(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 187 337 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
05.07.2017 Bulletin 2017/27

(21) Application number: **15836925.6**

(22) Date of filing: **31.08.2015**

(51) Int Cl.:
B41J 2/045 *(2006.01)* ***B41J 2/065*** *(2006.01)*

(86) International application number:
PCT/ES2015/070638

(87) International publication number:
WO 2016/030566 (03.03.2016 Gazette 2016/09)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA

(30) Priority: **29.08.2014 ES 201431266**

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(54) DEVICE, METHOD, AND MACHINE FOR DEPOSITING FLUIDS ON A SURFACE

(57) Machine, device and method for deposition of fluids, for reproducing designs or decorations onto a surface, particularly the surface of objects, by means of fluids spraying, ejection or deposition, in particular fluids containing high concentration of solids, by recirculation of said fluid in a device chamber under pressure, such that the side wall of said device communicates, by means of an orifice drilled therein, with a spraying channel arranged on an adjacent wall and being communicated with said orifice, such that, upon the action of a shutter, being individually operated for each orifice arranged over an actuator, the activation of this actuator arranged in the spraying direction, causes the shutter to slide in a perpendicular direction, detaching from the orifice and releasing the communication path of the pressurized chamber with the ejection channel.

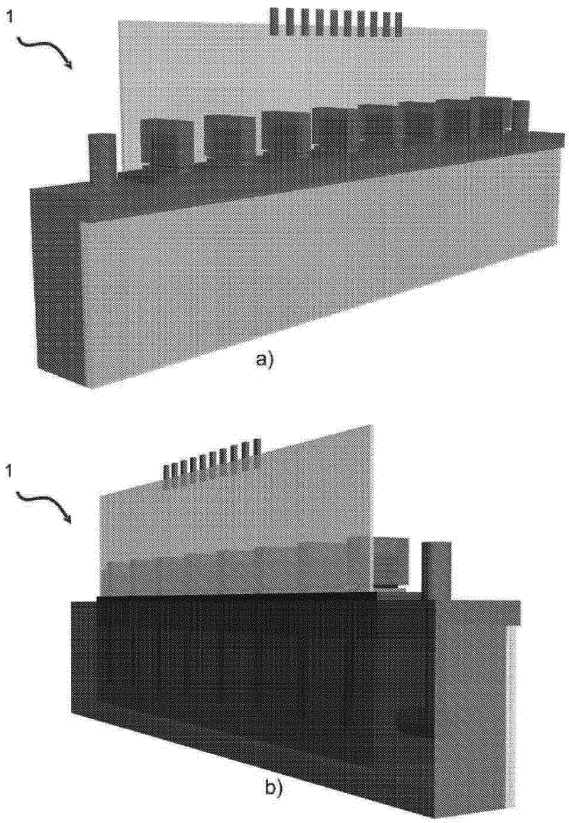

Fig. 16

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Description

Field of the invention

[0001] The present invention refers to a device and method for deposition of fluids, for reproducing designs or decorations onto a surface, particularly the surface of objects, by means of fluids spraying, ejection or deposition, in particular fluids containing high concentration of solids, and it is one object thereof to solve the problems that object decorations currently have, especially ceramic products such as stabs or tiles and/or glass, problems which can also be extended to other fields of application of dispersions having a high solid content according to a determined pattern, design or motif.

State of the art:

[0002] In the state of the art, there are several references to devices and methods for deposition of fluids, for reproducing designs or motifs on a surface, by means of fluids spraying, ejection or deposition, particularly graphic printing inks.

[0003] It is known that there are different types of deposition devices according to the way they operate, thereby usually distinguishing between continuous ejection methods (CIJ, from Continuous Ink Jet), or methods by means of selective or on demand ejection (DOD, from Drop-on-demand).

[0004] Likewise, within the DOD category, several typologies are known which are well differentiated: thermal devices (TIJ, from Thermal Ink Jet), devices actuated by valves and devices activated by means of piezoelectric actuators, such that droplets are only generated when they are intended to be injected onto the object or substrate.

[0005] In these DOD devices, the droplet size can be very small (lower than 80 picolitres, compared to the 600 picolitres of the CIJ technology), the place where the droplets are deposited is perfectly controlled and the distance between the printheads for the different inks is reduced to few centimetres. All that makes the printing quality optimum and it also makes it possible to work readily with four-colour process (CYMK).

[0006] The CIJ technology is used, above all, for product and container marking and coding, and in this technology a pump conducts the fluid from a deposit to the small nozzles ejecting a continuous stream of droplets at a high frequency (in the range of about 50 kHz to 175 kHz), by the action of a piezoelectric glass which vibrates, thus pressing the walls of the supply channel, and the droplets are subjected to an electrostatic field which provides them of a charge, then the charged droplet goes through a deflection field that determines, based on the intensity of the electric field applied, if the droplets are directed to different points in the substrate or otherwise recirculated. The high droplet frequency of the CIJ is directly reflected in the high speed printing capacity, as it is evidenced by applications such as the date coding on beverage cans. An additional advantage of CIJ is the ejection speed (about 25 m/s) allowing (as compared to other ink injection technologies) relatively large distances between the printhead and the substrate, which is useful in industrial environments. Finally, historically, the CIJ has been provided with an advantage over other ink injection technologies in its capacity for using inks based on volatile solvents, which allows for a quick drying which helps the adherence onto many substrates.

[0007] However, it has several drawbacks, such as the big size of the droplets being produced, the difficulty for exactly depositing the droplet onto the required point in the substrate, the large distance between the different inks printheads, etc., which translates into a low quality of the printing being obtained, hindering, many times, the work with a four-colour process. Because of this, the industrial application thereof is reduced to marking or printing documents in which a good finishing quality is not required, and it generates a perception of it being a dirty technology and not environmentally-friendly due to the use of fluids based on volatile solvents.

[0008] Additionally, it has limitations related to the printed fluid being required to be electrically chargeable, and the solvent loss due to continuous recirculation requires measurements and corrections of fluid density, viscosity and surface tension.

[0009] The TIJ technology (also known as Bubble-Jet), is based on the sudden evaporation of small amounts of ink (micro-explosion), causing a bubble, which pushes the ink out of the printhead, forming the corresponding droplet that is deposited onto the substrate to be printed. The main application is in home printers, due to the low productivity that can be reached and to the fact that the printheads or injectors are not so robust for industrial applications.

[0010] Thermal printheads must be changed periodically, since the repetitive heating cycles required for the thermal inkjet printing causes the electronic system operation of the printheads to deteriorate.

[0011] The piezoelectric technology (usually known as Piezoelectric Pressure Wave) is based on the application of an electric current to a piezoelectric device which, upon deformation, generates a pressure wave (by sudden reduction of the ejection chamber volume) producing ejection of the droplets of ink that are sprayed onto the substrate. The production reached is very high, with the printheads being reliable for continuous operation for long periods of time, thereby this is the technology that has been implemented for industrial applications.

[0012] Several types of piezoelectric deposition devices are known which are based on the way the actuator is deformed [Alex Grishin, Piezoelectric shear mode drop-on-demand inkjet actuator, Sensors and Actuators A 101 (2002), 371-382] and therefore on the way the pressure wave is created, with the compression (squeeze mode actuator), bent (bend mode actuator), piston (push mode inkjet actuator) and shear ones (shear

mode actuator) being mostly used.

Technical problem

[0013] As it is indicated in the introduction to the state of the art, DOD technology allows obtaining solutions for fluid ejection or deposition with a small droplet size (lower than 80 picolitres, compared to the 600 picolitres of the CIJ technology), featuring high resolution and for fluids having very low viscosity at the ejection temperature.

[0014] Currently, several new applications (digital glazing, creation of 3D structures, circuit encapsulating, etc.), cannot be performed because of the limitations of the present technology, or, where appropriate, they must be performed by multiple depositions with multiple serial devices, making them very expensive to be applied.

[0015] For certain fluid formulations, particularly those formulated on an aqueous base, deposition devices, being currently on the market, feature an additional insuperable drawback.

[0016] Another additional technical problem is the non-scalability of many of the current solutions, since the ejection of droplets with a size higher than 1,000 picolitres, involves high volume ejection chambers, wherein the generation of a pressure wave with the current methods technically and/or economically unfeasible.

[0017] On the other hand, deposition devices have been previously suggested featuring deposition by ejection through mechanically shuttered nozzles, operating over a pressure circuit of the fluid to be deposited, involving multiple scaling, resolution, mechanical complexity and viability drawbacks, which make them unsuitable for solving the technical problem stated.

[0018] Thus, the most recent patent, known by the applicant, for solving the technical problem, is WO 2013/013983, which discloses a device in which, by the action of a plunger (of about 3 and 5 mm diameter, claim 14), from certain means placed outside the supply channel, shuttering of the ejection orifice is produced, being the supply channel pressurized at a pressure lower than the atmospheric pressure.

[0019] Said invention has the drawback of providing low resolution and high technical complexity regarding the sealing of the aforementioned plungers, with respect to the supply chamber, the existence of springs, the mechanical fatigue and time of response of which can seriously constraint the reliability of the device operating at 1kH as it is claimed, and the use of electromagnetic means for operation thereof, adding further complexity factors because of its volume, thus, according to the description, drawings and claims, it seems clear that it is not able to achieve a resolution higher than 1/3.3 points per centimetre.

[0020] On the other hand, WO 2010/146473 discloses a printhead being particularly suitable for viscous or particle-containing fluids, having multiple channels, the operation of said device being controlled by means of a micro-electro-pneumatic circuit containing a micro-valve 18 and a regulating pneumatic throttle 23, so as to generate a control pressure Pc actuating a diaphragm 8 actuated by the control pressure Pc, thus controlling fluid discharge through the fluid outlet 6.

[0021] Thus, said invention provides a version of a device being pneumatically controlled which is analogous to one of the "piezo bend mode" technology, using a diaphragm, having the advantage that the pressure created in the chamber is higher than that being reached with a piezoelectric actuator, but it does not solve the problem of the mechanical resistance of said membrane at high pressures and frequencies, which are necessary for the ejection and the solution of the technical problem.

[0022] On the other hand, US 2002/0191053 describes, in the first claim, a fluid dispensing apparatus for selectively dispensing desired quantities of a fluid under pressure, said apparatus comprising a base plate having a dispensing passage extending about a first axis, a valve arrangement associated with said dispensing passage, and a piezoelectric transducer acting on said valve arrangement to effect displacement of said valve arrangement between a first position in which said dispensing passage is closed and a second position in which said dispensing passage is connected to a source of said fluid under pressure, wherein said valve arrangement comprises a slide valve, said slide valve and said piezoelectric transducer being arranged such that during, at least, the initial displacement of the valve arrangement from said second position towards said first position, said slide valve being displaced in a direction transverse to said first axis.

[0023] One of the main problems that such a device does not solve is that of the possible blockage due to sliding of the dispensing valve over the surface containing the nozzle, particularly if the fluids to be dispensed are liquids having a high solid content. Another additional problem is that of being a big device, in view of the transverse arrangement of the actuator and the length of said actuator.

[0024] Patents US 2009/0115816 and US 2005/084952 similarly claim an ink jet printing element comprising a pressurized ink chamber, at least one ink nozzle that is closed by a mobile valve body, and a piezoelectric valve actuating element which performs bending motions, in a reciprocating motion, and that is electrically connected to a control device. The spring strip is bent in such a way that an end pulls from the valve side (LLA) extending transversely to the reciprocating motion of the valve (6), and a longitudinal section of the strip is perpendicular thereto. The end of the valve side attaches in a way it is allowed to move, to the valve body through a traction rod or through a wire having an adjusting nut.

[0025] Said devices, are characterized in that they feature an indirect action of the actuator over the closure or valve, the position of which has to be secured by a spring, and the connection between the traction rod or the wire and the exterior feature additional sealing and abrasion problems, particularly when used for liquids with high sol-

id content.

[0026] US 2009/0115816 and US 2005/084952 are further differentiated in the resting positions (open and closed, respectively), due to the spring tension supplementing the actuator action. On the other hand, patent US 4,450,375 refers to a bending typology piezoceramic element or bender which cooperates with an impacting element, membrane and valve seat to provide a novel piezoelectric transducer arrangement for achieving desired rapid and accurate control of fluids under pressure in a variety of different applications, such as, computer printing, fluidics, etc. The piezoelectric element is isolated from the fluid being used.

[0027] US 4,450,375 claims a piezoelectric device for selectively dispense desired quantities of a fluid under pressure comprising:

> A). a valve body having a fluid chamber and inlet and outlet means, communicating said chamber with said inlet means adapted to be connected to a source of said fluid under pressure; and
> B). fluid control valve means for controlling such fluid dispensation through said outlet means comprising:
>
> > I). said body having at least one valve seat communicating with said outlet means;
> > II). a deformable member mounted on the valve body which, in cooperation with said valve seat, effectively controls communication with said outlet means about said valve seat, and impacting means directly engageable with the deformable member for selectively distorting said member in said valve seat so as to change the condition of said deformable member about said valve seat, in order to establish or disrupt such communication with said outlet means as desired; and
>
> C). piezoelectric bender means mounted on the valve body isolated from said fluid chamber and adapted to be electrically connected to a DC. source; said bender means including a detectable spring portion engaging with said impacting means to move selectively upon energizing or de-energizing of said piezoelectric bender means for selectively distorting the deformable member, with none of said impacting means or said bender means contacting said fluid.

[0028] US 4,629,926, of the same applicant, also refers to a flow control device of the same type, wherein piezoelectric spring-like benders are operably associated with impacting members, each capable of deforming a membrane so as to control flow past a valve seat upon change in the electrical condition of the piezoelectric members. Each bender and impacting member is isolated from the fluid by the membrane. The benders may be mounted individually, arranged side-by-side for multiple uses or can be grouped in a comb-like configuration. A mounting is provided for the benders, which permits the force exerted on the impacting member by the free end of the bender to be adjusted, and keeps the electrical isolation of the benders one from the others. The mounting as installed provides an adjustable supporting point and a clamping member cooperating with the support for fixing the adjustment. The mounting keeps the free end of the bender centred over the impacting member, and enables initial deflection adjustment and further provides electrical connection of the benders with a fixed receptacle. Where required, any differences in thickness between the assembled benders and the receptacle can be corrected.

[0029] Regarding the disclosures described above, US 4,629,926 and US 4,450,375, do not solve the technical problem of working with very viscous fluids, having a high solid content, since the use of a deformable membrane and a deforming means being interposed (by impact with the bender), introduces a higher stress load for the actuator, particularly for operation at high frequency, furthermore, the high distance between the printheads of the different inks due to the actuators arrangement and size, makes it practically impossible to use due to the distance between the printheads for the different inks, when resolutions higher to the native one are intended.

[0030] Nevertheless, US 4,629,926 is considered the nearest document to the state of the art, with respect to the present invention.

[0031] So, since the technical problem being described remains unsolved, it is an object of the present invention to disclose a device and method for deposition of droplets with a size higher than 100 picolitres, and more preferably between 500 and 50,000 picolitres, of fluids featuring a high solid concentration and high viscosity at the ejection temperature.

[0032] It is also an object of the present invention to describe a fluid deposition device being compacted and small, that is, featuring a reduced dimension in the advance direction of the object onto which the fluid is to be deposited, allowing an interlinked arrangement of devices, so as to enable deposition onto objects wider than the native width of the devices, in such a way that the printing bands "w_i" of the devices can be widen by "n" times, by partial overlapping of the native printing widths "w_i" of n-devices.

[0033] It is also an object of the present invention to describe a deposition method for large volumes of high viscosity fluids and/or fluids containing high percentages of solid dispersions, and that must be applied onto object surfaces, without contact and according to a determined pattern or design.

[0034] Finally, it is an object of the present invention to describe a machine that using said method and device, allows deposition of large volumes of fluids, particularly solid-containing fluids, onto objects surfaces, such as in the application of glazes and engobes onto ceramic products, and other coatings on metal, wooden, card and glass objects (in a non-limitative manner), requiring dep-

osition of high volumes of fluids or dispersions which have to be done contactless and following a determined pattern or design.

Detailed description of the invention

[0035] The present invention describes a method, device and machine for fluid deposition, particularly solid dispersions in fluids, having high solid contents and high viscosity, such that the problems related to the application thereof, in an efficient and cost-effective manner, may be solved.

[0036] The present invention describes a fluid deposition, injection or spraying method, in particular solid dispersions in fluids, and more preferably solid dispersions in liquids, by recirculation of said fluid in a device chamber under pressure, such that the side wall of said device communicates, by means of a orifice drilled therein, with a spraying channel arranged on an adjacent wall and being communicated with said orifice, such that, upon the action of a shutter, being individually operated for each orifice arranged over an actuator, the activation of this actuator arranged in the spraying direction, causes the shutter to slide in a perpendicular direction, detaching from the orifice and releasing the communication path of the pressurized chamber with the ejection channel.

[0037] Said method for the elements deposition allows, due to the vertical situation of the actuators (that is, in the ejection direction), a reduced dimension in the (x) direction in which the ejection nozzles extend (that is, printing width), keeping a constant separation from each other (native resolution) and a reduced size in the (y) direction, perpendicular to this (x) direction of the printing width (w_i) and to the ejection direction (z), which allows a reduced spacing between devices, a reduced size thereof and thus an efficient way of working with fluids.

[0038] Likewise, a device is described using the method above and a machine making intense use thereof.

Description of the drawings

References

[0039]

1. Device for fluid deposition
2. Fluid supply channel
3. Ejection nozzle
4. Ejection channel
5. Passage orifice
6. Means for opening and closing said passage orifice
7. Control means of the device.
8. Fluid inlet channel
9. Fluid outlet channel
10. Device body
11. Access surface
12. Closing plate
13. Sheet containing the passage orifices
14. Sheet containing the ejection channels (4) and the ejection nozzle (3)
15. Sheet constituting the last layer of the closure
16. Actuators access channel
17. Closure
18. Control means cover
21. Shutter
22. Actuator
23. Piezoelectric actuator
24. Actuators glove
31. Piezoelectric actuator electrodes
32. Contactor of the actuator (23) electrodes with the control means (7)
41. Arrangement with a certain degree of non-alignment and overlapping of devices (1).
42. Arrangement being inclined with respect to the perpendicular advance direction.
43. Multiple arrangement being inclined with respect to the perpendicular of the advance of the material.

(p_c) operation pressure

(p_a) atmospheric pressure

(x) direction in which the n nozzles and ejection channels extend.

(y) direction being perpendicular to the plane containing the passage orifices.

(z) direction in which the ejection or deposition takes place.

(d) sliding of the actuator after activation thereof.

(w_i) native printing width of the device.

(r_i) native printing resolution of the device.

(w) printing width of the machine, according to the devices arrangement.

(r) printing resolution of the machine, according to the devices arrangement.

(p) advance direction of the object over the conveying means of the machine.

Figure 1 shows a general view of the device with a detail of the ejection nozzles (3) arrangement and the inlet (8) and outlet (9) of the fluid into the body of the device (19).

Figure 2 shows an exploded view of the elements of the device, based on the device body (10).

Figure 3 shows the device in different assembly stages of the elements, in particular 3a shows the device body, while additionally, 3b shows the device body having the opening means inserted therein, 3c shows the device with the plate of the passage orifices, 3d shows the plate with the ejecting channels and 3e with the closing cover.

Figure 4 shows a detail of the elements of the device body.

Figure 5 shows the body of the device with the open-

ing and closing means (6), with the shutter arrangement (21), the actuator (22) and the piezoelectric actuator (23) being indicated, as well as the control means (7) arrangement.

Figure 6, shows an exploded view of the closing plate (12), comprising the sheet (13) arrangement and constitution containing the passage orifices (5), the sheet (14) comprising the ejection channels (3) and at the bottom thereof, the ejection nozzles (2).

Figure 7 shows an exploded view of the passage orifices opening and closing means (6), including a detail of the shutters (21), actuators (22), the piezoelectric actuator (23), the actuator glove (24), contactors (32) of the piezoelectric actuators in the control means (7) and the closure (18).

Figure 8 shows the inner side of the supply chamber with the different elements being arranged in the resting or closing position, the closing cover (12) constituting a single piece comprising the passage orifices (5), the ejection channels (3) and the ejection nozzles (2).

Figures 9 and 10 show the inner side of the supply channel with the different elements being arranged in the resting or closing position (fig. 9), and in the opening position (fig. 10).

Figure 11 shows two ways for the arrangement and operation of the actuator (22), as this slides the shutter a determined distance "d" in a direction according to the (x) axis over the plane containing the passage orifices (5), or in a direction perpendicular to said plane, in a direction according to the (y) axis.

Figure 12 shows the preferred arrangement according to the modus operandi and operation of the actuator (22) in the (y) direction and of the members said actuator (22) consist of.

Figure 13 shows two view (a and b) with the actuators arrangement being substantially oriented in planes parallel to YZ, and the arrangement thereof after activation of one of the actuators (figures 13-a2 and 13-b2), releasing the passage orifice (5) after the shutter sliding in a direction parallel to the (y) axis.

Figure 14 shows different views of an enlargement of the front side of the device, showing the operation similarly to figure 13.

Figure 15 shows an exploded view of the device elements, based on the device body (10).

Figure 16 shows a general view of the device with a detail of the arrangement of the ejection nozzles (3) and the fluid inlet (8) and outlet (9) into the inner side of the device body (19).

Figure 17 shows how the actuators arrangement in the YZ plane, allows a greater number of actuators, facing figure 17a, in which actuators are equally distanced as in the case of the actuators arrangement in the XZ plane, while figure 17b shows a bigger number of actuators, which allows increasing the number of passage orifices (5) in the (x) direction and thus, a higher resolution of the device (r) compared to the maximum reachable resolution (r_i), according to an arrangement of the actuators in the XZ plane.

Figure 18 shows several arrangements of the devices in a machine, such that printing is produced in the (p) direction, from the left to the right or from the right to the left of said figure, with figure 18a representing the device assembly (1), with a certain degree of non-alignment and overlapping in a direction perpendicular to the advance direction (p) of the object onto which the deposition is performed.

Figure 18b, shows two of the possible assemblies of the obliquus device (42 and 43), allowing the native resolution of the device (r_i) to be increased.

[0040] Particularly, figures 10 and 12 show the bending experimented by the piezoelectric actuator, after it being applied a determined electric charge onto the electrodes thereof, releasing the passage orifice, by the individualized and controlled action if the control means (7).

Disclosure of an embodiment of the invention

[0041] For realizing the present invention, a mechanized body is provided having different cavities and orifices (figure 4), which will make up the body (10) of the device, and which comprises an fluid inlet channel (8) and a fluid outlet channel (9), a fluid supply channel (2), an actuator port or assembly channel (16) and a rectangular opening made in the body of the device in an access surface (11), which is sealed with respect to the outside by means of a closing plate (12).

[0042] In connection with the fluid supply channel (2), being accessible to the outside through one of the faces (11) thereof, there is arranged a part, sheet or plate (13), wherein a series of orifices (5) have been drilled allowing the passage of fluid towards the outside, towards a second part, sheet or plate (14) containing mechanized or pre-formed channels extending to the lower end of said part, ends that will form, once the assembly is closed with a new part, sheet or plate (15), the side closure (12) of the body (10) of the device (1).

[0043] Said plate or sheet (14) comprising the ejecting channels (4) has a thickness which is equal to the final width of the channel, that is the section that will constitute

the ejecting nozzle (3) after mounting the closing sheet (15), in case said ejecting nozzle is intended to have a square section.

[0044] For selective shuttering of each of the passage orifices (5), inside the body of the device, some shutters (21) are arranged, being pre-formed over the flexible material inside which a piezoelectric actuator is introduced (23), making up the so-called actuator (22), the piezoelectric actuator (23) assembly plus the shutter (21) and the flexible material over which it is pre-formed and inside which the piezoelectric element is accommodated.

[0045] The present invention uses, preferably, piezoelectric actuators (23), preferably bimorphic, made up of two or more piezoceramic plates which are overlapping and counter-acting, such that one of them expands and the other contracts.

[0046] The dimensions of this push-pull configuration, defined as length (l), width (a) and thickness, comply with the condition:

$$l >> a >>> e,$$

such that the longest surface (s) corresponds to those dimensions delimited by the length (l) and width (a) sides.

[0047] By way of a non-limiting example, actuators of the following dimensions expressed in millimetres have been used:

$$(l = 18) >> (a = 5) >>> (e = 0.75)$$

For the correct operation of the device, "n" actuators (22) are used, each of them provided with a shutter (21), for each of the "n" passage orifices.

[0048] The "n" actuators assembly constitutes the actuator glove (24), accommodating and isolating the piezoelectric actuators inside thereof, and that through their design allow closing the actuators access (16) and face each of the "n" passage orifices (5) with a shutter (21).

[0049] In the device being described, the "n" shutters are in rest contacting the "n" passage orifices, such that when the supply channel operates at a pressure (p_c) higher than the atmospheric pressure (p_a) it will not experiment any fluid leakage or loss.

Detailed description of the preferred embodiment of the invention

[0050] The device object of the present invention is provided with a body (10) having different cavities and orifices (figure 4) which can be obtained, in a non-limiting way, by mechanizing, casting or extrusion, comprising a fluid inlet channel (8) and a fluid outlet channel (9), a fluid supply channel (2), an actuator port or assembly channel (16) and a rectangular opening in the body of the device in an access surface (11), which is sealed with respect to the outside by means of a closing plate (12).

[0051] Being in communication with the fluid supply channel (2), accessible to the outside through one of the surfaces (11) thereof, there is arranged a closing plate (12) which can consist of a single or several pieces, comprising: an area, part, sheet or plate (13), wherein a series of orifices (5) have been drilled allowing the fluid passage towards the outside, into a second area, part, sheet or plate (14) comprising mechanized or pre-formed channels (4) extending to the lower end of said part, ends which will constitute the ejecting nozzles (3), once the assembly is closed with a new area, part, sheet or plate (15). The three parts, sheets or plates (13, 14 and 15) cited above constitute the side closure (12) of the body (10) of the device (1), the orifices (5), ejecting channels (4) and ejecting nozzles (3) of which have been formed separately, or in one single part, by shear, injection, casting, ablation or mechanized.

[0052] Said plate or sheet (14) containing the ejecting channels (4), have a thickness being equal to the width of the channel end, that is the section that will constitute the ejecting nozzle (3) after mounting the closing sheet (15), in case said injecting nozzle is intended to have a square section.

[0053] In a preferred embodiment, the closing plate (12) is a single part, formed, in a non-limiting way, by casting or injection, containing the whole of the passage orifices (5), ejecting channels (4) and ejecting nozzles (3). This preferred embodiment has additional mounting advantages, as well as the design of the ejecting channels (4) and the ejecting nozzles (2), the shapes of which can be others than channels or orifices having a rectangular or square section.

[0054] For selective shuttering of each of the passage orifices (5), inside the body of the device, some shutters (21) are placed, being pre-formed over the flexible material inside which a piezoelectric actuator (23), the piezoelectric actuator (23) assembly plus the shutter (21) are introduced, as it is also the flexible material over which it is pre-formed and inside which the piezoelectric element is accommodated, constituted the so-called actuator (22).

[0055] In a preferred embodiment, the flexible material portions covering each piezoelectric actuator (23) and isolating it from the fluid, and over which a shutter (21) is pre-formed, that is, each actuator (22), are part of a single part or actuator glove, extending beyond them, further covering and isolating the control means (7).

[0056] For the correct operation of the device, "n" actuators (22) are used, each of them being provided with a shutter (21), for each of the "n" passage orifices (5).

[0057] By way of analogy, for better explaining the previous two points, each piezoelectric actuator is embedded into a flexible material, such that it shutters a specific passage orifice, in the fashion a hand in gloves will selectively shutter the orifices of a flute for playing music, such that each finger would be a piezoelectric actuator (23) sheathed into a finger of the glove (24), of flexible

material, and which based on the nerve impulses the hand received from the brain, this would act through the control means (7) situated in the rest of the hand (leaving the cited fingers aside), in such a way that in a preferred embodiment, both the piezoelectric actuators (fingers) and the control means (hands), are isolated from the outside by means of a glove.

[0058] Thus, the "n" actuator assembly constitutes the glove of the "n" actuators (24), accommodating the different "n" piezoelectric actuators (23), and is designed for, facing each of the "n" passage orifices (5) with one of the "n" shutters (21).

[0059] In the device being describes, the "n" shutters are in rest, contacting the "n" passage orifices (figures 8 and 9), such that when the supply channel operates at a pressure (p_c) higher than the atmospheric pressure (p_a), it will not experiment any fluid leakage or loss.

[0060] Upon the application of an exterior signal to the control means (7), these individually activate the piezoelectric actuators, releasing (figure 10) the corresponding passage orifices (5) of the shutters (21) thereof, causing the fluid ejection through selected nozzles.

[0061] The working method of the device object of the present invention, operates in such a way that, upon reception of the signals from an external control device, these are processed by the device control means (7), which based on them, will activate or not, by applying or not a determined electric charge on any of the "n" piezoelectric actuators (23) through the contacts of the electrodes (31) thereof, in such a way that this, upon receiving said activation, where appropriate, will experiment a bending deformation in the direction of its biggest dimension (l), in a direction being substantially perpendicular thereto, and to the axis coinciding with the ejection direction (z), so that the displacement thereof should move the shutter (21) away from the passage orifice (5) opposite thereto, releasing the orifice opening of the passage orifice (5) and generating, by action of the fluid pressure contained in the feeder (2), the fluid ejection through any of the "n" ejecting nozzles (3), the ejecting channel (4) of which is in communication with the passage orifices (5) being released.

[0062] In a non-preferred embodiment, the larger surface (s) of the actuators is oriented to a plane being parallel to the XZ plane, in such a way that deformation (d) of the actuator is obtained according to the directions parallel to the (y) axis.

[0063] In a preferred embodiment, the longest surface (s) of the actuators is oriented to a plane being parallel to the YZ plane, but aligned according to perpendicular planes thereto, that is, parallel to the XZ plane, such that the actuator deformation is obtained according to the directions being parallel to (x) axis.

[0064] Figure 11 show both possible orientations and the shutter displacements based on the deformations being experimented.

[0065] The present invention describes the use thereof in a Machine, such that said devices can be mounted in a machine, placed in any of the ways provided in patent ES2302634 of the applicant (inkjet printing autonomous module), that is, in one or several rows substantially perpendicular to the advance direction of the object (fig. 1 a and 2a of the cited patent), or having certain degree of inclination (figure 1b and 2b of the referred patent), in which figure 1 a shows the schematic arrangement of devices for printing at just one passage the wide required, following a configuration in which the printing width is increased keeping the native resolution of the device, while figure 1b is a schematic view similar to figure 1a, according to a configuration in which the printing width and the printing resolution have been increased (by a factor equal to 1/sine α).

[0066] On the other hand, figure 2a of the referred patent ES'634 shows the structure of devices from figure 1a, repeated for each one of the different inks (colours) being used, ordered in different rows, and figure 2b is similar view to that of figure 2a in which the printheads are repeated for each of the different inks.

[0067] In both cases, different inks or fluids can be used, or else the same fluid, with which, according to 2a and 2b, the native resolution of the device could be multiplied by four.

[0068] Said machine will allow application of large volumes of fluid, easing the process of glazing or covering of materials, such as ceramic material and glass, plastic, wood, and in a non-limiting way, any other material requiring high volumes of selective deposition of fluids having a high solid content and/or high viscosity, following a defined pattern or design.

Claims

1. Device for deposition of fluids (1) comprising at least a fluid supply channel (2), at least an ejecting nozzle (3) being in communication with said supply channel through an ejecting channel (4) and a passage orifice (5), opening and closing means (6) for said passage orifice and control means (7) of the device, **characterized in that**:

   said fluid supply channel (2) is communicated with at least fluid inlet channel (8) and at least a fluid outlet channel (9), made in the body of the device, in such a way that it allows fluid recirculation through said supply channel,
   said fluid supply channel (2), is accessible from the outside through a rectangular opening made in the body (10) of the device in one of the surfaces (11) thereof, in such a way that said opening can be tightly sealed by means of at least a closing part (12), allowing that said supply channel can be operated at a pressure (p_c) higher than the atmospheric pressure (p_a)
   said at least one closing part (12) contains the passage orifices (5), the ejecting channels (4)

and the ejecting nozzles (3),
said opening and closing means (6) for the passage orifices (5) consist of at least a shutter (21) being opposite to each of the passage orifices (5), being arranged on the actuator (22) substantially oriented according to the ejection direction (z), such that a displacement of said actuator releases said shutter and communicates the supply channel (2) with the ejecting channel (4), and through the ejecting nozzle (3) with the outside, or otherwise it secures the closure by displacing in the opposite direction.

2. Device for deposition of fluids (1) according to claim 1, **characterized in that** said at least one ejecting nozzle (3) constitutes a plurality of ejecting nozzles (3) being homogeneously spaced at a distance (r) among the centres thereof, along a direction (x), being each of a plurality of ejecting nozzles (3) in communication with said supply channel (2) through its own ejecting channel (4) and an individual passage orifice (5), individually operated through opening and closing means (6) associated to each passage orifice (5) and ejecting nozzle (3), by the control means (7).

3. Device for deposition of fluids (1) according to any of the previous claims, **characterized in that** said actuator (22) consists of:

- at least a piezoelectric actuator (23), electrically actuated by means of the control means (7), in such a way that, depending on the polarity and voltage being applied to the electrodes (31) thereof, it is bent in the direction perpendicular to the plane defining the longest surface (s), thus releasing the passage orifice (5) from its corresponding shutter (21) or securing the closure if it bent to the opposite direction, and **in that**
- a flexible part or glove, which, enclosing the piezoelectric actuator (23) constitute a flexible body comprising the shutter (21) and the piezoelectric actuator (23), isolating the latter from contacting the fluid, said shutter (21) consisting of a cylindrical closure of a flexible material, having a diameter being substantially bigger than the passage orifice (5) to which it blocks, and being pre-formed over said flexible part.

4. Device for deposition of fluids (1) according to claim 3, **characterized in that** the direction being perpendicular to the plane defining the longest surface (s) thereof, coincides with the (y) axis being perpendicular to the plane of the closing plate (12), releasing the passage orifice (5) from its corresponding shutter (21) by displacement (d) thereof in the direction parallel to said (y) axis.

5. Device for deposition of fluids (1) according to claim 3, **characterized in that** the direction being perpendicular to the plane defining the longest surface coincides with the (x) axis being perpendicular to the plane of the closing plate (12), releasing the passage orifice (5) from its corresponding shutter (21) by displacement (d) thereof over the plane containing the passage orifices (5), in the direction being parallel to said (x) axis.

6. Device for deposition of fluids (1) according to any of the previous claims, **characterized in that** said flexible part (22) enclosing each one of the actuators (23) constitute a part of a single flexible body (24) comprising a plurality of shutters (21) and isolating the plurality of actuators (23) from contacting the fluid, in such a way that each one of the plurality of passage orifices (5) remains opposite to the shutter (21) and to a piezoelectric actuator (23), being specific and individualized in the action thereof, within the plurality of shutters and actuators contained in a single flexible body (24).

7. Device for deposition of fluids (1) according to any of the previous claims, **characterized in that** said at least one closing plate (12) consists of: at least a sheet (13) comprising the passage orifices (5), at least a sheet (14) comprising the ejecting channels (4) and the ejecting nozzles (3) and at least a last sheet (15) constituting the last layer of the closure.

8. Device for deposition of fluids (1) according to any of the previous claims, **characterized in that** the flexible body (24) covering and isolating the piezoelectric actuators (23), extend encapsulating and covering the control means (7), in such a way that they remain isolated from the fluid and the outside.

9. A method for deposition of fluids **characterized in that** the deposition is performed from a fluid supply channel (2), through at least one orifice (5) made in a wall (13) of the body of said device, parallel to the deposition direction, which by releasing a shutter (21) situated in said supply chamber (2), transmits the fluid to a second wall (14) being parallel and adjacent thereto, onto which a groove has been made in a direction parallel to the ejecting axis and constituting a ejecting channel (4), the end of which constitutes the ejecting nozzle or orifice (3), said channel remaining closed towards the outside by another wall (15) being adjacent and parallel.

10. A method for deposition of fluids according to claim 9, **characterized in that** said at least one ejecting nozzle (3), said at least one ejecting channel (4) and said at least one passage orifice (5), have been mechanized or formed in a single piece which constitutes the closing wall (12).

11. A machine for deposition of fluids according to any of the previous claims **characterized in that** placing the devices (1) according to an inclined arrangement (42 and 43) with respect to a direction being perpendicular to the advance direction (p) of the object onto which the deposition is performed, allows extending the native printing width (w_i) of the device (1) and the native resolution of the mentioned devices (r_i).

12. A machine for deposition of fluids according to any of the previous claims **characterized in that** by means of the arrangement (419 of said devices (1) in a direction being perpendicular to the advance direction (p) of the object onto which the deposition is to be performed, with certain degree of non-alignment and overlapping of the deposition devices (1), allows extending the native printing width of the device (w_i).

13. A machine for deposition of fluids according to claims 11 and 12, **characterized in that** said depositions of the devices allow extending the native printing width of the device and increasing the native resolution of the above mentioned devices, if two or more of said depositions are used for the same fluid.

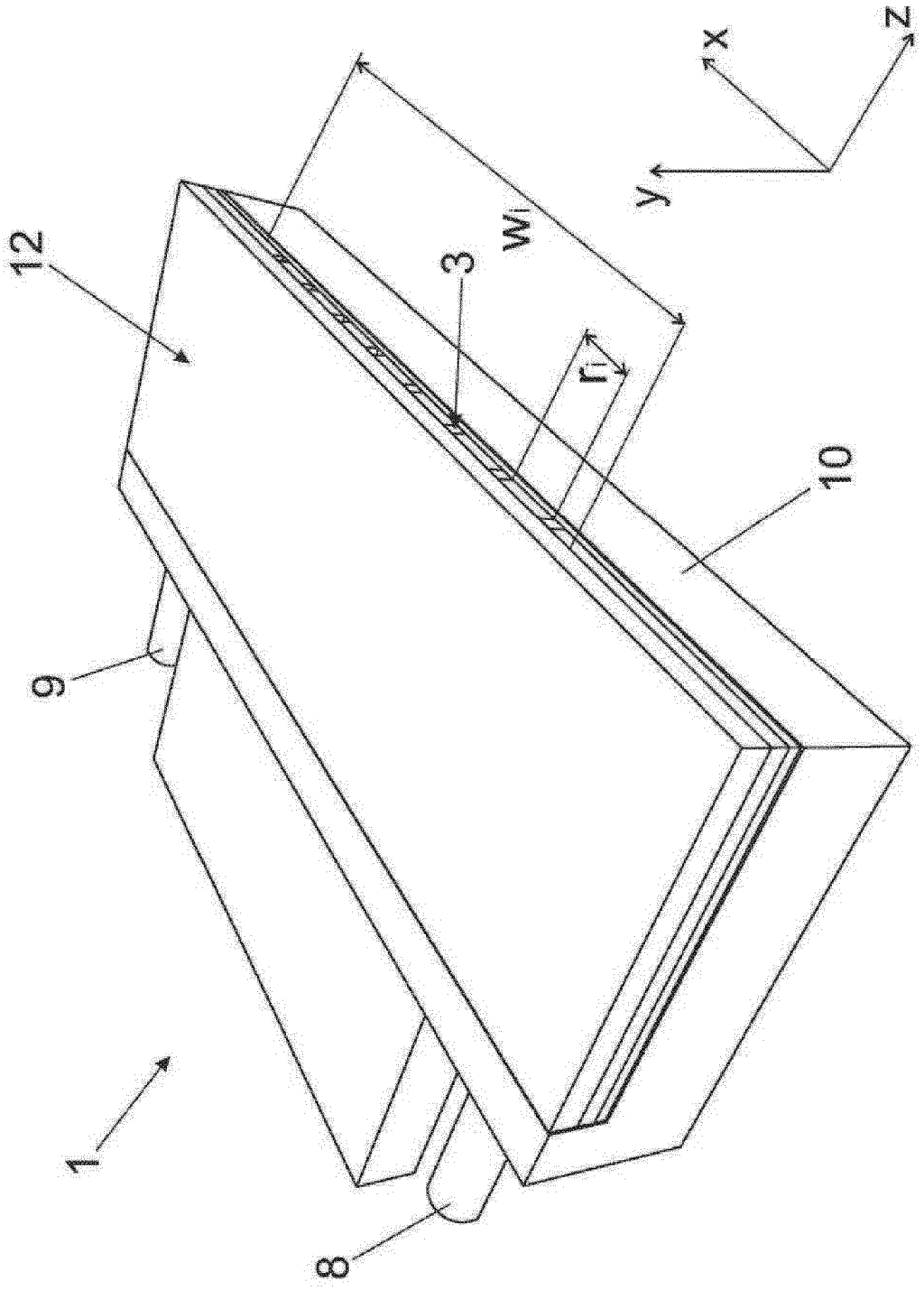

Fig. 1

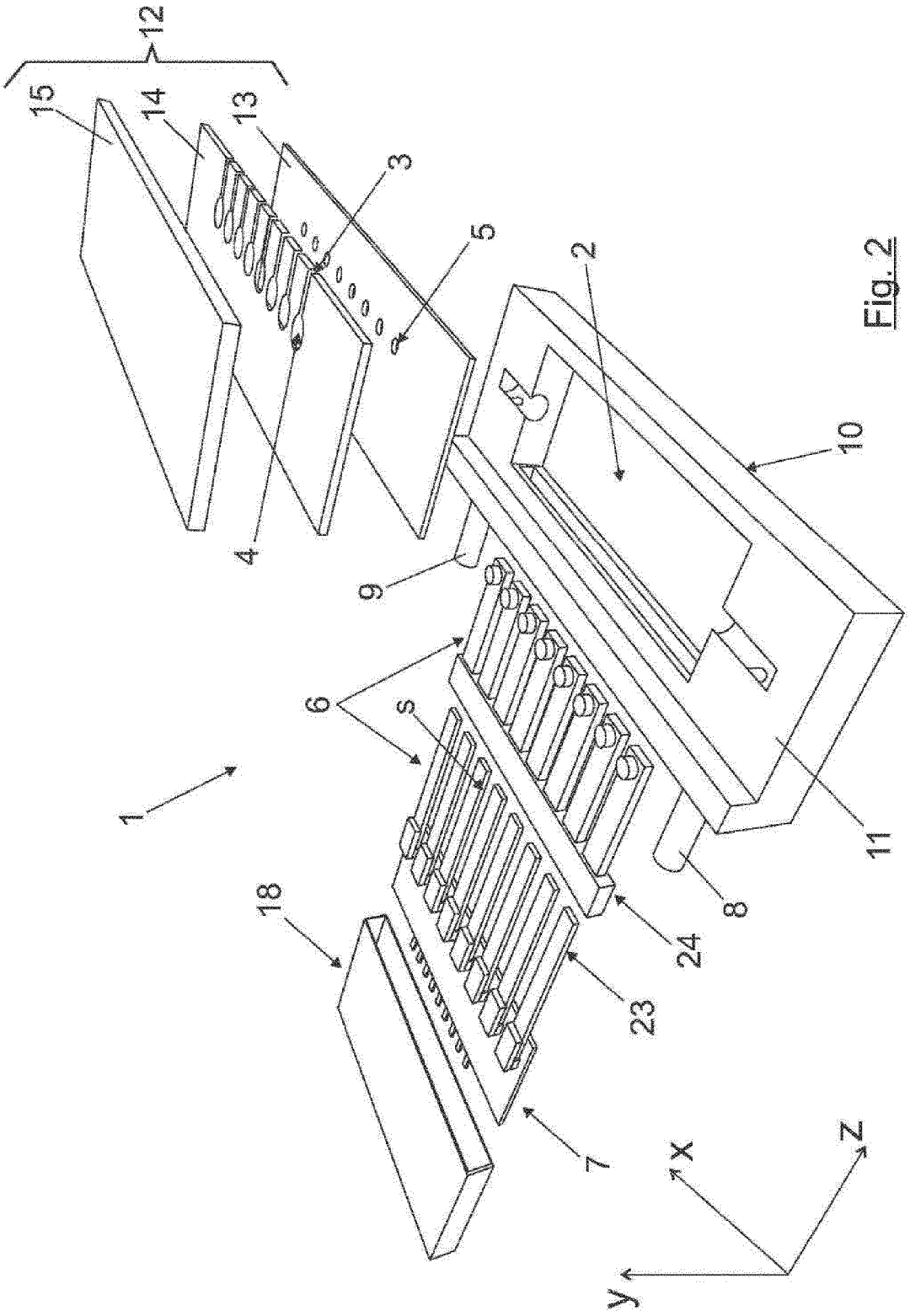

Fig. 2

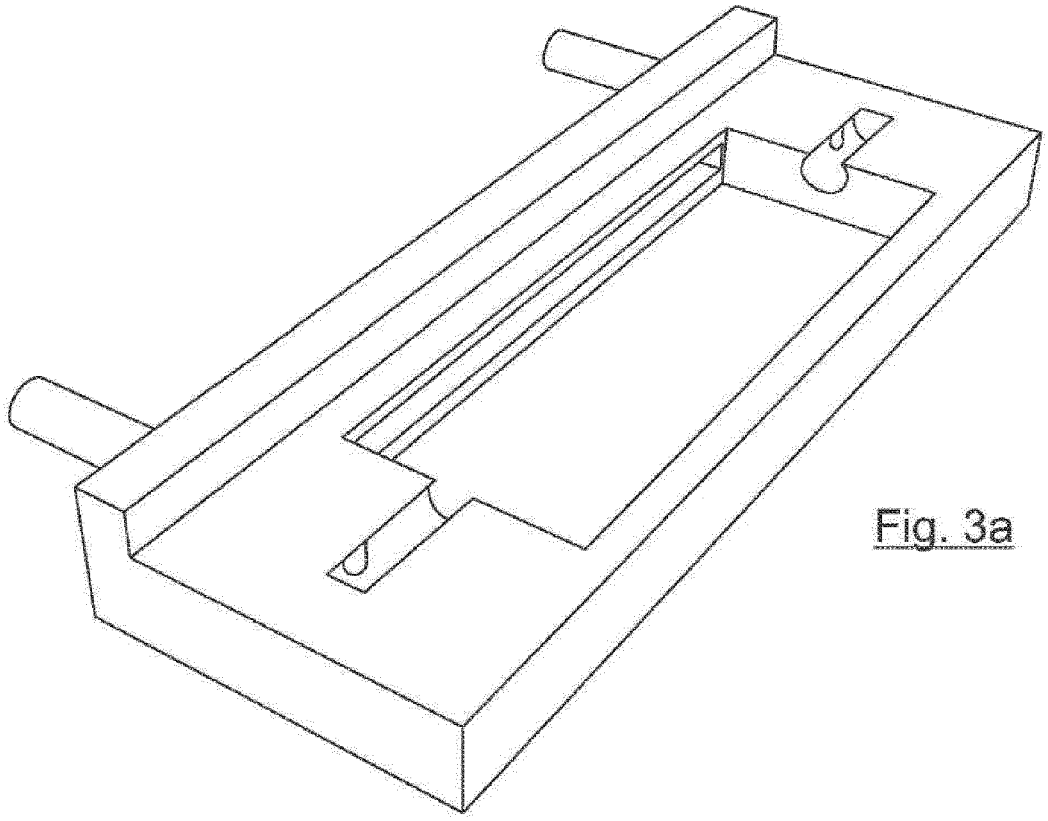

Fig. 3a

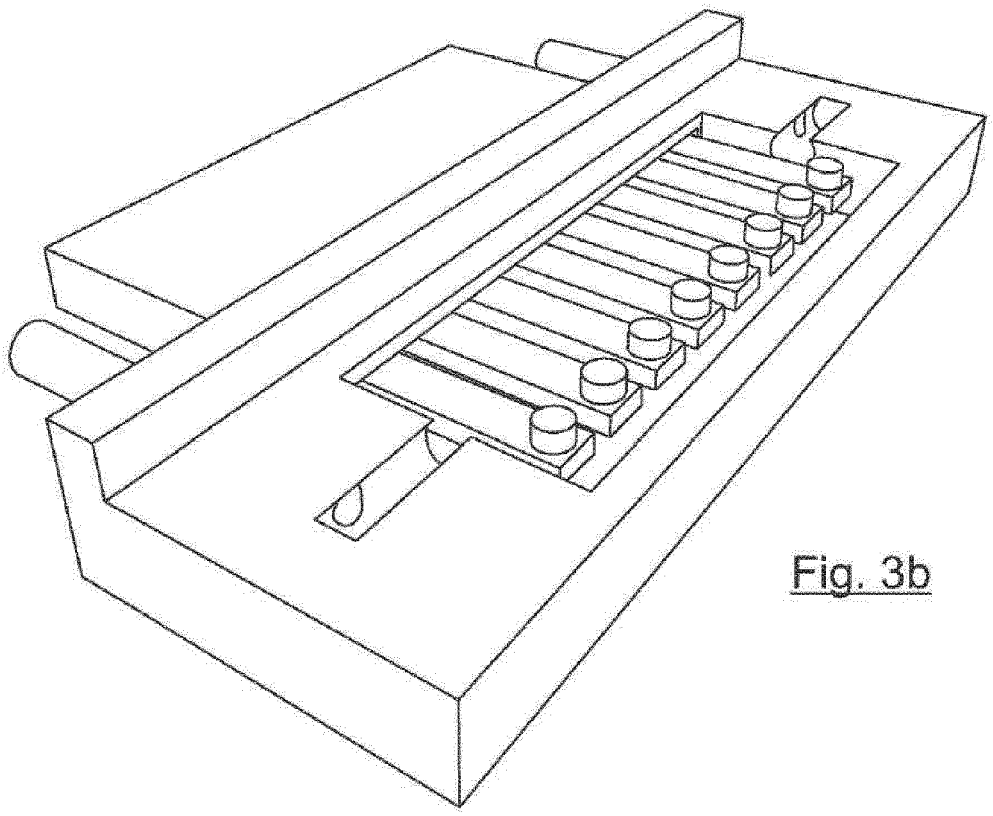

Fig. 3b

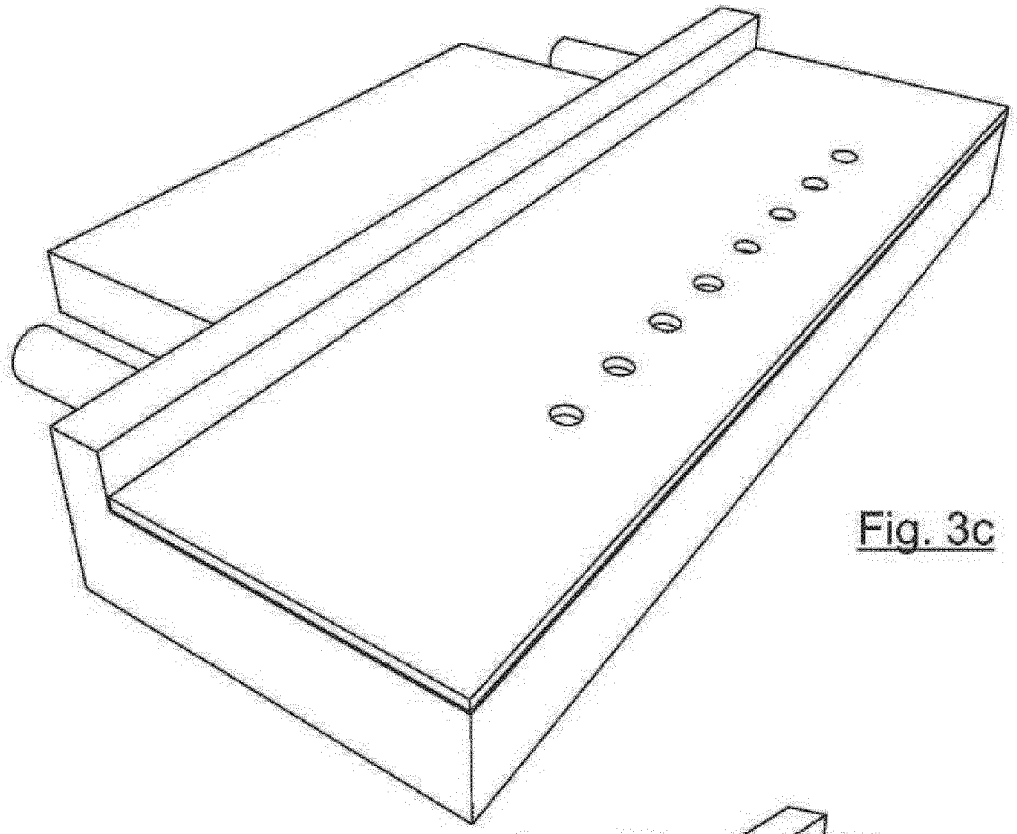

Fig. 3c

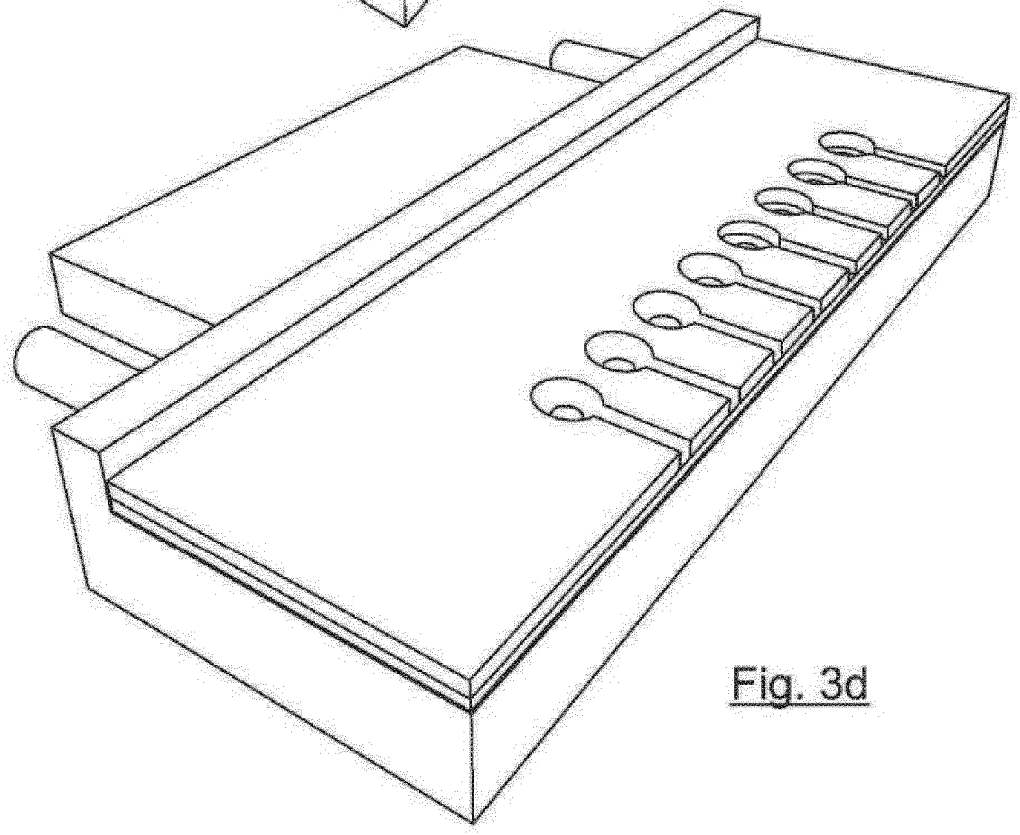

Fig. 3d

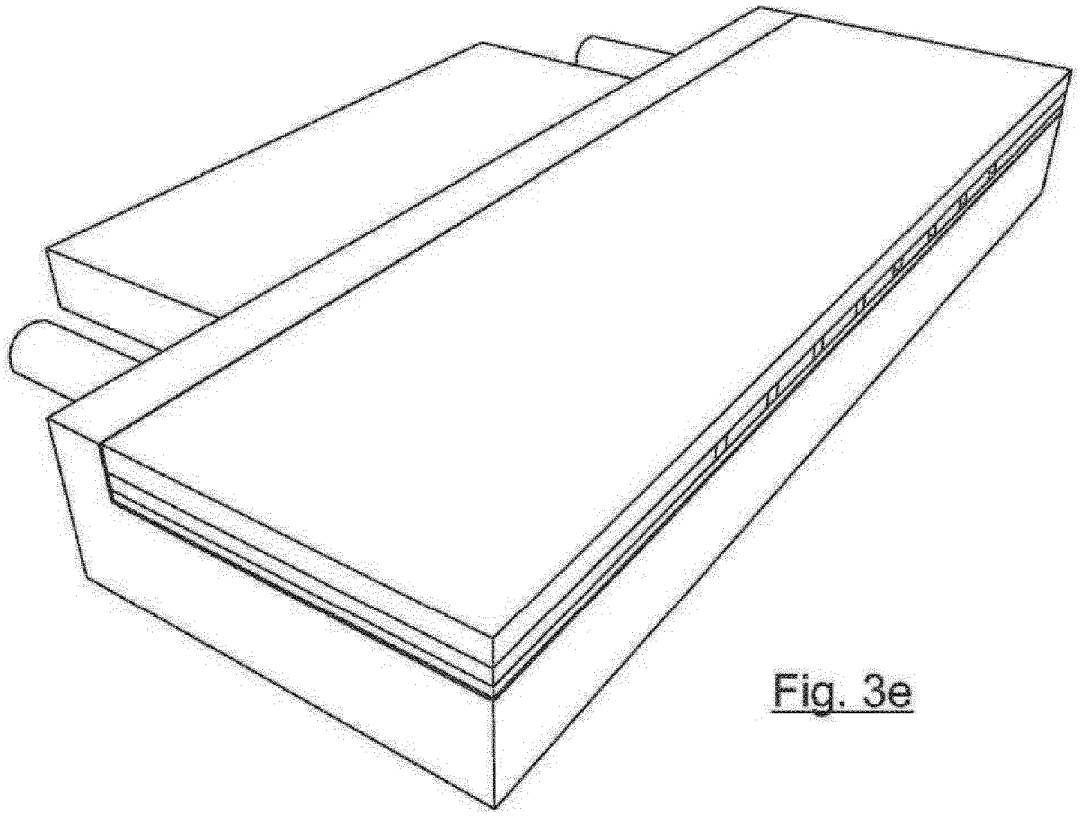

Fig. 3e

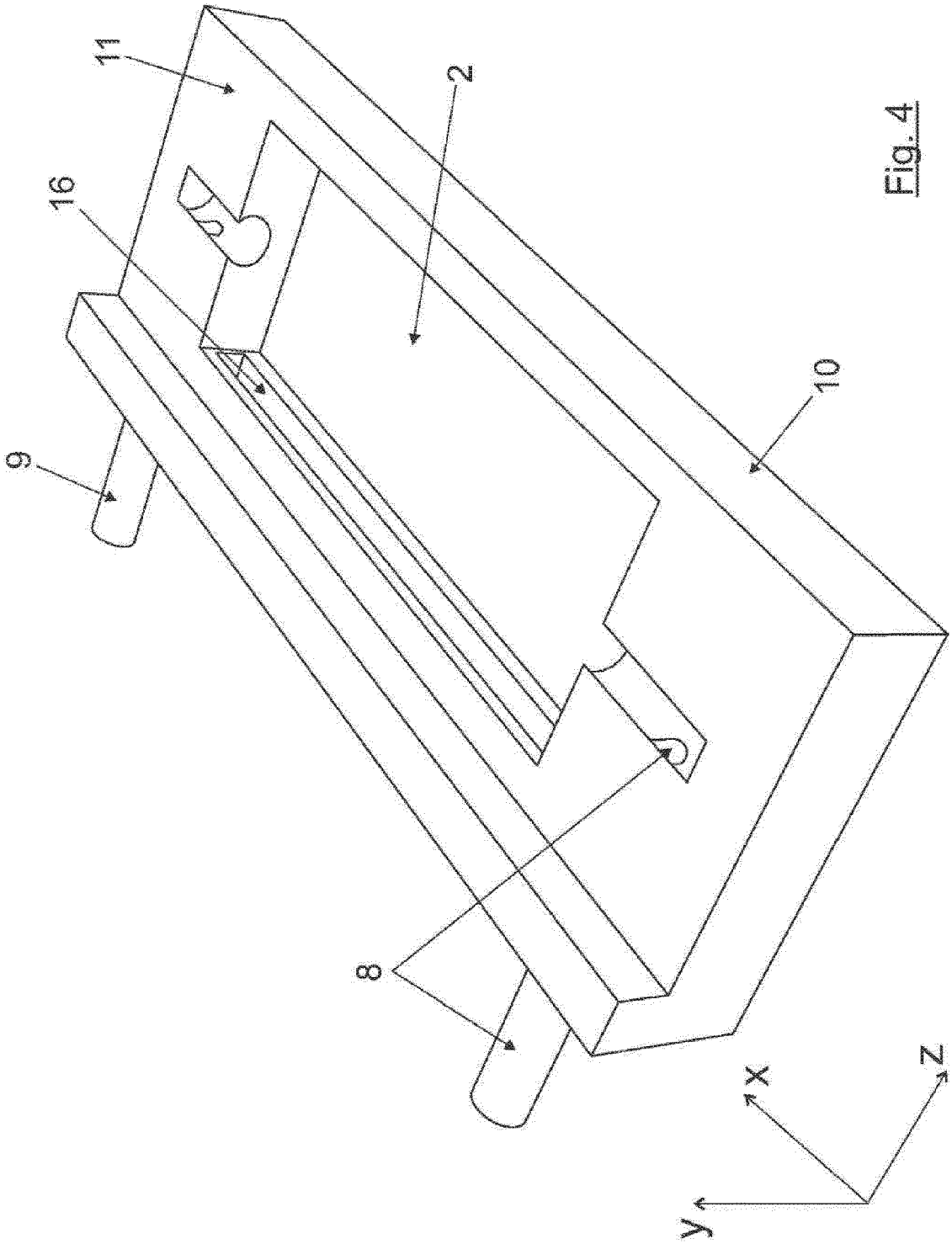

Fig. 4

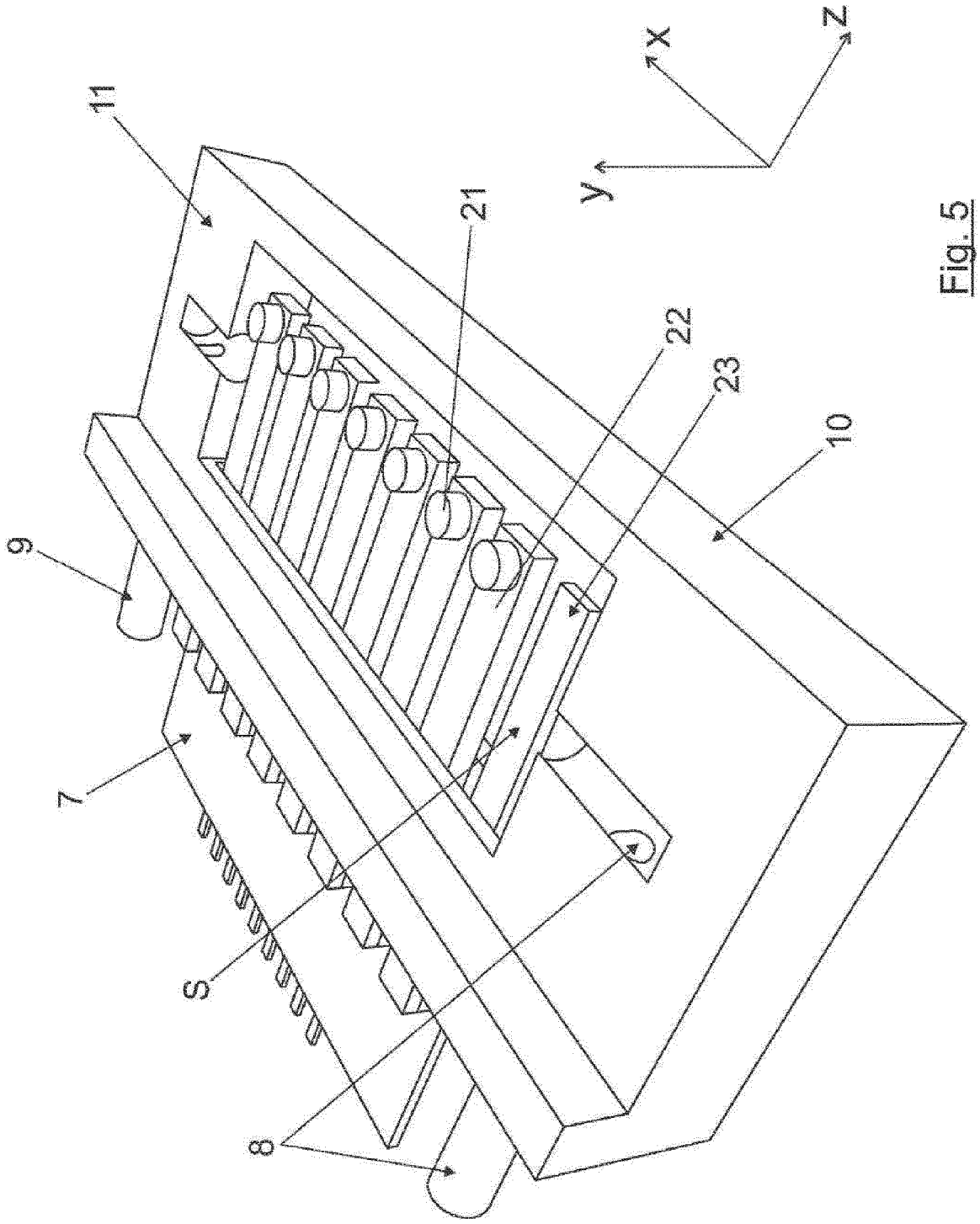

Fig. 5

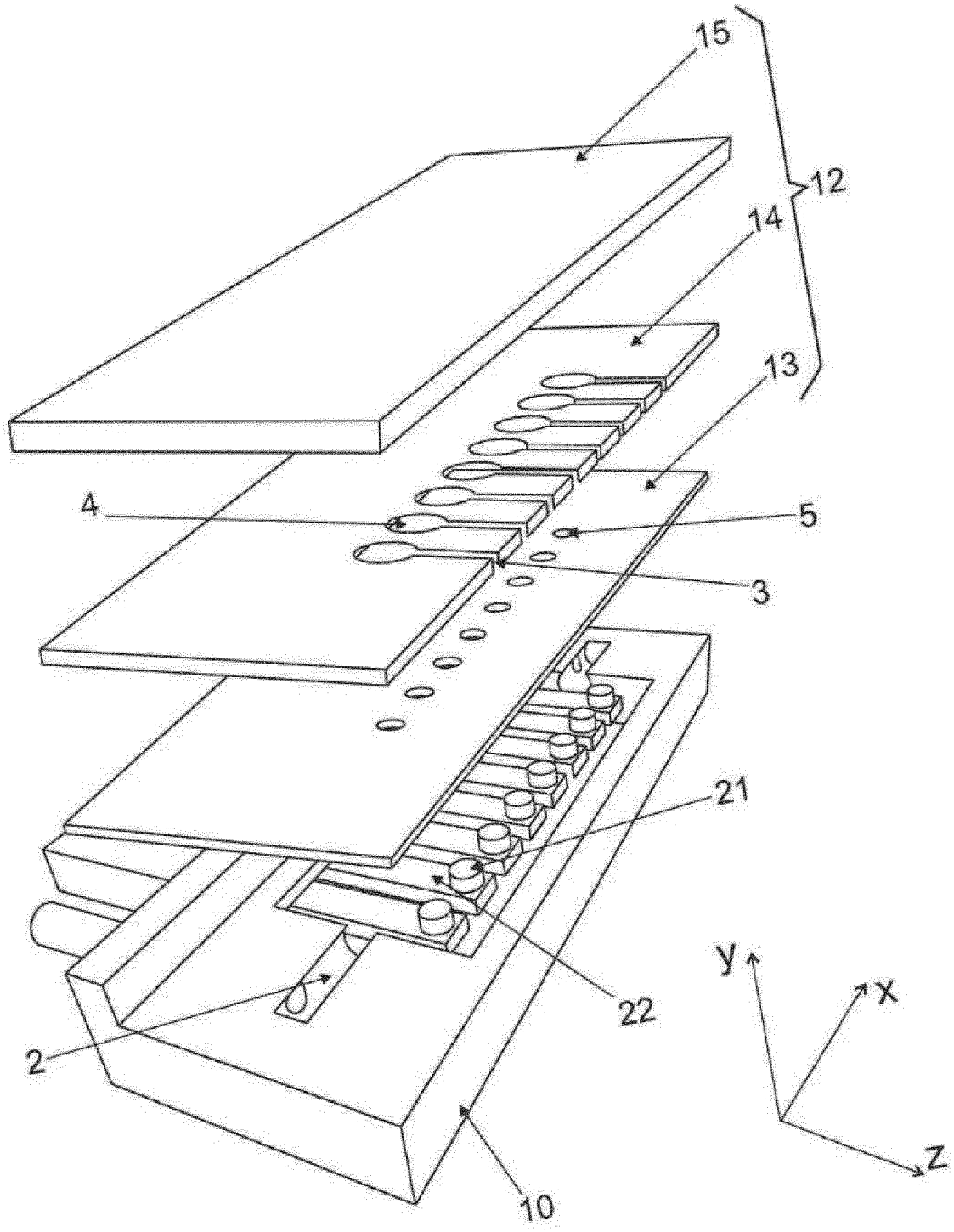

Fig. 6

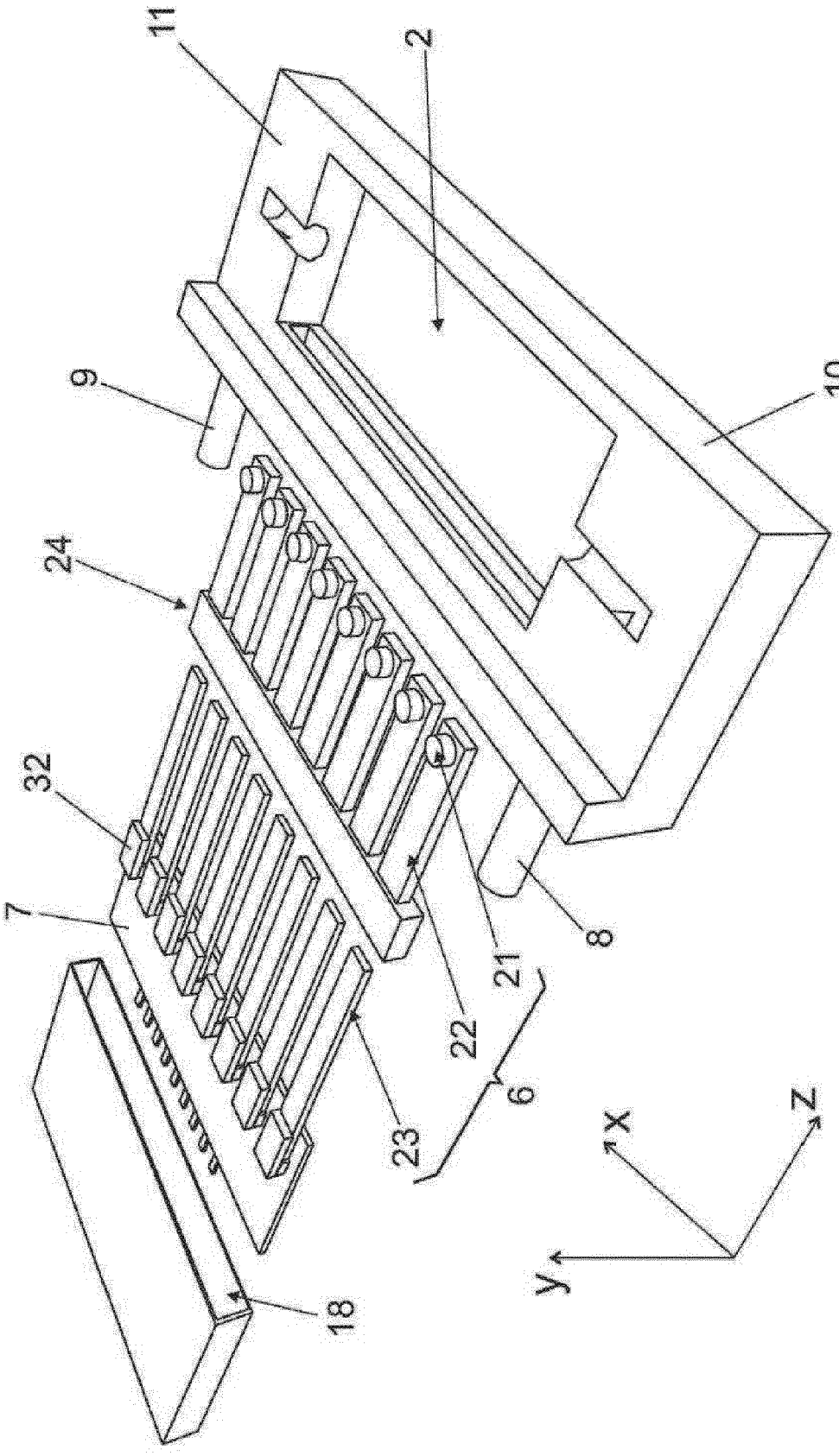

Fig. 7

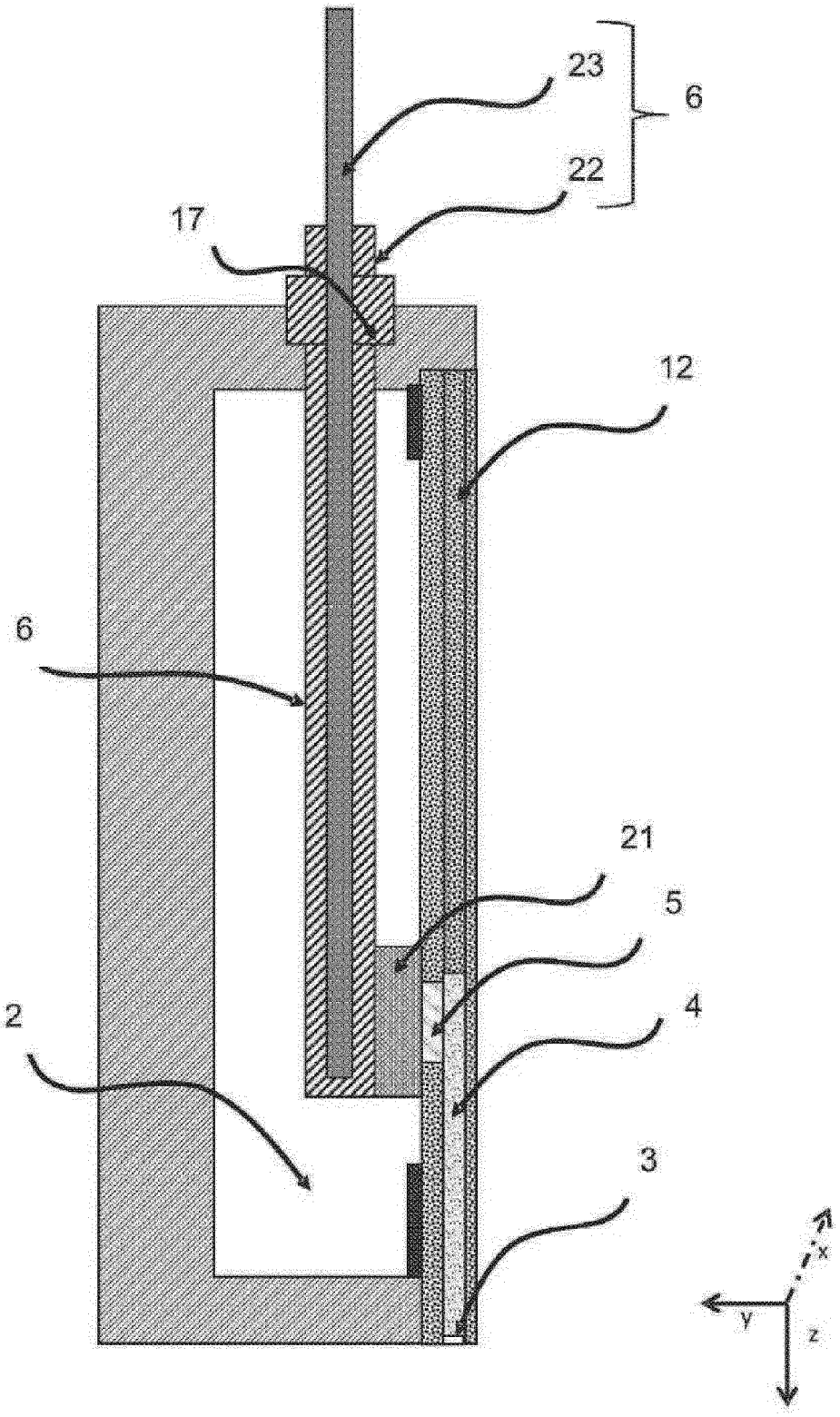

Fig. 8

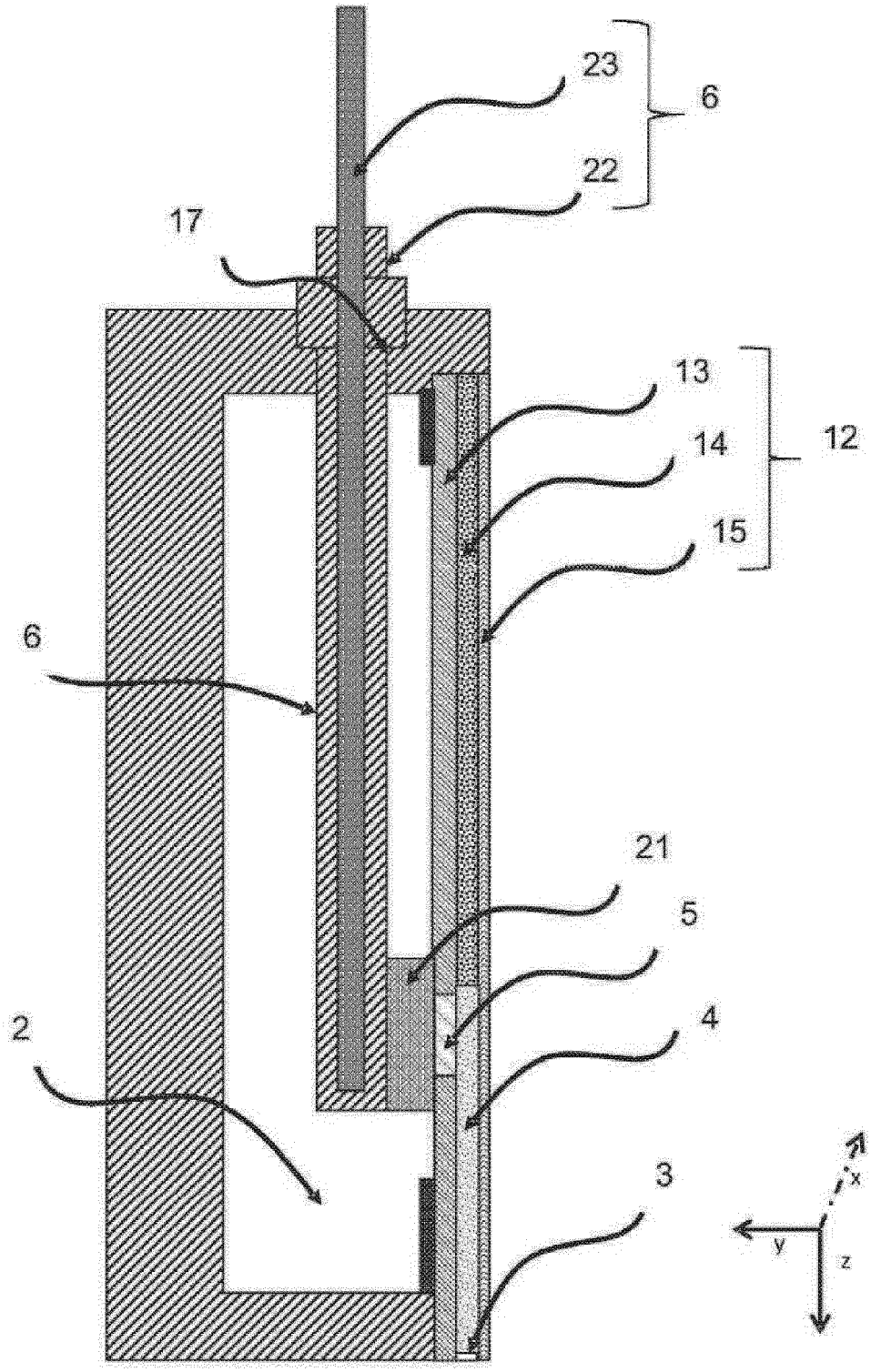

Fig. 9

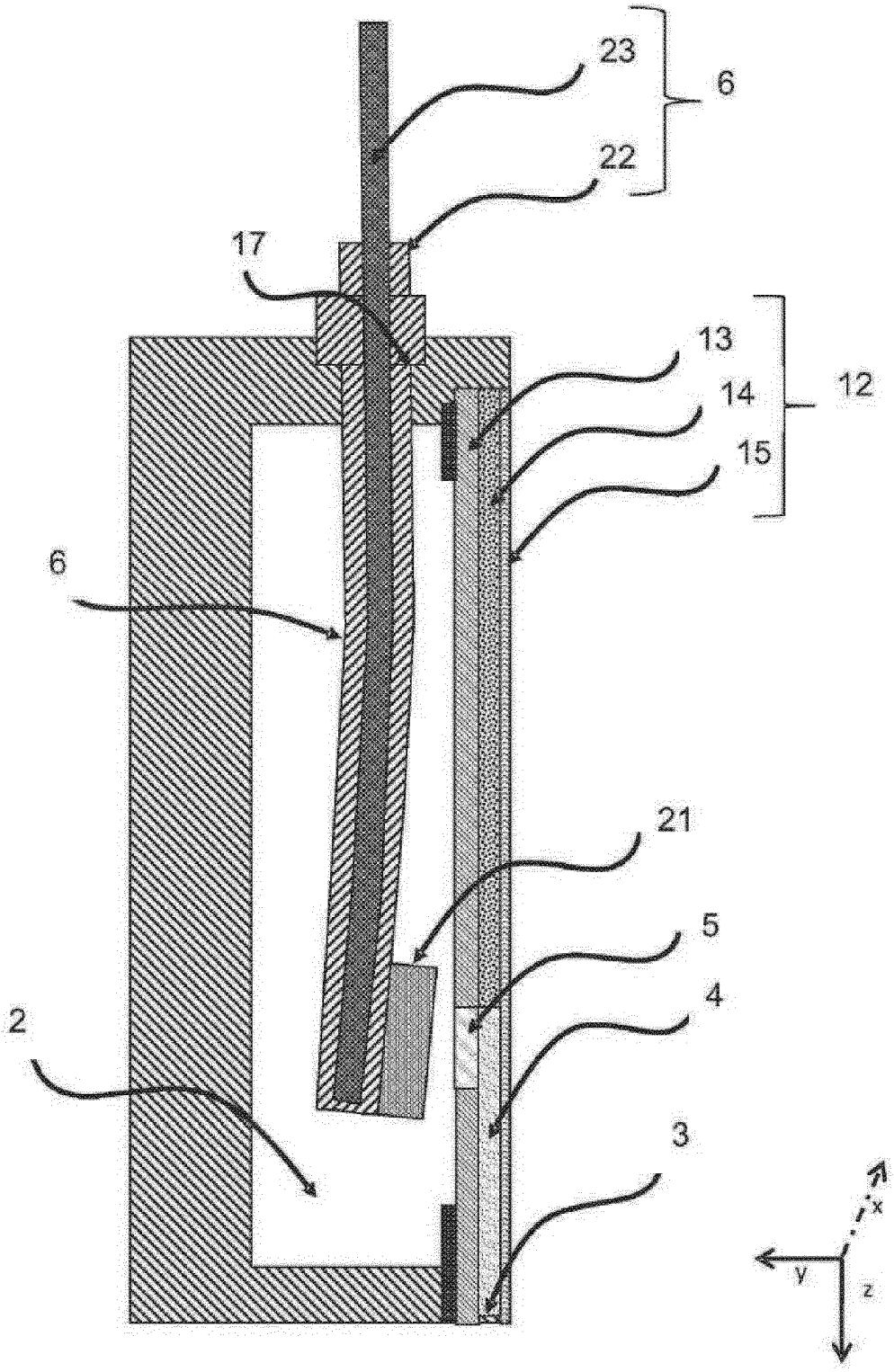

Fig. 10

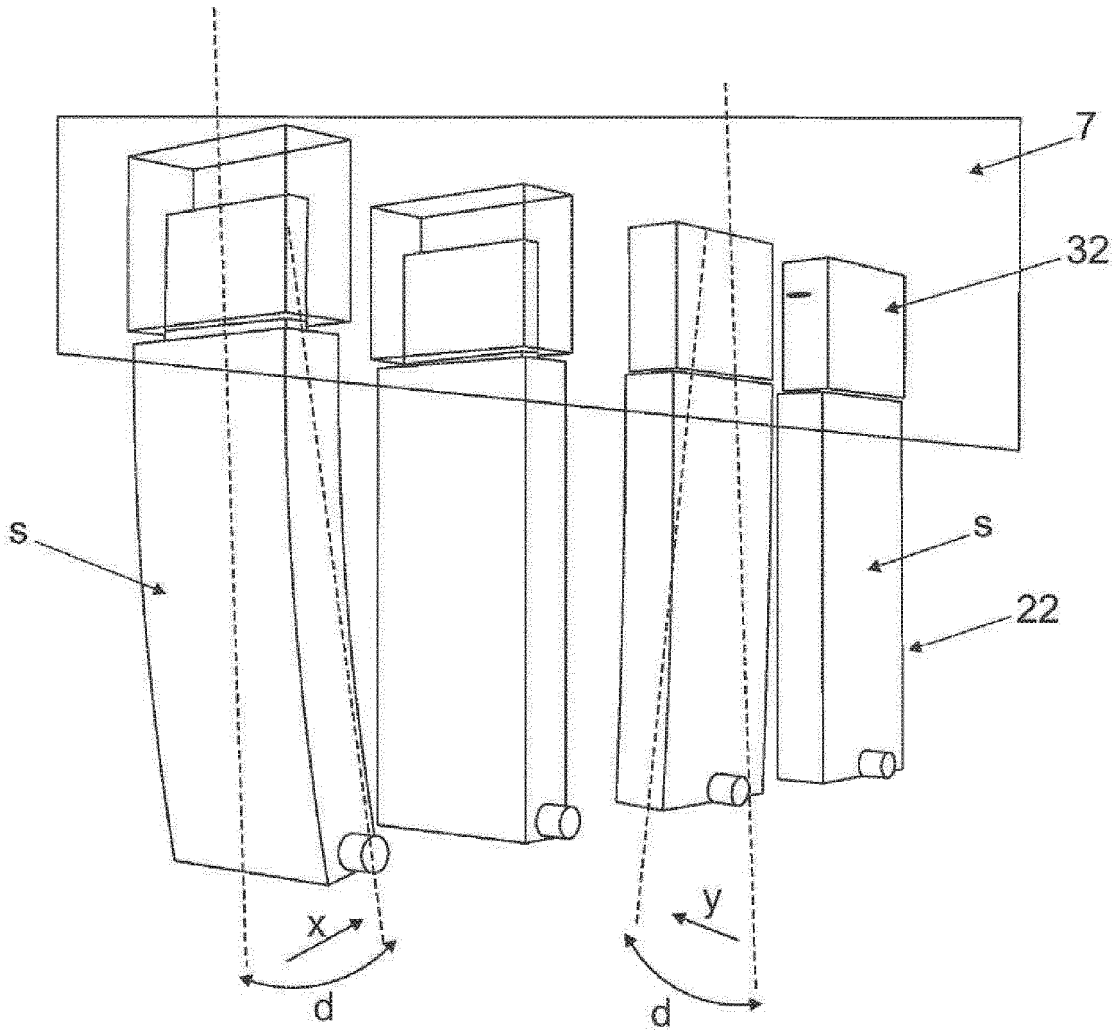

Fig. 11

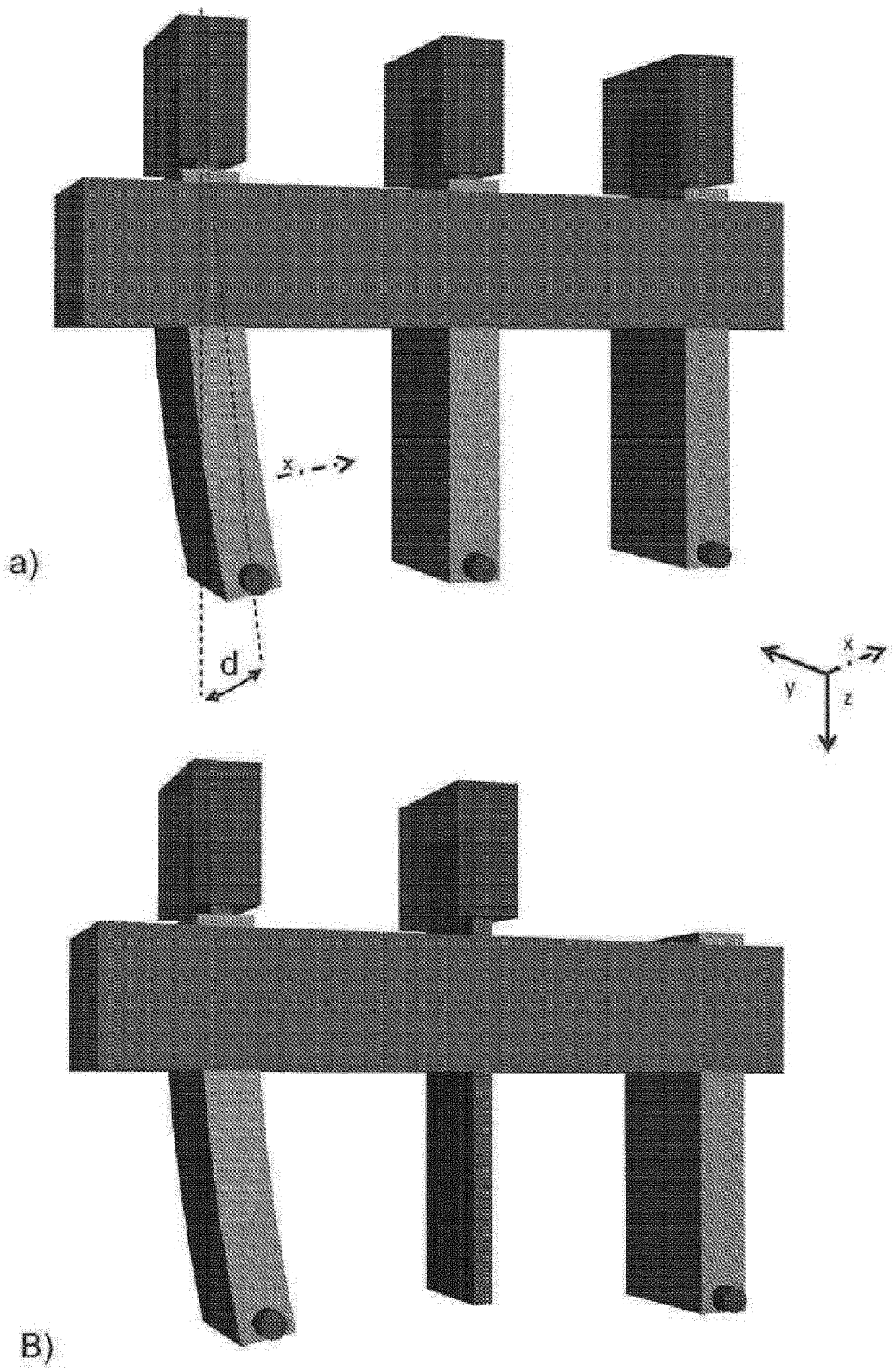

Fig. 12

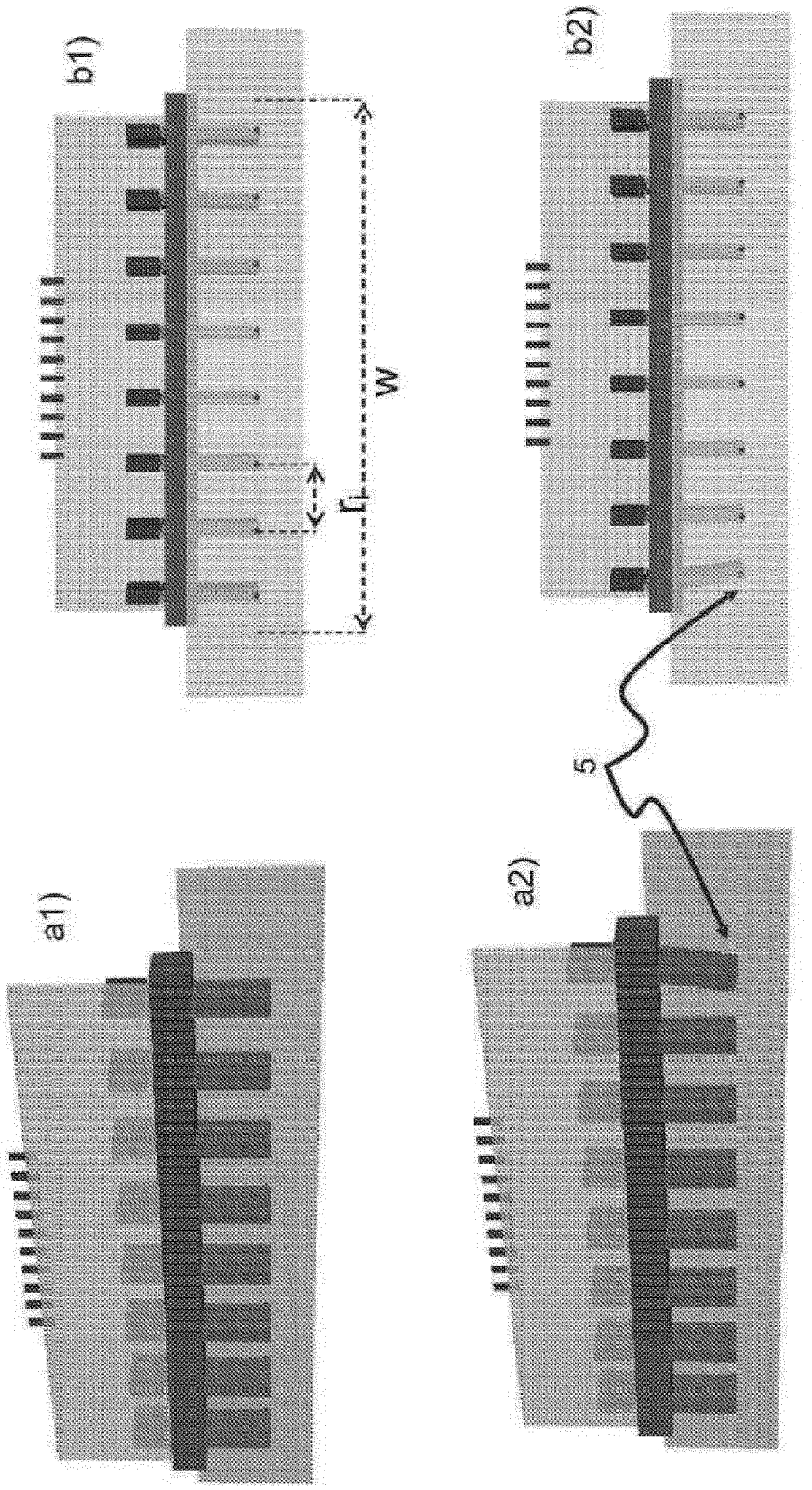

Fig. 13

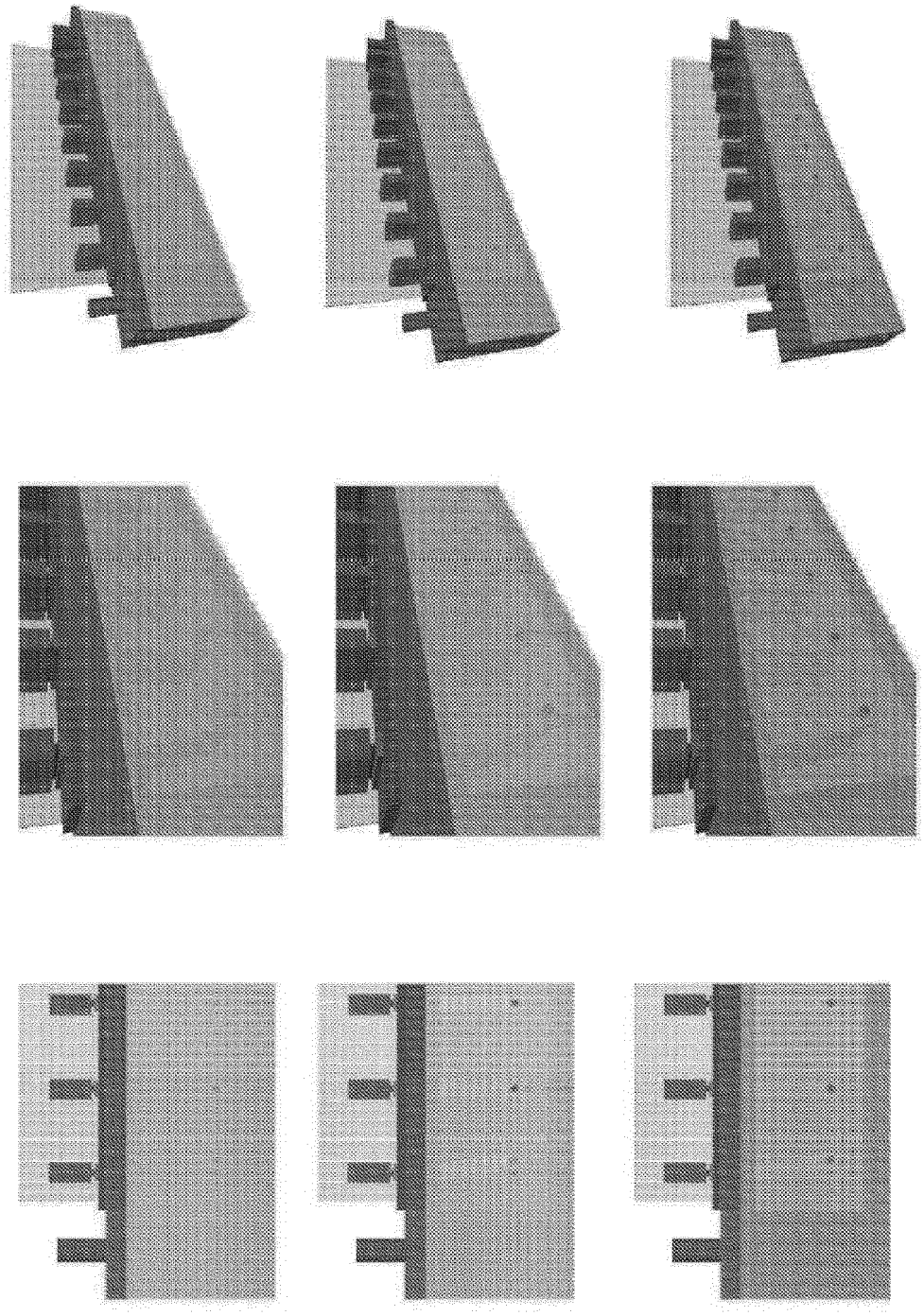

Fig. 14

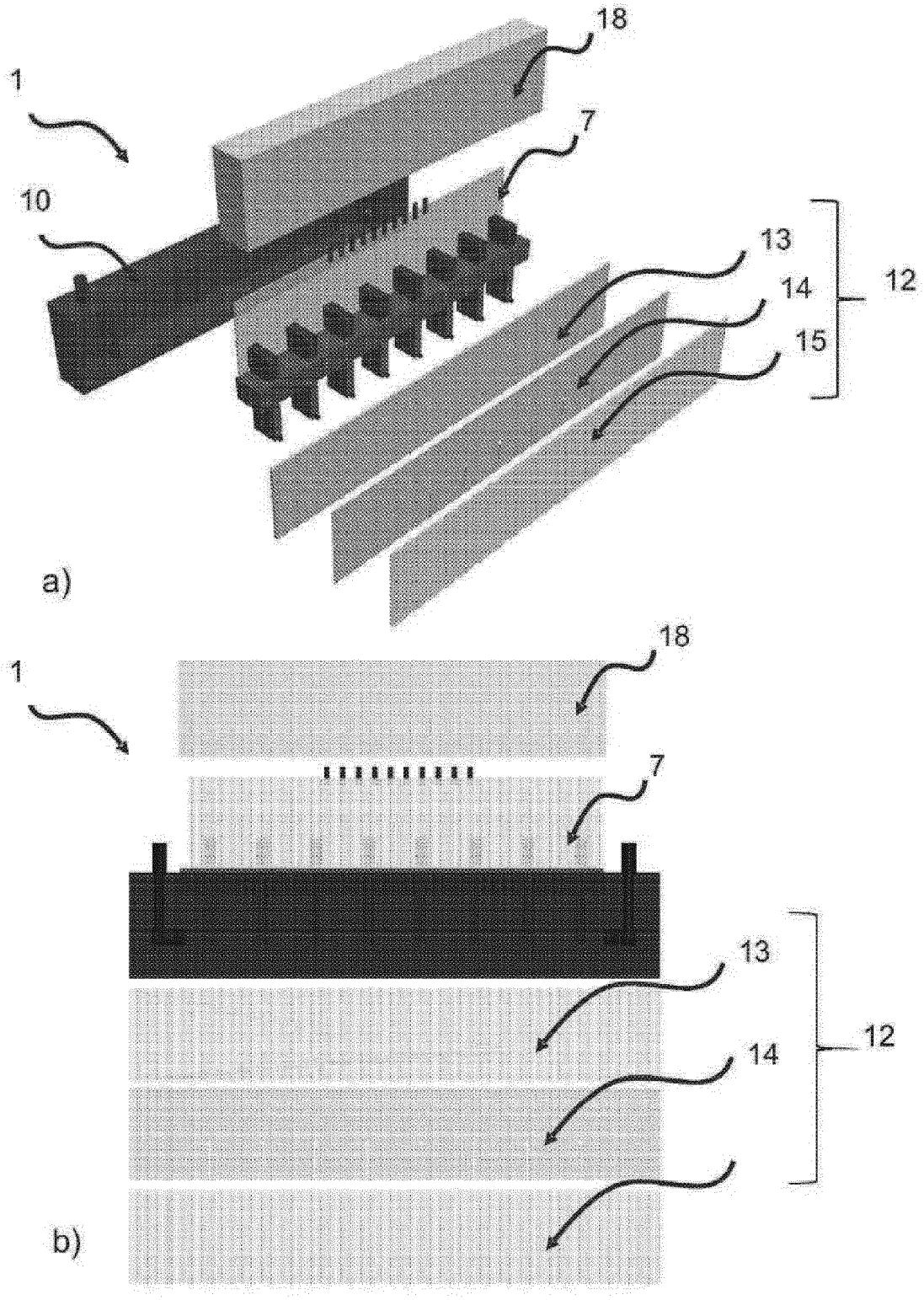

Fig. 15

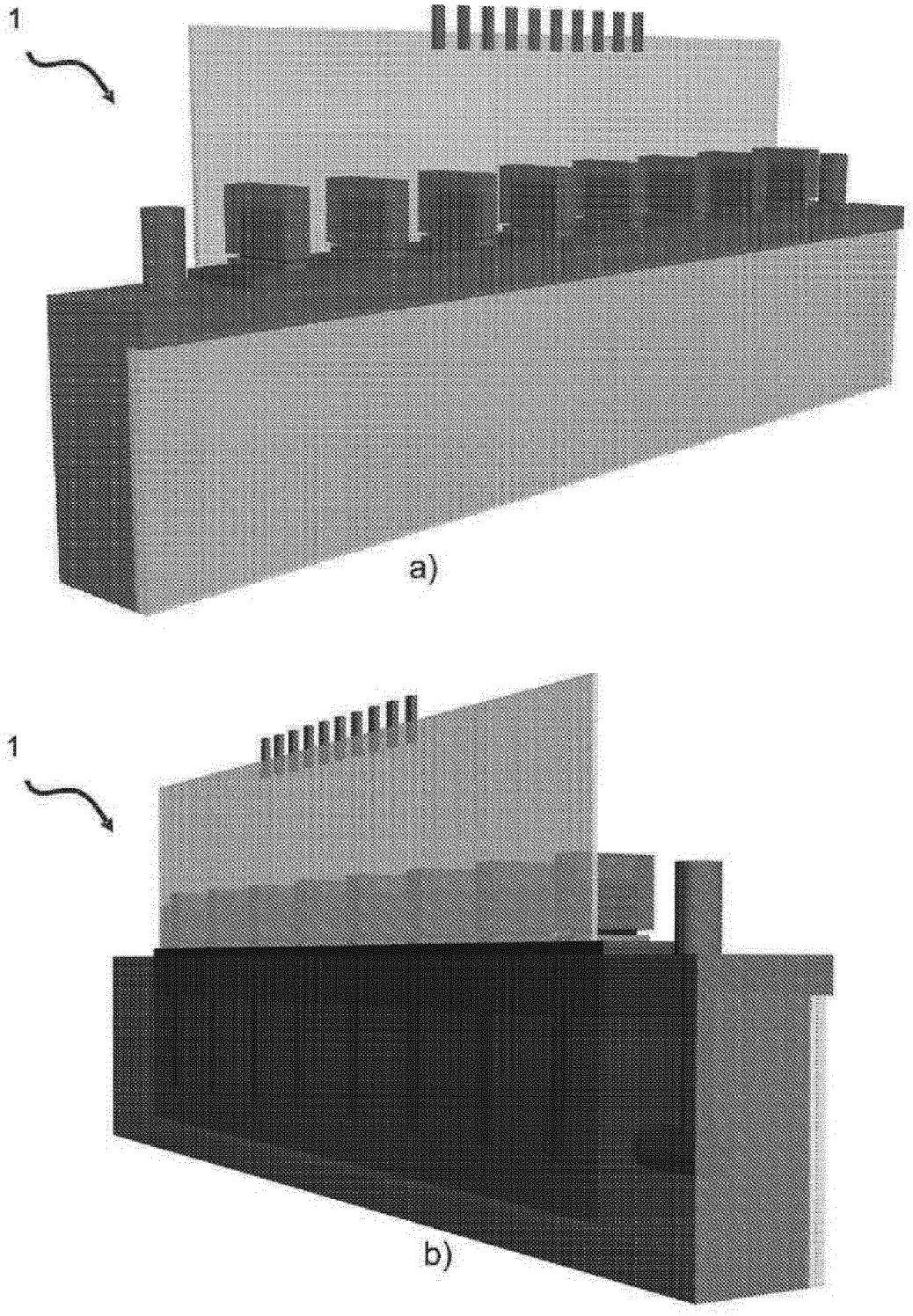

Fig. 16

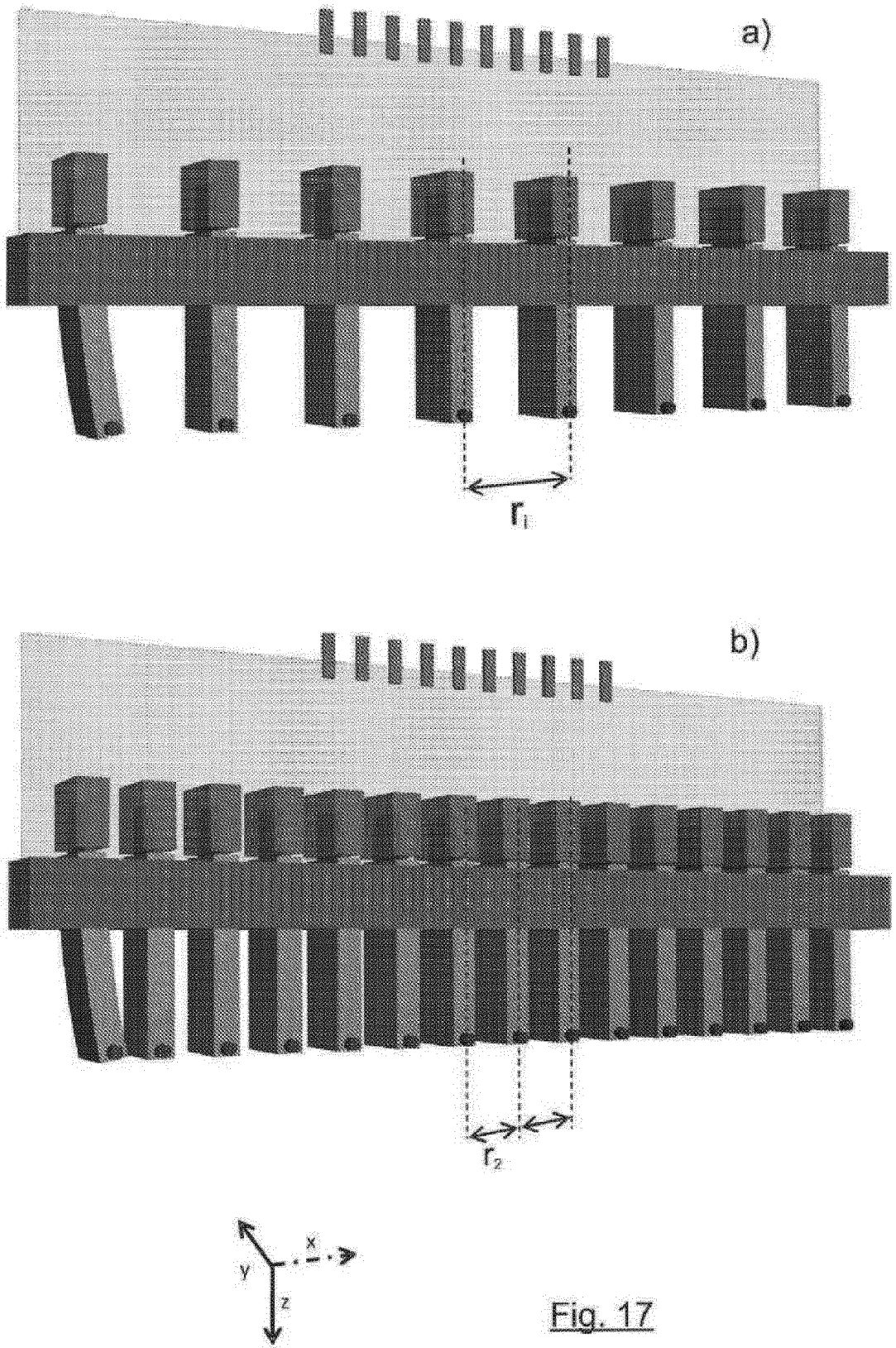

Fig. 17

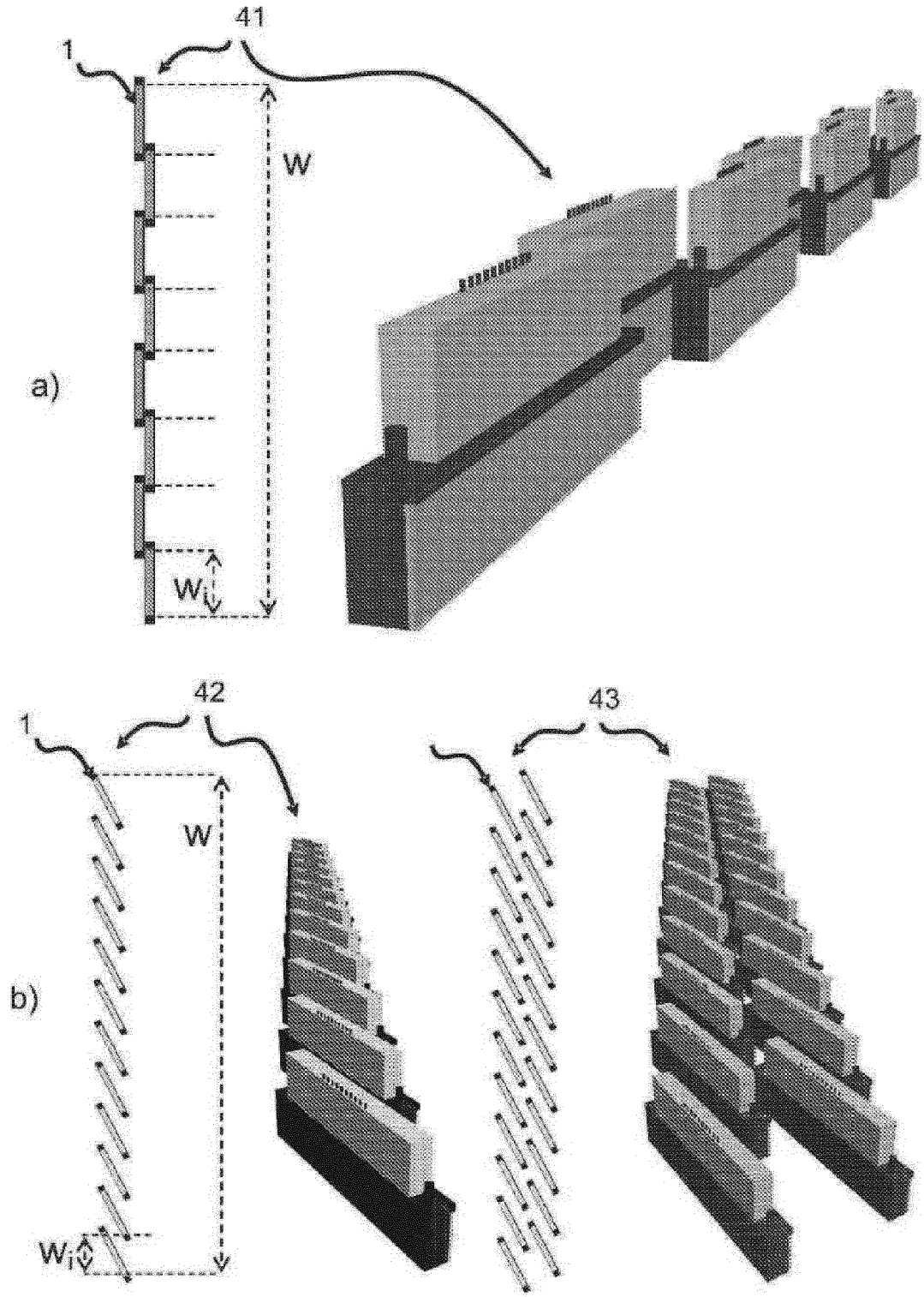

Fig. 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2015/070638

A. CLASSIFICATION OF SUBJECT MATTER

B41J2/045 (2006.01)
B41J2/065 (2006.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B41J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, INVENES

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2010146473 A1 (EPAINTERS GBR) 23/12/2010, paragraphs[0030 - 0090]; Figures.	1-13
A	US2013250009 (ISHIMORI MASAHIRO ET AL.) 26/09/2013, figure 3, paragraphs[0064 - 0075].	1-13
A	EP 2090439 A1 (KERAJET S A) 19/08/2009, paragraphs[0016 - 0031].	1-13
A	EP 0993953 A2 (SEIKO EPSON CORP) 19/04/2000, Figures.	1-13

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"E" earlier document but published on or after the international filing date
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"O" document referring to an oral disclosure use, exhibition, or other means.
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other documents , such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16/10/2015	**(19/10/2015)**
Name and mailing address of the ISA/ OFICINA ESPAÑOLA DE PATENTES Y MARCAS Paseo de la Castellana, 75 - 28071 Madrid (España) Facsimile No.: 91 349 53 04	Authorized officer C. Galdeano Villegas Telephone No. 91 3493099

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
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- ES 2302634 **[0065]**

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