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(54) **VERTICAL CONTINUOUS FURNACE**

(57) A vertical continuous compact furnace has been engineered and implemented for metallurgical heat treatments in a continuous cycle in a wide pressure range, from high vacuum to supra atmospheric pressure. The furnace provides for heat treatments with high energy efficiency and high productivity of treated workpieces per time unit in a compact vertical cylindrical bell. The furnace has cylindrical chambers with horizontal and vertical symmetry in sequence to minimize or maximize the dissipation according to the stages of the cycle and to shield thermally the separation gate valves and handling system. It also presents a compact thermal chamber with adjacent thermal zones differentiated and shielded from the workpieces according to an innovative scheme. It also presents a new pumping system for the creation of a differential pressure inside the furnace.

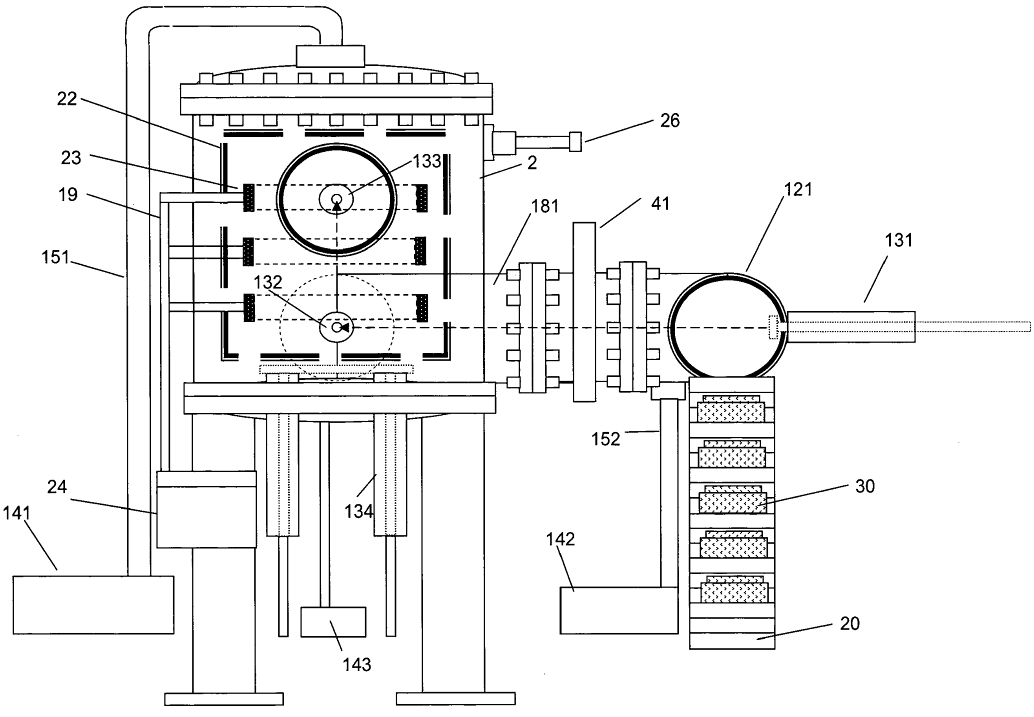

Figure 2

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Description

Technical Sector

[0001] The present invention relates to a furnace for carrying out the thermal treatment of various types of multiple materials, in a wide pressure range, from high vacuum to supra atmospheric pressure. More specifically, the present invention relates to a vertical continuous furnace, in which the parts to be treated are inserted and extracted sequentially from the furnace without interrupting furnace operation and without altering the working pressure of said thermal treatments.

State of the art

[0002] The rising demand for always more resistant materials for modern applications in industries such as aerospace, automotive, commercial and metalworking has led to performing metallurgical thermal treatments of considerable complexity and precision over and above the introduction of the materials and innovative technologies. Heat treatments such as brazing, sintering, magnetic annealing, hardening, diffusion bonding and infiltration are metallurgical processes that require, for the high quality of machining, vacuum treatments, or partial inert gas pressure, which avoid the presence of contaminants, oxidizing agents and substances that could affect the perfect execution of the procedure. For this reason, in recent years, thermal treatment under vacuum or partial inert gas pressure, has become crucial for the obtaining of high quality materials and the sector of thermal treatment under vacuum plant designers shows an average annual growth of 6.5%. The growing demand for parts to be treated has led to the construction of furnaces of ever increasing sizes and to the need to eliminate downtimes in the production cycle, such as the switching on and off of the system, or the insertion and extraction of the pieces to be treated. Vacuum furnaces and partial pressure, for the great majority of cases, are furnaces of the type denominated "batch", here batches of workpieces are loaded and unloaded to the furnace after the interruption of the thermal treatment process and the switching off of the same furnace. An example of this type of furnace is described by the patent US 4417722 A "Vacuum furnace for thermal treatment." For many years, in order to increase the productivity of the thermal treatments, "continuous" furnaces have been also proposed, in the sense that the thermal treatment is carried out on pieces loaded on a conveyor belt, as a continuous flow of production without having to interrupt the process by switching off the system. These furnaces require a chamber for loading and one for the unloading of the workpieces treated at atmospheric pressure. In the past, some companies have patented and produced systems of this type, such as the one described by patent US4118016 A of Hayes Ine, whereby the furnace has a longitudinal symmetry and the thermal treatment is carried out on chambers set in sequence, separated by doors for thermal cutting and vacuum between a chamber and the other, which considerably increases the dimensions of the system or the patent US 4430055 A "Semi-continuous vacuum heat-treating furnace, and its operation process", which uses adjacent thermal chambers for the heating and cooling treatment of the workpieces. Systems like the two mentioned present some issues such as, for example, the need for space, as they develop longitudinally to provide for a sequential process. In fact, the workpieces to be treated are transported on one or more longitudinal conveyor belts that run along the entire furnace. In addition, the size and geometry determine a strong dissipation of energy. The thermal and pressure insulation of the pre-chambers and of the sealing valves between a chamber and the other, the presence conveyor belts, and several chambers in cascade for complex treatments, are critical factors to the energy efficiency of the process and weigh heavily on the cost of the system and of the thermal treatment. Furnaces such as those mentioned, do not allow to obtain locally differentiated vacuum and temperature levels, without introducing bulky communicating chambers via gate valves.

[0003] T.A.V. S.P.A.-TECNOLOGIE ALTO VUOTO, has set itself the problem of building a compact continuous oven, energy-efficient, with minimal heat and vacuum loss. It also set itself the aim of achieving thermal and vacuum zones differentiated and adjacent, so as to limit the sequential thermal treatments to a limited area. This concept has led to conceive the first vertical continuous furnace, having a handling and a geometry enabling the implementation of complex thermal treatments in a single compact chamber with multiple thermal zones, without the use of doors or gate valves between a thermal zone and the other or the presence of more thermal chambers in cascade and local areas at a differential vacuum system level. Furthermore, said concept has led to minimizing heat dissipation and loss of vacuum and to the elimination of the conveyor belts. Furnaces of vertical type are already present in the state of the art, such as that described by the patent JP2013024486 "Vertical type vacuum furnace for thermal treatment on metallic semi-finished product", but are not designed to work in continuous operation, that is, with the ability to upload and download the furnace continuously without interrupting the pressure treatment process and temperature of the workpieces loaded and unloaded according to a continuous cycle.

Detailed presentation of the invention

[0004] This invention relates to a continuous furnace for thermal treatment. Said continuous furnace consists of:

1. A loading chamber for the workpieces to be treated;

a. These objects to be treated, according to a first implementation form are positioned directly on graphite drawers;

b. these objects to be treated, according to a second implementation form are positioned inside containers;

According to a preferred implementation form these containers are made of graphite;
According to an alternative implementation form said containers have a hole on said lid;
Alternative forms and materials for these containers do not constitute a contribution to innovation, as is clear to a skilled person.

a. These containers according to a first implementation form are placed on the mentioned graphite drawers for displacement inside the furnace;

b. These containers according to a second implementation form are moved inside the furnace directly without using the mentioned graphite drawers;

2. A first knife gate valve for the isolation in pressure of the load chamber;

3. A vertically symmetric cylindrical steel bell with heat exchangers for the cooling of the walls;

4. An horizontal symmetry cylindrical inlet as connection between the loading chamber and said vertically symmetric cylindrical bell;
Here we specify that with "horizontal symmetry" the axis of the horizontal cylinder is intended, while with "vertical symmetry" the axis of the vertical cylinder.

5. A first slide for moving said drawers or said containers in the input duct;

6. A first thermal insulation panel at the inlet of this bell;

7. A heating chamber placed inside the cylindrical bell for the thermal treatments of the workpieces with seats for the positioning of the drawers or the containers. These drawers or containers are placed in the thermal chamber in a vertical fixed stack:

a. By four pistons on which the second and the last of the drawers or containers rest, stacked from the bottom, according to a first implementation form;

b. By four gravitational shelves on which the second and the last of the drawers or containers rest, stacked from the bottom, according to a first implementation form;

c. By two or more gravitational shelves on which all containers rest according to a third implementation form;

These gravitational shelves are supports set on the fixed shelves, anchored to the heating chamber or bell. The shelves are opened pushed by the drawers or containers, as one is shifted upwards, and fall back in the original position as effect of gravity when these drawers or containers go beyond the vertical positioning of the associated shelf.

a. According to a first implementation of said gravitational shelves are made of a body of graphite and a graphite sheet which facilitates the falling down of the same on the associated shelf;

b. According to a second implementation form of said gravitational shelves are made of a body of graphite and a graphite cloth which facilitates the falling down of the same on the associated shelf;

c. According to a third implementation form of said gravitational shelves are made of a body of graphite and a ceramic sheet which facilitates the fallback on the associated shelf;

Alternative forms and materials for the implementation of said shelves do not constitute a contribution to the invention, as is clear to a skilled person.

8. One or more resistors distributed in height on orthogonal planes to the cylinder axis of said bell in order to create adjacent differentiated thermal zones;

a. According to a first implementation form, these resistors are in graphite;

b. According to a second implementation form, these resistors are in molybdenum;

c. According to a third implementation form, these resistors are in steel;

9. A discharge chamber;

10.An horizontally symmetrical cylindrical cooling duct as connection between the vertically symmetric cylindrical bell and said discharge chamber;

11.A second slide for moving said drawers or said containers in said cooling duct;

12.A second knife gate valve between said cooling duct and said discharge chamber;

13.A second panel of thermal insulation between said bell and said cooling duct;

14.A thrust based handling system for the displacement and sorting of said drawers or containers inside the furnace object of the invention, by:

a. Electro-operated pistons, according to a first implementation form;

b. Electro-mechanical jacks, according to a second implementation form;

This thrust based system comprises:

a. A first piston or jack with a thrust direction parallel to the axis of said input duct;

b. A second piston or jack with a thrust direction orthogonal to the axis of said input duct;

c. One or more pistons or jacks with the thrust direction parallel to the axis of said cylindrical bell; they serve to push vertically said drawers or containers, towards the following thermal zone. Are sufficient in number to ensure redundancy in case of failure of one or more of them;

d. A third piston or jack with a thrust direction parallel to the axis of said cooling duct;

e. A fourth piston or jack with a thrust direction orthogonal to the axis of said cooling duct;

15.A water cooling hydraulic circuit of said vertically symmetrical bell;

16.A pumping system for the creation of the vacuum in said furnace object of the invention;

17.A pumping system for the creation of a local vacuum in said containers;

a. According to a first implementation form it is made by direct suction from a hole present in said containers;

b. According to a second implementation form it is done by the use of a vacuum-tight hood, external to said containers, which draws the gas contained in said containers through seal leakages on the basis of the same;

18.One or more transformers for the power supply of said resistors;

19.An electrical panel for the power supply of the electrical elements of said furnace. Said electrical panel consists of items such as:

a. Power thyristors for current adjustment in said resistors;

b. PLC-type logic for the configuration of the security system of said furnace and of the thermal treatment cycles;

c. Power switches of said furnace;

d. Fuses for the power supply of said furnace;

e. One or more uninterruptible power sources for the safeguarding of the operation of said furnace from a situation of interruption of the electrical supply;

20.A control panel for the configuration of the thermal cycles of said furnace object of the invention;

21.A valve system for the evacuation and the vacuum setting of said furnace object of the invention;

22.A system of valves and pipes for the insertion of partial pressure gas in said furnace object of the invention;

[0005] A first advantage of the furnace object of the invention, compared to the state of the art in horizontal continuous furnaces, is related to its geometry, since the combination of said vertically symmetric cylindrical bell with said cooling duct in horizontal symmetry minimizes and maximizes thermal dissipation according to the stages of the cycle. In fact, since the furnace bell is in vertical symmetry, and usually the objects to be treated are placed on a base with a dimension greater than the height, a geometry of the vertical cylinder is allowed to a section next to the square. It is well known that this symmetry minimizes the surface volume ratio, at an equal volume with respect to the cylindrical structure with a rectangular longitudinal section, typical of the state of the art continuous vacuum furnaces, and therefore minimizes heat loss. In the contrary, the cooling duct in horizontal symmetry, deliberately maximizes the thermal losses to obtain a rapid cooling. A second advantage of the present invention, always related to its vertical geometry, is the combination of adjoining chambers with alternated cylindrical symmetry and vertical symmetry. This structure decreases greatly the overall dimensions and isolates the gate valves and the movements of the adjacent chambers. Indeed, since the heat transfer occurs by radiation, the alternation of cylindrical chambers with an horizontal axis with cylindrical chambers with a vertical axis, the view factor decreases between a chamber and the adjacent one and consequently isolates them thermally. A third advantage of the present invention, still linked to its geometry, is the thrust based compact handling, which allows to avoid the employment of bulky and complex conveyor belts for the objects to be treated. The chambers, pairwise adjacent and with orthogonal symmetry, allow the use of said pistons and thrust jacks which move the objects to be treated in queue separating them at the same time from the next input and output, allowing an easy handling and easy maintenance. At the state of the art a continuous furnace which alternates cylindrical chambers with differentiated geometry does not exist. Furthermore, in the conventional continuous furnaces also the adjacent thermal zones for the thermal treatments are separated longitudinally by knife gate valves and insulation panels, with a great expenditure of complexity and surface, with a resulting lower heat dissipation and vacuum seal. A fourth advantage of the present invention, is that the thermal zones for the heat treatments are all concentrated in the vertically symmetric cylindrical bell, in a compact manner, these using one or more resistors distributed in height. The insulation between a thermal zone and the adjacent one is obtained with an innovative positioning system for the workpieces to be treated that brings said containers or drawers to occupy the space between two adjacent thermal zones so as to constitute a thermal breaking element between them. In fact, the heat transfer occurs by radiation and the presence of said containers or drawers decreases the view factor between adjacent heating zones. In this way, with thermal zones very close together, and without the presence of additional knife gate valves and insulation panels, the thermal chamber remains compact, minimizing dispersion and thus maximizing the efficiency of the heat treatment. A further advantage of the present invention compared to the continuous longitudinal furnaces state of the art, is the fact that the vertical symmetry allows for the introduction of an innovative system for the creation of a vacuum locally inside said containers of the workpieces to be treated. In fact the vertical movement within said cylindrical bell, is used both to move said containers with the wokpieces to be treated, and to create a seal between the containers and said pumping system for the creation of a local vacuum inside. When said containers reach the last heating resistor in height, said pumping system for the creation of local vacuum draws the gas inside, in order to allow a thermal treatment with a differentiated pressure with respect to that present in the bell. This provides for heat treatments of extreme accuracy with a differential between partial pressure in the bell and the finely regulated local pressure of the workpieces to be treated. Said compact vertical geometry also provides for a minimization of pressure loss and a fast transfer of workpieces from a thermal zone to the adjacent one.

List of Drawings

[0006] The features and advantages of the invention will now be illustrated with reference to implementation forms shown in the Annexes as a non-limiting example in which:

Figure 1 shows a diagram of a conventional longitudinal continuous furnace;

Figure 2 shows a front section of the continuous furnace object of the invention, according to a preferred implementation form;

Figure 3 shows a side section of the continuous furnace object of the invention, according to a preferred implementation form;

Figure 4 shows a top section of the continuous furnace object of the invention, according to a preferred implementation form;

Figure 5 shows a diagram of said heating chamber for the treatment of workpieces, according to a first implementation form;

Figure 6 shows a diagram of said heating chamber for the treatment of workpieces, according to a second implementation form;

Figure 7 shows a diagram of said heating chamber for the treatment of workpieces, according to a third implementation form;

Figure 8 shows a diagram of said pumping system for the creation of a local vacuum in said containers;

Figure 9 shows a detailed diagram of said containers for the creation of a vacuum locally, according to a first implementation form;

Figure 10 shows a detailed diagram of said containers for the creation of a vacuum locally, according to a second implementation form;

Implementation of the invention

[0007] Figure 1 shows an implementation form of a conventional continuous furnace, which implements a sintering thermal treatment. The bell (2) has a longitudinal cylindrical shape.

[0008] The load (1) to be treated is moved through said conventional vacuum furnace via a conveyor belt system (3). In the implementation of figure 1, said conventional vacuum furnace has two closing hatches (6) and a sequence of chambers for the thermal treatment. Said sequence consists of a load heating chamber (7), in which the load in the air is put in a vacuum after the closing of the knife gate valve (4). To the said loading chamber (7) a heat chamber follows for a subsequent heat treatment, which in the implementation form of Figure 1 takes place in a "debinder" chamber (8), isolated in pressure by a further knife gate valve (4), by a sintering chamber (9). The overall heat treatment is carried out in sequence as a combination of the treatments of said chambers (8) and (9) isolated in pressure and thermally from each other. In the implementation form of figure 1 said thermal chambers (8) and (9) are followed by an additional thermal chamber (10) for an aging thermal treatment, isolated by a further knife gate valve (4). Finally, the load (1) is cooled in the cooling chamber (11), by means of the cooling fan (5). The concept of the continuous furnace reported in figure 1 is a furnace with a predominant longitudinal dimension, in which the load (1) undergoes suitable thermal treatments in sequence, simultaneously in successive loads on a continuous production line. As a result of this concept, said conventional furnace is greatly lengthened, with the need for numerous knife gate valves (4) for the isolation in pressure between one stage and the next, and with the need of thermally insulating a chamber from the adjacent one.

[0009] Figure 2 shows a front section of an implementation form of the vertical continuous furnace object of the invention. Said bell (2) has a cylindrical shape with a section close the square. It allows to minimize heat loss, as the surface / volume ratio is minimized. Said square shaped cylindrical shape is allowed by the vertical symmetry of the furnace object of the invention and an innovative system of multiple thermal zones close together, that exploits the loads to be treated in the queue for the thermal isolation of a thermal zone from the adjacent one. According to the subdivision shown in figure 2, said containers (30) containing the objects to be treated, are loaded by means of the conveyor (20) in said loading chamber (121) delimited by said first knife gate valve (41). Once loaded the workpiece, the loading chamber (121) is closed and brought to a vacuum via a pump (142) and on the related suction pipe (152). Once the optimum vacuum level is reached, the knife gate valve is opened (41) and the workpiece is pushed by the first piston (131) in the vicinity of said heating chamber (22) through the cylindrical duct in horizontal symmetry (181). The heating chamber (22) is, for this implementation, at a partial pressure of 150 mbar of nitrogen, injected through the duct (26), part of the system of valves and pipes for the insertion of partial pressure gas. Said partial pressure is ensured by the maintaining pump (143), which together with the pump (142) and relative suction pipes, form the pumping system for the creation of the vacuum. The containers (30) are thus pushed, by means of the second piston (132), with a thrust direction orthogonal to the first, in the heating chamber (22) located inside said vertically symmetric cylindrical bell (2). The containers (30) are then raised by two electro-mechanical jacks (134) in the thermal chamber (22). Said electro-mechanical jacks (134) are two, because in case one of them fails the load would still be supported by the second. They pass through the ball valves which are closed in case of maintenance. The containers (30) are then stopped in correspondence of three graphite resistors (23), supplied by the transformer (24) via the conductors (19). The graphite resistors (23) are the thermal chamber heating elements (22) and are positioned, in the present implementation, in three thermal zones transverse to the thermal chamber (22). The containers (30) pass through the three heating zones and land in contact with said pumping system for the creation of the vacuum locally, made by the pump (141) and the related suction pipe (151). There a local vacuum is produced in the containers (30) in order to achieve a thermal treatment in vacuum conditions differentiated compared to the 150 mbar of the thermal chamber (22). The containers (30) at the end of the thermal treatment are then pushed into the cooling duct with longitudinal cylindrical symmetry, the front circular cross-section of which is visible, via the third thrust piston (133).

[0010] In figure 3 is shown a front section of the vertical continuous furnace object of the present invention for a better understanding of the geometry. The containers (30) follow the path of the dotted arrow and stop in correspondence with the graphite resistors (23), stacked one above the other. In the side view in figure 3 said loading chamber (121), said discharge chamber (122), said input duct (181), said horizontally symmetrical cylindrical cooling duct (182), the first thermal insulation panel (161), the second thermal insulation panel (162) are better highlighted. The containers (30) are pushed up to the discharge chamber (122) by means of said thrust handling system which comprises the first piston (131), the second piston (132), the two jacks (134) and the third piston (133).

[0011] Figure 4 shows a top view of the continuous furnace object of the invention, according to a preferred implementation form; In this you can see the path followed by the containers (30) from the loading chamber (121) through the input duct (181), closed from the first knife gate valve (41), up to the thermal chamber (22), driven by the pistons (131), (132) and (133). Furthermore it is easier to see the conformation of the graphite resistors (23) and the horizontally symmetrical cylindrical cooling duct (182), whose lengthened shape favours the dissipation and therefore the cooling phase of said containers (30). It ends with the discharge chamber (122), from which it is separated by the knife gate valve (42) and is thermally isolated from the thermal chamber (22) from said second thermal insulation panel (162). The fourth piston (135) with a direction orthogonal to the axis of the duct (182) serves to extract the single container (30) heading the row of containers (30). As seen in figure 4, the gate valves (41) and (42) are geometrically thermally insulated from the resistors (23), the irradiation of which they do not perceive, since they are placed along axes orthogonal to the direction of the cooling duct axis (182).

[0012] Figure 5 shows a diagram of said thermal chamber (22), according to a first implementation form; In this implementation form it is made of graphite and the containers (30) are placed inside the graphite drawers (31). This configuration has the advantage of being able to use simple containers (30), without the need of reinforcement to support the pressure of the stack of three containers (30) shown in Figure 5, since the load-bearing function is entrusted to the drawers (31). The piston (131) inserts the drawers (31) in sequence over the two electro mechanical jack system (134), which reposition them vertically in the heating chamber (22) in correspondence of the resistors (23) where thermal treatment is carried out. The drawers (31) are stacked in sequence, as the continuous treatment process advances. The last drawer (31) on top of the stack, once the processing has been performed, is moved to the cooling duct (182), while the remaining drawers (31) move vertically one position. In the implementation of figure 5, the four central drawers (31) are stacked one above the other and therefore the first of the four drawers must have sufficient mechanical strength to support the weight of the three upper drawers (31). On the other hand the first and last tray (31) are rested on graphite guides (27) supported by a four piston system (13), which are moved away in presence of a vertical movement of the drawers (31). The implementation of figure 5, has three resistors (23), with a drawer (31) which is interposed between a resistor (23) and the adjacent one, thus making a shielding system to thermally isolate the areas in which the heat treatment takes place.

[0013] Figure 6 shows a diagram of said thermal chamber (22), according to a second implementation form;
In the implementation of figure 6, the four pistons (13) are replaced by said four gravitational graphite shelves (32), resting on said shelves (28) bound to the thermal chamber (22). The shelves (32) are raised, when the drawers (31) are driven vertically up until the graphite backrest (33), to which, in this implementation, they are bound by means of a graphite cloth (34). Once driven by the drawer (31), they fall back into the original position due to the force of gravity. The advantages of the shelves (32) with respect to said pistons (13), are a minor mechanical complexity, the fact that they cost less, that they do not require an external control and the fact that they do not disperse heat to the outside. In figure 6 also a top view is given of said shelves (32), in order to better show the geometry of the movement.

[0014] Figure 7 shows a third implementation form of said thermal chamber (22); In it there are eight gravitational shelves (32) supporting each of said containers (30), this time without the related drawers (31). Said containers (30) must be suitably reinforced and shaped to support the vertical displacement mechanical stresses. The advantage of the implementation of figure 7 is that the containers (30) are not in thermal contact one with the other, this ensures a higher thermal insulation between the thermal treatments in correspondence of the resistors (23). This implementation is supported by the presence of the gravitational shelves (32), which not having the complexity and cost of the pistons (13), can be placed in large quantities in the thermal chamber.

[0015] Figure 8 shows, related to the thermal chamber (22) said pumping system for the creation of the vacuum locally in the containers (30), comprised of the pump (141) and the related suction pipe (151). This innovative system, allowed by the vertical symmetry of the bell (2), uses the vertical movement to create a pressure seal between the pumping system and the containers (30). The container (30) on top of the stack is brought into contact with the suction pipe (151) and the pump (141). Aspirating the gas contained in the containers (30), a level of vacuum is created within differentiated with respect to the medium vacuum level present in the thermal chamber (22).

[0016] Figure 9 shows an implementation for said pump system for the creation of the vacuum locally in the containers (30), comprised of the pump (141) and the related suction pipe (151) according to a first implementation form. Said objects to be treated (1) are placed inside the containers (30), having the shape and mechanical strength such as to support an external pressure much higher than the internal pressure. The suction pipe (151) of the pump (14) is inserted in the sealed hole (301) set at the centre of said container. Therefore the thermal treatment, in the stage in which the container (30) is on top of the stack, is made in a local vacuum condition for the parts therein contained.

[0017] Figure 10 shows a second implementation of said pump system for the creation of the vacuum locally in the containers (30), comprised of the pump (141) and the related suction pipe (151). In this implementation the local vacuum inside the container (30) is created by means of the extractor hood (152) that is positioned outside said container (30). The advantage of the implementation shown in Figure 10 is the fact that the container (30) does not have to withstand external pressures higher than the internal pressure and therefore requires significantly lower mechanical strength properties, compared to the container (30) in figure 9 and thus can cost less.

Claims

1. A continuous furnace for thermal treatments, comprising a loading chamber (121), an input duct (181), a cylindrical bell (2) with vertical axis, a heating chamber (22) in which workpieces are continuously introduced (1) and a thermal treatment performed without interrupting the level of pressure of said heating chamber (22), a cooling duct (182), a discharge chamber (122), a set of containers (30) in which to insert said workpieces (1), a set of drawers (31) in which to insert said containers (30), a system for the vertical positioning of said drawers (31) or containers (30) according to a stack in said heating chamber (22), one or more resistors (23) distributed in height which delimit the thermal zones, a pumping system to bring said heating chamber (22) in high vacuum conditions, a system of valves and pipes for the insertion of partial inert gas pressure sub- or supra atmospheric, a pumping system for the creation of

local vacuum in said containers (30), a thrust handling system for moving and sorting of said containers (30) or drawers (31);

2. Furnace according to claim 1, **characterized by** an input duct (181) cylindrical with horizontal axis;

3. Furnace according to claim 1, **characterized by** a cylindrical cooling duct (182) with horizontal axis;

4. Furnace according to claim 1, **characterized by** the presence of one or more drawers (31) or containers (30) between one of said thermal zones and the adjacent one, as vertical positioning system of said drawers (31) or containers (30) according to a stack;

5. Furnace according to claim 1, **characterized by** the presence of a four piston system (13) on which the second and the last rest, starting from the bottom of the stack of said drawers (31) or containers (30) present in said thermal chamber (22), as vertical positioning system of said drawers (31) or containers (30) according to a stack;

6. Furnace according to claim 1, **characterized by** the presence of a four gravitational shelves (32) on which the second and the last rest, starting from the bottom of the stack of said drawers (31) or containers (30) present in said thermal chamber (22), as vertical positioning system of said drawers (31) or containers (30) according to a stack;

7. Furnace according to claim 1, **characterized by** the presence of more than one gravitational shelves (32) on which all said drawers (31) or containers (30) rest, as vertical positioning system of said drawers (31) or containers (30) according to a stack;

8. Furnace according to claims 6 and 7, **characterized by** graphite gravitational shelves (32), bound to a graphite backrest (33), by means of a graphite sheet (34);

9. Furnace according to claim 1, **characterized by** a suction pipe (151), connected to a pump (141), inserted in a sealed hole (301) of said container (30), on top of said vertical stack, as pumping system for the creation of local vacuum in said containers (30);

10. Furnace according to claim 1, **characterized by** a suction hood (152), including said container (30), on top of said vertical stack, as pumping system for the creation of local vacuum in said containers (30);

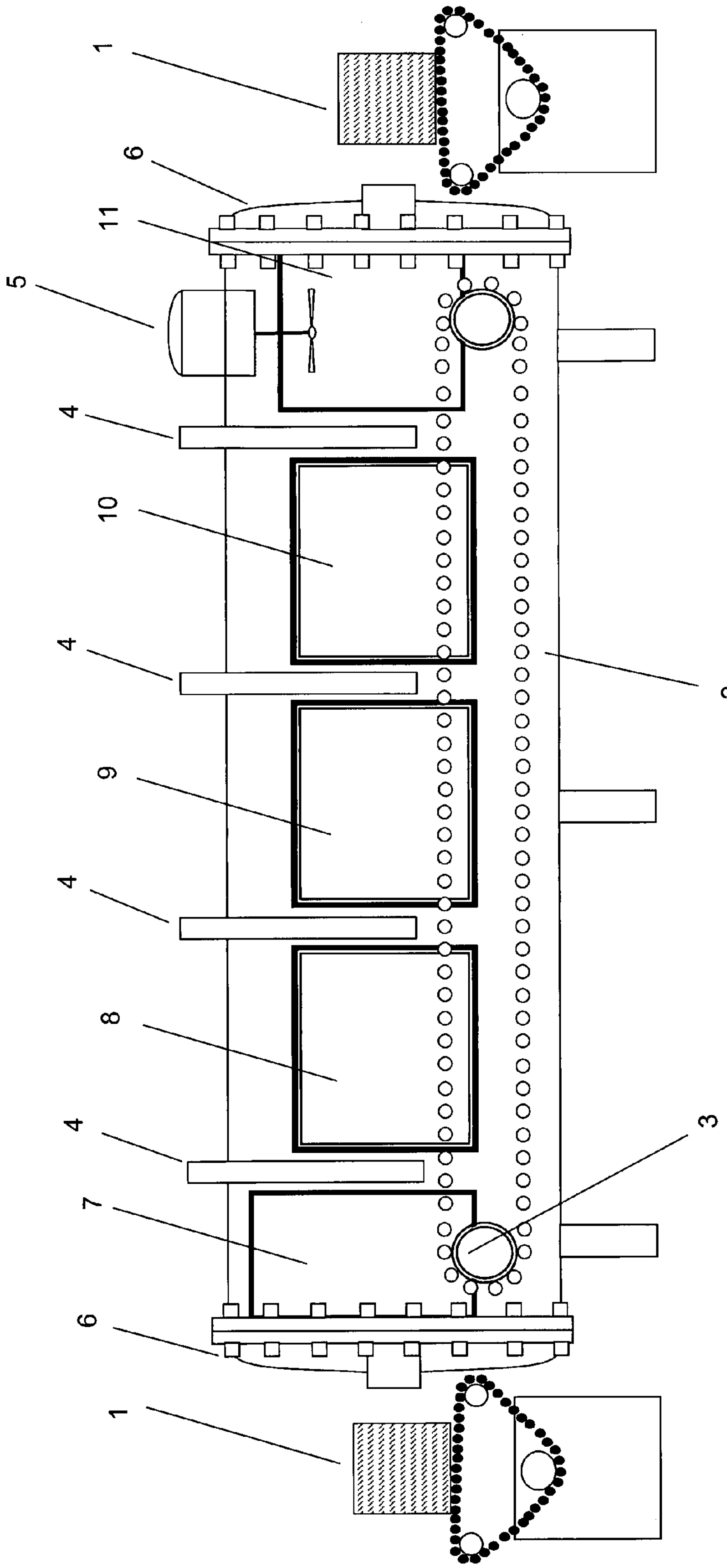

Figure 1

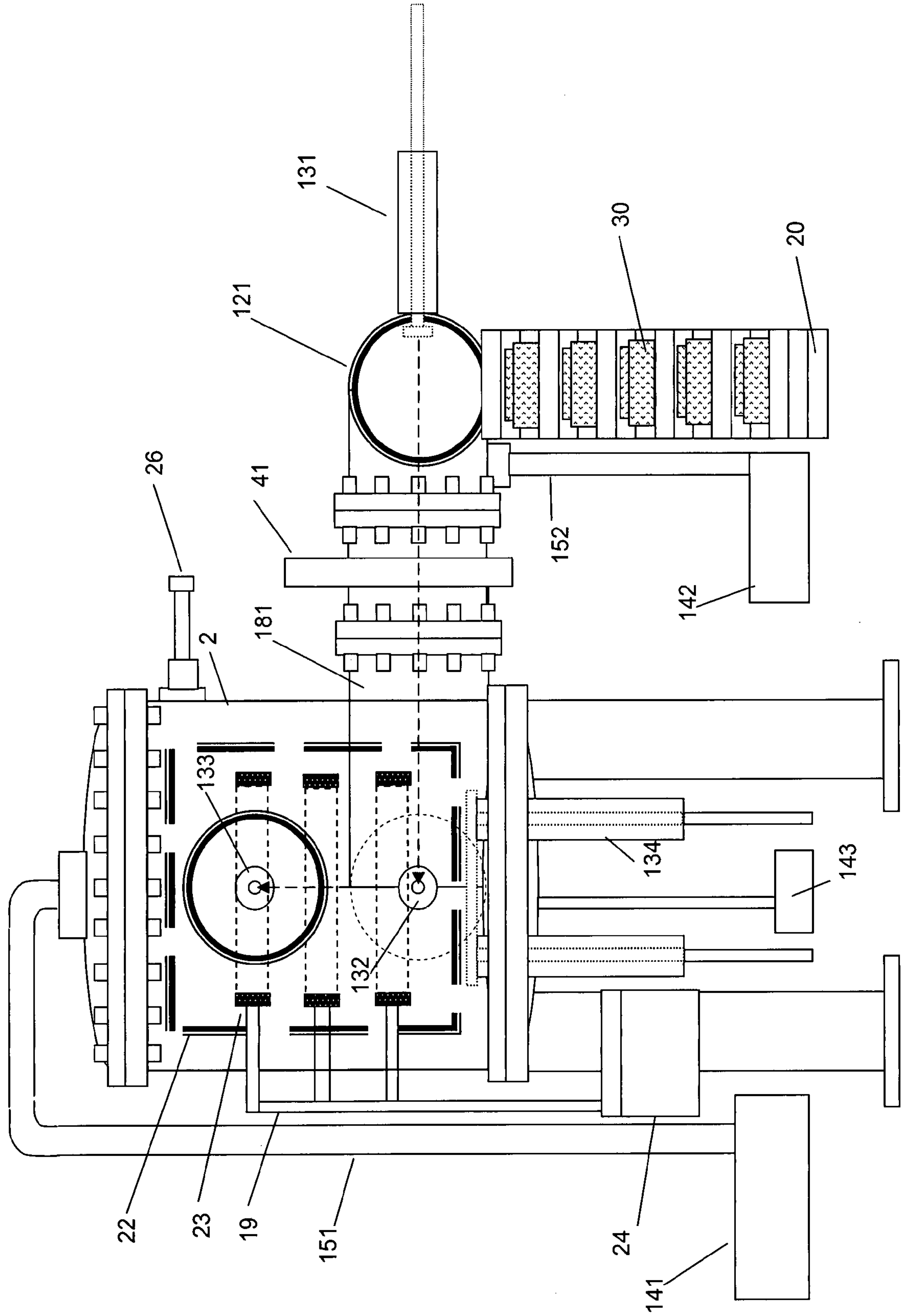
131
121
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Figure 2

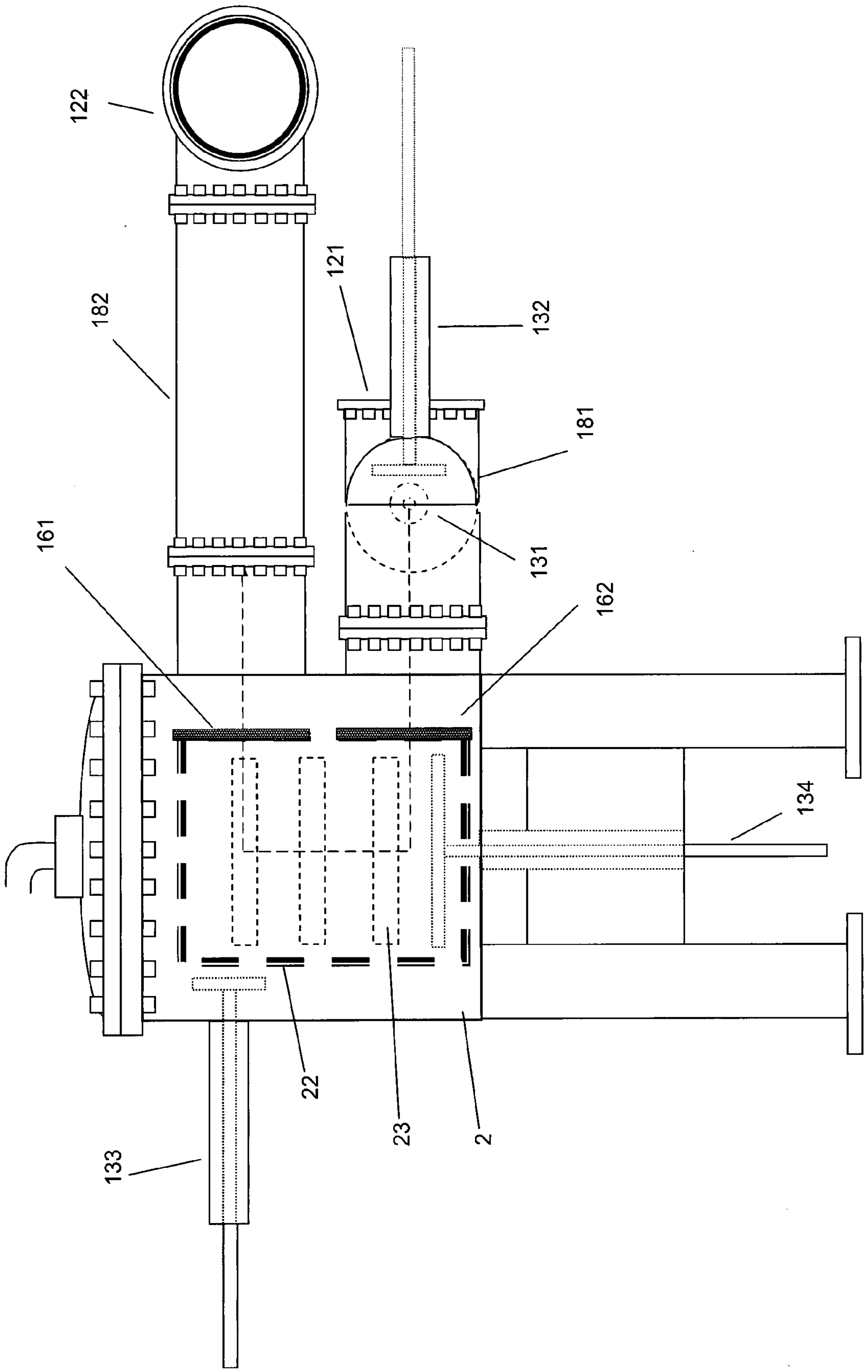

Figure 3

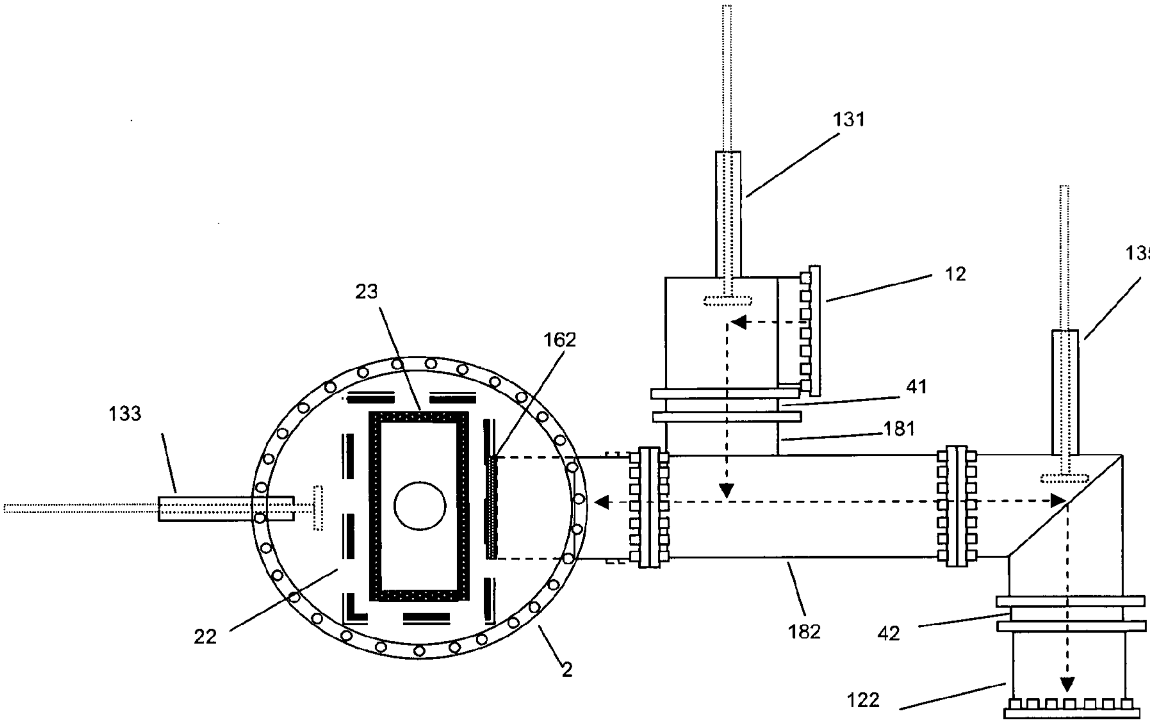

Figure 4

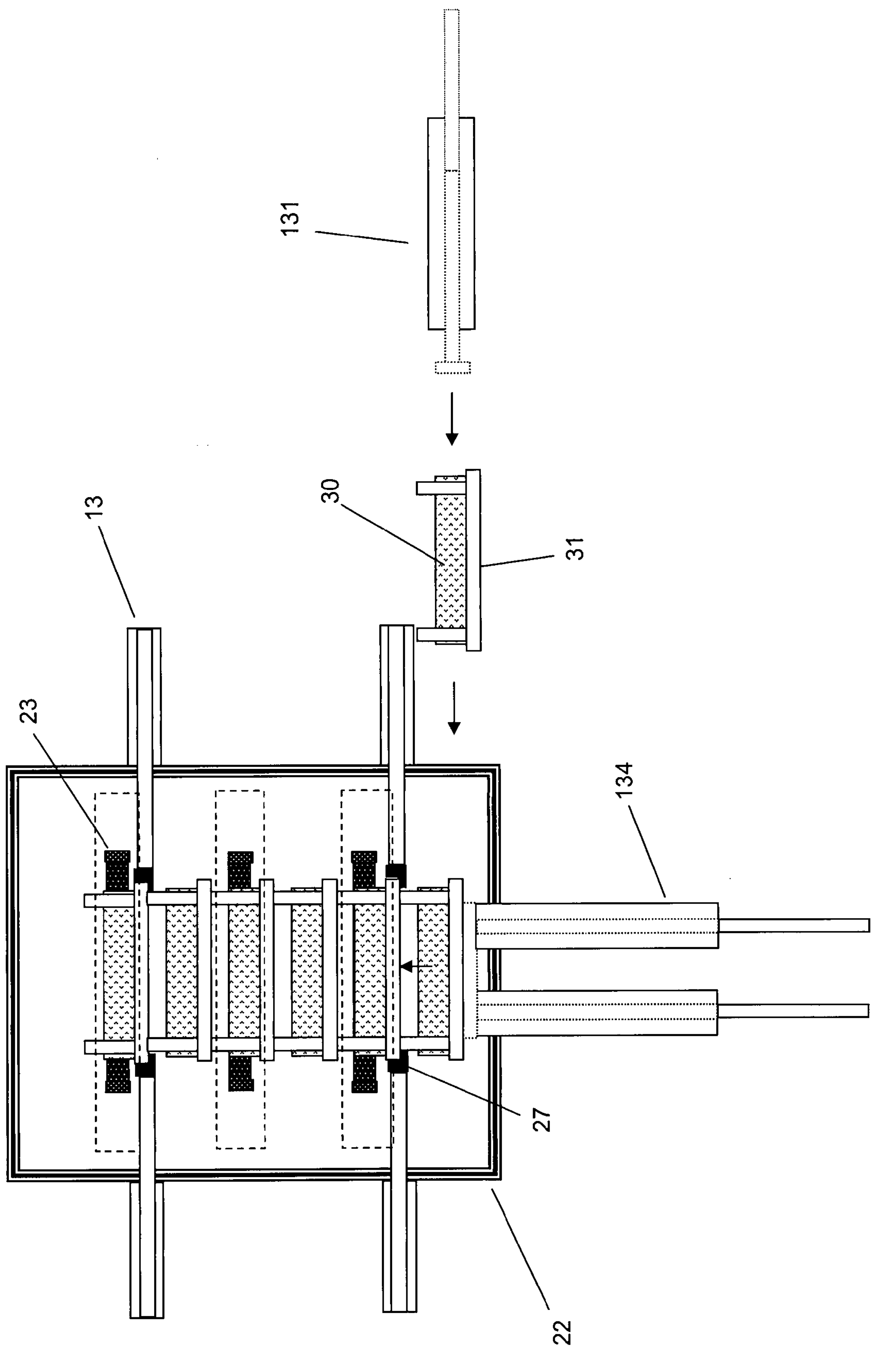

Figure 5

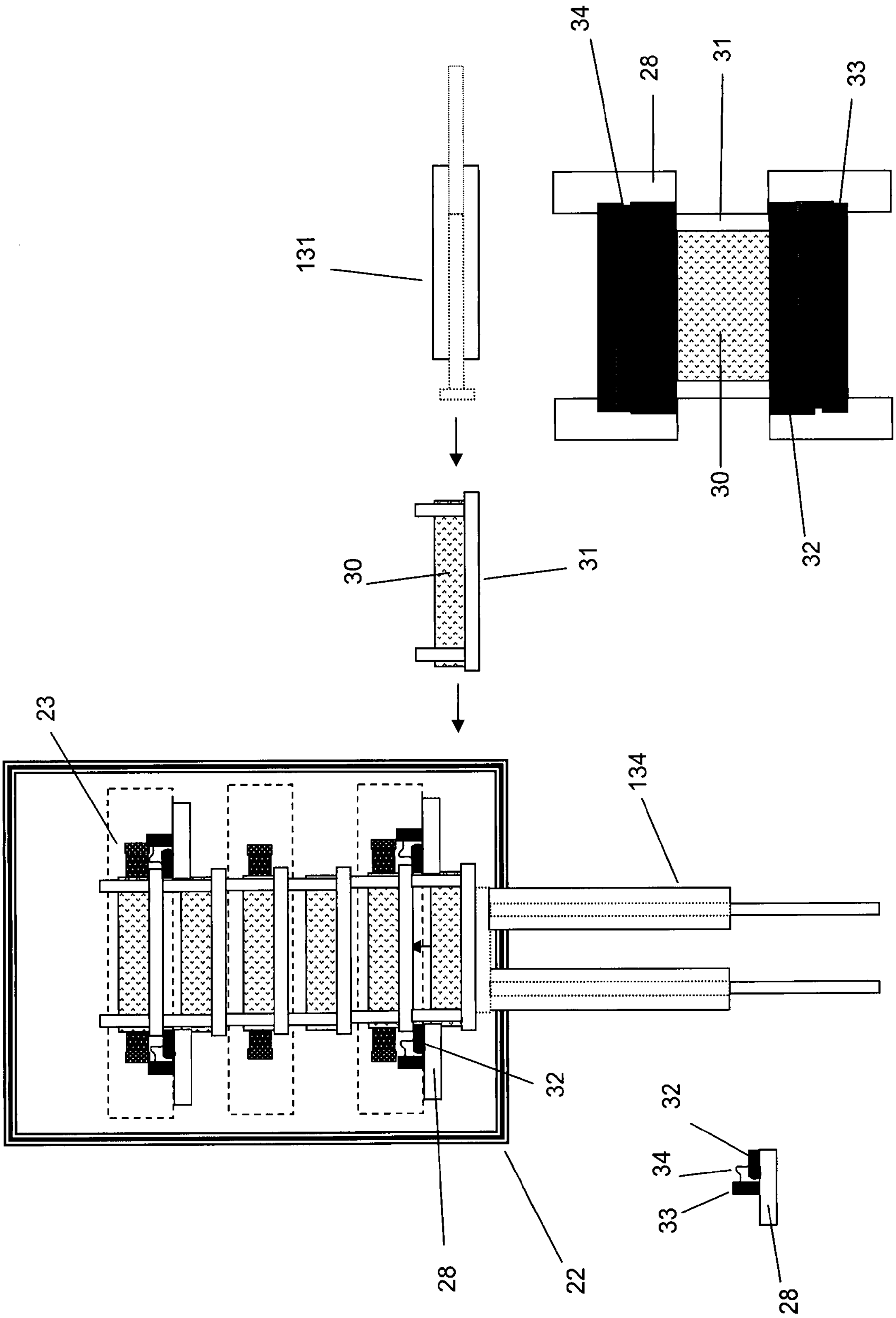

Figure 6

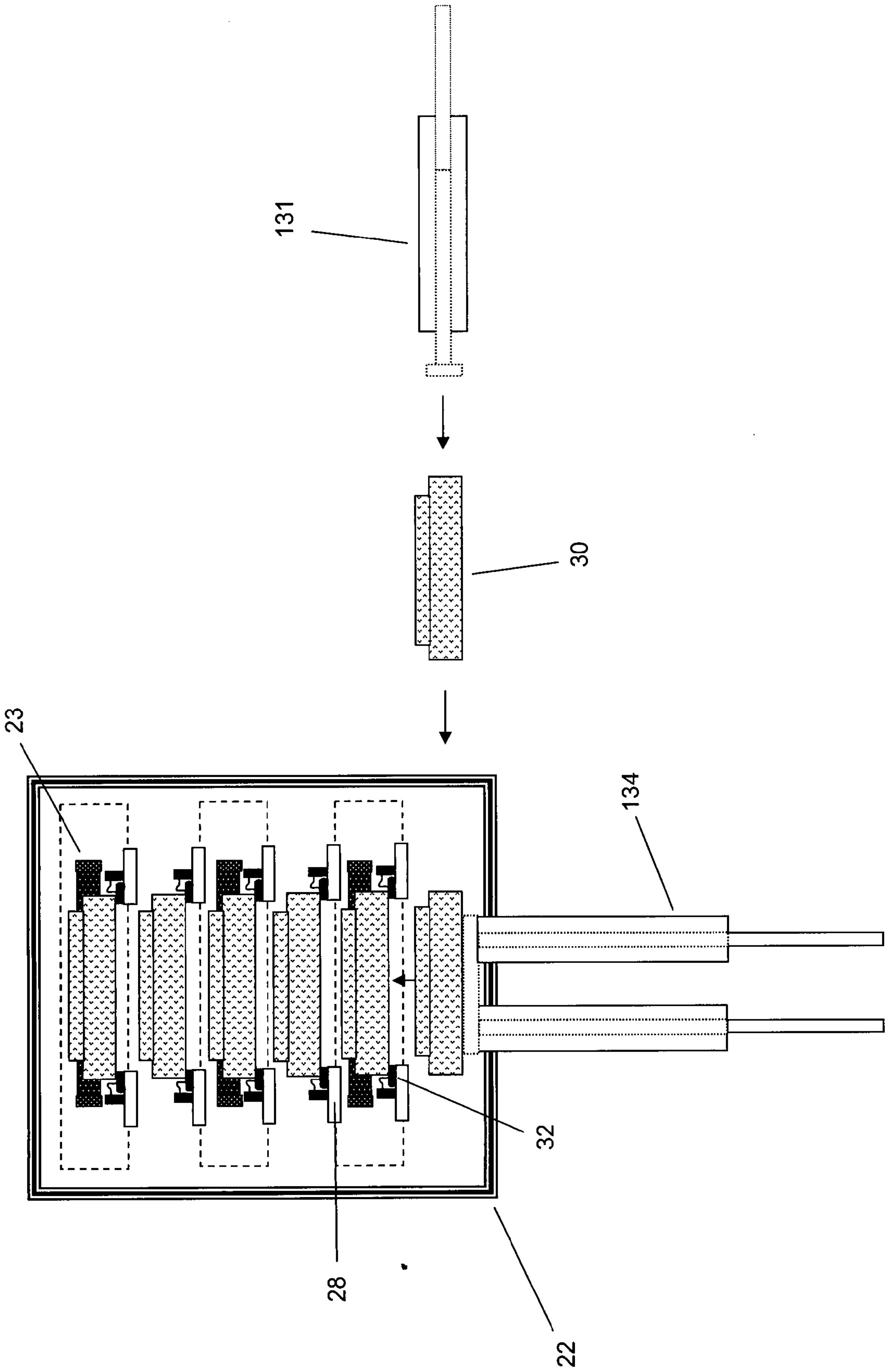

Figure 7

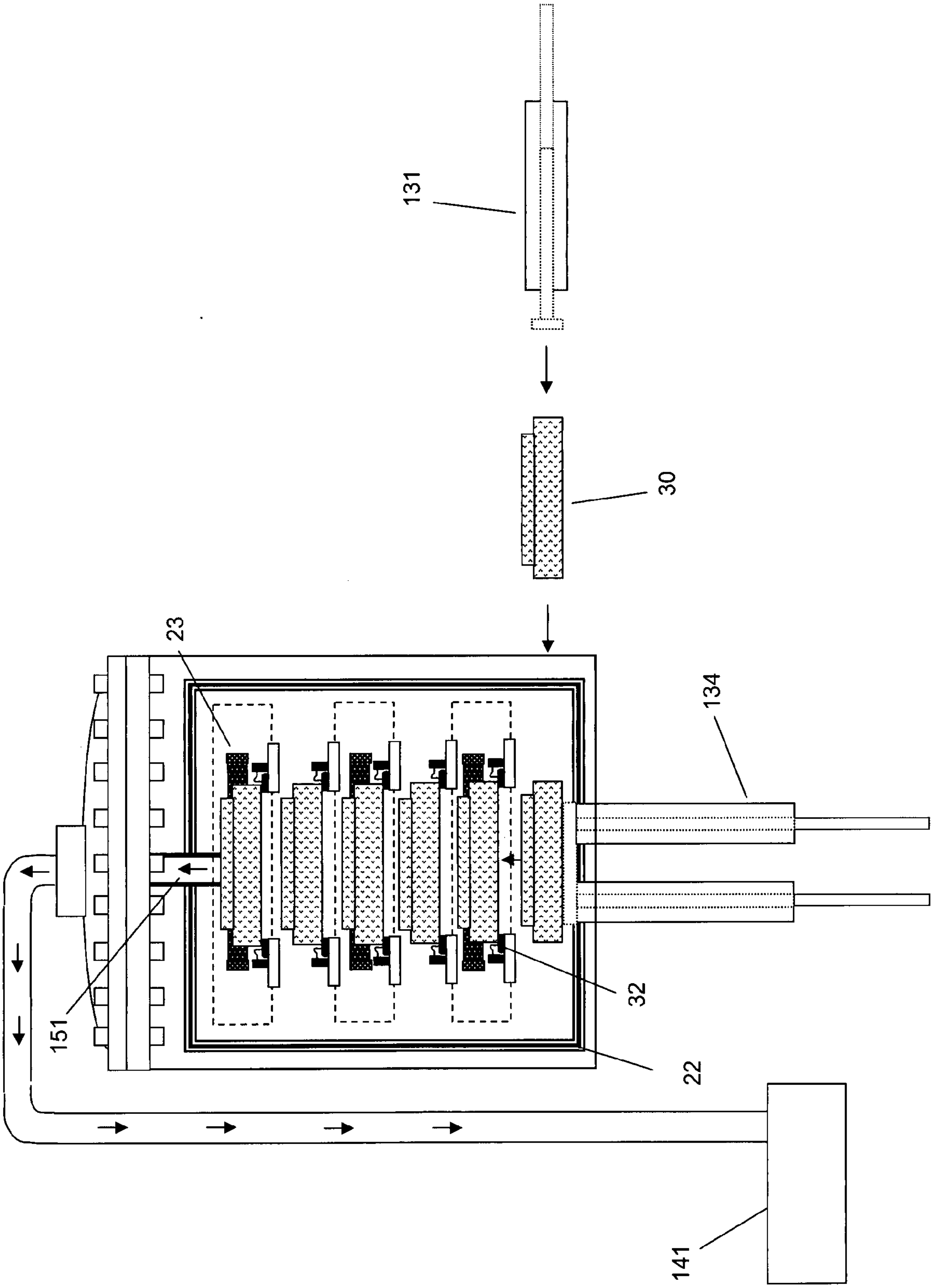

Figure 8

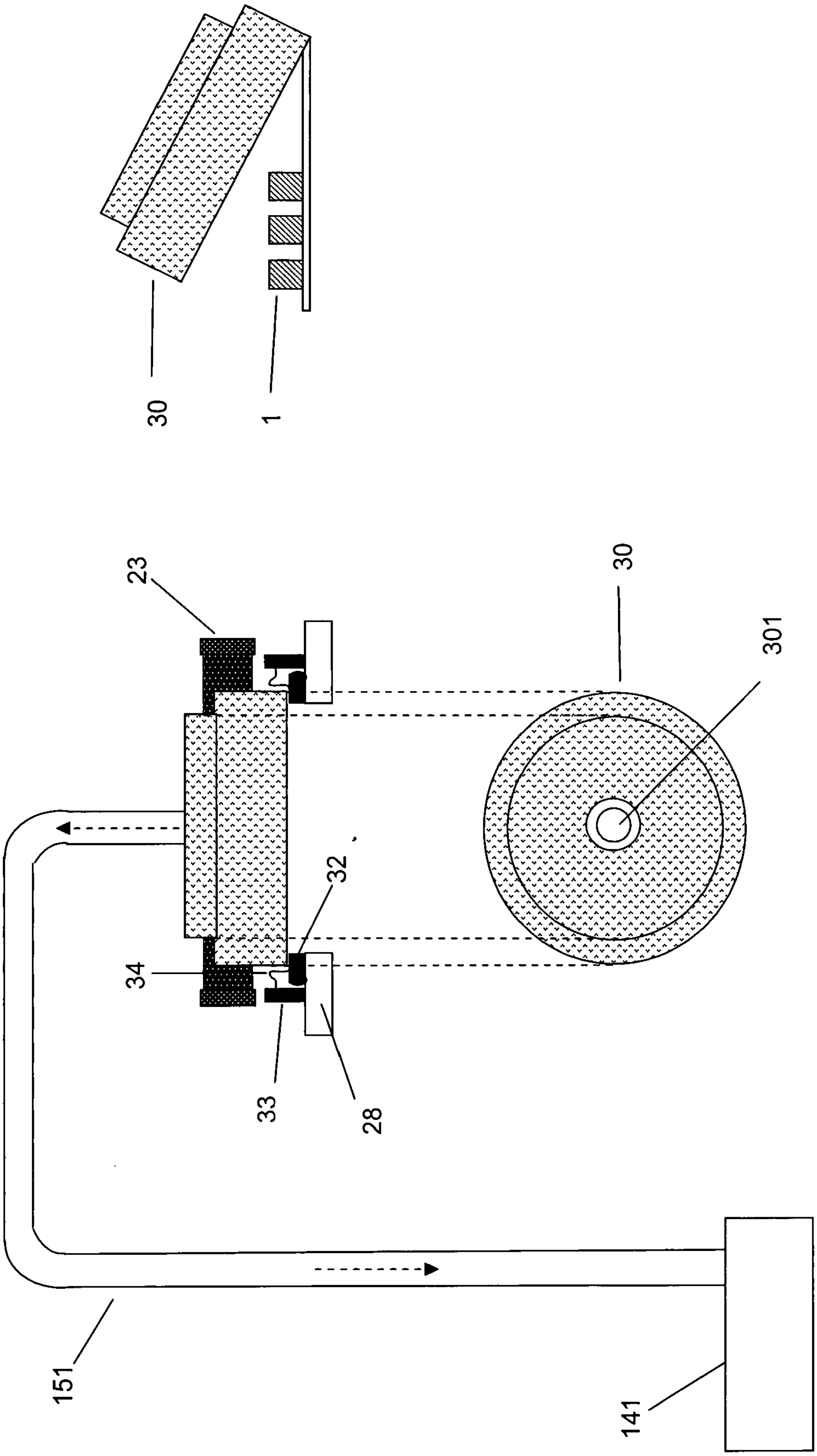

Figure 9

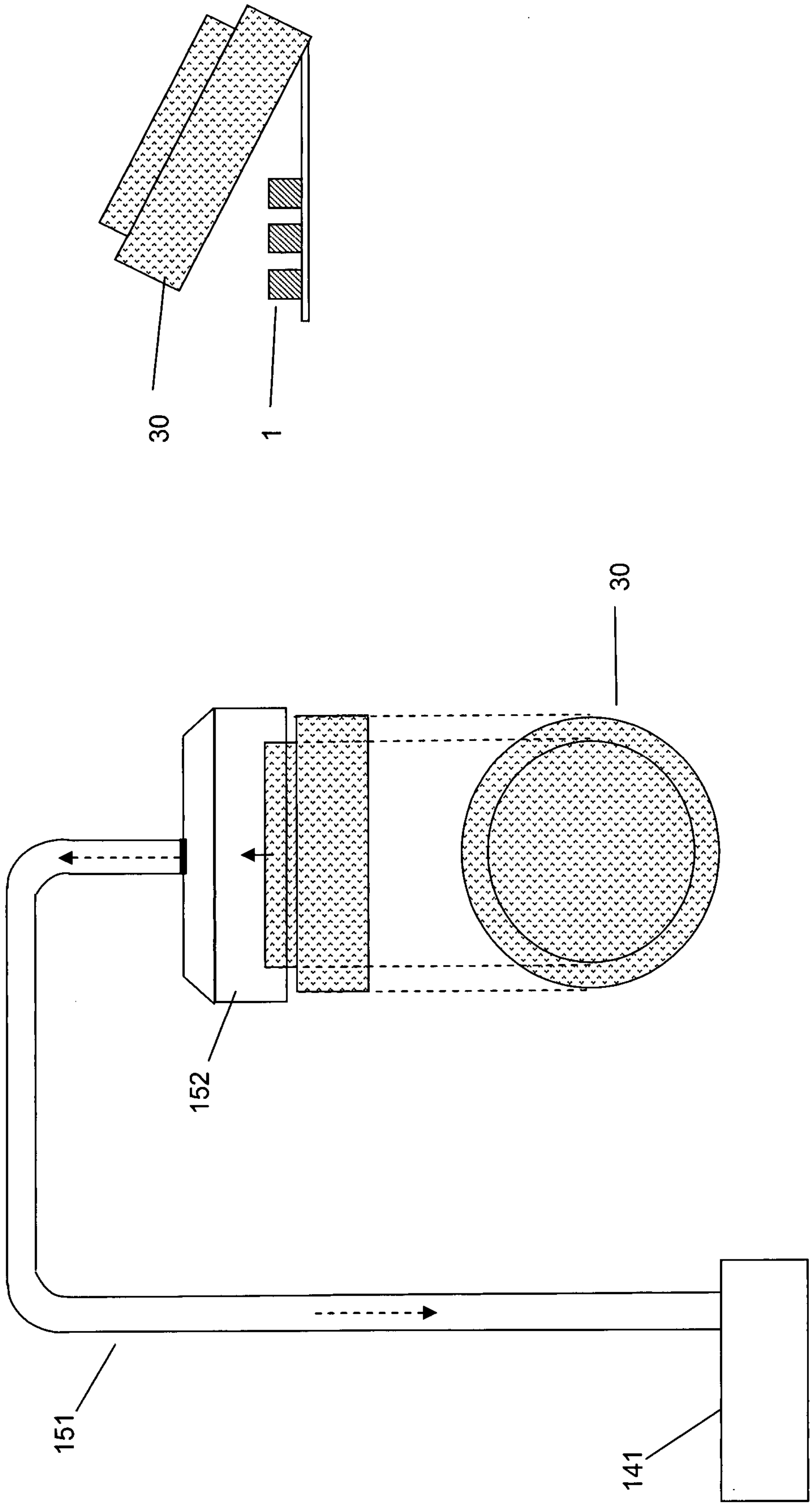

Figure 10

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EUROPEAN SEARCH REPORT

Application Number
EP 15 00 2295

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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	1 February 2016	Gavriliu, Alexandru

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