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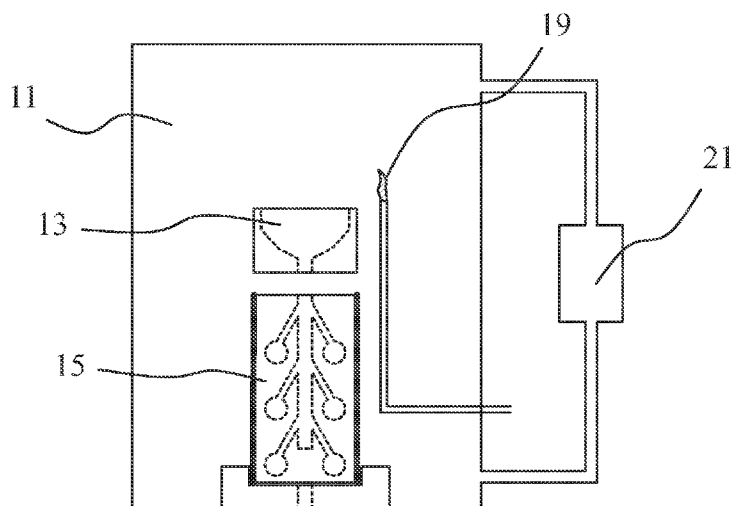


Fig. 2a

(57) **Abstract:** The present invention provides a method for manufacturing a biocompatible precious metal alloy object. According to a first aspect melting of alloying elements and casting of the biocompatible precious metal alloy are carried out in a process chamber (11) being provided with a process gas of predetermined composition. A burning flame (19) of a hydrocarbon-containing gas provides low oxygen and water content. According to a second aspect post-processing of a precious metal alloy is made in atmosphere provided by the process gas to form the biocompatible precious metal alloy object. The biocompatible precious metal alloy object manufactured according to the invention has a low probability of causing sensitisation when in contact with the human body.



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METHOD OF PRODUCING PRECIOUS METAL ALLOY OBJECTS

Technical field of the invention

The present invention relates to precious metal alloys and methods of manufacturing such. In particular the present invention relates to precious metal alloy objects such as jewellery and other precious metal containing objects, for example dental implants and decorative members, that are intended to be in contact with a human body.

Background of the invention

Precious metals are commonly used in jewellery or other objects which are intended to be in contact with the human body. One reason for this is that precious metals are less reactive than most elements. Another is their high economical value. Moreover, precious metals usually have an attractive lustre and high ductility. The most well-known precious metals are gold and silver, but other precious metals such as platinum and palladium are commonly used for the same purposes.

Precious metal objects which are worn on the human body are subjected to wear and damage. The ductility of precious metals is an advantage since the risk for fracture is low, but precious metals have relatively low hardness making them susceptible to wear. To make them harder, and also due to the high cost of the precious metals, precious metals used in jewellery, implants, etc. are usually alloyed with other elements. The precious metals may also be alloyed to improve other properties of the precious metal, such as for example to obtain a certain lustre or colour or to improve the workability.

It is known that some people cannot wear jewellery or other decorative members due to hypersensitivity or allergy, which may cause dermatitis or allergic reactions. The allergenic potency of different elements differs and generally precious metals have the lowest potency. Among the alloying elements commonly used for gold, nickel has been identified as having the highest allergenic potency. Therefore the nickel release in a synthetic sweat solution has been established as a measure on the allergenicity of a nickel-containing material, and a threshold level (0.2 $\mu\text{g}/\text{cm}^2/\text{week}$) below which an object may be considered non-allergic has been defined in the European Union "Nickel Directive" (94/27/EC). Similar threshold levels for other alloying elements have not been established, but it is likely that other alloying elements, even silver, copper and gold, may also cause sensitisation. Allergic reactions or the like may

also occur due to impurities in the precious metals or metal alloys. The impurities may appear due to impurities of the raw materials used or due to the manufacturing of the alloy. For example impurities may be added if the precious metal or metal alloy is treated with an acid in a step following a casting step to remove oxides formed on the cast object. Irrespective of the reason for the sensitisation, a precious metal object can be regarded as biocompatible if the probability of causing sensitisation is below a certain degree.

One common belief is that allergenic reactions do not occur if only pure alloying elements of precious metals are used. Using conventional manufacturing methods this does not necessarily yield a precious metal alloy that is non-allergenic and more important the semi-finished or finished product may not have e.g. the required hardness, fracture toughness, workability, colour, etc. As mentioned above the hardness of a precious metal or metal alloy is important to provide wear resistance. By way of example, a gold alloy comprising the alloying elements gold, silver and copper is usually manufactured by melting the alloying elements in a crucible and casting them in a mould to form a raw material that subsequently is subjected to further processing to form the final object. In manufacturing of a precious metal alloy object, the raw material is typically cold or hot worked and it may be subjected to heat treatments and/or cooling steps necessary to obtain certain material properties in the final object. This process is by no means simple, e.g. an increased hardness due to e.g. strain hardening during cold working of the raw material may cause difficulties due to decreased workability and on the contrary hot working of the raw material may significantly decrease the workability of the alloy making it difficult to form the final object. Also the alloy may be brittle after the casting of the raw material, making additional annealing steps necessary.

Summary of the invention

The prior art has drawbacks with regard to being able to provide a precious metal alloy object that is biocompatible and has the desired material properties, such as high hardness and good workability.

The object of the present invention is to overcome the drawbacks of the prior art. This is achieved by a biocompatible precious metal alloy object and a method for manufacturing such as defined in the independent claims.

The method for manufacturing a biocompatible precious metal alloy object according to the present invention comprises the step of forming the biocompatible precious metal alloy object in a process chamber. The method further comprises the step of providing a process gas of predetermined composition having a water content of less than 0.005kg H₂O per kg process gas and an oxygen content of less than 5%. The process gas is provided in the process chamber at least during said forming of the biocompatible precious metal alloy object.

According to a first aspect of the present invention the step of forming the biocompatible precious metal alloy object comprises the steps of melting alloying elements together in order to form the precious metal alloy, and casting the molten alloying elements of the precious metal alloy.

According to a second aspect of the present invention the step of forming the biocompatible precious metal alloy object comprises the step of post-processing a precious metal alloy, i.e. a raw material, in the process chamber to form the biocompatible precious metal alloy object. Preferably the raw material is manufactured in accordance with the method of the present invention. The post-processing may for example include soldering and/or welding.

According to one embodiment of the present invention a solder alloy, suitable for being used in the above mentioned soldering of the precious metal alloy raw material or object, is manufactured in accordance with the method of manufacturing the biocompatible precious metal alloy object according to the first aspect.

In one embodiment of the present invention the content of the process gas and hence the environment in the process chamber is controlled by burning a flame that is supplied with a hydrocarbon-containing gas. Thereby oxygen present in the process chamber is combusted.

The bulk of a biocompatible precious metal alloy object that has been manufactured according to the method of the present invention has an oxygen content of less than 5µg/g, preferably less than 3µg/g and more preferably less than 1µg/g; and a hydrogen content of less than 0.05µg/g, preferably less than 0.01µg/g and more preferably less than 0.005µg/g.

A biocompatible precious metal alloy object according to the present invention preferably comprises 2% Ag. More preferably it is a gold alloy of more than 14 carat or a silver alloy.

Thanks to the invention it is possible to provide a biocompatible precious metal alloy object which is not likely to cause sensitisation when in contact with a human body.

It is a further advantage of the invention to provide a precious metal alloy object which has tailored material properties with regards to e.g. hardness and workability. Such an object can be used as a raw material that is subjected to post-processing in order to form a final precious metal alloy object having adequate material properties such as high hardness and high fracture toughness.

It is a yet further advantage of the invention to provide post-processing of a biocompatible precious metal alloy raw materials in a dedicated workstation to substantially maintain the tailored material properties of the biocompatible precious metal alloy raw material which preferably has been manufactured according to a method in accordance with the present invention.

Embodiments of the invention are defined in the dependent claims. Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings and claims.

20

Brief description of the drawings

Preferred embodiments of the invention will now be described with reference to the accompanying drawings, wherein:

Figs. 1a-d are schematic diagrams of embodiments of a method of manufacturing a precious metal alloy object according to the present invention;

Figs. 2a-b are schematic illustrations of process chambers according to the present invention;

Fig. 3 is a schematic illustration of a crucible arranged on a mould with an intermediate pre-heater chamber according to the present invention;

30

Fig. 4 is a schematic diagram of a method in accordance with the present invention for manufacturing a precious metal alloy comprising the step of evacuating the mould; and

Fig. 5 is a schematic illustration of a process chamber suitable for post-processing
5 according to the invention.

Detailed description of embodiments

During manufacturing of a precious metal alloy object the alloying elements are usually melted and subsequently cast to form a precious metal alloy object, a so-called raw material, which subsequently is subjected to post-processing, including
10 e.g. forging, welding, soldering, casting, grinding, polishing or drawing, to form a precious metal alloy object such as a jewellery. One object of the present invention is to provide a method for manufacturing of precious metal objects which are biocompatible so that they do not cause sensitisation when carried in contact with
15 the human body. Examples of such objects are jewellery (including piercing jewellery), decorative members of other kind, dental implants, etc. as well as the raw material mentioned above. The precious metal alloy composition according to the present invention comprise of precious metal alloys compositions commonly used for e.g. jewellery, dental implants, and decorative members. Examples of such, however
20 not limited to these, are gold (22K, 18K, 14K, etc.) and sterling silver. Although a gold alloy manufactured according to the present invention may be of a certain carat it may differ slightly in the content of the main alloying elements (Au, Ag, Cu) and the additional alloying elements may differ in content or composition to obtain e.g. a certain lustre. Furthermore, although the term alloy is used, the present invention is
25 not limited to alloys comprising two or more materials. Also pure precious metals may be manufactured using the method of the present invention.

Referring to Figs. 1a-d, a method for manufacturing a biocompatible precious metal alloy object that is made of a precious metal alloy according to the present invention comprises the steps of:

- 30 - 100 forming the biocompatible precious metal alloy object in a process chamber; and
- at least during said forming 101 providing a process gas of predetermined composition in the process chamber 11, wherein the process gas has a water content

of less than 0.005 kg H₂O per kg of process gas and an oxygen content less than 5% oxygen.

In one embodiment of the present invention the step of forming further comprises the steps of:

5 - 102 melting alloying elements together in order to form the precious metal alloy;
and

- 103 casting the molten alloying elements of the precious metal alloy, wherein the steps of melting and casting are carried out within the process chamber 11 in a controlled atmosphere comprising the process gas.

10 In another embodiment of the present invention step of forming comprises the step of 111 post-processing the precious metal alloy in the process chamber 11 to form the biocompatible precious metal alloy object. The post-processing is preferably performed on a precious metal alloy raw material that has been manufactured according to the above mentioned steps of melting and casting. However, the
15 invention is not limited to this and suitable raw materials manufactured according to other methods can be used. The post-processing may be made in the same process chamber 11 as used in the manufacturing of the raw material or in another process chamber such as a dedicated workstation chamber.

In one embodiment of the present invention the step of providing the process gas
20 further comprises the step of 104 combusting oxygen of the process chamber 11 using a flame 19 that is supplied with a hydrocarbon-containing gas.

Referring to Figs. 2a-b, the process chamber 11 is preferably designed such that a controlled atmosphere that is separated from the ambient air can be provided in the process chamber 11. In one embodiment of the present invention the step of
25 providing the process gas comprises the step of generating an overpressure in the process chamber 11 in order to have a net flow of gas from within the process chamber 11 to the outside, for example by using a check valve or a pump. A suitable overpressure can also be maintained by having a net flow through doors of an airlock system 28. This also automatically provides a controlled atmosphere in the airlock
30 system.

Fig. 2a schematically illustrates a process chamber 11 according to one embodiment of the present invention. A process gas of predetermined composition is provided in the process chamber 11, preferably before and during melting and casting of alloying

elements, by combusting burning a flame 19 that is supplied with a hydrocarbon-containing gas within the process chamber. The combustion process lowers the oxygen content of the process chamber 11 to at least less than 5%, preferably less than 2% and more preferably to less than 1%. In addition dehydration means 21 may be used. This limits the water content of the process gas to at least less than 0.01 kg H₂O per kg air, preferably less than 0.005 kg H₂O per kg air, and most preferably less than 0.001 kg H₂O per kg air. The process chamber 11 may further comprises a crucible 13 arranged on a mould 15, which, for example, may be a so-called flask comprising a plaster compound inside, which a skilled person is familiar with. The alloying elements are provided in the crucible 13 and melted. The mould 15 is at least partly filled by the molten alloying elements and after solidification of the molten alloying elements a precious metal alloy object is formed in the mould 15.

Fig. 2b schematically illustrates a process chamber 11 suitable for the melting and casting according to one embodiment of the present invention. A process gas of predetermined composition in the process chamber 11 is accomplished by supplying a hydrocarbon-containing gas to a burning flame 19 within the process chamber 11. By way of example the hydrocarbon-containing gas may be a mixture of oxygen and acetylene, i.e. a welding flame, wherein the oxygen/acetylene ratio is adjusted to give a reducing flame (an over-rich mixture). The combustion process lowers the oxygen content of the process chamber 11 to at least less than 5%, preferably less than 2% and more preferably to less than 1%. In addition dehydration means 21 are used to limit the water content of the process gas to at least less than 0.01 kg H₂O per kg air, preferably less than 0.005 kg H₂O per kg air, and most preferably less than 0.001 kg H₂O per kg air. The process chamber 11 may further comprise a crucible 13 arranged on a mould 15, which may be a so-called flask comprising a plaster compound. The alloying elements are provided in the crucible 13. Inductive heating by inductive heaters 25 may be used to melt the alloying elements, which subsequently are supplied as a melt to the mould 15, for example through an openable and closable opening in the bottom of the crucible 13. After solidification of the melt a precious metal alloy object is formed in the mould 15.

In one embodiment of the present invention the step of providing said first process gas further comprises the step of supplying a protective gas such as nitrogen, argon, etc. to the process chamber 11. This protective gas can be used as means for removing ambient air from the process chamber and also can function as an inert gas during melting and casting.

In one embodiment of the present invention the step of providing said first process gas comprises the step of 106 drying the first process gas of predetermined composition using dehydration means 21. This can be achieved, for example, by water vapour in the first process gas being condensed onto a cold surface and led to
5 a drain.

In one embodiment of the present invention the method further comprises the step of evacuating a gas from the mould 15 prior to the casting of the molten alloying elements e.g. by connecting a vacuum pump to one end of the mould 15.

In one embodiment of the method according to the present invention the step of
10 evacuating further comprises drying of an inert gas, optionally pre-heating of the inert gas, and providing a flow of the optionally pre-heated inert gas through the mould before casting. The inert gas may be provided from the process gas of pre-determined composition. One alternative is to supply an inert gas of another
15 composition. Inert gas is for the purpose of this application interpreted to mean a gas having a water content of less than 0.005 kg H₂O per kg air and an oxygen content of less than 5% oxygen.

In one embodiment of the invention the drying of the inert gas is obtained using dehydration means 21 in the form of e.g. a refrigeration drier. Gas from the process chamber 11 is pumped into the refrigeration drier, wherein water vapour in the gas is
20 condensed and removed from the gas. The dried gas may then be fed back to the process chamber 11.

Referring to Fig. 3, in one implementation of the method of the present invention the mould 15 is preheated, e.g. in a separate oven, to about 350-400 °C. Thereafter, a pre-heater chamber 17, a mould 15 and a crucible 13 are assembled with the mould
25 15 underneath the crucible 13. Alloying elements are provided in the crucible 13. Heater means, for example, inductive heaters 25, are used to heat the crucible 13 to a temperature which is sufficient to melt the alloying elements. The temperature depends on the composition of the alloying elements but may be about 900 °C. The pre-heater chamber may be heated by heat transferred from the crucible 13. The
30 temperature of the pre-heater chamber 17 may be about 600 °C. A pressure gradient is applied over the mould 15, e.g. by applying a vacuum pump to one end, i.e. an outlet, of the mould 15, in such way that the process gas of the process chamber 11 is sucked into the pre-heater chamber 17 and gets preheated before entering the

mould 15. This gives a preheating of the mould 15 which is at least sufficient for maintaining the temperature obtained after the preheating. By supplying the mould through an inlet of the mould with a gas having a controlled composition to provide a flow of the gas through the mould the conditions for casting a biocompatible object is improved. Residual oxygen and water trapped in the mould may be forced out of it. By way of example the crucible may have an exit hole in the bottom, which initially is sealed using a rod. When the alloying elements have melted and reached the desired temperature the rod can be removed and the melt is poured down into the preheated mould 15. The method of the present invention results in precious metal objects having substantially no oxidation layer. One advantage with this is that no subsequent treatment in an acid bath (as is commonly used in the prior art) is required. Treatment in such acid baths is believed to be one source of impurities which may give sensitisation for a carrier of a precious metal alloy object manufactured from the acid bath-treated raw materials.

Referring to Fig. 4, in one embodiment of the present invention wherein alloying elements are melted in a crucible 13 and a biocompatible precious metal alloy object is casted in a mould 15 within a process chamber 11 having an atmosphere of a process gas of predetermined composition, the method comprises the steps of:

- optionally 107 pre-heating the mould 15 before casting in said mould 15,
- 108 pre-heating an inert gas in a pre-heater chamber 17 arranged in-between the mould 15 and the crucible 13, and
- 109 flowing the inert gas through the mould 15 by evacuating the inert gas from the one end of the mould 15.

A pre-heater chamber according to the invention may comprise a cylindrical body having holes around the perimeter to allow gas from the atmosphere of the process chamber to enter into a through bore which is open for the melted alloying elements to be supplied to the mould. Hence the gas enters the pre-heater chamber from the side and is sucked down into the mould.

As mentioned above, the step of casting comprises solidification of the melted alloying elements in the mould 15. In one embodiment of the method of the present invention the cooling of the solidified precious metal alloy object resulting from the solidification of the molten alloying elements is made in a controlled environment such as an atmosphere of the process gas of predetermined composition in the process chamber. The cooling may be performed e.g. within the process chamber or

in an adjacent chamber which can be entered from the process chamber without exposing the mould to the ambient air.

In one embodiment of the method of the present invention the mould with the solidified precious metal alloy object is quenched in an alcohol-containing water bath
5 having a temperature of less than 5 °C.

The bulk of the precious metal alloy object that has been manufactured according to a method in accordance with the present invention will have an oxygen content of less than 5µg/g, preferably less than 3µg/g and more preferably less than 1µg/g. In addition, the bulk of the precious metal alloy object that has been manufactured
10 according to the method of the present invention will have a hydrogen content of less than 0.05µg/g, preferably less than 0.01µg/g and more preferably less than 0.005µg/g. The surface layer of the same precious metal alloy object will have an oxygen content of less than 30µg/g, preferably less than 20µg/g and more preferably less than 10µg/g and a hydrogen content of less than 3µg/g, preferably
15 less than 2µg/g and more preferably less than 1µg/g. The oxygen and hydrogen content of the precious metal alloy object are important for their mechanical properties, in particular if the cast precious metal alloy object is a raw material that is going to be worked by a goldsmith to form for example jewellery. High hydrogen content may, for example, give a hard and brittle alloy which is not easily post-
20 processed by a goldsmith. This phenomenon is known in the field of metallurgy as hydrogen embrittlement. A method for testing the hydrogen and oxygen content in the surface layer comprises heating of the precious metal alloy object to a temperature close to, but below, the melting temperature of the alloy and then measuring the residual gases. At this temperature only gases originally trapped in
25 the surface of the alloy object are released. The bulk values have been obtained in a similar way but by heating the alloy object to a temperature well above the melting temperature so that gases originally trapped in the bulk of the alloy object are released.

In one embodiment of the present invention the precious metal alloy object
30 comprises at least 2% Ag. Examples of such precious metal alloys are 18 carat gold, 14 carat gold, Sterling silver etc.

Referring to Fig. 5, the advantageous properties of the precious metal alloy object of the present invention may be ruined by improper treatment of e.g. a goldsmith in his post-processing to form e.g. jewellery of the precious metal alloy object, i.e. a raw material, which has been manufactured in accordance with the method of the present invention. Hence, in one embodiment of the present invention a process chamber that is a dedicated workstation chamber for post-processing of a precious metal alloy in accordance with the method of the present invention is provided. The precious metal alloy is preferably manufactured according to the method of the present invention, but this embodiment is not limited to this. In one embodiment of the present invention the workstation chamber is a glove box, i.e. a closed chamber having two gloves extending into the chamber.

Any kind of machining that normally is performed on precious metal alloys objects can benefit from being performed within the workstation chamber. In particular, if biocompatible precious metal alloy has been formed e.g. using the method of the present invention, the properties of that alloy can be maintained using this workstation. Using conventional techniques there is an overwhelming risk that the advantageous properties are ruined. Examples of machining that can be performed are cold working, hot working, soldering, drawing, forging, polishing, etc.

In one embodiment of the invention the method further comprises the step of soldering and/or welding of a precious metal alloy object, which preferably has been melted and cast according to the method of the present invention, in the process gas of the process chamber or the dedicated workstation chamber. A typical solder for soldering precious metal alloy objects of the present invention is a precious metal alloy itself. Preferably the solder is fabricated in the same way as the precious metal alloy object of the present invention in a process chamber having a process gas of predetermined composition, i.e. having a water content of less than 0.005kg H₂O per kg process gas and an oxygen content of less than 5%.

The method for manufacturing a biocompatible precious metal alloy object can be used to manufacture a solder alloy as well. A method for manufacturing a solder according to the present invention comprises the steps of providing a process gas of predetermined composition in a process chamber, the process gas having a water content of less than 0.005 kg H₂O per kg air and an oxygen content less than 5% oxygen; melting solder elements; and casting the molten solder elements to form the

solder, by way of example in the form of a rod or a block, wherein the steps of melting and casting are carried out within the process chamber. Preferably the step of providing further comprises the step of combusting oxygen of the process chamber using a flame that is supplied with a hydrocarbon-containing gas. By way of example

5 the hydrocarbon-containing gas may be a mixture of oxygen and acetylene, i.e. a welding flame, wherein the oxygen/acetylene ratio is adjusted to give a reducing flame. The combustion process lowers the oxygen content of the process chamber. Dehydration means may be used to limit the water content of the process gas. In one implementation of the method for manufacturing of a solder alloy the process

10 chamber comprises a crucible arranged on a mould. The solder elements are provided in the crucible. Heating, for example by inductive heaters may be used to melt the alloying elements, which subsequently are supplied to the mould, by way of example through an opening in the bottom of the crucible. After solidification of the melt a solder alloy is formed in the mould. Optionally the step of providing further

15 comprises the step of supplying a protective gas such as nitrogen, argon, etc. to the process chamber. This protective gas can be used as means for removing ambient air from the process chamber and also work as an inert gas during melting and casting.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, it is to be

20 understood that the invention is not to be limited to the disclosed embodiments, on the contrary, it is intended to cover various modifications and equivalent arrangements within the appended claims.

CLAIMS

1. A method for manufacturing a biocompatible precious metal alloy made of a precious metal alloy, wherein the method comprises the step of (100) forming the biocompatible precious metal alloy object in a process chamber (11),
5 **characterised in that** the method further comprises the step of at least during said forming (101) providing a process gas of predetermined composition in the process chamber (11), wherein the process gas has a water content of less than 0.005kg H₂O per kg of process gas and an oxygen content of less than 5%.
2. The method according to claim 1, **wherein** the step of forming comprises the
10 steps of (102) melting alloying elements together in order to form the precious metal alloy, and (103) casting the molten alloying elements of the precious metal alloy.
3. The method according to claim 1 or 2, **wherein** the step of forming comprises the step of (111) post-processing the precious metal alloy in the process
15 chamber (11) to form the biocompatible precious metal alloy object.
4. The method according to anyone of claims 1 to 3, **wherein** the step of providing the process gas comprises the step of (104) combusting oxygen present in the process chamber (11) using a flame (19) that is supplied with a hydrocarbon-containing gas.
- 20 5. The method according to anyone of claims 1 to 4, **wherein** the step of providing the process gas comprises the step of drying the process gas using dehydration means (21).
6. The method according to anyone of claims 2 to 5, **further comprising** the step of evacuating a gas from a mould (15), and wherein the step of casting
25 comprises the step of at least partly filling the mould (15) with the molten alloying elements.
7. The method according to claim 6, **further comprising** the step of flowing an inert gas (8) through the mould (15).
8. The method according to claim 7, **wherein** the inert gas (8) comprises process
30 gas extracted from the process chamber (11).

9. The method according to claim 7 or 8, **further comprising** the step of pre-heating the inert gas (8) in a pre-heater chamber (17) arranged in between a crucible (13) for melting the alloying elements and the mould (15).
10. The method according to anyone of claims 2 to 9, **wherein** the step of casting
5 comprises the step of cooling the moulded precious metal alloy in the process gas without exposing it to ambient air.
11. The method according to anyone of claims 3 to 10, **wherein** the step of post-processing comprises soldering and/or welding of the precious metal alloy.
12. The method according to claim 11, **wherein** the soldering is performed using a
10 solder alloy that is manufactured a solder alloy in the process gas of the process chamber.
13. A biocompatible precious metal alloy object, **characterised in that** the biocompatible precious metal alloy object is manufactured according to the method of anyone of the preceding claims and the bulk of the biocompatible
15 precious metal alloy object has an oxygen content of less than $5\mu\text{g/g}$, preferably less than $3\mu\text{g/g}$ and more preferably less than $1\mu\text{g/g}$; and a hydrogen content of less than $0.05\mu\text{g/g}$, preferably less than $0.01\mu\text{g/g}$ and more preferably less than $0.005\mu\text{g/g}$.
14. The biocompatible precious metal alloy object according to claim 17, **wherein**
20 the biocompatible precious metal alloy object comprises at least 2% Ag.
15. The biocompatible precious metal alloy object according to claim 13 or 14, **wherein** the biocompatible precious metal alloy object is a gold alloy of more than 14 carat.
16. The biocompatible precious metal alloy object according to claim 13 or 14,
25 **wherein** the biocompatible precious metal alloy is a silver alloy.
17. The biocompatible precious metal alloy object according to anyone of claims 13 to 16, **wherein** the surface layer of the biocompatible precious metal alloy object has an oxygen content of less than $30\mu\text{g/g}$, preferably less than $20\mu\text{g/g}$ and more preferably less than $10\mu\text{g/g}$; and a hydrogen content of less than
30 $3\mu\text{g/g}$, preferably less than $2\mu\text{g/g}$ and more preferably less than $1\mu\text{g/g}$.

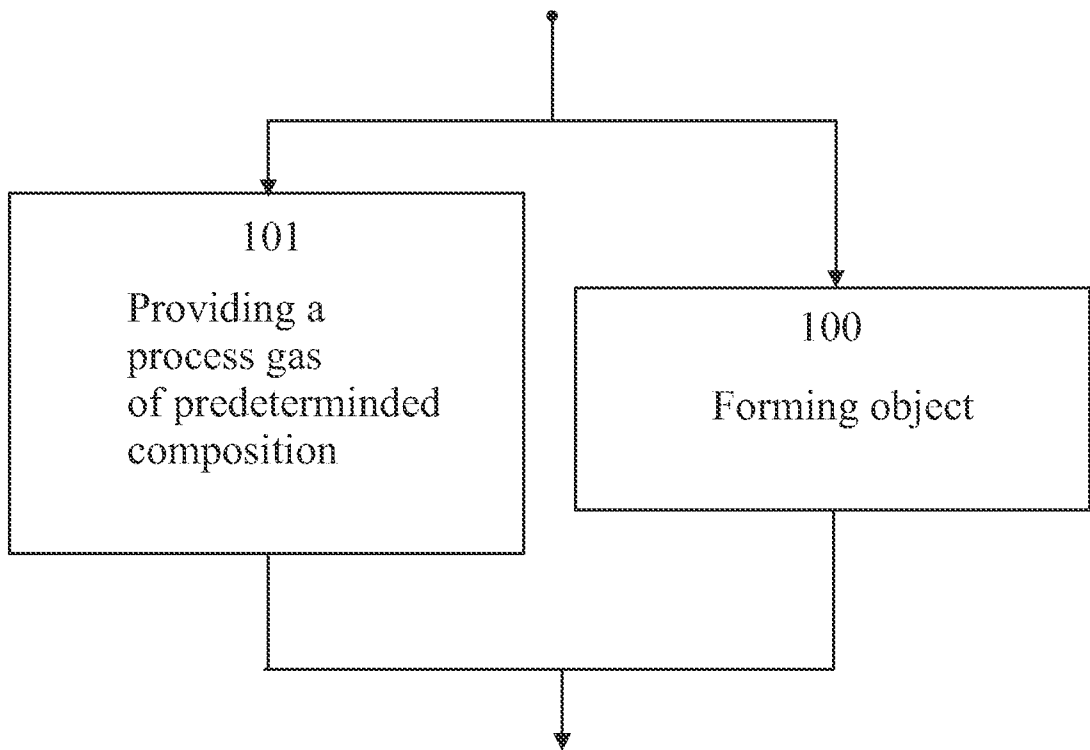


Fig. 1a

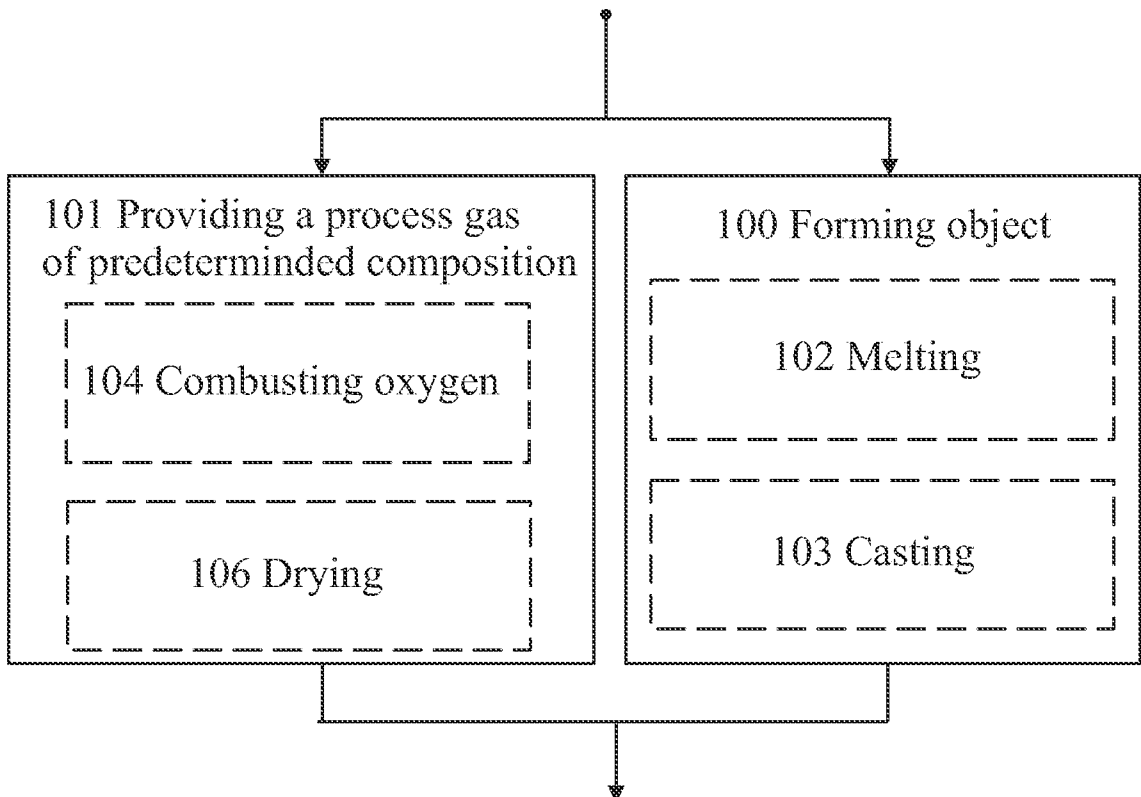


Fig. 1b

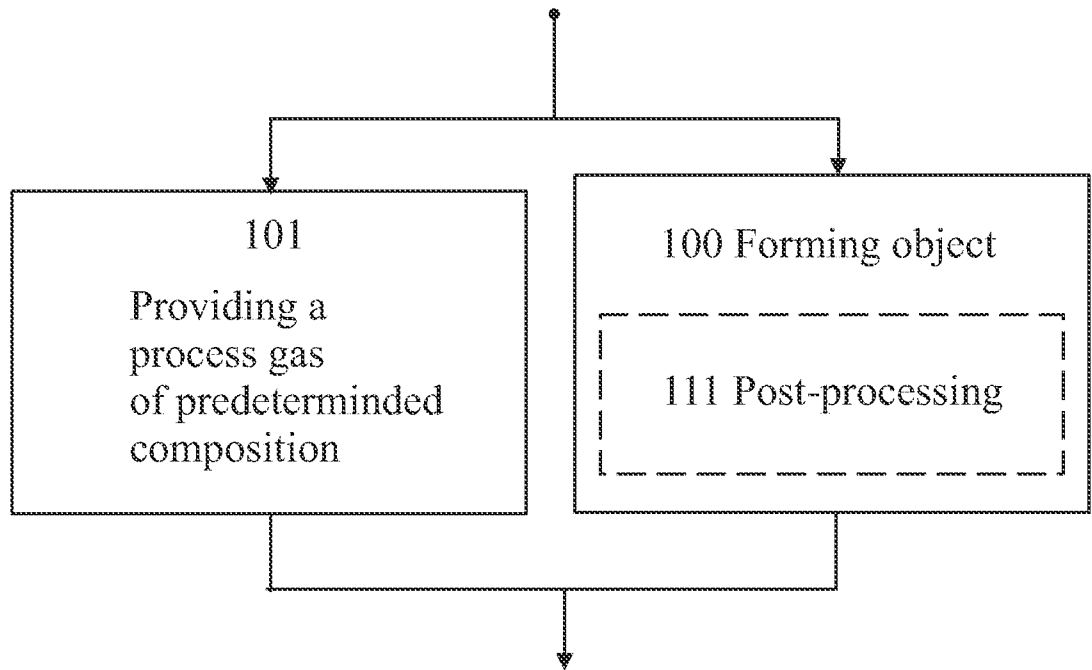


Fig. 1c

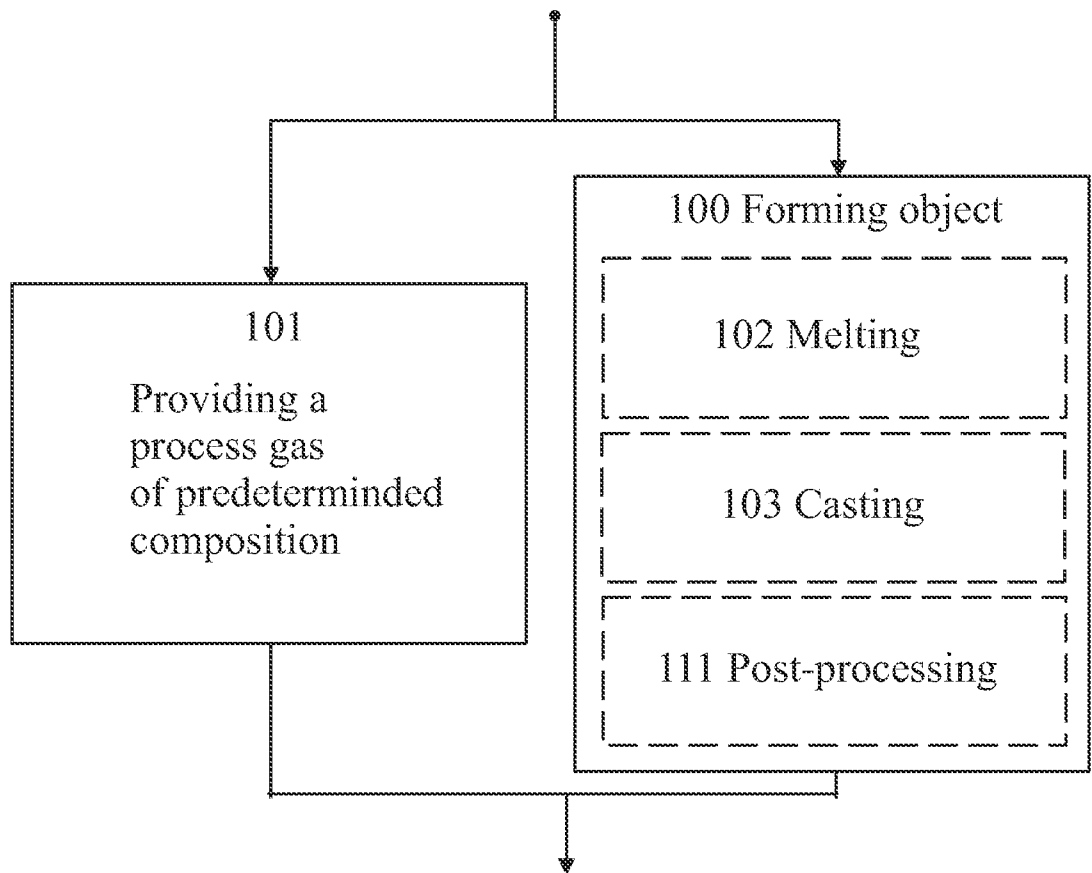


Fig. 1d

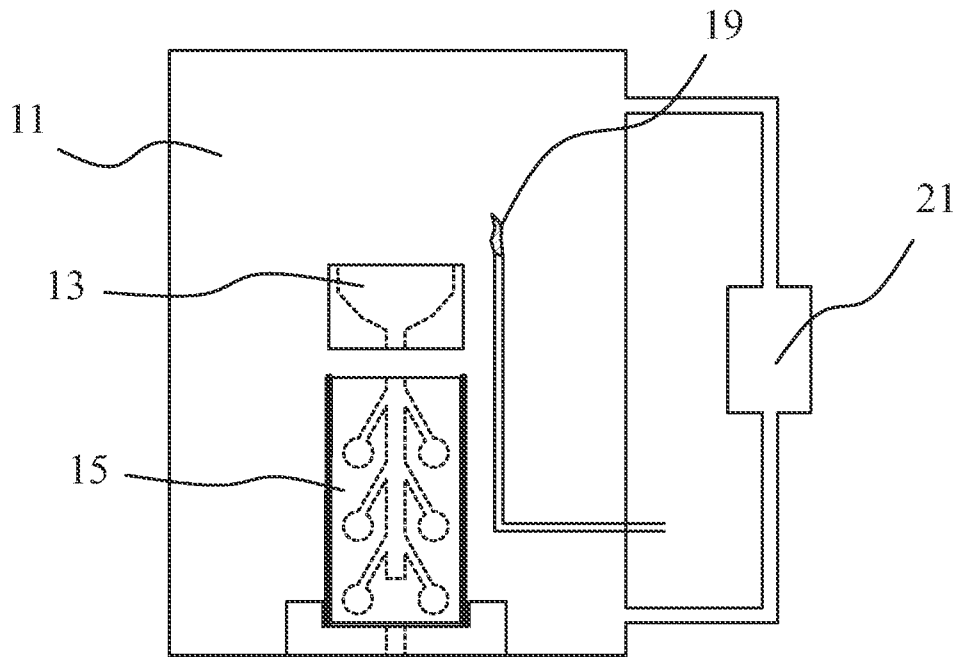


Fig. 2a

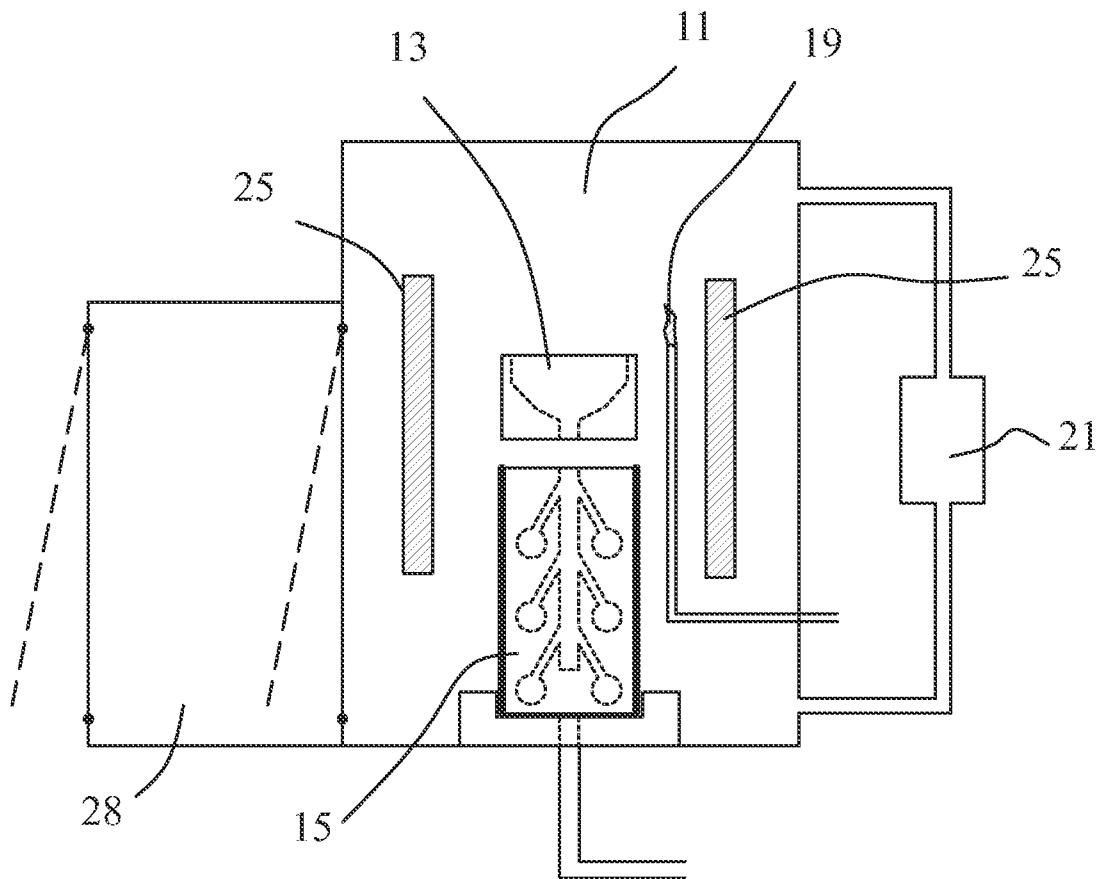


Fig. 2b

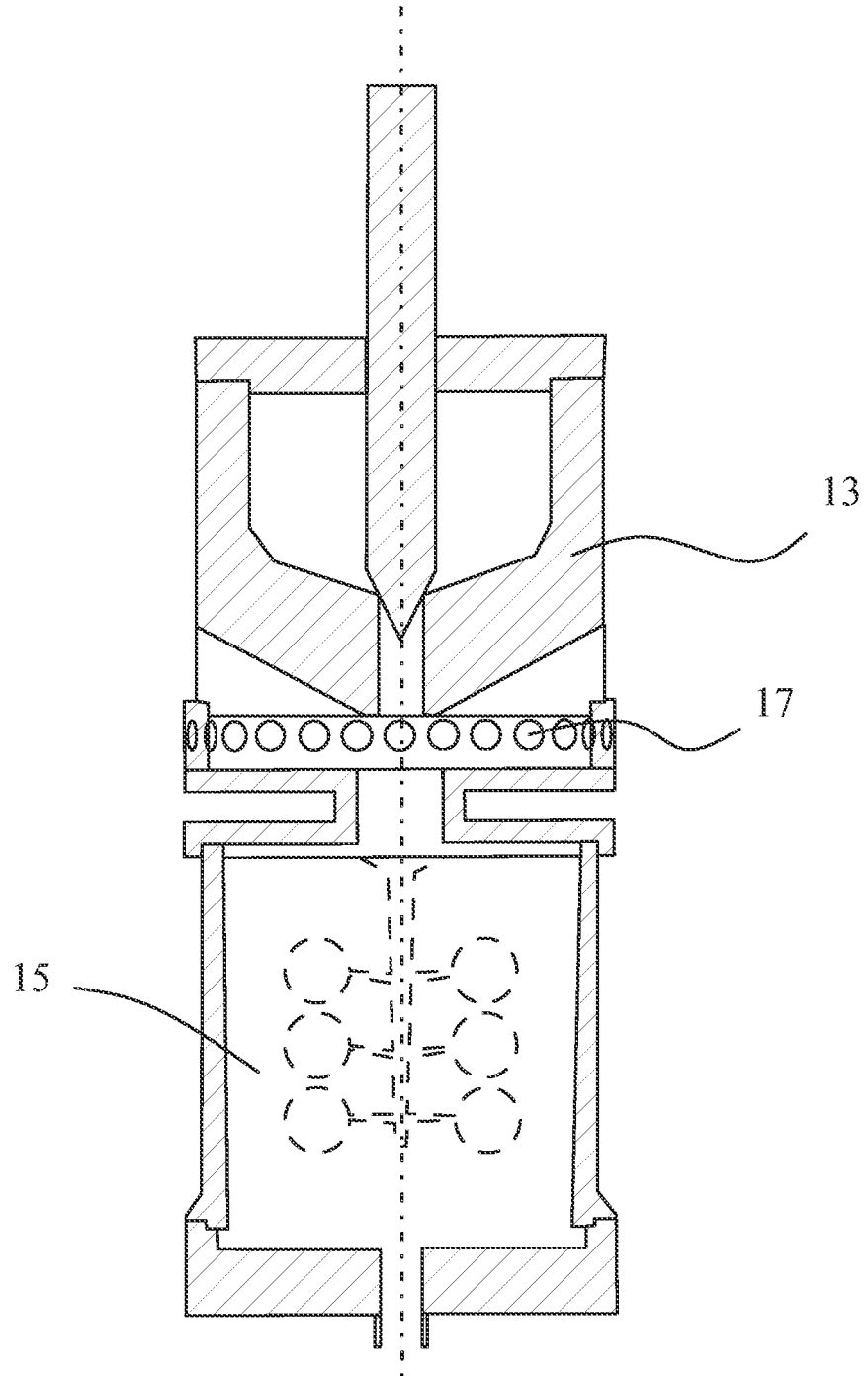


Fig. 3

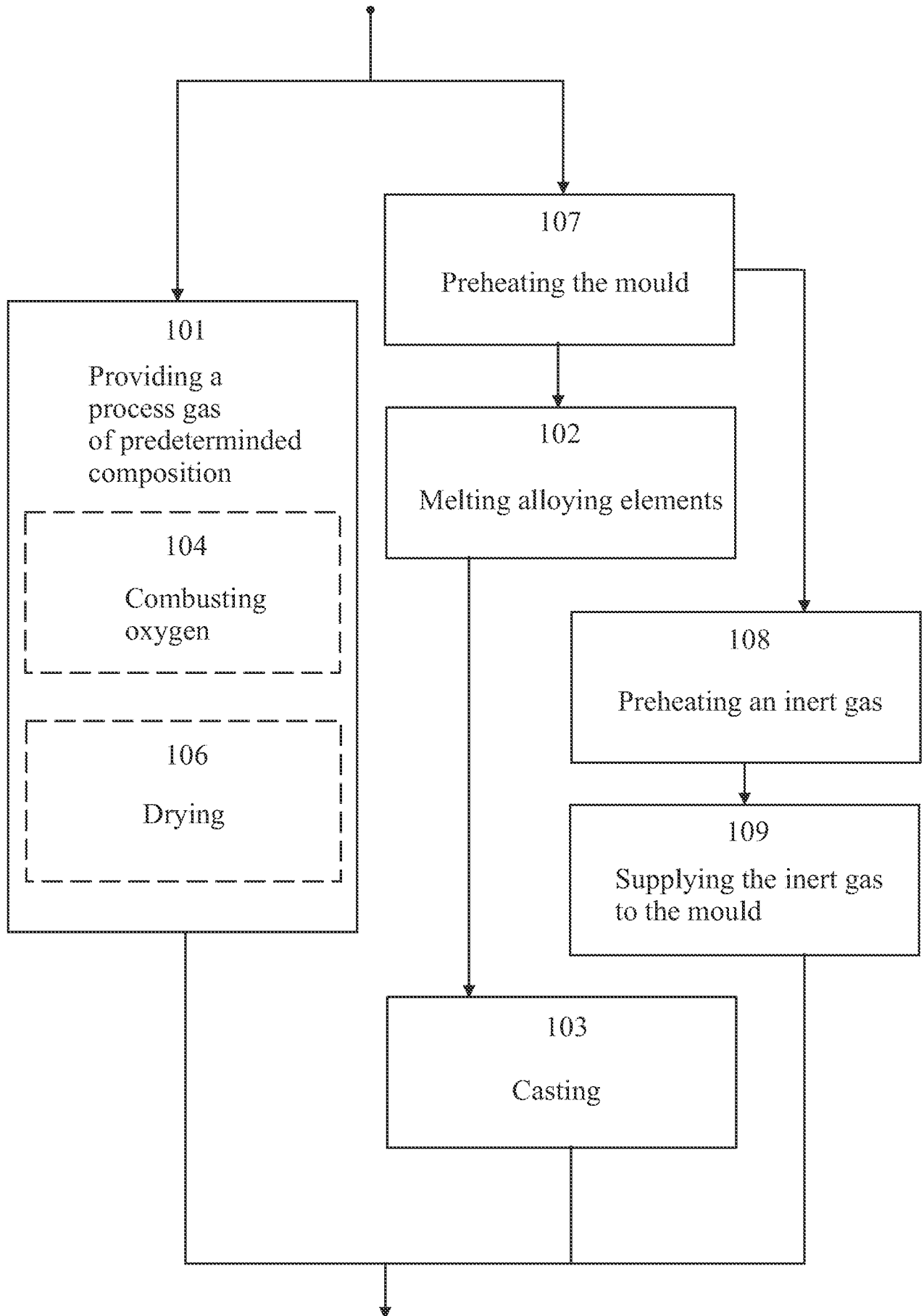


Fig. 4

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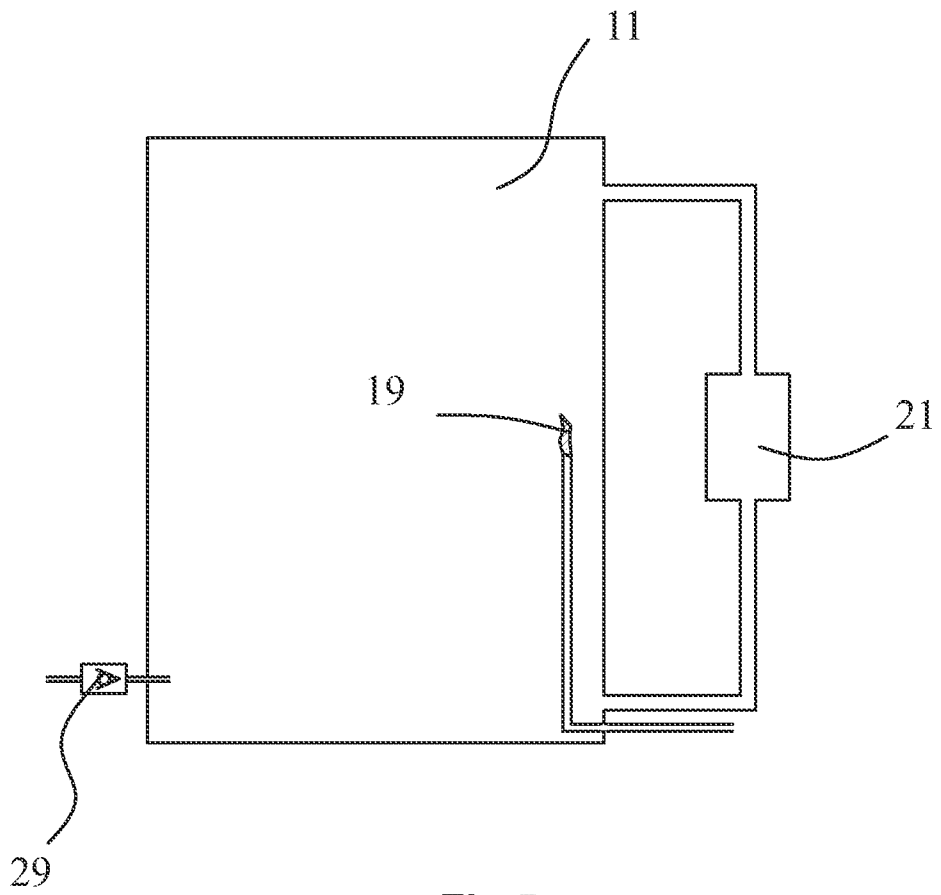


Fig.5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2009/050317

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: C22C

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0124574 B1 (WAHLBECK, HANS G.E.), 14 November 1984 (14.11.1984), see the whole document --	1-17
A	EP 1331280 A1 (W.C. HERAEUS GMBH & CO. KG), 30 July 2003 (30.07.2003) --	1-17
A	US 698769 A (WALKER, JAMES H.), 29 April 1902 (29.04.1902) --	1-17
A	US 5226946 A (DIEHM, RANDALL S. ET AL), 13 July 1993 (13.07.1993) -- -----	1-17

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Date of the actual completion of the international search

9 July 2009

Date of mailing of the international search report

14-07-2009

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2009/050317

International patent classification (IPC)

C22C 5/00 (2006.01)

C22C 1/02 (2006.01)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

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