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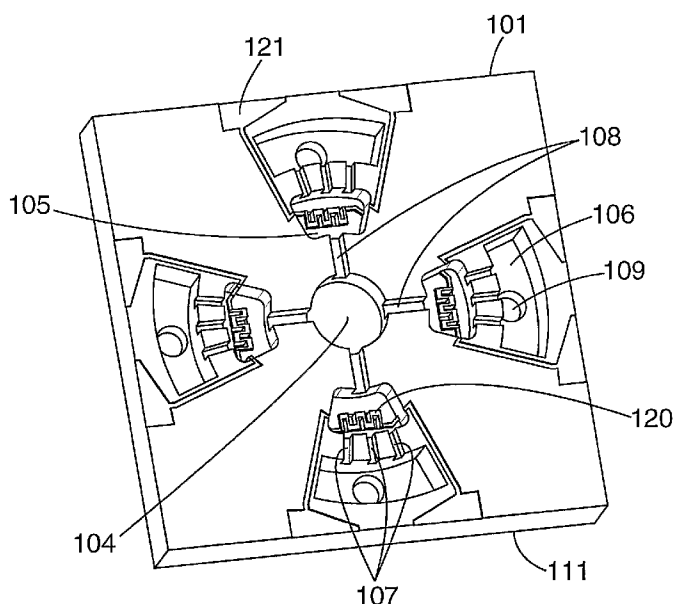
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(54) Title: A LIQUID DROPLET EJECTING HEAD, A WRITING INSTRUMENT COMPRISING SUCH A HEAD, AND A
METHOD OF EJECTING LIQUID DROPLETS FROM SAME



(57) Abstract: A liquid droplet ejecting head (100) designed to be mounted in a liquid ejecting instrument(1). The liquid droplet
ejecting head contains actuating chambers (105) with inlets to be connected to liquid supply chambers (106) and an outlet (108)
connected to an ejection nozzle (99). The actuating chambers also contain actuating means (120) for creating a pulse wave in the
liquid contained therein when activated by energy received from a control device. The outlets (108) of the actuating chambers are
linked to a single common ejection nozzle (99) through which a droplet is ejected.

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A liquid droplet ejecting head,
a writing instrument comprising such a head, and
a method of ejecting liquid droplets from same

5 The present invention relates to liquid droplet ejecting heads, and to liquid droplet ejecting instruments comprising such heads. The present invention also relates to methods of ejecting liquid droplets from such liquid droplet ejecting heads.

10 More particularly the present invention relates to a liquid droplet ejecting head designed to be mounted in a liquid ejecting instrument, comprising a plurality of actuating chambers, each actuating chamber having at least one inlet to be connected to at least one liquid supply
15 chamber for providing liquid to said actuating chamber, at least one actuating means suitable for creating a pulse wave in the liquid contained therein when activated by energy received from a control device, and at least one outlet connected to an ejection nozzle.

20 Prior art is known describing ink ejecting heads containing a plurality of actuating chambers. However, they have one nozzle of ejection for each ink-ejecting actuator, and a plurality of droplets originating from a plurality of nozzles are ejected. These ejecting heads are
25 generally used in a protected environment where drafts of air are minimal, ejecting distances are known and generally stay constant, for example in desk printers. In cases where it has been provided for variable scan speed prior art have generally relied on varying the frequency
30 of ejection to achieve more ink deposition. However this does not resolve the problem that they still face of ejecting over greater distances.

The present invention has been conceived in consideration of the above mentioned problems, and an object of the invention is to provide a liquid droplet ejecting device suitable notably for ejecting a droplet from a substrate onto a support at a distance greater than usual. To this end an aspect of the invention is to provide a liquid droplet ejecting head of the above mentioned type characterised in that the outlets of said plurality of actuating chambers are linked to a single common ejection nozzle through which a droplet is to be ejected from said head.

Bigger, and therefore heavier, droplets will be ejected, and they will travel further and truer than smaller droplets. This is an important advantage when using hand-held writing instruments where distances between the liquid droplet ejecting head and the writing surface are generally far larger than applications where traditional ink ejection technology is used, such as inkjet printers. It should also be noted that this invention allows for the use of typically-sized actuators, such as those used in desktop inkjet printers, to create bigger-than-typical sized drops by combining many small droplets into bigger ejected droplets. Because of the smaller actuator size, this allows for greater positioning and arranging freedom of the actuators within a liquid droplet ejecting head.

A supplementary advantage is the possibility to vary the volume of the ejected droplets as a function of user-input or deduced outcome by having the option of actuating a different number of actuators at each ink firing, and have a single drop of varying size exit through a single nozzle towards a support. This is especially useful to

mark lines of varying thickness without having to vary frequency.

Various embodiments of the invention may additionally include any one of the following provisions:

- 5 - the outlets of the actuating chambers are connected to a common central exit chamber, said exit chamber being in connection with the ejection nozzle;
- the central exit chamber contains a deflection member in the centre to deflect liquid flow pulses towards the ejection nozzle;
- 10 - the plurality of actuating chambers are arranged around the common ejection nozzle in a radial pattern;
- the actuating chambers are arranged in a symmetrical pattern and in an even number;
- 15 - the plurality of actuating chambers represent an odd number, preferably three actuating chambers extending respectively toward the 3 edges of a triangular shaped flat body;
- a plurality of liquid feed chambers are provided, each communicating with at least one actuating chamber and having or sharing a through hole to be in fluidic connection with a liquid reservoir;
- 20 - the liquid droplet ejecting head is substantially flat shaped with a front face and a rear face, parallel to each other, the nozzle being formed in the front face, and holes in communication with the inlets of the actuating chambers being provided on the rear face;
- the inlets and outlets of the plurality of actuating chambers extend globally in the main plane of the flat body, and preferentially along a radial direction from the ejection nozzle direction;
- 30 - the liquid ejecting head is manufactured out of a silicon wafer, or other suitable material;

- the actuating means comprises one of the following means chosen in the group including: electrostatic, thermal, piezoelectric actuating means, and preferably an electrostatic means;

5 An ejecting head as defined above is particularly suitable to be used in a hand held liquid ejecting instrument having a substantially tubular body with an opening at a front end and containing a liquid reservoir, an energy storage means, a control unit and a liquid
10 droplet ejecting head according to any one of the previous provisions, and wherein the ejection nozzle of the ejection head faces the front opening of the tubular body.

 The present invention concerns also a droplets ejecting method for controlling the ejection of droplets
15 by the liquid ejecting head mounted in a liquid ejecting instrument characterised in that it comprises the following steps:

- providing a plurality of actuating chambers, each actuating chamber having at least one inlet, at least one
20 actuating means suitable for creating a pulse wave in the liquid contained therein, and at least one outlet;
- providing a common ejection nozzle in a fluidic connection with the outlets of said plurality of actuating
-chambers,
- 25 - feeding the actuating chambers through their inlet with liquid provided from a liquid reservoir;
- actuating at least one of the actuating means by a supply of energy from a control unit in a manner such that one liquid droplet is ejected through the common ejection
30 nozzle.

 In another preferred embodiment, the invention may also additionally include any one of the following steps:

- the actuating step comprises the simultaneous actuation of at least two actuators;
- the actuating step comprises the actuation of an even number of actuating means, and wherein the actuators are
5 arranged in opposite symmetrical pairs;
- the actuating step comprises the actuation of an odd number of actuating means, preferably 3 or 5, and wherein the actuators are arranged equidistant and in equiangular position with respect to the common ejection nozzle;
- 10 - the method further comprises a step of determining a number of actuating means to be actuated to obtain a determined droplet size, before the actuating step;
- the instrument is a hand held instrument, comprising position and/or movement sensing means, wherein the liquid
15 is an ink, and wherein the method further comprises the steps of:
 - determining a writing condition from the signals sensed by sensing means;
 - ejecting ink droplets repeatedly while a writing
20 condition is determined, and preferably at constant ejection frequency.
- the steps of evaluating the droplet size according to a least one of the parameters of the group including a sensed scan speed of the writing instrument, a sensed
25 distance between a writing surface and the ejection nozzle, and desired thickness or style of the line to be drawn.

Other characteristics and advantages will appear to those skilled in the art in the following detailed
30 descriptions, in which:

Figure 1 is a sectional representation of a writing instrument comprising an ejection head according to a first embodiment.

Figure 2a shows perspective cut-away view of the first embodiment of the ejection head comprising a cover plate and a base plate, positioned on a mounting block.

Figure 2b shows the base plate of the head
5 represented in Fig 2a.

Figure 3 is a view similar to figure 2 of a second embodiment of the ejection head.

Figure 4 is a view similar to figure 2 of a third embodiment of the ejection head.

10 Figure 5 is a view similar to figure 2 of a fourth embodiment of the ejection head.

Figure 6 is perspective view of a portion of a base plate of an ejecting head, showing just a single ejection chamber.

15 On each of the figures, the same reference numerals refer to identical or similar elements.

Figure 1 represents a particular embodiment of a liquid droplet ejecting head 100 mounted in a non-contact writing instruments 1. However, the invention also lends
20 itself to being used in handheld or desktop printers, or other similar devices.

The writing instrument has a substantially tubular element that extends between a front end 11 and a rear end 12 for forming a pen. The tubular element has an inside
25 wall 13 defining a hollow internal space, and an outside wall 14 designed to be held in the hand of a user.

The interior hollow section of the writing instrument comprises a liquid reservoir 15 mounted in a removable fashion such that it may be easily end-user replaceable
30 and contains liquids 16. It is to be noted that the liquid used in this particular embodiment presented, that of the writing instrument, will have visible ink as its liquid. However depending on the application, the liquid may also

be correcting fluid, glue or others to suit the application.

The writing instrument 1 further comprises an energy storage unit 17 to provide energy to a control unit 20 and
5 a liquid ejecting device 100. The energy storage 17 may be mounted from the writing instrument 1 such that it may be easily replaceable, or it may be integrated with the liquid reservoir 15 as described in the French patent application filed on 22/07/2004 under the application
10 number FR0408138, or have means on the writing instrument for recharging.

The writing instrument may also comprise other devices such as a means of measuring distance between the liquid ejecting head 100 and the writing medium 2, such as
15 with an optical range finder 21, and means of measuring writing activity of the pen, for example with an accelerometer 22.

The writing instrument 1 further comprises the liquid droplet ejecting head 100 according to a first embodiment,
20 which faces a front opening 19 situated at the front end 11 of the writing instrument 1. The head is physically small such that it can be located near to the front end 11 forming the pen tip without causing visual obstruction to
~~the user.~~

25 It would be apparent to those skilled in the art that this is just one possible application and that this invention has equally valid uses in handheld printers, desktop printers, or other instruments which releases liquids onto a support without physical contact between
30 the instrument and the support.

At least one fluidic link 130 exists between the liquid reservoir 15 and the liquid droplet ejection head 100.

The control unit 20, which comprises a central processing unit, system clock, and other parts, serves to process all data such as those of distance and writing activity measurements, and also to regulate and energise
5 the energy pulses provided for the actuation of the droplet ejecting head 100 responsible for ejecting liquid 16 out of the nozzle 99.

The control unit 20 may also be adapted to only allow the liquid droplet ejecting head 100 to eject liquid 16
10 while the accelerometer 22 is detecting movement of the writing instrument 1 relative to the medium 2, and simultaneously the optical system 21 detects that the distance between nozzle 99 and the writing medium 2 lies in a range of values defined by a pre-determined minimum
15 value and a predetermined maximum value. It may also follow the principle of "ink again unless already marked".

As best shown on Fig 2a, the end portion of a mounting block 115 serving as both a support for the ejection head 100 and as a channel 130 for the feeding of
20 liquid incoming from the liquid reservoir 15.

The liquid droplet ejecting head 100 is defined by a base plate 101 on which multiple actuating means 120, also called actuators, for ejecting liquid 16 are provided and a cover plate 102 placed onto the base plate 101 to cover
25 the base plate and thus contain the liquid 16 in the chambers contained therein. The base plate 101 contains multiple channels 107,108 etched in it.

A plurality of actuating chambers 105 and feeding chambers 106 are provided, although only one is visible on
30 Figure 2a. As best shown on Figure 5, three channels 107 establish a fluidic communication between the feeding chamber 106 and the actuating chambers 105, and form the inlets of the actuating chamber 105. The channel 108

establishes a fluidic communication between the actuating chamber 105 and the common ejection chamber 104, and form the outlet of the actuating chamber 105. However a different number of channels are possible.

5 The actuating chamber 105 comprising an actuation means 120 is linked to a control unit 20 by signal lines 121 for driving the actuation means 120. The cover plate 102 has a single nozzle 99 formed therein positioned in the centre of the plate 102, aligned with the centre of
10 the central ejection chamber 104 of the base plate 101. The outer face 110 of the cover plate 102 forms a front face of the ejecting head 100 in which emerges the nozzle 99.

As can be seen on figure 2b, the six actuating
15 chambers 105 and liquid feed chambers 106 are arranged around the common ejection chamber 104 in a radial pattern. Each path formed by the channels 107,108 of one actuating chamber 105 and one feeding chamber 106 radiates from the common ejection chamber 104 and is separated from
20 adjacent paths 107,108 by separating walls formed integrally in the base plate 101. Equidistant from the centre, equiangular from each other, and lying on the same said paths are the actuating chambers 105 and the feeding chamber 106 at the periphery. All chambers 104,105,106
25 extend globally in the main plane of the base plate 101 constituted by a flat body. Liquid 16 flows into the central ejection chamber 104 from pulses by the actuators 120 which are part of the actuating chamber 105. The actuating chambers 105 themselves are supplied with liquid
30 16 from liquid feed chambers 106, such that each actuating chamber 105 is singularly connected with one liquid feed chamber 106. However in other embodiments it may be

realisable to have one liquid feed chamber 106 connected to more than one actuating chamber 105.

An ink supply hole 109 located in each liquid feed chamber 106 is perforated through the thickness of the base plate 101 and emerges in the rear face 111 of the
5 base plate 101 which constitutes the rear face of the ejecting head. The holes 109 communicate with the liquid reservoir 15. The base plate 101 and the cover plate 102 are of a substantially flat rectangular shape, and are
10 manufactured by a semiconductor process using a silicon wafer.

The liquid feed chamber 106 is in fluidic communication with the liquid reservoir 15 and temporarily stores a small amount of liquid 16 that is allowed to flow
15 from the feed chamber 106 into the actuating chamber 105.

Furthermore, the fluidic connection from the liquid feed chambers 106 connecting the actuating chambers 105 is designed in such a way for easing the flow of liquid 16 into the actuating chamber 105 but providing much greater
20 resistance to backward flow under a pulsed pressure effected by the actuators 120. The channel 108 between the actuating chamber 105 and the central exit chamber 104 should provide as little resistance as possible to the pulsed liquid traversing this channel towards the nozzle
25 99.

Located centrally in the central exit chamber is positioned a deflection member 103 to guide the liquid droplet pulses out of the singular nozzle 99.

Each module section, as shown in Fig 6, is positioned
30 in a radial direction around the central exit chamber 104, the module including a feed chamber 106 and an actuation chamber 105 with channels 107 therebetween, and channel

108 leading out of the actuating chamber 105. Each module is sensibly sector-shaped.

However they may be formed of any shape, but preferably the distances between the actuators 120 and the
5 central chamber 104 remain substantially equal and/or in a radial pattern.

For this first embodiment, six actuating chambers are provided, but other embodiments are also possible, such as the second and third embodiment illustrated in Fig 3 and
10 Fig 4. Figure 3 illustrates a base plate 101 with four sets of actuation modules surrounding a central exit chamber 104. Figure 4 illustrates a base plate 101 with 12 sets of chambers. However, embodiments are not limited to these examples and could take any number of chambers
15 105.

The embodiments illustrated in Fig 3 and Fig 4 differ further in that these embodiments do not have a deflection member 103 positioned in the central ejection chamber 103. In these embodiments, instead of using a deflection member
20 103, the deflection will be effected by having actuation actuated in pairs in the exact same instant of time with the same amount of energy provided by the control unit 20, such that the droplets meet in the centre of the exit chamber 103 and are self-deflected out through the
25 singular nozzle 99. An even number of chambers 105 enable to obtain frontal collision in the central ejection chamber, and an exit through the nozzle 99.

In a fourth embodiment shown in fig 5 three actuators are provided. The same process may also be effected
30 provided all three actuators 120 actuate at the same time with the same energy. The base plate 101 in this case is triangular shaped and each of the three sets of actuating chambers 105 and liquid feed chambers 106 are positioned

and aligned towards the apex of the triangular shape, i.e. the feeding and actuating chambers 106, 105 form modules at 120° apart from each other. These properties would also apply to any other embodiments having an odd number of chambers. In the case of three chambers 105, it has the advantage of having a 50% space and material saving, which for mass production can lead to significant cost savings, as well as time saving for manufacturing as less chambers would have to be created and less through-holes 109 machined in the liquid feed chamber 106.

Actuating chambers 105, and more particularly actuators 120, can be controlled individually, in groups, or all together in parallel. However in practice the actuators 120 are operated in opposite pairs or groups, irrespective of the numbers of chambers present.

In a typical configuration of such a droplet ejecting device 100 as described above, a microscopic droplet pulsed from the actuating chamber 105 typically has a volume in the range 25 to 80 pl, such that the total volume of all chambers is approximately 150-200pl.

It is important to note that this concept could be implemented using any actuating means, including piezoelectric, thermal, or electrostatic actuators. The different means of actuation will just serve to pressurize or depressurize liquid 16 in an actuating chamber 120 in different ways in order to pulse the liquid into the central chamber 104 and then onto a support 2.

Figure 6 is a detailed view of one liquid ejecting module. This particular embodiment illustrates a thermal ink ejection head 120. The electrical connection connecting the head to the control unit 20 is embedded in, but may be superimposed on, the base plate 101. For this embodiment, these connections 121 lead to the edge of the

wafer 101 where it will be further connected to the control unit 20.

The most common means of actuating a liquid pulse is with a thermal head, however it suffers from the disadvantage of limited life. To go some way towards alleviating this problem of limited life, the control unit can be configured to rotate the usage of a specific actuator as a function of previous action to spread the wear evenly across all actuators.

Another actuating means is with piezoelectric actuators. These have the advantage of having no limitations when used together with non water-based liquids. However they suffer in hand-held applications from the high-voltages needed for actuation.

The preferred means of actuation is with an electrostatic actuator due to its high energy efficiency, particularly at small scales. It is not limited also to water based liquids and only low voltages are needed.

A further embodiment possible under this invention is the ability of mixing different liquids, for example the ability of mixing different coloured inks. Instead of having a liquid reservoir 15 containing a single colour, one could conceivably separate the reservoir into different containers for different colours, but not necessarily in equal volumes, to take into account different weighing factors or usage rates. A plurality of feeding channels 130 could then be made into the support 110 of the liquid ejecting head such that only a subset of the total number of actuator is responsible for each colour. With this embodiment, and using four separate colours comprising cyan, magenta, yellow and black, it is conceivable that the user could write in any colour, from a combination of the above colours.

Next, a method of ejecting a liquid droplet from the liquid droplet ejecting heads 100 according to the embodiments will be described.

As mentioned above, the ejecting head 100 is mounted
5 on the end of a writing instrument 1 for a particular embodiment, and the liquid instrument 1 comprising a control unit 20, an energy source 17 for powering the control unit 20, and a liquid reservoir 15.

The ink is stored in either a fixed or replaceable
10 ink reservoir 15 in the body of the writing instrument 1, and feeds the droplet ejecting head 100 with ink 16 through at least one fluidic communicating channel 130. The liquid feed chamber 106 allows a small individual reserve of ink 16 to be available to its corresponding
15 actuating chamber 105, and the perforated hole 109 provided in said feed chamber 106 communicates with the liquid reservoir 15.

The actuator 120 type in the actuating chamber 105 may comprise, but is not restricted to, the following
20 types: electrostatic, piezoelectric, thermal. This document will not enter into the detailed working of these different types of actuators as they exist in various embodiments, and they are well known in the art.

~~-----~~ Once the control unit 20 determines it appropriate,
25 the actuators 120 in the actuating chambers 105 actuates from a pulsed energy input provided by the control unit 20. This burst of energy will be mostly directed through the path of least resistance which is along a ray towards the central ejection chamber 104, passing notably through
30 the provided channel 108. A pulse wave containing a small amount of liquid 16 from the actuating chamber 105 will move toward the nozzle 99. This liquid-carrying pulse

wave from the actuating chamber 105 will traverse the base plate 101 along the main plane towards the nozzle 99.

If the embodiment contains a deflecting member 103, then the droplet is deflected on the member 103 and exits
5 out of the nozzle 99 contained in the cover plate 102, and possibly at the same time amalgamating with other pulsed droplets effected at the same instant of time, from other actuating chambers 105.

If there is no central deflection member 103, then
10 the pulse wave of liquid are ejected in opposite symmetrical pairs such that their lateral energy cancel out and only a longitudinal component of this exists to exit as a single drop out of the nozzle 99. Note that this arrangement is also conceivable with three or five
15 actuators 120 positioned 120° or 72° apart.

Generally it will be preferable to have an even number of actuators 120 effected in opposite pairs, whether or not there is a deflection member 103 contained in the central ejection chamber 104 or not.

20 It may be desirable to spread the usage of the actuators 120 such that each actuator accumulates, on average, approximately the same number of actuation. This is especially desirable for the thermal-type actuators. The head 100, and also the control unit 20, must be
25 capable of inking at a sufficiently high frequency such that individual drops of ink are not visible and the ejection appears continuous. The control unit 20 will therefore actuate a varying number of actuators 120 at a fixed frequency of between 500-800Hz, such as to attain a
30 reasonable drop size on the writing surface so as to attain a reasonable perceived thickness of the written line depending on the scan speed of the instrument 1. A total nozzle drop volume of approximately 150-200pL is

desirable in order to create a reasonable line width on the writing surface 2, for example 0.3mm on a single pass.

An advantage of this over having a varying droplet size is that inking frequency can be maintained at a
5 reasonable rate to prevent the individual drops from visibly separating, even if the pen tip moves quickly.

The control unit 20 will determine the number of actuators 120 to actuate to vary line widths as a function of pen scanning speed sourced from internal sensors such
10 as accelerometers 22, or external commands such as pressure on the pen grip, or user settings.

The droplets size could be also determined according to the sensed distance between the nozzle 99 and the medium 2 to guarantee an impact of the droplets against
15 the medium 2. It is also possible to vary the droplets size to vary the thickness of the written line.

Claims

1. A liquid droplet ejecting head (100) designed to be mounted in a liquid ejecting instrument (1), comprising a plurality of actuating chambers (105), each actuating chamber having at least one inlet (107) to be connected to at least one liquid supply chamber (106) for providing liquid (16) to said actuating chamber (105), at least one actuating means (120) suitable for creating a pulse wave in the liquid contained therein when activated by energy received from a control device (20), and at least one outlet (108) connected to an ejection nozzle (99),
- characterised in that** the outlets (108) of said plurality of actuating chambers (105) are linked to a single common ejection nozzle (99) through which a droplet is to be ejected from said head (100).
2. The liquid droplet ejecting head according to claim 1, wherein the outlets (108) of the actuating chambers (105) are connected to a common central exit chamber (104), said exit chamber being in connection with the ejection nozzle (99).
3. The liquid droplet ejecting head according to claim 2, wherein said central exit chamber (104) contains a deflection member (103) to deflect liquid flow pulses towards the ejection nozzle (99).
4. The liquid droplet ejecting head according to anyone of the previous claims, wherein the plurality of actuating chambers (105) are arranged around said common ejection nozzle (99) in a radial pattern.
5. The liquid droplet ejecting head according to claim 4, wherein the actuating chambers (105) are arranged in a symmetrical pattern and in an even number.

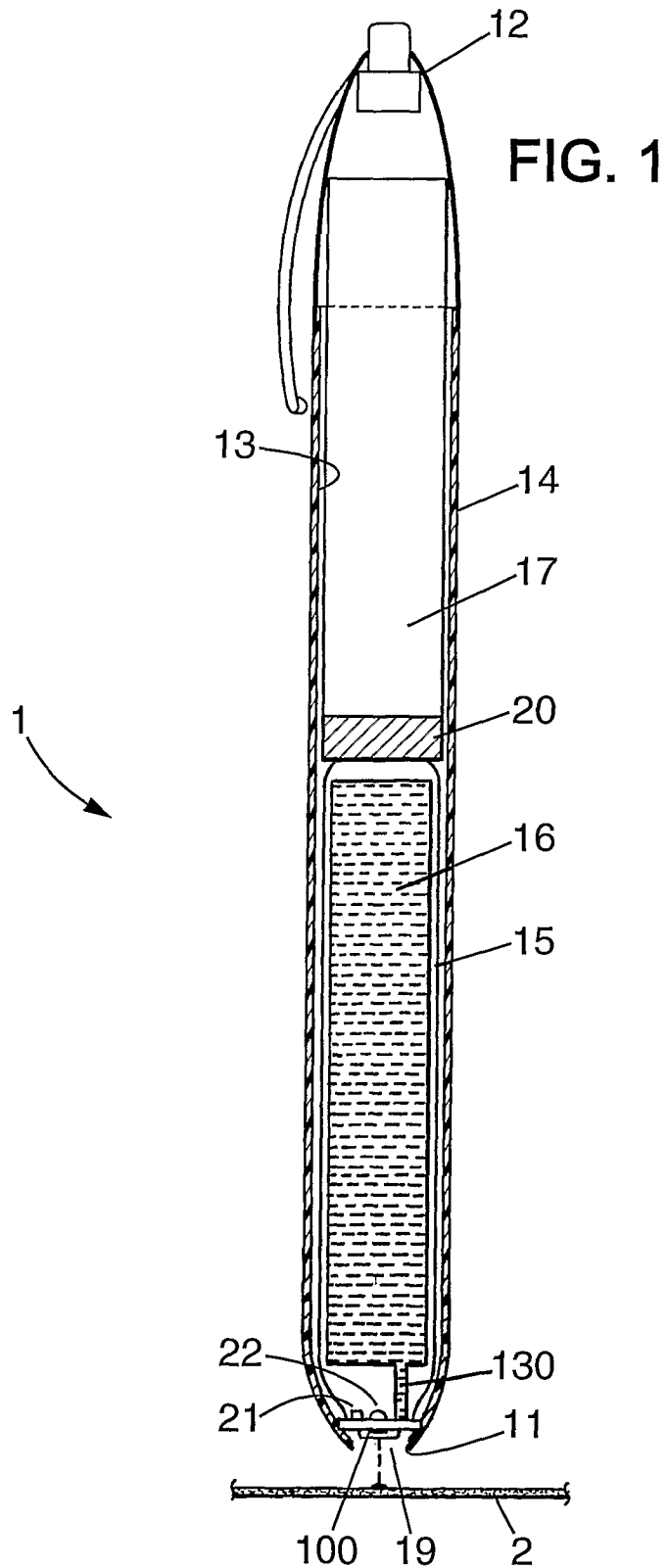
6. The liquid droplet ejecting head according to claim 4, wherein the plurality of actuating chambers (105) represent an odd number, preferably three actuating chambers extending respectively toward the 3 edges of a triangular shaped flat body (101).
5
7. The liquid droplet ejecting head according to any one of the previous claims, wherein a plurality of liquid feed chambers (106) are provided, each communicating with at least one actuating chamber (105) and having or sharing a through hole (109) to be in fluidic connection with a liquid reservoir (15).
10
8. The liquid droplet ejecting head according to any one of the previous claims, wherein said head (100) is substantially flat shaped with a front face (110) and a rear face (111), parallel to each other, the nozzle (99) being formed in the front face (110), and holes (109) in communication with the inlets of the actuating chambers (105) being provided on the rear face (111).
15
9. The liquid droplet ejecting head according to claim 7, wherein the inlets (107) and outlets (108) of the plurality of actuating chambers extend globally in the main plane of the flat body (101), and preferentially along a radial direction from the ejection nozzle (99) direction.
20
10. The liquid droplet ejecting head according to any of the preceding claims, wherein said liquid ejecting head (100) is manufactured out of a silicon wafer, or any suitable material.
25
11. The liquid droplet ejecting head according to any one of the preceding claims, wherein actuating means comprises one of the following means chosen in the group including: electrostatic, thermal, piezoelectric actuating means, and preferably an electrostatic means.
30

12. A hand held liquid ejecting instrument (1) having a substantially tubular body (14) with an opening (19) at a front end (11) and containing a liquid reservoir (15), an energy storage means (17), a control unit (20) and a liquid droplet ejecting head (100) according to any one of claims 1 to 11, wherein the ejection nozzle (99) of the ejection head (100) faces out of the front opening (19) of the tubular body (14).
13. A method of ejecting liquid droplets from a liquid ejecting head (100) mounted in a liquid ejecting instrument (1) **characterised in that** it comprises the following steps:
- providing a plurality of actuating chambers (105), each actuating chamber having at least one inlet (107), at least one actuating means suitable for creating a pulse wave in the liquid contained therein, and at least one outlet (108),
 - providing a single ejection nozzle (99) in a fluidic connection with the outlets (108) of said plurality of actuating chambers (105),
 - feeding the actuating chambers (105) through their inlet (107) with liquid (16) provided from a liquid reservoir (15),
 - actuating at least one of the actuating means (120) by a supply of energy from a control unit (20) in a manner such that one liquid droplet is ejected through said ejection nozzle (99).
14. The method of ejecting liquid droplets from a liquid ejecting head according to claim 13, wherein the actuating step comprises the simultaneous actuation of at least two actuators (120).

15. The method of ejecting liquid droplets from a liquid ejecting head according to claim 14, wherein the actuating step comprises the actuation of an even number of actuating means (120), and wherein the actuated means (120) are arranged in opposite symmetrical pairs.
16. The method of ejecting liquid droplets from a liquid ejecting head according to claim 14, wherein the actuating step comprises the actuation of an odd number of actuating means (120), preferably 3 or 5, and wherein the actuators (120) are arranged equidistant and in equiangular position with respect to the common ejection nozzle (99).
17. The method of ejecting liquid droplets from a liquid ejecting head according to claim 14, wherein the method further comprises a step of determining a number of actuating means (120) to be actuated to obtain a determined droplet size, before the actuating step.
18. The method of ejecting liquid droplets from a liquid ejecting head according to any one of the claims 14 to 17, wherein the instrument is a hand held instrument (1) comprising distance (21) and/or movement (22) sensing means, wherein the liquid (16) is an ink, and wherein the method further comprises the steps of:
- determining a writing condition from the signals sensed by sensing means;
 - ejecting ink droplets repeatedly while a writing condition is determined, and preferably at constant ejection frequency.
19. The method of ejecting liquid droplets from a liquid ejecting head according to claims 17 and 18, further comprising the steps of:

- evaluating the droplet size according to a least one of the parameters of the group including a sensed scan speed of the writing instrument (1), a sensed distance between a writing surface and the ejection nozzle (99),
5 and desired thickness or style of the line to be drawn.

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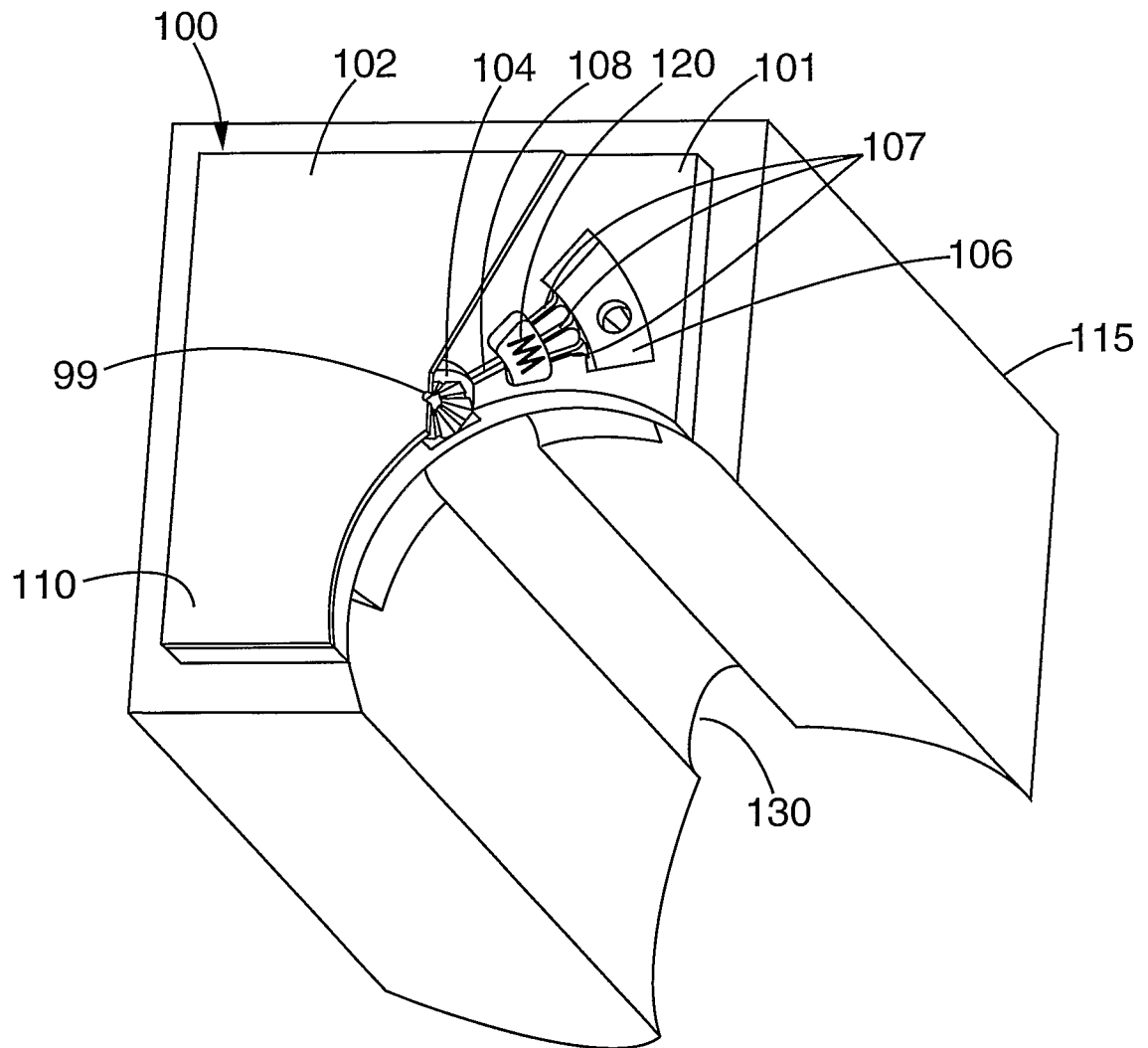


FIG. 2a

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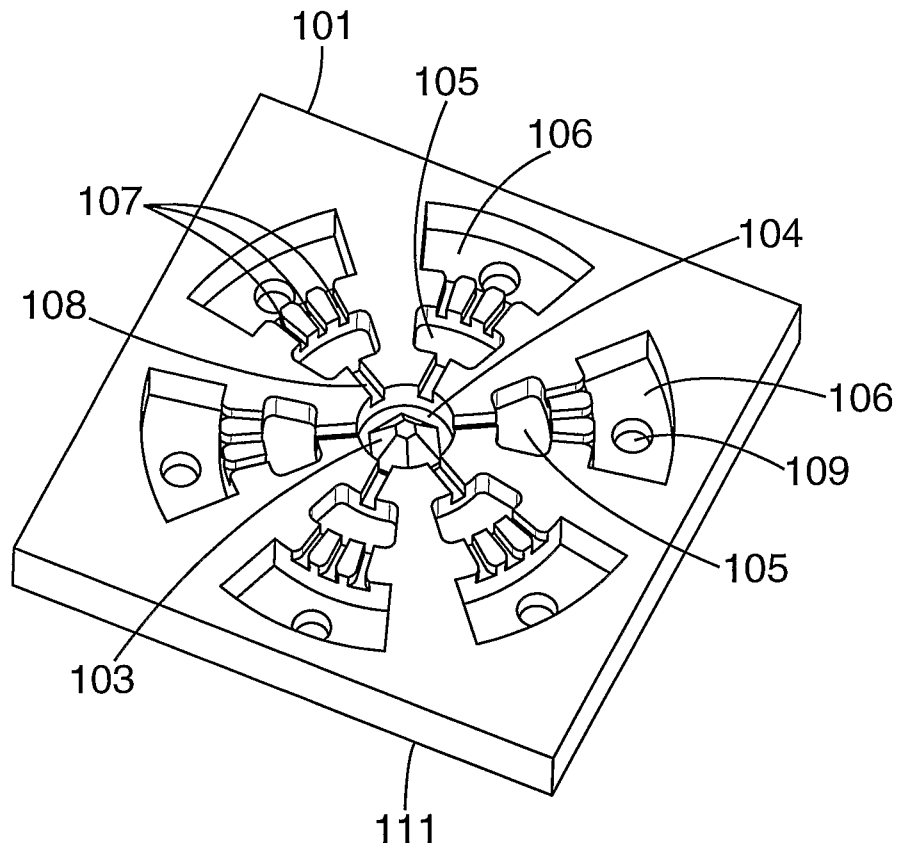


FIG. 2b

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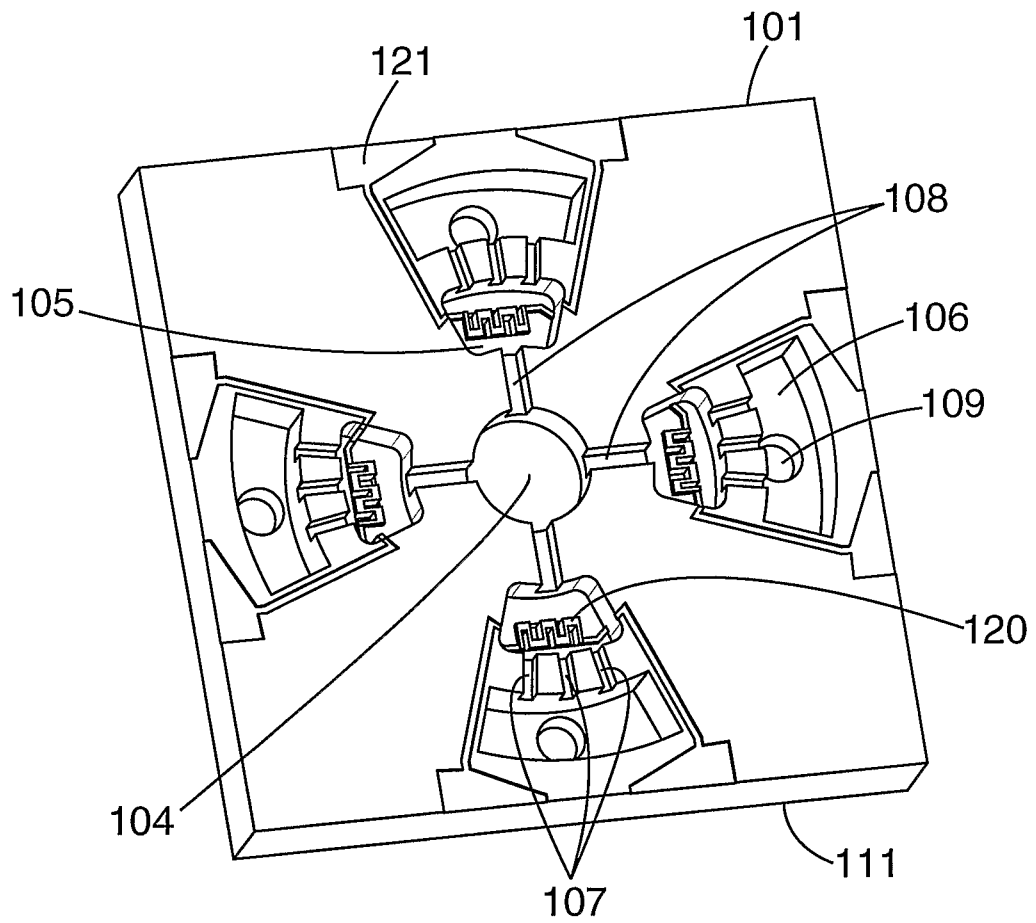


FIG. 3

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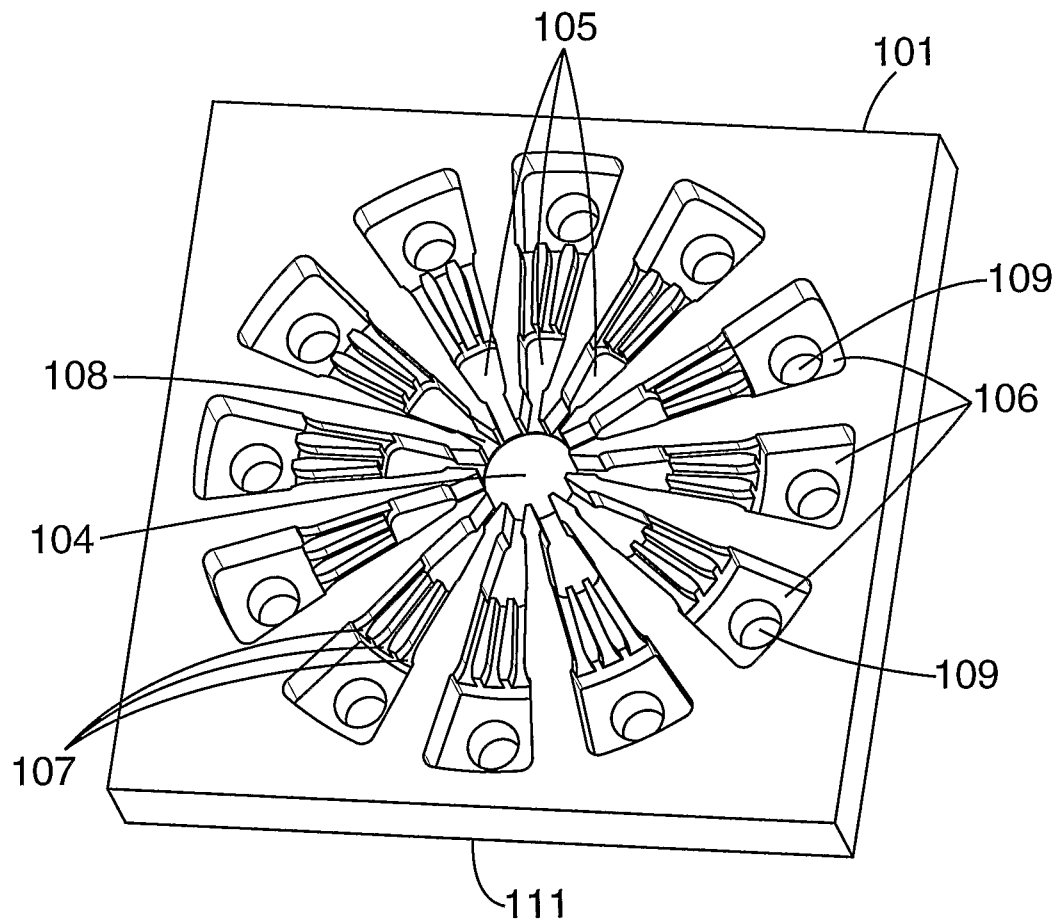
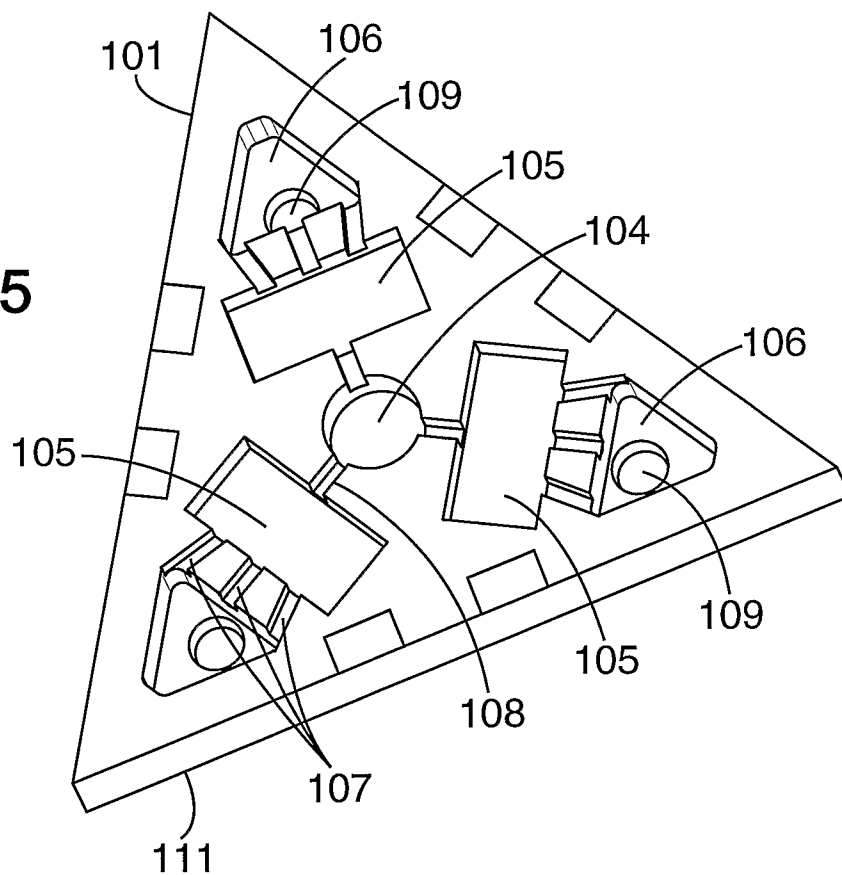


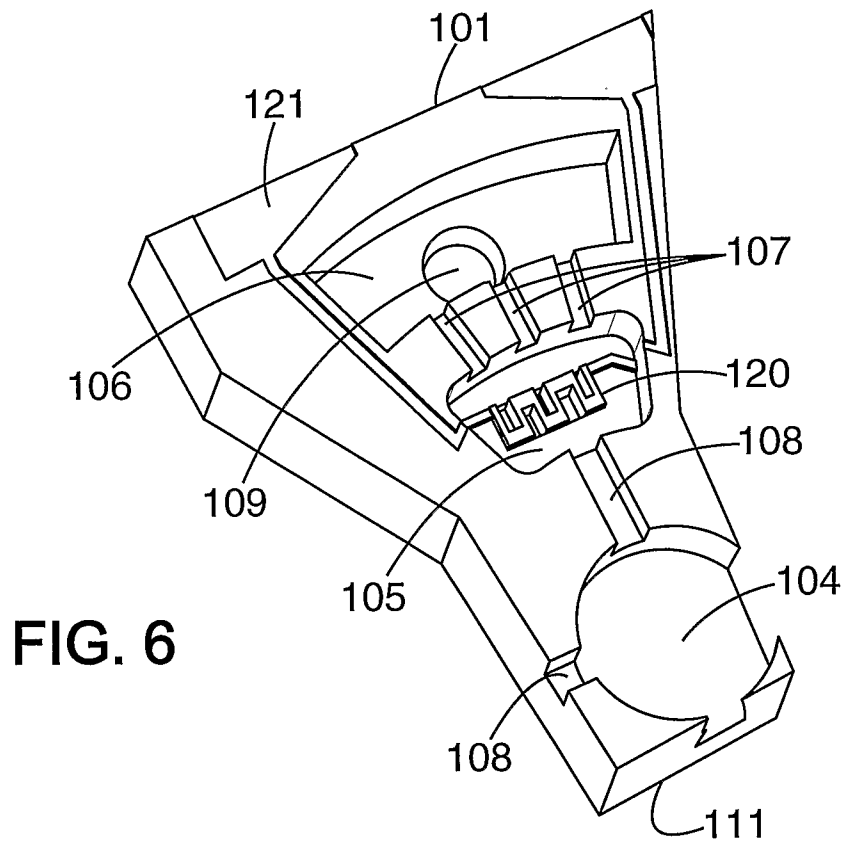
FIG. 4

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FIG. 5



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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2005/009224

A. CLASSIFICATION OF SUBJECT MATTER
INV. B43K8/22

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)
B43K

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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 02/34549 A (SILVERBROOK RESEARCH PTY LTD; KING, TOBIN, ALLEN; SILVERBROOK, KIA) 2 May 2002 (2002-05-02) page 5, line 2 - line 3 page 9, line 2 - line 34 page 11, line 8 - line 15 page 12, line 13 - page 13, line 36; claims 13-15	1,2,4-19
A	US 2002/136587 A1 (BRAMLETT BRIAN W ET AL) 26 September 2002 (2002-09-26) page 1, paragraph 4 - paragraph 15; figure 1	1,2,12, 13,17,18
A	US 2004/052569 A1 (BICH XAVIER ET AL) 18 March 2004 (2004-03-18) paragraph [0031] - paragraph [0034]; figure 1	11,12,18

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

18 May 2006

Date of mailing of the international search report

29/05/2006

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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