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(54) **Method for operating a jetting device**

(57) The present invention relates to a method for operating a jetting device, the jetting device being configured to expel droplets of an electrically conducting fluid. The method involves applying an actuation pulse to the electrically conductive fluid, as well as applying a maintenance pulse to the electrically conductive fluid. The present invention further relates to a jetting device for performing such method.

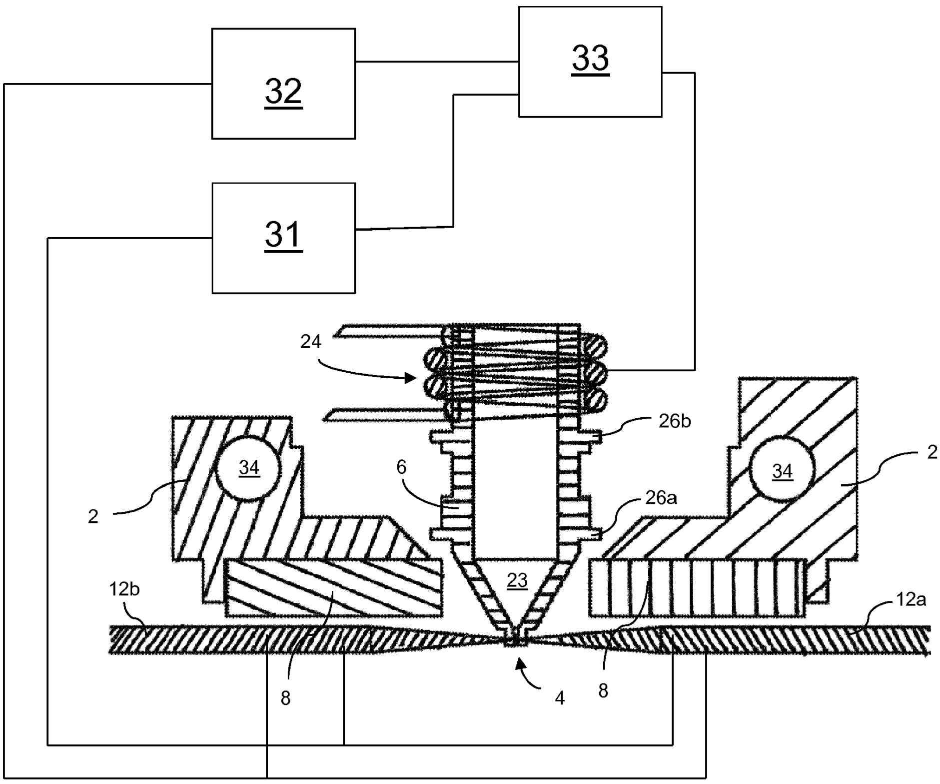

Fig. 2

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Description

Method for operating a jetting device

[0001] The present invention relates to a method for operating a jetting device. The present invention further relates to a jetting device for printing a droplet of an electrically conductive fluid.

Background of the invention

[0002] A jetting device for ejecting droplets of a molten metal is known. An example of a jetting device for ejecting droplets of a molten metal is described in WO 2010/063576 A1. In such a printing device, a Lorentz force is generated in the molten metal due to which a droplet is expelled through an orifice of the printing device. Such a device may be used to eject droplets of a molten metal at a high temperature. Hence, using such device, metals having a high melting point, such as silver, gold and copper can be jetted.

[0003] Direct printing of molten metals may be employed for printing electronic circuitry, for example. In such an application it is essential that all droplets are actually printed accurately as otherwise the electronic circuitry may not function due to an interruption in the electronic connections as a result of a missing droplet, for example. Ejection of a droplet may be hampered in case the jetting device is malfunctioning. A possible cause for malfunctioning of the jetting device is blocking of an orifice. An orifice that is blocked contains solid material that is deposited in and/ or around the orifice. The solid material may comprise e.g. contaminants present in the metal.

[0004] When an orifice is blocked, it may be more difficult or even impossible to eject a droplet of fluid from the orifice. As a consequence, a decrease in the jetting stability may result in missing droplets. It is therefore desirable to prevent the orifice from becoming blocked.

[0005] EP2792490 describes a method for operating a jetting device configured to expel droplets of an electrically conductive fluid. In this method, a direct current and an alternating current are applied to the electrically conductive fluid, such that the heat generated by the direct current and the alternating current is constant. A disadvantage of this method is that a large amount of heat is supplied to the electrically conductive fluid; the amount of heat applied may not be lowered temporarily. Hence, when operating the jetting device according to the method described in EP2792490, the jetting device is operated at high temperatures, for example more than a few hundred degrees Celsius above the melting temperature of the electrically conductive fluid. Operating the jetting device at such temperatures may have disadvantageous effects. For example, the materials of the jetting device may degrade at increased rate, which hampers stable jetting in the long term.

[0006] Therefore, it is an object of the invention to provide a method that prevents blocking of the orifice. It is a further object of the invention to provide a method that allows operating the jetting device at lower temperatures.

Summary of the invention

[0007] It has been found that the objects of the invention can be at least partially achieved by applying a method for operating a jetting device, the jetting device being configured to expel droplets of an electrically conducting fluid wherein at least a part of the conductive fluid is positioned in a magnetic field, the method comprising the steps of:

a) providing a first actuation pulse by providing direct electrical current in the part of the conductive fluid positioned in the magnetic field, thereby generating a Lorentz force in the conductive fluid and generating an amount of heat; and
b) providing a second actuation pulse by providing direct electrical current in the part of the conductive fluid positioned in the magnetic field, thereby generating a Lorentz force in the conductive fluid and generating an amount of heat; and
c) in between the first actuation pulse and the second actuation pulse, providing a maintenance pulse by providing an alternating electrical current in the part of the conductive fluid positioned in the magnetic field, the alternating electrical current generating an amount of heat;

wherein the amount of heat generated by the alternating current is different from the amount of heat generated by the direct current.

[0008] In a known system for printing a molten metal composition, a droplet of said metal composition is expelled through an orifice by a Lorentz force. This force causes a motion in the metal. This motion may cause a part of the molten metal to move from the fluid chamber through the orifice, thereby generating a droplet of the molten metal. The Lorentz force is related to the electric current and the magnetic field vector; $\overline{F} = \overline{I} \times \overline{B}$. The Lorentz force resulting from the electric current and the magnetic field is generated in a direction perpendicular to both the electrical current and the magnetic field. By suitably selecting the direction and the magnitude of the electric current, as well as the direction and the magnitude of the magnetic field, the direction and the magnitude of the resulting Lorentz force may be selected. In the system according to the present invention, in normal operation, the magnetic field is provided and an electrical current is provided in the molten metal composition, such that a suitable force for ejecting a droplet is generated. Thus, in the context of the present invention, the direct current pulse may be configured to actuate the electrically conductive fluid thereby generating a droplet of said fluid. The direct current pulse is also referred to as actuation pulse. Typically, when printing an image a plurality of droplets is applied onto a recording medium in a pre-determined pattern. When operating the jetting device, a first actuation pulse may be provided by applying direct electrical current in the part of the conductive fluid positioned in the magnetic field, thereby generating a Lorentz force in the conductive fluid. The first actuation pulse may result in expelling a first droplet of the electrically conductive fluid. In addition, the first actuation pulse may also generate an amount of heat. Further, when operating the jetting device, a second actuation pulse may be provided by applying direct electrical current in the part of the conductive fluid positioned in the magnetic field, thereby generating a Lorentz force in the conductive fluid. The second actuation pulse may result in expelling a second droplet of the electrically conductive fluid. In addition, the first actuation pulse may also generate an amount of heat. Optionally, a third, fourth, etc actuation pulse may be applied to the electrically conductive fluid.

[0009] There may be a time interval in between the first actuation pulse and the second actuation pulse. During this time interval, a maintenance pulse may be applied by providing an alternating electrical current in the part of the conductive fluid positioned in the magnetic field, the alternating electrical current generating an amount of heat.

[0010] The jetting device in accordance with the present invention comprises a fluid chamber and has an orifice extending from the fluid chamber to an outer surface of the fluid chamber element. In operation, the fluid chamber comprises a molten metal composition.

[0011] When applying an actuation pulse, a Lorentz force is generated within the metal, causing the molten metal composition to move through the orifice in a direction away from the fluid chamber. The actuation pulse may be applied by applying a pulsed magnetic field and a continuous electrical current, or a pulsed electrical current in a continuous magnetic field, or a combination thereof. Alternatively, a constant Lorentz force may be generated within the metal by applying a constant electrical current to the electrically conductive fluid in a constant magnetic field. However, application of a constant Lorentz force to the molten metal composition may result in the ejection of a stream of the electrically conductive fluid, instead of in the ejection of droplets.

[0012] The jetting device may be positioned in an inert atmosphere, for example an inert gas such as nitrogen or a noble gas. By using an inert atmosphere, oxidation of the metal by reacting with oxygen from the air may be prevented and hence, the rate of oxidation of the metal may be decreased. However, it was found that, even if an inert atmosphere is applied, still oxidation of the metal and of impurities in the metal may occur.

[0013] Both the actuation pulse and the maintenance pulse may generate an amount of heat. The actuation pulse is applied to the fluid by providing a direct current. The amount of heat generated by the actuation pulse per unit of time is:

$$\frac{Q}{t} = I_{direct}{}^{2} * R = \frac{V^2}{R} \qquad \text{formula 1}$$

[0014] The maintenance pulse, in contrast to the actuation pulse, applies an alternating current to the electrically conductive fluid. The magnitude of the alternating current changes with time according to a sinusoidal curve. The amplitude of the sinusoidal curve is the maximum current (I_{max}). Furthermore, the alternating current has a *root mean square* current (I_{RMS}). The average heat generated by the alternating current per unit of time equals:

$$\frac{\overline{Q}}{t} = \left(I_{RMS}\right)^2 * R = \frac{\left(V_{RMS}\right)^2}{R} \qquad \text{Formula 2}$$

[0015] Applying a maintenance pulse may not result in ejection of a droplet. The magnitude and the direction of the alternating current changes constantly, inertia may prevent that the movement generated by the maintenance pulse may result in the ejection of a droplet through the orifice of the jetting device.

[0016] In the method according to the present invention, the amount of heat generated by the alternating current is different from the amount of heat generated by the direct current. It was found that applying a maintenance pulse in between a first actuation pulse and a second actuation pulse improves the jetting stability. When applying the method according to the present invention, stable operation of the jetting device was observed, even at temperatures of just above the melting temperature of the electrically conductive fluid, for example less than 100°C above the melting temperature.

[0017] In an embodiment, the amount of heat generated by the alternating current is smaller than the amount of heat generated by the direct current.
It is preferred to operate the jetting device at relatively low temperatures, as at high temperatures the materials of the jetting device may degrade at an increased rate. The jetting device may be heated during operation by the heat generated by the actuation pulses and the maintenance pulses. Optionally, other sources of heat may also influence the temperature of the jetting device.
The heat generated by the actuation pulse depends e.g. on the magnitude of the current used and the duration of the pulse. When applying an actuation pulse, a direct current is applied to the electrically conductive fluid. The magnitude of the current and the duration of the pulse may be tuned to eject a droplet of a pre-determined volume at a pre-determined speed.
In between a first and a second actuation pulse, a maintenance pulse may be applied. The maintenance pulse may be applied by applying an alternating current to the electrically conductive fluid. The magnitude of the current may be selected such that the heat generated by the alternating current is smaller than the amount of heat generated by the direct current. By limiting the amount of heat generated by the alternating current, the total amount of heat supplied to the fluid and the jetting device may be limited, allowing to operate the jetting device at relatively low temperatures. The amount of heat generated by the alternating current may be less than 90% of the heat generated by the direct current. Preferably, the amount of heat generated by the alternating current may be less than 75% of the heat generated by the direct current. More preferably, the amount of heat generated by the alternating current may be less than 50% of the heat generated by the direct current.
[0018] In an embodiment, the alternating electrical current has a frequency in the range of from 40 kHz to 500 kHz.
The frequency of the alternating current may be in the range of from 40 kHz to 500 kHz. Preferably, the frequency of the alternating current may be in the range of from 100 kHz to 400 kHz. An alternating current having a high frequency, for example a frequency in the range mentioned above, is a current having a sinusoidal curve, wherein the time in between two adjacent maxima is short. Because the high frequency alternating current quickly changes sign, the direction of the Lorentz force generated by the alternating current quickly changes.
If the direction of the Lorentz force generated would change slowly then the application of the alternating current might result in movement of the fluid leading to the ejection of a droplet. This may be undesired, because the alternating current may be configured not to actuate the electrically conductive fluid, thereby not generating a droplet of said fluid. However, due to inertia, it may take some time for the direction of the (net) movement of the fluid, induced by the Lorentz force, to change. Therefore, the faster the direction of the Lorentz force generated changes, the less likely that the alternating current will result in significant movement of the fluid within the pressure chamber. This may be beneficial for jetting stability. Furthermore, applying an alternating electrical current to the electrically conductive fluid does not need to result in the ejection of a droplet.
[0019] In an embodiment, the electrically conductive fluid is a molten metal. Molten metals may be efficiently jetted using the method according to the present invention. The molten metal may comprise e.g. silver, gold or copper. Optionally, the molten metal may comprise a mixture of molten metals.
Jetting droplets of a molten metals may be a suitable way of producing electronic circuitry.
[0020] In an aspect of the invention, a jetting device for printing a droplet of an electrically conductive fluid is provided, the jetting device comprising:

- a fluid chamber or holding an amount of the electrically conductive fluid; and
- an actuation assembly configured to expel droplets of the electrically conductive fluid from the chamber through a nozzle, the actuation assembly comprising

    - a magnetic field generating unit for generating a magnetic field in at least a part of the fluid chamber; and
    - an electrical direct current generating unit for generating a direct electrical current in the electrically conductive fluid in the part of the chamber provided with the magnetic field, thereby generating a pressure wave in the conductive fluid in said part of the fluid chamber,

  wherein the jetting device further comprises :

    - an electrical alternating current generating unit for generating an alternating electrical current in the electrically conductive fluid in the part of the chamber provided with the magnetic field,
    - control means configured to carry out the method according to the present invention.

[0021] The printing device according to the present invention is thus configured for performing the method according to the present invention.
[0022] In an embodiment, the electrical direct current generating unit is operatively connectable to two electrodes in

contact with the electrically conductive fluid for providing the electrical direct actuation current in the conductive fluid, the jetting device being configured such that the two electrodes are operatively connected to the electrical direct current generating unit upon actuation.

The two electrodes may both be operatively connected to electrically conductive fluid and may thereby apply the direct electrical current provided by the electrical direct current generating unit to the electrically conductive fluid.

[0023] In an embodiment, the electrical alternating current generating unit is operatively connectable to the two electrodes in contact with the electrically conductive fluid.

In this embodiment, the two electrodes may be used to apply both the direct current provided by the electrical direct current generating unit as well as the alternating current provided by the electrical alternating current generating unit to the electrically conductive fluid. The heat dissipated in a system depends e.g. on the total resistance of the several parts of the system through which a current runs, e.g. the electrode resistance, the print head material resistance, the liquid metal resistance, and contact resistances. In case the resistance of the connection between the electrical alternating current generating unit and the two electrodes is similar, preferable equal, to the resistance of the connection between the electrical direct current generating unit and the two electrodes, then the control unit may control the direct electrical current and the alternating electrical current such that I_{direct} and I_{RMS} are different. Preferably, I_{RMS} is smaller than I_{direct}.

Brief description of the drawings

[0024] These and further features and advantages of the present invention are explained hereinafter with reference to the accompanying drawings showing non-limiting embodiments and wherein:

Fig. 1	shows a perspective view of a printing device for printing droplets of an electrically conductive fluid.
Fig. 2	shows a cross-sectional view of a part of the printing device shown in Fig. 1.
Fig. 3A and Fig. 3B	schematically show a first example of the method according to the present invention.
Fig. 4	schematically shows a second example of the method according to the present invention.

[0025] In the drawings, same reference numerals refer to same elements.

Detailed description of the drawings

[0026] Fig. 1 shows a part of a jetting device 1 for ejecting droplets of a relatively hot fluid, in particular a molten metal such as copper, silver, gold and the like. The jetting device 1 comprises a support frame 2, made of a heat resistant and preferably heat conductive material.

The jetting device 1 is provided with an ejection nozzle 4 through which a droplet of the fluid may be ejected. The nozzle or orifice 4 is a through hole extending through a wall of a fluid chamber body 6. In the fluid chamber body 6 a fluid chamber is arranged. The fluid chamber is configured to hold the fluid.

For ejecting droplets of molten metal, the jetting device 1 is provided with two permanent magnets 8a, 8b (hereinafter also referred to as magnets 8). The magnets 8 are arranged between two magnetic field concentrating elements 10a, 10b (hereinafter also referred to as concentrators 10) made of magnetic field guiding material such as iron. The jetting device 1 is further provided with two electrodes 12a, 12b (hereinafter also referred to as electrodes 12) both extending into the fluid chamber body 6 through a suitable through hole such that at least a tip of each of the electrodes 12 is in direct electrical contact with the molten metal present in the fluid chamber. The electrodes 12 are supported by suitable electrode supports 14 and are each operatively connectable to a suitable electrical current generator (not shown) such that a suitable electrical current may be generated through the electrodes 12 and the molten metal present between the tips of the electrodes 12.

[0027] Fig. 2 shows a cross-section of the embodiment illustrated in Fig. 1, which cross-section is taken along line b-b (Fig. 1). Referring to Fig. 2, the support frame 2 and the magnets 8 are shown. In the illustrated embodiment, the support frame 2 is provided with cooling channels 34 through which a cooling liquid may flow for actively cooling of the support frame 2 and the magnets 8. An induction coil 24 is shown. The fluid chamber body 6 is arranged in a centre of the induction coil 24 such that a current flowing through the induction coil 24 results in heating of a metal arranged in the fluid chamber 6. Due to such heating the metal may melt and thus become a fluid. Such inductive heating ensures a power-efficient heating and no contact between any heating element and the fluid, limiting a number of (possible) interactions between elements of the jetting device 1 and the fluid. Nevertheless, in other embodiments, other means for heating the metal in the fluid chamber may be applied. The presence of the induction coil may help in controlling the temperature of the fluid in a position away from the orifice 4. Also, it may be useful to heat the fluid using the induction coil 24, for example at start up of the jetting device, when the electrically conductive material is molten to become an electrically conductive fluid.

The jetting device 1 further comprises a control unit 33. The control unit 33 is operatively connected to the electrical alternating current generating unit 31 and the electrical direct current generating unit 32. Non-limiting examples of suitable electrical direct current generating units are batteries, solar cells and dynamos. Non-limiting examples of suitable electrical alternating current generating units are high power amplifiers or high current amplifiers. In the embodiment shown in Fig. 2, both the electrical alternating current generating unit 31 and the electrical direct current generating unit 32 are connected to electrodes 12. Thus, the direct electrical current generated by the electrical direct current generating unit 32 can be applied to the fluid present in the actuation chamber 23 through the electrodes 12.The amount of direct electrical current supplied to the fluid via the electrodes as well as the amount of alternating electrical current supplied to the fluid may be controlled by control unit 33. The control unit 33 may control the direct electrical current and the alternating electrical current such that the heat generated by the direct electrical current ($I_{direct}{}^{2} * R$) is different from the alternating electrical current ($(I_{RMS})^2 * R$).

In the embodiment shown in Fig. 2, the control unit 33 is also operatively connected to the induction coil 24. The induction coil 24 is positioned further away from the orifice than the electrodes 12. Heating of the fluid in the fluid chamber 6 using the induction coil 24 may have less influence on the temperature of the orifice 4 as heating the fluid in the actuation chamber 23 using the electrodes. However, the induction coil 24 may assist in keeping the fluid as well as the fluid chamber body 6 around a desired temperature and keeping the fluid molten.

[0028] Fig. 3A shows a first example of the method according to the present invention. Fig. 3B shows the corresponding amount of heat generated in the electrically conductive fluid by the alternating and direct electrical current.

In the first example, a plurality of direct current pulses (I_{direct}), also referred to as actuation pulses, is applied to the electrically conductive fluid. The magnitude of the current applied during each of the direct current pulses (I_{direct}) is equal. Such sequence of direct current pulses may be used for example to print a series of droplets. In case the pulse width of the direct current pulse is constant, then each of the droplets of the series of droplet may have the same volume. However, the widths of the pulse may also vary along the different pulses of direct current applied.

In between t_0 and t_1, a first actuation pulse is provided by applying a direct current having a magnitude of I_{direct}. As a result of this current, an amount of heat Q that equals $Q_{actuation}$ is generated in the electrically conductive fluid as is shown in Fig 3B. At t_1, the first direct current pulse stops and an alternating current $I_{alternating}$ is applied, thereby providing a maintenance pulse. The alternating current is applied until t_2. The magnitude of the alternating current is selected such that the amount of heat generated by the alternating current ($(I_{RMS})^2 * R$) is smaller than the amount of heat generated by the pulse of direct current ($I_{direct}{}^{2} * R$). As is shown in Fig. 3B, the amount of heat Q generated in the fluid is lowered when the direct current I_{direct} is replaced by the alternating current $I_{alternating}$. At t_2, the alternating current $I_{alternating}$ is stopped and an actuation pulse is applied again. The magnitude of the current applied in this second direct current pulse equals the magnitude of the current applied in the first direct current pulse. As a consequence, as is shown in Fig. 3B, in between t_2 and t_3, the amount of heat Q generated in the system equals $Q_{actuation}$, which is equal to the amount of heat generated during the first direct current pulse in between t_0 and t_1. At t_3, the second direct current pulse is stopped and an alternating current is applied. The amplitude of the alternating current $I_{alternating}$ applied in between t_3 and t_4 equals the amplitude of the alternating current $I_{alternating}$ applied in between t_1 and t_2. Therefore, as is shown in Fig. 3B, the total amount of heat Q generated equals $Q_{maintenance}$. At t_4, the alternating current is stopped and a third direct current pulse is applied, the magnitude of the direct current I_{direct} being equal to the magnitude of the direct current pulses applied in between t_0 and t_1 and in between t_2 and t_3, respectively.

[0029] Fig. 4 shows a second example of the method according to the present invention. In Fig. 4, three actuation pulses are schematically shown. A first actuation pulse is applied between t_0 and t_1, a second actuation pulse is applied between t_2 and t_3 and a third actuation pulse is applied between t_4 and t_5. The actuation pulses provide a certain amount of heat (not shown). In this second example, the actuation pulses have a trapezoidal shape.

In between the first and the second actuation pulse, a maintenance pulse is applied. However, the maintenance pulse does not start at t_1, but starts at a small time interval after the first actuation pulse is finished ($t_{1'}$). From $t_{1'}$ until $t_{1''}$, a maintenance is applied by applying an alternating current. At $t_{1''}$, the alternating current is stopped. In between $t_{1''}$ and t_2, no pulse is applied. The maintenance pulse may provide an amount of heat (not shown). During the intervals wherein no pulse (actuation pulse or maintenance pulse) is applied to the electrically conductive fluid, no heat is provided to the electrically conductive fluid by the pulses. Hence, in this example, the amount of heat supplied to the electrically conductive fluid by the (actuation and maintenance) pulse is not constant.

In between the second and third actuation pulse, a second maintenance pulse is applied. The maintenance pulse starts at $t_{3'}$, a short time interval after the second actuation pulse has stopped (t_3). From $t_{3'}$ until $t_{3''}$, a maintenance is applied by applying an alternating current. At $t_{3''}$, the alternating current is stopped. In between $t_{3''}$ and t_4, no pulse is applied.

[0030] Detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually and appropriately detailed structure. In particular, features presented and described in separate dependent claims may be applied in combination and any combination of such claims are herewith disclosed. Further, the terms and phrases used herein are not intended to be limiting; but rather, to provide an understandable description of the invention. The terms "a" or "an", as used herein, are defined as one or more than one. The term plurality, as used herein, is defined as two or more than two. The term another, as used herein, is defined as at least a second or more. The terms including and/or having, as used herein, are defined as comprising (i.e., open language). The term coupled, as used herein, is defined as connected, although not necessarily directly.

Claims

1. Method for operating a jetting device (1), the jetting device (1) being configured to expel droplets of an electrically conducting fluid wherein at least a part of the conductive fluid is positioned in a magnetic field, the method comprising the steps of:

a) providing a first actuation pulse by providing direct electrical current in the part of the conductive fluid positioned in the magnetic field, thereby generating a Lorentz force in the conductive fluid and generating an amount of heat; and
b) providing a second actuation pulse by providing direct electrical current in the part of the conductive fluid positioned in the magnetic field, thereby generating a Lorentz force in the conductive fluid and generating an amount of heat; and
c) in between the first actuation pulse and the second actuation pulse, providing a maintenance pulse by providing an alternating electrical current in the part of the conductive fluid positioned in the magnetic field, the alternating electrical current generating an amount of heat;

wherein the amount of heat generated by the alternating current is different from the amount of heat generated by the direct current.

2. Method according to claim 1, wherein the amount of heat generated by the alternating current is smaller than the amount of heat generated by the direct current.

3. Method according to claim 1 or 2, wherein the alternating electrical current has a frequency in the range of from 40 kHz to 500 kHz.

4. Method according to any of the preceding claims, wherein the electrically conductive fluid is a molten metal.

5. Jetting device (1) for printing a droplet of an electrically conductive fluid, the jetting device (1) comprising:

- a fluid chamber (23) for holding an amount of the electrically conductive fluid; and
- an actuation assembly configured to expel droplets of the electrically conductive fluid from the chamber through a nozzle (4), the actuation assembly comprising

  - a magnetic field generating unit (8) for generating a magnetic field in at least a part of the fluid chamber (23); and
  - an electrical direct current generating unit (32) for generating a direct electrical current in the electrically conductive fluid in the part of the chamber (23) provided with the magnetic field, thereby generating a pressure wave in the conductive fluid in said part of the fluid chamber (23),

wherein the jetting device (1) further comprises :

  - an electrical alternating current generating unit (31) for generating an alternating electrical current in the electrically conductive fluid in the part of the chamber (23) provided with the magnetic field,
  - control means (33) configured to carry out the method according to any of the claims 1-4.

6. Jetting device (1) according to claim 4, wherein the electrical direct current generating unit (32) is operatively connectable to two electrodes (12a, 12b) in contact with the electrically conductive fluid for providing the electrical direct actuation current in the conductive fluid, the jetting device (1) being configured such that the two electrodes (12a, 12b) are operatively connected to the electrical direct current generating unit (32) upon actuation.

7. Jetting device (1) according to claim 5, wherein the electrical alternating current generating unit (31) is operatively connectable to the two electrodes (12a, 12b) in contact with the electrically conductive fluid.

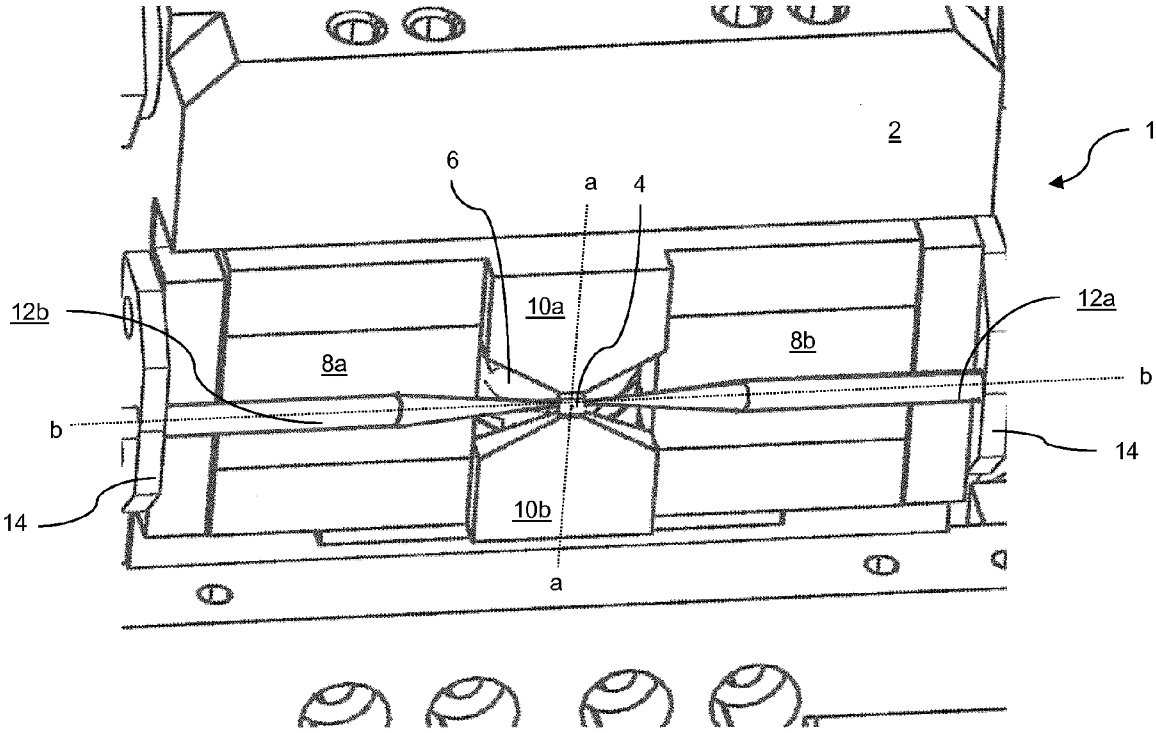

Fig. 1

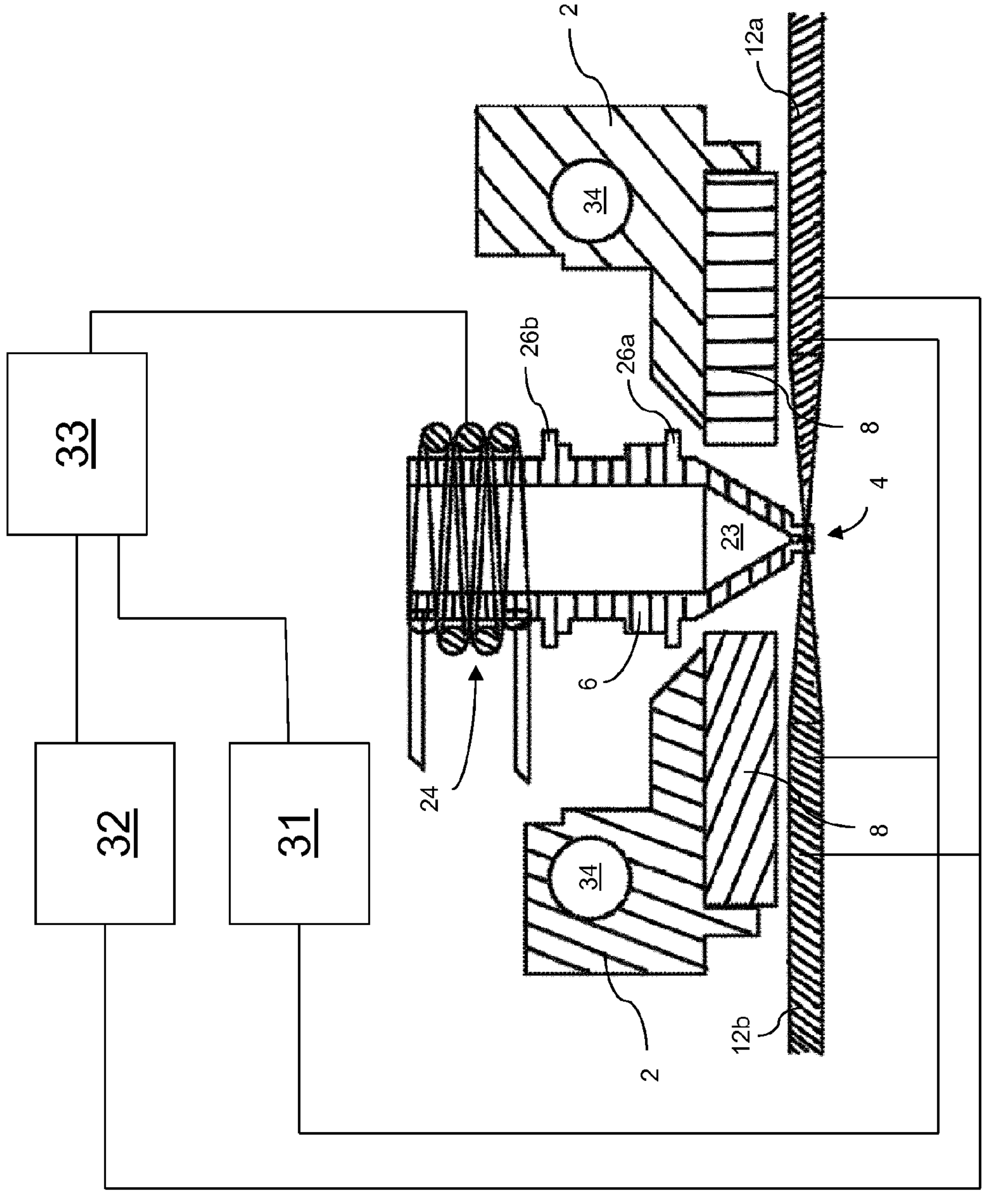

Fig. 2

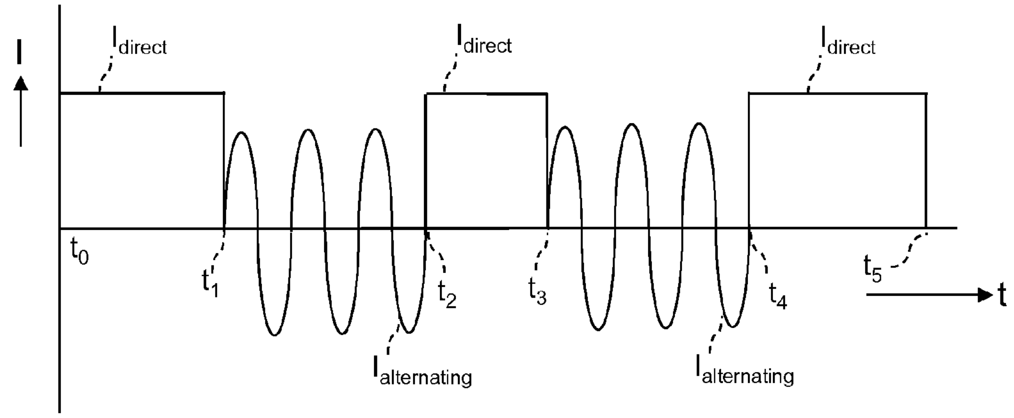
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Fig. 3A

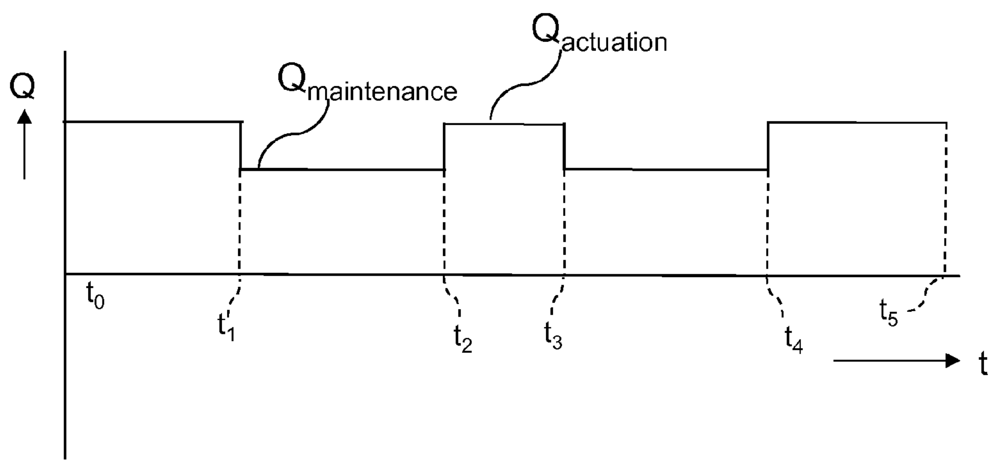
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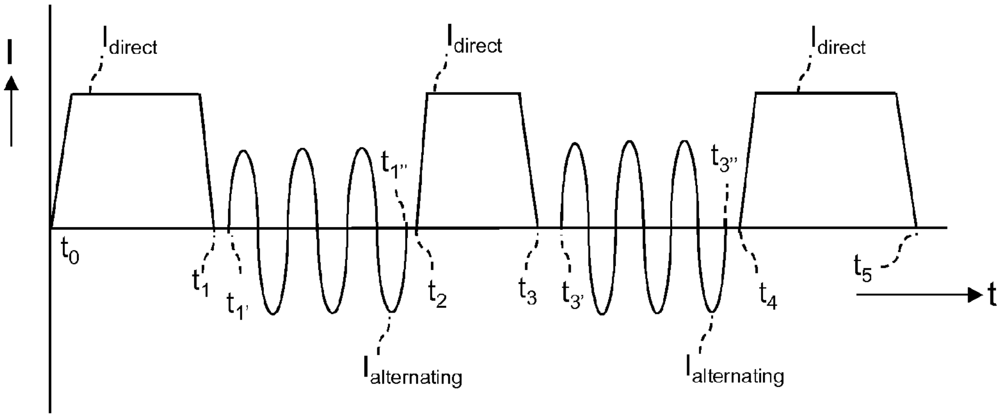
Fig. 3B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t5
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Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 14 19 5047

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D	EP 2 792 490 A1 (OCÉ TECHNOLOGIES B V [NL]) 22 October 2014 (2014-10-22) * paragraph [0030]; figures 2,3a,3b * -----	1-7	INV. B41J2/045 B41J2/14
X	JP H02 74349 A (CITIZEN WATCH CO LTD) 14 March 1990 (1990-03-14) * abstract; figure 9 * -----	1,5	
A	JP 2008 173770 A (HITACHI LTD) 31 July 2008 (2008-07-31) * abstract * -----	1,5	
			TECHNICAL FIELDS SEARCHED (IPC)
			B41J

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	30 April 2015	Bardet, Maude

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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30-04-2015

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