for receiving said flowable material, hopper means suitable for delivering said flowable material to said cavity means, characterised in that, distribution means is further provided, said distribution means being arranged for enabling uniform distribution of said flowable material in said hopper means.

[0035] The distribution means enables the flowable material to be uniformly distributed along the entire perimeter of the hopper means and therefore enables the cavity means defined between the first half mould and

the second half mould to be uniformly filled. This constitutes a good basis for obtaining better compaction of the flowable material and therefore higher quality in the finished object.

[0036] In one preferred embodiment, the distribution means comprises a plurality of grooves, preferably arranged radially on a distribution element that substantially corresponds to the plan shape of the object to be pressed.

[0037] In a further preferred embodiment, the grooves are bordered at the bottom by a bottom surface that diverges towards the zone of the distribution means that is nearest said first and/or second half mould.

[0038] In a further preferred embodiment, the grooves are separated by protruding radial elements that preferably have a height that is the same as the height of said distribution element.

[0039] In yet another further preferred embodiment, the distribution means further comprises diffuser means suitable for spreading the flowable material over a preset angle extension.

[0040] Advantageously, the diffuser means comprises blade means actuated to rotate around a preset rotation axis.

[0041] Also advantageously, feeding conduit means is provided the outlet of which is near the diffuser means.

[0042] The flowable material coming from the feeding conduit means is conveyed by means of the diffuser means to the radial grooves of the distribution element, and said grooves deliver said material to the cavity between the half moulds into which it will be compacted. As the diffuser means comprises rotating blade means and as the grooves are arranged on the entire area of the distribution element, the flowable material is distributed over 360 degrees and can thus fill the hopper means in a significantly uniform manner.

[0043] In one advantageous embodiment, the distribution means comprises spoon means suitable for distributing the flowable material along the entire area of the hopper means.

[0044] In a further advantageous embodiment, the spoon means is moved by chain means.

[0045] Preferably, the chain means is so configured as to move the spoon means along a path that develops peripherally inside the hopper means.

[0046] In yet another further advantageous embodiment, input means is provided suitable for supplying the flowable material and arranged to the side of the spoon means.

[0047] The spoon means receives the flowable material from the input means and distributes said material over the entire perimeter area of the hopper means, optimising filling of the cavity means comprised between the first half mould and the second half mould.

[0048] In a preferred embodiment, the hopper means is bordered by shutter ring means, that is preferably movable through translation between an opening position, wherein the flowable material can reach the cavity means, and a closing position, wherein the flowable material cannot leave the hopper means.

[0049] In a further preferred embodiment, the shutter ring means cooperates with punch means of the second half mould.

[0050] The distribution means is preferably contained inside container means that is bordered on the sides by transparent wall means.

[0051] Thus, the degree of filling of the hopper means by the flowable material can be checked.

[0052] Also preferably, level sensor means is associated with the container means, said level sensor means being arranged for detecting the quantity of flowable material inside the container means.

[0053] The level sensor means enables the correct quantity of flowable material to be restored in the container means, when this is necessary.

[0054] According to a third aspect of the invention, a device is provided for compacting flowable material, particularly for forming ceramic objects, comprising a first half mould interacting with a second half mould to define pressing cavity means, said second half mould being suitable for shaping a surface of said objects that is to remain visible during use, characterised in that, cleaning means is further provided, said cleaning means being so configured as to interact cyclically with said second half mould.

[0055] The cleaning means enables the second half mould to be kept clean, thereby eliminating the need for cladding said second half mould with self-cleaning material, which cladding could impair the gloss of the finished object. Thus, ceramic objects can be obtained that are provided with a high level of aesthetic properties.

[0056] In a preferred embodiment, the cleaning means is movable between a first position wherein it does not interact with the second half mould, and a second position wherein it cooperates with the second half mould.

[0057] In a further preferred embodiment, the cleaning means is fixed to the first half mould.

[0058] Advantageously, in the first position of said cleaning means, the first half mould faces the second half mould so as to make said compacting possible.

[0059] Also advantageously, in the second position the first half mould is distanced from the second half mould so as to enable said objects to be removed from said cavity.

[0060] Extractor means can further be provided that is suitable for removing said objects from the first half mould in the second position of the cleaning means.

[0061] Thus, after the flowable material has been compacted to form the ceramic object, the cleaning means moves from the first position to the second position to remove from the second half mould any residue of flowable material. Simultaneously, the first half mould goes to a position wherein it can interact with the extractor means, which removes the finished object. This enables operating time to be optimised, significantly in-

creasing production without adversely affecting the quality of the produced objects.

[0062] In a preferred embodiment, the cleaning means comprises brush means.

[0063] In a further preferred embodiment, lubricating means is associated with the cleaning means, said lubricating means being suitable for applying a lubricating substance to the second half mould.

[0064] Thus the second half mould is kept suitably clean and lubricated, which enables an accurate surface finish of the pressed object and an easy removal of said pressed object from the second half mould to be obtained.

[0065] In a fourth aspect of the invention, a device is provided for compacting flowable material so as to form tableware, comprising a first half mould interacting with a second half mould to define cavity means wherein said tableware is formed, said second half mould being arranged for forming a surface of said tableware that is to remain visible, suction means suitable for assisting the entry of said flowable material into said cavity means, characterised in that, said suction means is operationally associated with said first half mould.

[0066] As the suction means is not associated with the half mould that will generate the surface of the tableware that is to remain visible, said surface is free of the defects caused by the suction means and is therefore provided with good quality and gloss of a high level.

[0067] Furthermore, positioning the suction means far from the visible surface of the tableware does not in any way impair the functions of the suction means.

[0068] In order that the invention may be clearly and completely disclosed, reference will now be made, by way of examples that do not limit the scope of the invention, to the accompanying drawings, wherein:

Figure 1 is a front view of a press equipped with a top half mould and a bottom half mould, in the rest position;

Figure 2 is a partially sectioned side view of said press, showing a brushing system of the top punch and a suction cup conveyor, all in the rest position;

Figure 3 is an enlarged front section of two half moulds, brought up to each another axially, in a loading phase of the ceramic granulate into a shaped cavity of the mould, showing a first embodiment of the distribution means;

Figure 4 is a section like the one in Figure 3, enlarged further and showing elastic membrane means and suction means associated with the bottom half mould, during the loading phase;

Figure 5 is a section like the one in Figure 4, showing the elastic membrane means and the suction means in a pressing phase;

Figure 6 is a section like the one in Figure 3, showing a second embodiment of the distribution means;

Figure 7 is a view from above, partially sectioned, of the distribution means of Figure 6;

Figure 8 is a section of the distribution means, taken along the plane VIII-VIII of Figure 7.

[0069] Figure 1 shows the front view of a vertical structure of press 1 equipped with a horizontal conveyor 2, provided with a suction cup 2' to pick up the pressed object 50 and transfer it to a relative evacuator 3, whereas the numeral 4 indicates the position of the electrohydraulic control unit of the assembly. Through the feeding conduit 5 the flowable material, e.g. ceramic granulate, is introduced into the top half mould 51, consisting of: a stiff convex punch 6 that is fixed to the structure 1 by means of a top punch holder 26, shown in Figure 3, which punch holder 26 is connected in turn to the plane-protecting plate 9 and to the top fixed crosspiece 11. The latter is equipped with double acting actuators 10 whose rods actuate a container 8 to which a shutter ring 7 is fixed. In the same structure 1 the bottom half mould 52 is positioned, which consists of: a perimeter seal ring 12 that hermetically retains the concave elastic membrane 32, shown in Figure 3, on the containing body 13 underneath, having the form of a glass-like container, wherein an element arranged under the membrane or support 34 is provided, which is also shown in Figure 3. The bottom half mould 52 is fixed to a plate 14 that is equipped with guides 19 and translation means 20. The plate 14 is horizontally actuated to travel backwards and forwards on air cushion, on the underlying sliding plane 15. The latter is connected in turn to the bottom crosspiece 16 that is cyclically actuated by relative hydraulic actuators 17 and 18.

[0070] Figure 2 shows, partially in section form, the side view of the press of Figure 1, showing the fact that a rotating brushing system 24 with attached tool 25 is fixed to the plate 14. The translating means 20, assisted by motor means 21, positions the plate 14 and everything that is attached and connected to it. In particular, the translating means 20 moves the bottom half mould 52 in the direction of the arrow F1 from a first position A to a second position B. In the first position A the bottom half mould 52 faces the top half mould 51 and can interact with it to compact the ceramic granulate, whereas the brushing system 24 does not interfere with the top half mould 51. In the second position B, the bottom half mould 52 moves to near the horizontal conveyor 2, whilst the brushing system 24 is arranged immediately below the top half mould 51.

[0071] The sliding surfaces involved in the movement in the direction of the arrow F1 described above are protected by respective elastic sheets 22 and 23 equipped with counterweights 53 and 54.

[0072] Figure 2 also concisely shows a possible way of feeding the granulate into the press by means of the device 55.

[0073] Figure 3 shows the front section of the top half mould 51 and bottom half mould 52 in a filling and preforming phase of the ceramic granulate in the shaped cavity 36' defined between said half moulds when they

face each other. This phase precedes the final closing phase with subsequent compacting of said material. The preferred main feature of the stiff and convex top punch 6, consists in the fact that the shaped surface 6' is highly resistant to compression stress and wear and therefore, in addition to being hardened, is chromed and finely polished.

[0074] The top punch holder 26 has toothing or radial protruding elements 27 that are vertically separated by grooves 28 with tilted planes that decrease on the perimeter. In other words, the top punch holder 26 comprises a distribution element that has a shape that substantially corresponds to the plan shape of the object 50 to press, on said distribution element the radially arranged grooves 28 being made. The grooves 28 are inferiorly bordered by a bottom surface 28' that diverges towards the zone of the distribution element that is nearest the first half mould 52 and/or the second half mould 51. In particular, in the case of Figure 3, the bottom surface 28' is provided with a frustoconical shape. The grooves 28 are separated by the protruding elements 27, that are preferably equidistant from one another, that develop from the bottom surface 28' for a height that substantially corresponds to the height of the distribution element mentioned above. In the top central part of said element an opening is made wherein a diffuser with rotating blades 29 is housed, said diffuser being actuated by a motor shaft 29' (connected to a suitable external rotating device) through passages 9' and 11' as well as the feeding conduit 5. The punch 6 and the punch holder 26 are fixed to the press structure 1 through the plane-protecting plate 9 and the top fixed crosspiece 11.

[0075] In particular, the punch 6 is centered on the punch holder 26 by means of a frustoconical element 31 and is kept in contact with said punch holder 26 by means of magnetic elements 30.

[0076] The metal container 8, which is suspended to the rods of the actuators 10 and arranged around the punch 6 and the top punch holder 26, together with the connected shutter ring 7, acts as a tank for the ceramic granulate, insulated from the surrounding environment by a semirigid transparent panel 8'. Hopper means 41 is therefore defined, that is bordered internally by the punch 6 and by the punch holder 26, and externally by the shutter ring 7 and by the container 8. The hopper means 41 is shown in Figures 4 and 5.

[0077] The container 8 comprises a plurality of small columns 42 interposed between a top annular body 43 and a bottom annular body 44. The semirigid panel 8' is arranged inside the perimeter defined by the small columns 42, and owing to its transparency the quantity of ceramic granulate in the hopper means 41 can be monitored.

[0078] A perimeter semi-conduit 33, arranged between the container 8 and the shutter ring 7, communicates with an external compressor. Said perimeter conduit 33, through the slit made at the base of the container 8, generates a blade of compressed air for the fluidisation of said granulate.

[0079] A capacitive sensor cyclically checks the preset level of the ceramic granulate and the relative restoration.

[0080] The opposed bottom punch consists of a metal containing body 13, having a concave shape corresponding to the enlarged shape of the ceramic object to be produced, inside which a perimeter support 34 is housed, which can be shaped and decomposed at will according to the perimeter and profile of the piece to be pressed. At the centre of the container body 13 a support plane 34' is provided. The perimeter support 34 and the support plane 34' can be adjusted independently and can be positioned both horizontally and vertically to thereby enable limited dimensional adjustments of the products to be produced, whereas by means of suitable arrangement of small cross bores and consequent rear joining channels they enable timely uniform distribution of the incompressible fluid on the rear of the elastic membrane 32 during the final isostatic pressing phase. Said membrane 32, forming the bottom face of the ceramic piece, is hermetically anchored to the containing body 13 by means of the perimeter sealing ring 12 assisted by a second metal ring 33', provided with small concentric grooves with sharp edges that ensure the adhesion of the incompressible fluid through perimeter crushing of the membrane 32 into said grooves.

[0081] The same membrane 32 wraps hermetically around a stiff insert 35, comprising a disc 45 covered by the membrane 32 on both the bottom face and the top face, as shown in Figure 4. The stiff insert 35 further comprises a vertical sleeve 35' connected to the disc 45; the sleeve 35' is not wrapped by the membrane 32 and is provided with peripheral circular seats for housing suitable seal and guide gaskets 35'' that can slide axially within the bush 37 that is fixed to the containing body 13 so as to form a seal by means of the ringnut 38.

[0082] In the insert 35 there is a housing wherein suction means is lodged comprising a semistatic valve 36 (see Figure 2 of the Italian application for utility model MI 98U000041 of 27.01.98). The semistatic valve 36 is cyclically connected by means of conduits 39 and 39' to an external high-vacuum generator.

[0083] A further conduit 40 enables the incompressible fluid to flow to and from the inside of the container body 13, said incompressible fluid acting on the rear of the membrane 32 in the different phases of the press cycle. A mini-actuator that is not shown can act axially on the sleeve 35' of the insert 35 and therefore on the central section of the membrane 32, varying to a limited extent its position and conditioning the thickness of the bottom of the ceramic object to be produced. The stroke of the sleeve 35' is limited by a stroke-limiting element, e.g. a Seeger ring that is not shown, said Seeger ring being fixed to the portion of the sleeve 35' that is furthest from the disc element 45.

[0084] The seal and guide gaskets 35'' enable the sleeve 35' to remain guided in relation to the bush 37

and exert a seal action, both with regard to the incompressible fluid, which is prevented from descending by more than a given limit along the external surface of the sleeve 35', and with regard to the air aspirated through the semistatic valve 36.

[0085] The operation of the system proposed as described and illustrated is already clear and is certainly advantageous inasmuch as the ceramic granulate, gravitationally actuated by the diffuser with rotating blades 29, reaches the convex punch 29 by arranging itself as a ring, and is retained by the shutter ring 7 until the bottom half mould 52 together with the membrane 32, initially in contact with the perimeter support 34 and with the support plane 34', is positioned at a preset distance from the top punch 6.

[0086] During the descent of the ceramic granulate from the feeding conduit 5, the diffuser with rotating blades 29 and the punch holder 26, together with the relative grooves 28 and protruding elements 27, act as distribution means encouraging homogenous distribution of the ceramic granulate along the perimeter of the shutter ring 7.

[0087] When the bottom half mould 52 has been properly positioned below the top half mould 51, the double acting actuators 10 push down the container 8 and the shutter ring 7, removing said container 8 from the plane-protecting plate 9 by a distance X. A gap is thus identified that extends in a ring form between the shutter ring 7 and the punch 6. Through said gap the ceramic granulate contained in the hopper means 41 can reach the cavity 36' as shown by the arrows F3.

[0088] At the same time as the shutter ring 7 descends, said shutter ring 7 being hermetically pushed by the actuators 10 on the corresponding surface portion of the underlying membrane 32, an instantaneous vacuum is created in the cavity 36' through the semistatic valve 36, activating the flow of the ceramic granulate towards the mould centre and instantaneously filling all free space of said cavity 36'. Filling the cavity 36' is amongst other things favoured by the natural conformation of the open shapes of the ceramic objects that are normally used. Thus, a pre-forming of the ceramic granulate occurs. *

[0089] After granulate has been preformed, the mould is closed by hydraulically pushing the two half moulds 51 and 52 against each other. The granulate is simultaneously pre-compressed with consequent removal of air from the granulate, said removal being amongst other things facilitated by the initial annular opening between the top punch 6 and the shutter ring 7, and furthermore by the semistatic valve 36. Preferably, the bottom half mould 52 is pushed against the top half mould 51 by means of the hydraulic actuators 17 and 18, that cause said mould to translate in the direction of the arrow F2.

[0090] The gap identified between the shutter ring 7 and the punch 6 is closed by moving the shutter ring 7 towards the plane-protecting plate 9 by means of the double acting hydraulic actuators 10.

[0091] After the pre-compression operation has been promptly carried out, the maximum, pack-programmed, closing thrust is exerted between the two half moulds. Furthermore, the elastic membrane 32 is activated that provides final isostatic compaction of the granulate in the cavity 36'.

[0092] AS Figure 5 shows, the stiff insert 35 is preventively properly positioned in relation to the bottom half mould 52, by being actuated by the mini-actuator that is not shown and sliding in relation to the bush 37.

[0093] The incompressible fluid is sent, by means of the further conduit 40, underneath the elastic membrane 32 so as to fill a chamber 59, shown in Figure 5, identified on one side thereof by the support 34 and by the support plane 34' and on the other side thereof by the elastic membrane 32. The latter is therefore pushed towards the ceramic granulate contained in the cavity 36' and determines its final isostatic pressing.

[0094] When this operation too has terminated, the membrane 32 is suitably subject again to vacuum and is repositioned on the perimeter support 34 and on the support plane 34', enabling free expansion of the pressed object 50, promptly followed by maximum opening between the two half moulds 51 and 52. The bottom half mould 52, which until that moment was in the first position A, is then translated towards the second position B, approaching the horizontal conveyor 2. The latter picks the object 50 from the bottom half mould 52 and moves in the direction of the arrow F to take the object 50 towards the evacuator 3.

[0095] Simultaneously, the brushing and lubricating system 24 is brought below the top half mould 51, thereby cleaning and if necessary lubricating it. This cyclical cleaning operation of said punch 6 is carried out at the same time as picking up and evacuation of the pressed object 50 at the end of the programmed and promptly restored cycle.

[0096] In an alternative embodiment, shown in Figures 6 to 8, the distribution means comprises a plurality of spoons 46, each one of which is provided with a pushing element 47 fixed to a vertical rod 48. The spoons 46 are connected at the top to a chain system 49, driven by a drive pulley 56 along a path defined by a plurality of driven pulleys 57 and having a form that substantially corresponds to the plan shape of the object 50 to be compacted.

[0097] The ceramic granulate is introduced into the hopper means 41 by means of an inlet conduit 58 opening onto a side wall of the container 8, as indicated by the arrow F4. The spoons 46, along their path, push the ceramic granulate along the entire internal perimeter of the shutter ring 7, thereby ensuring uniform filling of the cavity 36'. The loading, pressing and unloading operations are then carried out as described previously.

[0098] As Figure 6 shows, the semistatic valve 36 can be associated with the top half mould 51, particularly with the punch 6, which is to form the visible face of the ceramic object. This solution is acceptable when the ce-

ramic objects to be obtained have not a top quality because the semistatic valve 36 risks leaving marks on the visible face of said objects.

[0099] In an embodiment that is not shown, the spoons 46 can be combined with the distribution element provided with grooves 28 and possibly also with the rotating blade diffuser 29 in order to make the distribution of the ceramic granulate in the hopper means 41 more uniform.

[0100] The foregoing remarks fully confirm that the objectives of the invention have been reached and that the constraints and drawbacks of known solutions have been advantageously overcome. Modifications and improvements of a practical and applied nature may be made to this invention without going beyond the scope of the inventive idea for which the following claims have been made.

Claims

1. Device for compacting flowable material, particularly for forming ceramic objects (50), comprising a first half mould (52) interacting with a second half mould (51) to define pressing cavity means (36'), suction means (36) associated with said first half mould (52) and suitable for assisting the entry of said flowable material into said cavity means (36'), **characterised in that**, said suction means (36) is so configured as to be operationally movable in relation to said first half mould (52).

2. Device according to claim 1, and further comprising distribution means (26, 27, 28, 29; 46, 47, 48) arranged for enabling uniform distribution of said flowable material in hopper means (41) suitable for delivering said flowable material to said cavity means (36').

3. Device for compacting flowable material, particularly for forming ceramic objects (50), comprising a first half mould (52) interacting with a second half mould (51) so as to form cavity means (36') suitable for receiving said flowable material, hopper means (41) suitable for delivering said flowable material to said cavity means (36'), **characterised in that**, distribution means (26, 27, 28, 29; 46, 47, 48) is further provided, said distribution means (26, 27, 28, 29; 46, 47, 48) being arranged for enabling uniform distribution of said flowable material in said hopper means (41).

4. Device according to claim 3, and further comprising suction means (36) associated with said first half mould (52) and suitable for encouraging the entry of said flowable material into said cavity means (36').

5. Device according to claim 4, wherein said suction means (36) is so configured as to be operationally movable in relation to said first half mould (52).

6. Device according to claim 1, or 2, or 4, or 5, wherein said suction means (36) is received by membrane means (32) that operationally defines chamber means (59) suitable for receiving a fluid that can exert pressure on said flowable material.

7. Device according to claim 6, wherein said membrane means (32) is supported by support means (34, 34') that can be divided into several sectors facing one another.

8. Device according to claim 7, wherein said sectors can be adjusted and positioned both horizontally and vertically.

9. Device according to claim 1, or 2, or according to one of claims 4 to 8, wherein said suction means (36) is associated with stiff insert means (35) that is movable in relation to said first half mould (52).

10. Device according to claim 9, as appended to one of claims 6 to 8, wherein said membrane means (32) winds at least partially around said stiff insert means (35).

11. Device according to claim 9, as appended to one of claims 6 to 8, or according to claim 10, wherein said membrane means (32) is anchored in a hermetic manner to said stiff insert means (35).

12. Device according to one of claims 9 to 11, wherein said stiff insert means (35) comprises a disc element (45) from which sleeve means develops (35').

13. Device according to claim 12, wherein said sleeve means (35') is provided with seal and guide means (35'').

14. Device according to claim 1, or 2, or according to one of claims 4 to 13, wherein said suction means comprises a semistatic valve (36).

15. Device according to one of claims 2 to 5, or according to one of claims 6 to 14 as appended to one of claims 2 to 5, wherein said distribution means (26, 27, 28, 29; 46, 47, 48) comprises a plurality of grooves (28).

16. Device according to claim 15, wherein said grooves (28) are bordered by a bottom surface (28') diverging towards a zone of said distribution means (26, 27, 28, 29; 46, 47, 48) nearest said first half mould (52) and/or said second half mould (51).

17. Device according to claim 15, or 16, wherein said grooves (28) are arranged radially on a distribution element the shape of which substantially corresponds to the plan shape of said objects (50), said grooves (28) being separated from one another by radially protruding elements (27).

18. Device according to one of claims 2 to 5, or according to one of claims 6 to 14 as appended to one of claims 2 to 5, or again according to one of claims 15 to 17, wherein said distribution means (26, 27, 28, 29; 46, 47, 48) further comprises diffuser means (29) suitable for diffusing said flowable material over a preset angle extension.

19. Device according to claim 18, wherein said diffuser means comprises blade means (29) that is actuated to rotate around a preset rotation axis.

20. Device according to one of claims 2 to 5, or according to one of claims 6 to 14 as appended to one of claims 2 to 5, or again according to one of claims 15 to 19, wherein said distribution means (26, 27, 28, 29; 46, 47, 48) comprises spoon means (46) suitable for distributing said flowable material along the entire area of said hopper means (41).

21. Device according to claim 20, wherein said spoon means (46) is moved by means of chain means (49).

22. Device according to claim 21, wherein said chain means (49) is so configured as to move said spoon means (46) along a path the form of which substantially corresponds to the plan shape of said objects (50).

23. Device according to one of claims 2 to 5, or according to one of claims 6 to 14 as appended to one of claims 2 to 5, or again according to one of claims 15 to 22, wherein said hopper means (41) is bordered by shutter ring means (7) which can be translated between an opening position, wherein said flowable material can reach said cavity means (36'), and a closing position, wherein said flowable material cannot leave said hopper means (41).

24. Device according to claim 23, wherein said shutter ring means (7) cooperates with a punch means (6) of said second half mould (51).

25. Device according to claim 23, or 24, wherein near said shutter ring means (7) slit means is made, said slit means being connected to a compressor to generate a blade of compressed air suitable for facilitating the flow of said flowable material.

26. Device according to one of the preceding claims, wherein said second half mould (51) is suitable for shaping a surface of said objects (50) that is to remain visible during use.

27. Device according to one of the preceding claims, and further comprising cleaning means (24, 25) configured so as to interact cyclically with said second half mould (51).

28. Device according to claim 27, wherein said cleaning means (24, 25) is fixed to said first half mould (52).

29. Device according to claim 27, or 28, wherein said cleaning means (24, 25) is movable between a first position (A) wherein it does not interact with said second half mould (51), and a second position (B) wherein it cooperates with said second half mould (51).

30. Device according to claim 29, wherein in said first position (A) said first half mould (52) faces said second half mould (51) so as to make said compacting possible, and in said second position (B) said first half mould (52) is distanced from said second half mould (51), so as to enable said objects (50) to be removed from said cavity means (36').

31. Device according to one of claims 28 to 30, wherein said cleaning means comprises rotating brush means (25).

32. Device according to one of claims 28 to 31, wherein said cleaning means (24, 25) is associated with lubricating means suitable for applying a lubricating substance on said second half mould (51).

33. Device for compacting flowable material, particularly for forming ceramic objects (50), comprising a first half mould (52) interacting with a second half mould (51) to define pressing cavity means (36'), said second half mould (51) being suitable for shaping a surface of said objects (50) that is to remain visible during use, **characterised in that**, cleaning means (24, 25) is further provided, said cleaning means (24, 25) being so configured as to interact cyclically with said second half mould (51).

34. Device according to claim 33, wherein said cleaning means (24, 25) is fixed to said first half mould (52).

35. Device according to claim 33, or 34, wherein said cleaning means (24, 25) is movable between a first position (A) wherein it does not interact with said second half mould (51), and a second position (B) wherein it works with said second half mould (51).

36. Device according to claim 35, wherein in said first position (A) (24, 25) said first half mould (52) faces

said second half mould (51), so as to make said compacting possible, and in said second position (B) said first half mould (52) is distanced from said second half mould (51), so as to enable said objects (50) to be removed from said cavity means (36').

37. Device according to one of claims 33 to 36, wherein said cleaning means comprises rotating brush means (25).

38. Device according to one of claims 33 to 37, wherein lubricating means is associated with said cleaning means (24, 25), said lubricating means being suitable for applying to said second half mould (51) a lubricating substance.

39. Device according to one of claims 33 to 38, and further comprising suction means (36) suitable for assisting the entry of said flowable material into said cavity means (36').

40. Device according to claim 39, wherein said suction means (36) is operationally associated with said first half mould (52).

41. Device according to claim 39, or 40, wherein said suction means (36) is received by membrane means (32) that operationally defines chamber means (59) suitable for receiving a fluid that can exert pressure on said flowable material.

42. Device according to claim 41, wherein said membrane means (32) is supported by support means (34, 34') that can be divided into several sectors that are next to one another.

43. Device according to claim 42, wherein said sectors can be adjusted and positioned both horizontally and vertically.

44. Device according to one of claims 39 to 43, wherein said suction means (36) is associated with stiff insert means (35).

45. Device according to claim 44, as appended to one of claims 41 to 43, wherein said membrane means (32) winds at least partially around said stiff insert means (35).

46. Device according to claim 44, as appended to one of claims 41 to 43, or according to claim 45, wherein said membrane means (32) is anchored in a hermetic manner to said stiff insert means (35).

47. Device according to one of claims 39 to 46, wherein said suction means comprises a semistatic valve (36).

48. Device for compacting flowable material so as to form tableware (50), comprising a first half mould (52) interacting with a second half mould (51) to define cavity means (36') wherein said tableware (50) is formed, said second half mould (51) being arranged for forming a surface of said tableware (50) that is to remain visible, suction means (36) suitable for assisting the entry of said flowable material into said cavity means (36'), **characterised in that**, said suction means (36) is operationally associated with said first half mould (52).

49. Device according to claim 48, wherein said suction means (36) is received by membrane means (32) that operationally defines chamber means (59) suitable for receiving a fluid that can exert pressure on said flowable material.

50. Device according to claim 49, wherein said membrane means (32) is supported by support means (34, 34') that can be divided into several sectors that are next to one another.

51. Device according to claim 50, wherein said sectors can be adjusted and positioned both horizontally and vertically.

52. Device according to one of claims 48 to 51, wherein said suction means (36) is associated with stiff insert means (35).

53. Device according to claim 52, as appended to one of claims 49 to 51, wherein said membrane means (32) winds at least partially around said stiff insert means (35).

54. Device according to claim 52, as appended to one of claims 49 to 51, or according to claim 53, wherein said membrane means (32) is anchored in a hermetic manner to said stiff insert means (35).

55. Device according to one of claims 48 to 54, wherein said suction means comprises a semistatic valve (36).

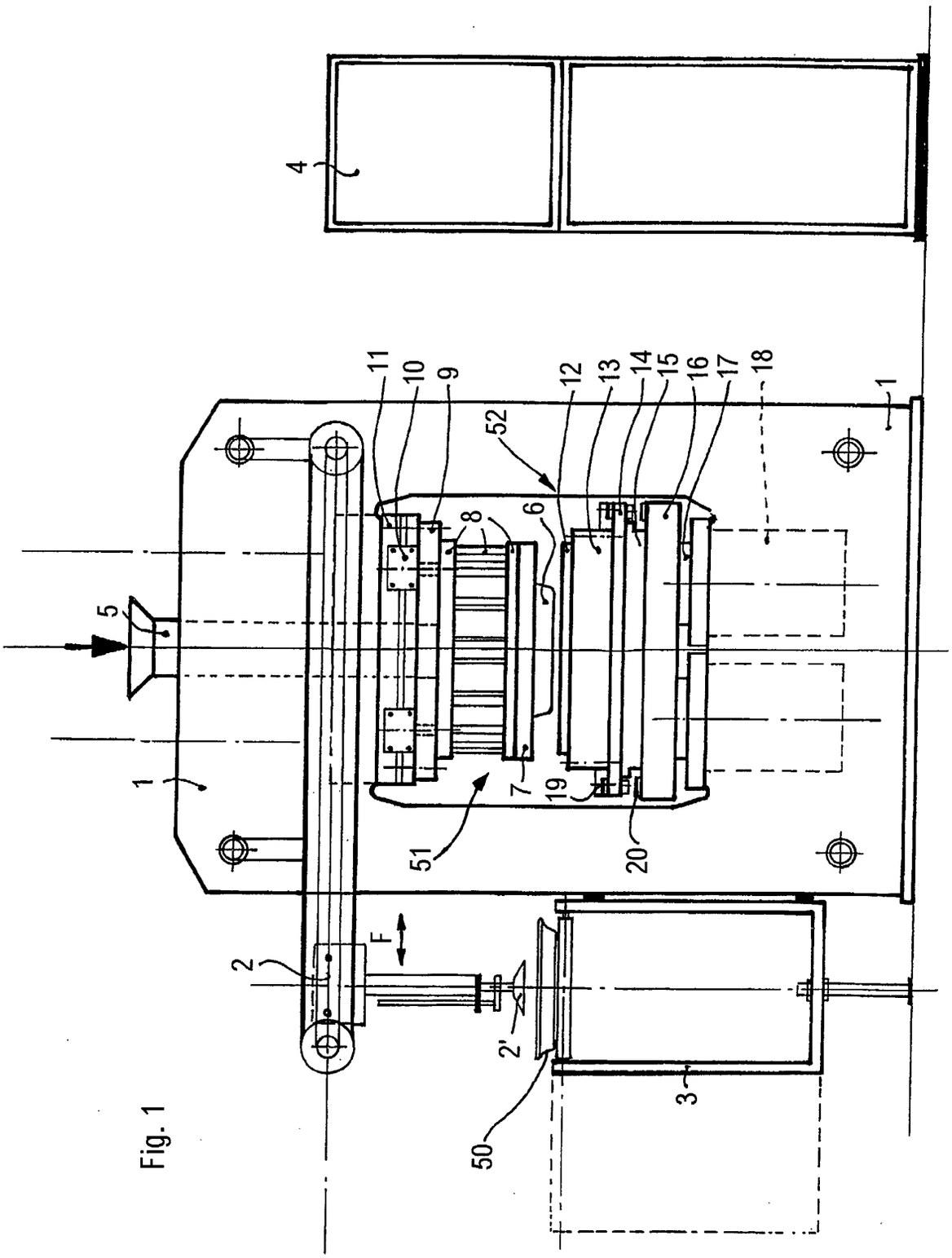

Fig. 1

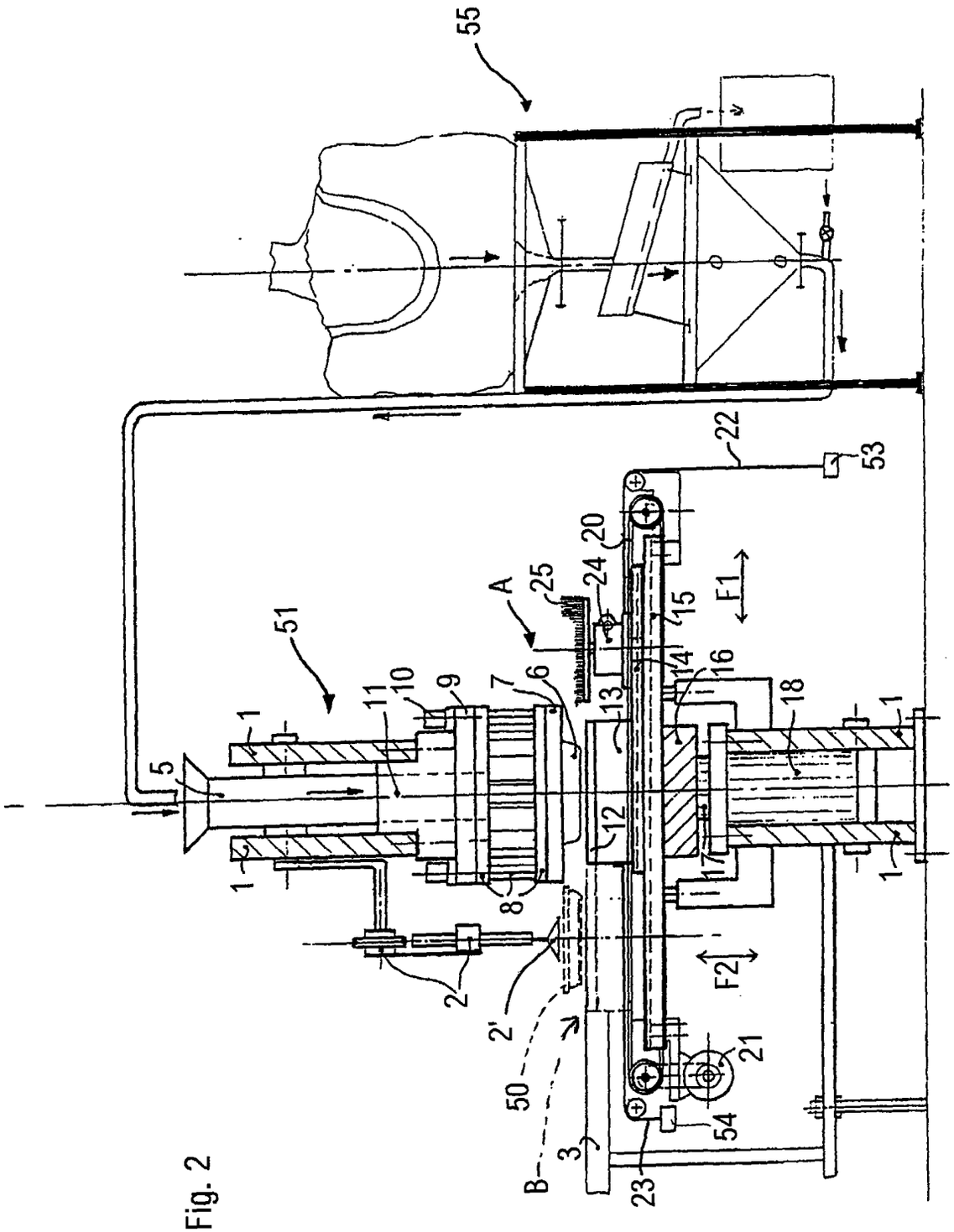
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Fig. 2

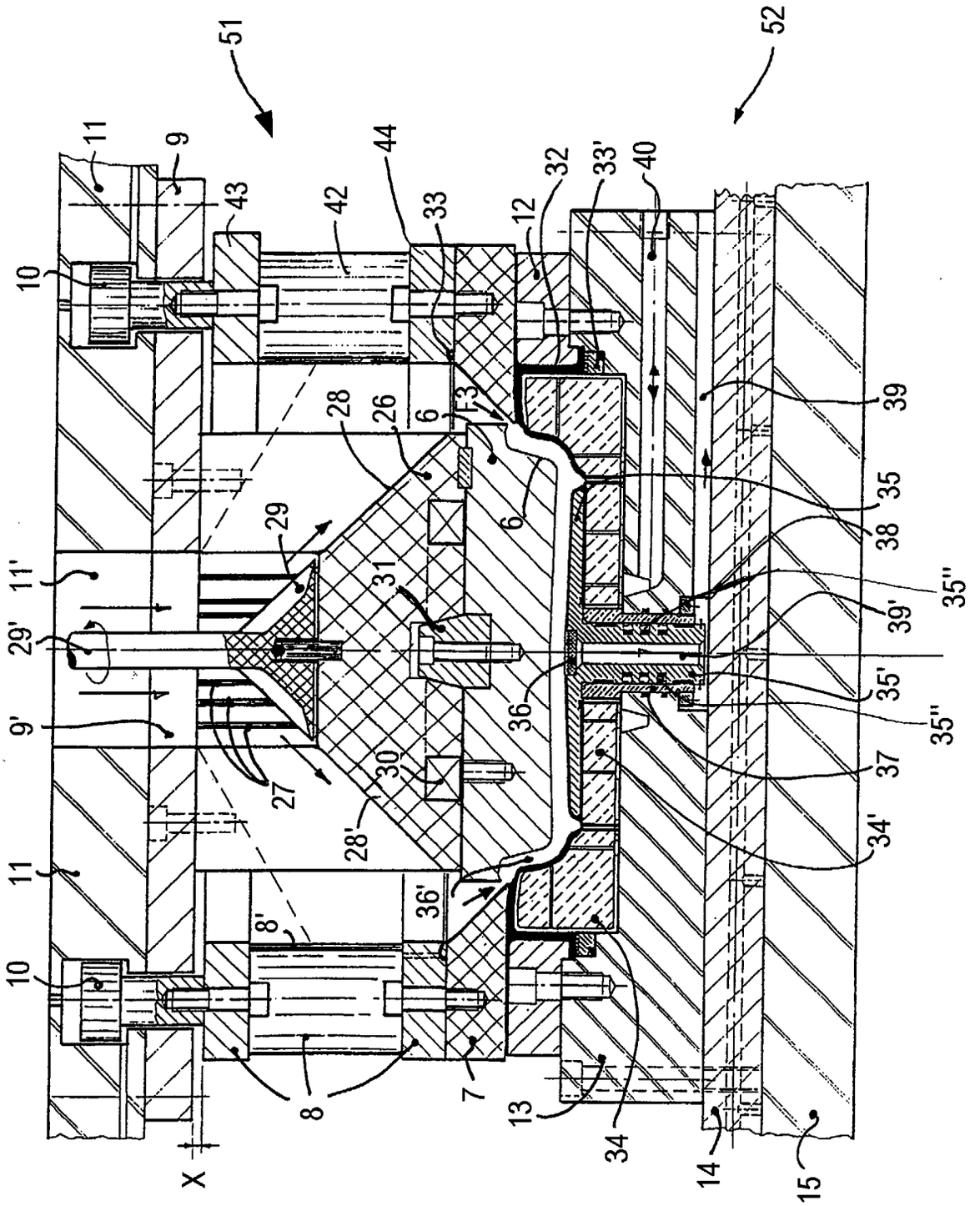
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Fig. 3

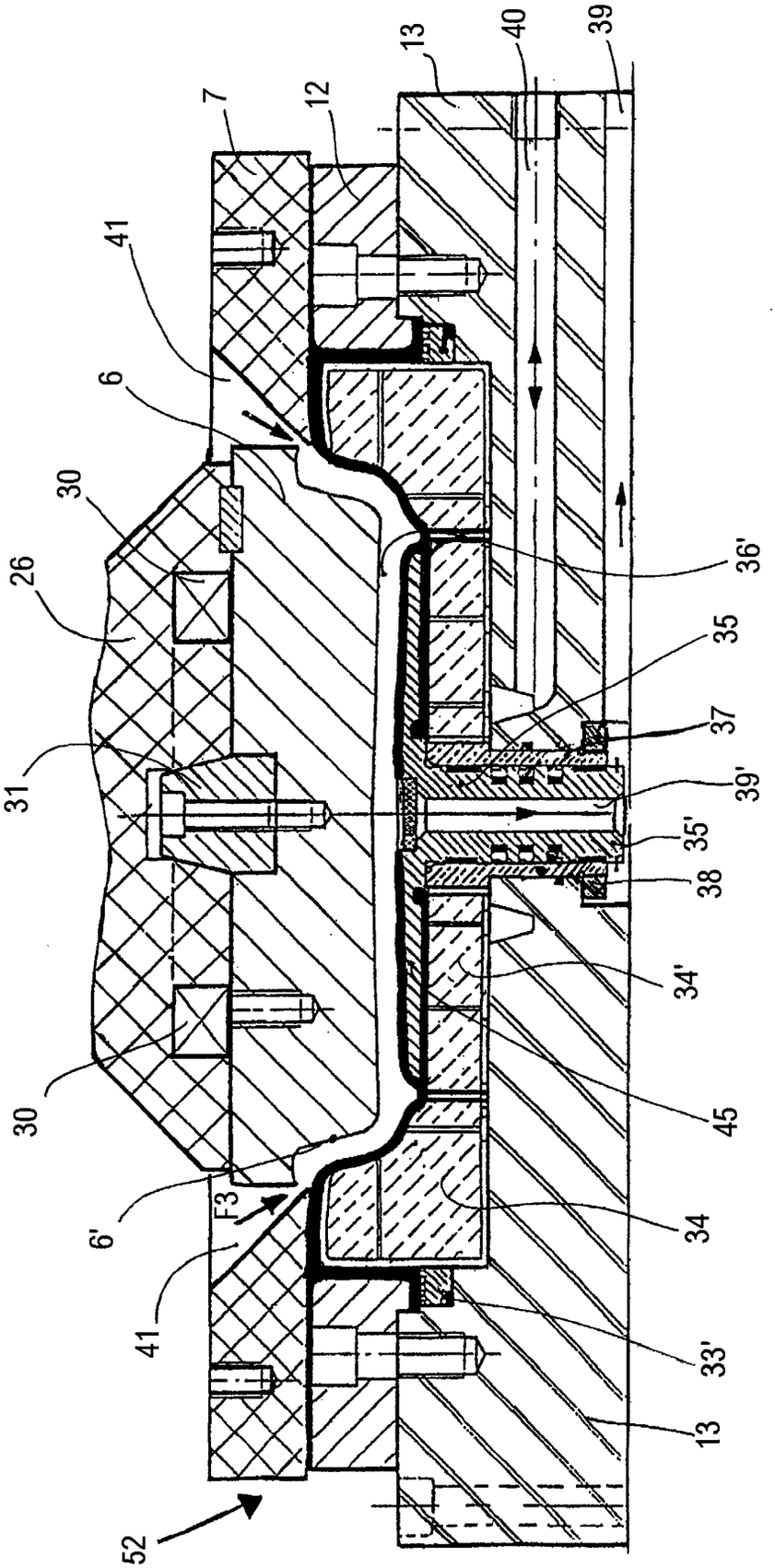

Fig. 4

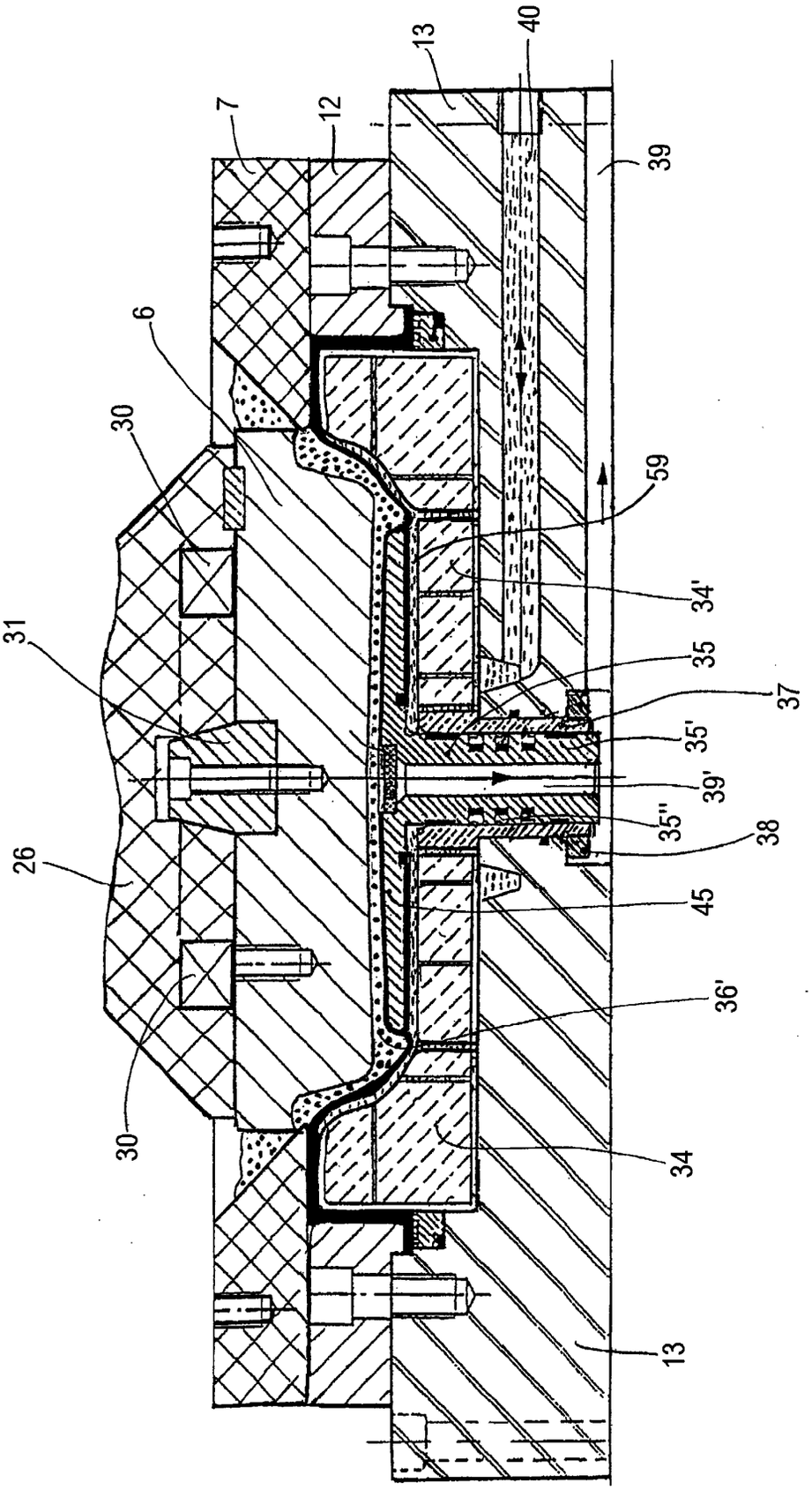

Fig. 5

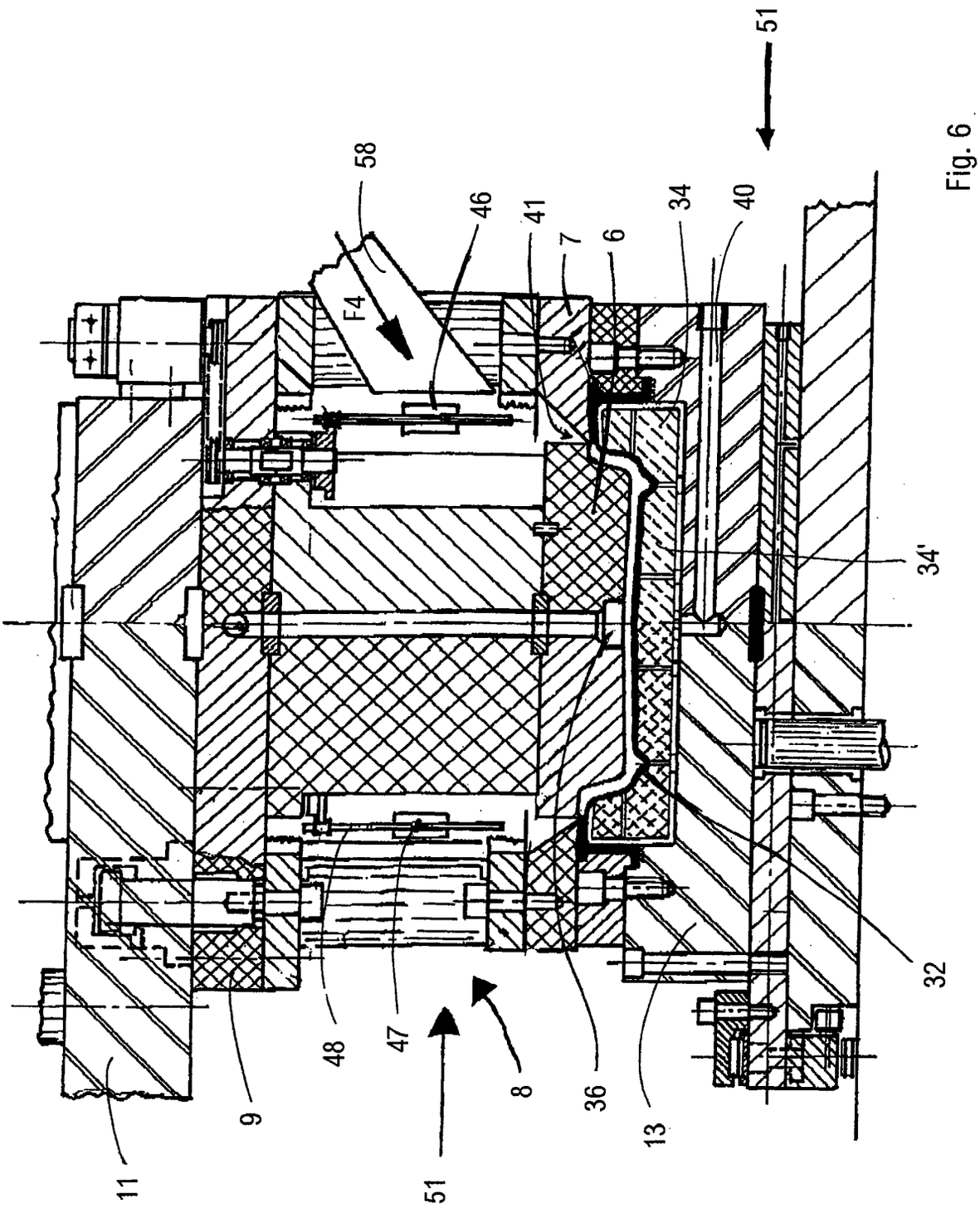

Fig. 6

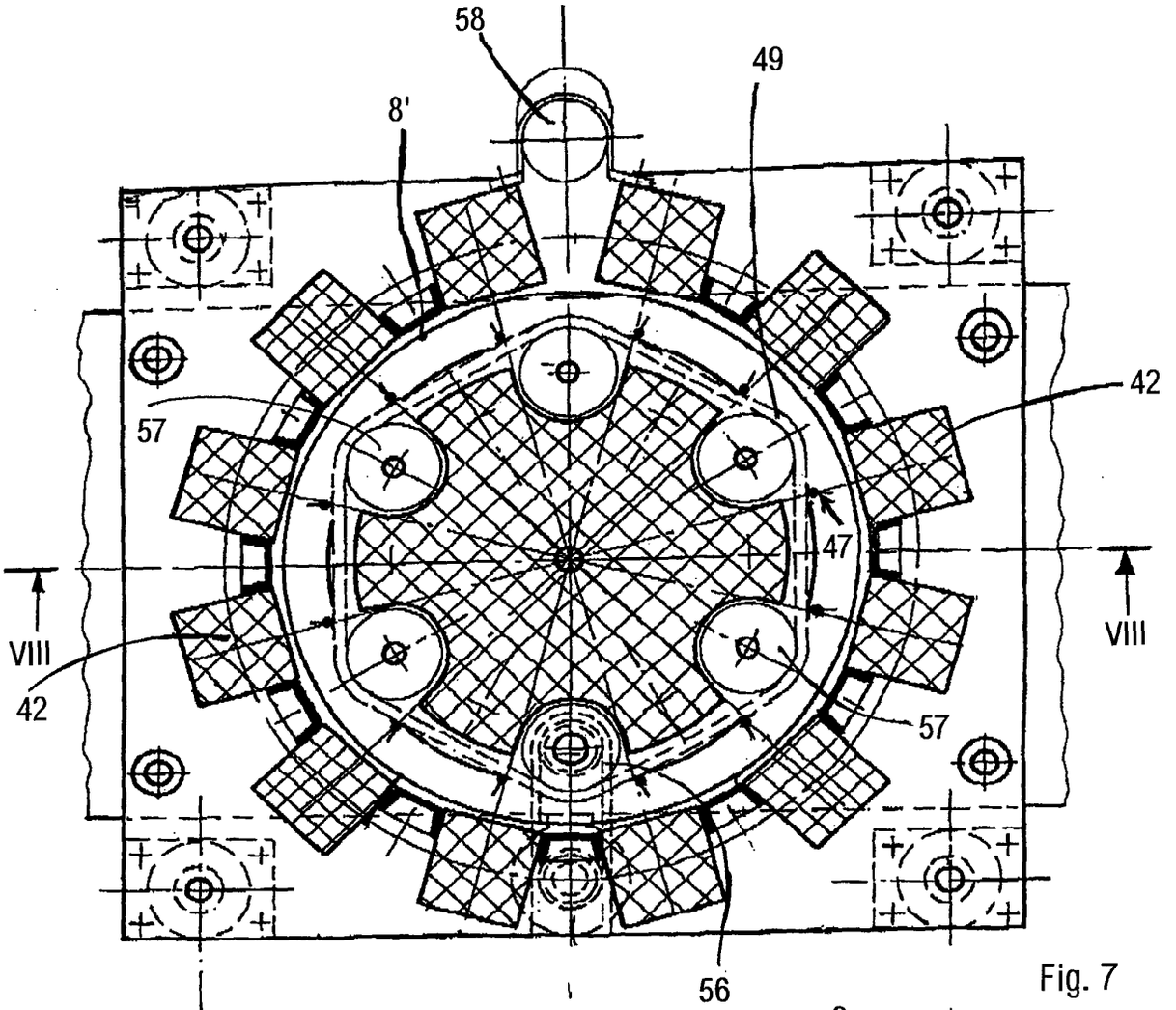

Fig. 7

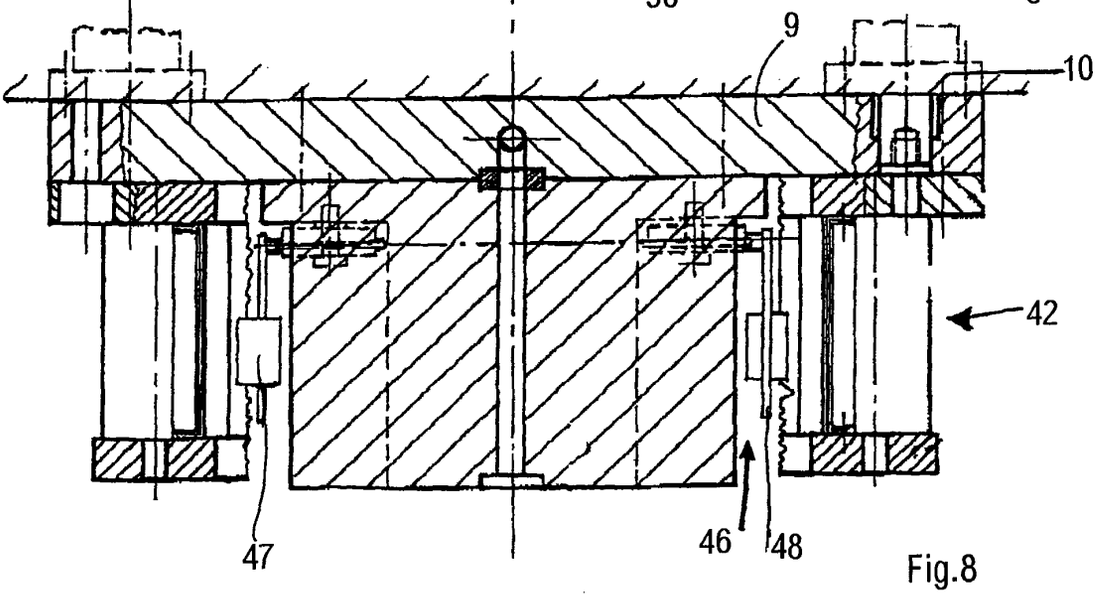

Fig.8