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(54) DECORATIVE ELEMENTS AND METHODS

(57) A method of attaching a connection element (130) to a decorative element (110); the method comprising the steps of: providing a decorative element (110) having at least one recess (122); providing a sacrificial body (150) having a first end (151) and a second end (153), the first end (151) comprising a sacrificial cap (152) defining an open chamber (154) configured to receive at least a portion of the decorative element (110) that includes the at least one recess (122); securing the sacrificial cap (152) to the decorative element (110) such that the portion of the decorative element (110) that includes the at least one recess (122) is received in the chamber (154) of the sacrificial cap (152); forming an investment mould (170) over the sacrificial body (150) and the decorative element (110) so as to encompass at least the sacrificial cap (152) and at least a portion of the decorative element (110) adjacent to the sacrificial cap (152), and wherein at least a portion of the second end (153) of the sacrificial body (150) is free of investment so as to define an opening in the mould (170); heating the decorative element (110), sacrificial body (150) and investment mould (170) until the sacrificial body (150) burns out and forms a cavity (174) within the investment mould (170), the cavity (174) comprising the shape of the sacrificial cap (152) and the at least one recess (122); filling the cavity (174) with a liquid material through the opening (172) of the mould (170); solidifying the liquid material to form a connection element (130) attached to the decorative element (110); and removing the investment mould (170).

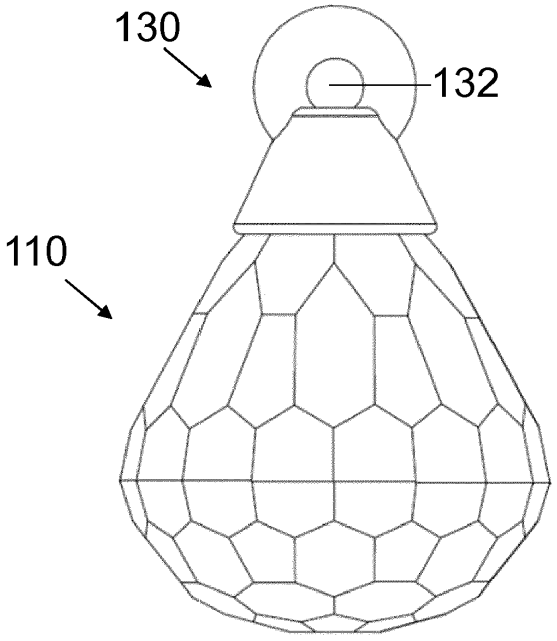

Fig. 7

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Description

Field of the Invention

[0001] The present disclosure relates to a method of attaching a connection element to a decorative element such as a gemstone, and an article comprising a decorative element and a connection element secured thereto.

Background of the Invention

[0002] Decorative elements 10 such as gemstones are commonly used in jewellery. To be wearable, such a decorative element 10 must generally be securely fixed to a jewellery piece (not shown).

[0003] It can often be desirable to attach a decorative element 10 (such as a briolette-shaped gemstone as shown in Figure 1; or a droplet-shaped gemstone) to a jewellery piece at a tapered end 12 of the decorative element 10. When a briolette is used as part of an earring or necklace, for example, it can be preferable to suspend the briolette from the tapered end 12 so that the crown 14 of the briolette hangs down (see Figure 1). To this end, the briolette must be attached to a jewellery piece at its tapered end 12.

[0004] However, it can be very difficult to reliably and securely connect a decorative element 10 to a jewellery piece at its tapered end 12.

[0005] One solution has been to a bore or connection aperture 16 through a width of the decorative element 10 (see Figure 2) and to attach a mount or connector of a jewellery piece through the bore. However, the bore 16 can significantly weaken the decorative element 10, which may break under the weight and movement of the decorative element 10 against the connector over time. Therefore, this solution is most suited only for sufficiently large decorative elements 10. Indeed, if the decorative element 10, or its tapered end 12, is too small, the integrity of the decorative element 10 may be compromised and will be prone to failure / breakage in use. Moreover, this configuration is further disadvantageous since it only allows for one particular appearance of the resultant jewellery item.

[0006] Another method of connecting a decorative element 10 to a jewellery piece is to fix a connection element 30 to the decorative element 10 with an adhesive. In this system, the connection element 30 may be adhered to a flat top surface 20 of the decorative element 10 (if one is provided; see Figure 3), or may extend over a portion of the sides of the decorative element adjoining the top so as to be adhered to the top and/or partially the sides of the decorative element).

[0007] Since an adhesive attachment of this type can be relatively weak, it has been known to bore a small blind hole 18 in the top surface 20 of the decorative element 10 where the connection element 30 is to be fixed with adhesive, and to provide a connection element 30 including a small protuberance 34 extending therefrom that is adapted to match the internal diameter and depth of the small hole 18 (see Figure 4). After applying adhesive both to the surface 20 of the decorative element 10 and to the small hole 18 (and/or to corresponding surfaces of the connection element 30), the connection element 30 can be mated with the decorative element 10 such that the protuberance 34 is received into the hole 18, and the connection element 30 is adhered to the decorative element 10 (see Figure 5). Since the contact area between the decorative element 10 and the connection element 30 is increased, the attachment is more secure. However, even with this improved method, detachments of decorative elements 10 from their connection elements 30 can frequently occur, especially when they are exposed to high temperatures or when left in the sun.

[0008] Disadvantages of this coupling system include that the blind hole 18 and protuberance 34 may be visible in the finished jewellery item - which may be undesirable; the hole provided in what may be the narrowest part of the decorative element 10 can significantly reduce the strength and integrity of the decorative element 10; and it may be necessary (to improve the security of the coupling) to provide a flat top surface of the tapered end 12 so that an increased surface area is available for adhering the connection element 30 to the decorative element 10.

[0009] The methods and decorative elements according to the present invention aim to solve or at least alleviate one or more of the problems associated with the prior art.

Summary of the Invention

[0010] From a first aspect, the invention resides in a method of attaching a connection element to a decorative element (or a tapered end of a decorative element) such as a gemstone; the method comprising the steps of: providing a decorative element having at least one recess (e.g. in the outer surface of the decorative element); providing a sacrificial body having a first end and a second end, the first end comprising a sacrificial cap defining an open chamber configured to receive at least a portion (e.g. the outer surface of) of the decorative element that includes the at least one recess; securing the sacrificial cap to the decorative element such that the portion (e.g. the outer surface of) of the decorative element that includes the at least one recess is received in the chamber of the sacrificial cap; forming an investment mould over the sacrificial body and the decorative element so as to encompass at least the sacrificial cap and at least a portion of the decorative element adjacent to the sacrificial cap, and wherein at least a portion of the second end of the sacrificial body is free of investment so as to define an opening in the mould; heating the decorative element, sacrificial body and investment mould until the sacrificial body burns out and forms a cavity within the investment mould, the cavity comprising the shape of the sacrificial cap and the at least one recess; filling the cavity with a

liquid material through the opening of the mould; solidifying the liquid material to form a connection element attached to the decorative element; and removing the investment mould.

[0011] This overcomes the difficulties of attaching a decorative element to a jewellery piece and avoids drilling a hole through the decorative element or using an adhesive to adhere a connection element to the jewellery piece, which connections can weaken over time.

[0012] Providing a decorative element having at least one recess (e.g. in the outer surface of the decorative element) may comprise providing a decorative element and forming at least one recess in the outer surface of the decorative element using a diamond applied saw (or any other suitable saw). The at least one recess may be formed using a diamond applied saw (or any other suitable saw).

[0013] The open chamber may be substantially bell-shaped or conical.

[0014] The investment mould may be formed over the sacrificial body and the decorative element so as to encompass at least the decorative element and at least the first end of the sacrificial body.

[0015] The investment mould forms a fluid tight seal with the portion of the decorative element adjacent to the sacrificial cap.

[0016] The connection element attached to the decorative element comprises a connection body and at least one extension portion integrally formed with said cap-shaped body that extends into the at least one recess.

[0017] The decorative element may comprise a tapered end. The at least one recess may be located at (e.g. in the outer surface of) the tapered end. The method of the invention overcomes the difficulties of attaching a decorative element to a jewellery piece at a tapered end of the decorative element and avoids drilling a hole all the way through the tapered end (which may result in weakening of the decorative element or even breakage), or using an adhesive to stick a connection element to the tapered end (which often comes weakened or unstuck).

[0018] The decorative element may be substantially briolette-shaped or droplet-shaped.

[0019] The at least one recess may be located adjacent to an extremity of the tapered end. The distance between the or each recess and the extremity of the tapered end is at least 0.2mm, between about 0.2 mm and 2.0 mm; between about 0.3 mm and 1.5 mm; between about 0.4 mm and 1.0 mm; between about 0.4 mm and 0.8 mm; or between about 0.45 mm and 0.5 mm.

[0020] The at least one recess may have a depth of at least about 0.1 mm; between about 0.1 mm and 2.0 mm; between about 0.1 mm and 1.5 mm; between about 0.1 mm and 1.0 mm; between about 0.15 mm and 0.8 mm; or between about 0.2 mm and 0.8 mm, between about 0.2 mm and 0.6 mm, between about 0.3 mm and 0.6 mm. This depth is required to form a positive fit between the connection element and the decorative element. Desirably, the depth of the recess is not larger than approx. 33% of the diameter of the decorative element in a plane through the at least one recess perpendicular to a(n) (longitudinal) axis of the decorative element. In this way, an acceptable strength of the decorative element may be maintained. Accordingly, it will be appreciated that the depth of the recess may be, in some instances, at least in part determined by the size of the decorative object.

[0021] The one or more recess may have a length around the circumference of the decorative element of at least about 2 mm, at least about 3 mm, 4 mm or between 2 mm and 10 mm, such as between about 3 mm and 8 mm. In some embodiments the length of the recess may be no more than about 25% of the circumference of the decorative element, up to 20%, up to 15%, or up to 10% of the circumference of the decorative element. Accordingly, the length of or number of recesses may be, at least in part, determined by the size of the decorative object.

[0022] The width of the recess may be at least about 0.2 mm, between about 0.5 mm and 3 mm; for example, up to about 2.5 mm, up to about 2 mm, up to about 1.5 mm or up to about 1 mm. Again, in some embodiments the width of the recess may be in part determined by the size of the decorative object.

[0023] The decorative element may comprise a tapered end which extends along a longitudinal axis (L). The at least one recess may be located at the tapered end. The at least one recess may comprise at least one pair of recesses, each pair of recesses being diametrically opposed on the outer surface of the tapered end.

[0024] The tapered end may be substantially conical. The tapered end may extend along a longitudinal axis (L). The at least one recess may be located at the tapered end. The at least one recess may be positioned in the outer surface of the tapered end in a plane (p) perpendicular to the longitudinal axis (L).

[0025] The at least one recess may comprise a plurality of recesses.

[0026] The at least one recess may comprise one or more blind bores and/or one or more elongate grooves that extend across the outer surface of the decorative element. Both grooves and bores result in a strong form-fitting connection between the connection element and the decorative element.

[0027] The tapered end may extend along a longitudinal axis (L) and have a curved outer surface. The at least one recess may comprise one or more circumferential elongate groove at the tapered end. The one or more circumferential elongate groove may extend curvedly around the curved outer surface of the decorative element. The tapered end may be substantially conical. The at least one circumferential elongate groove may be positioned in the curved outer surface of the tapered end in a plane (p) perpendicular to the longitudinal axis (L).

[0028] The at least one recess may comprise a pair of elongate grooves. Each of the elongate grooves may be diametrically opposed on the outer surface of the decorative element. In one particularly preferred embodiment,

the tapered end has two diametrically opposed grooves on the outer surface thereof. This arrangement results a strong connection between the decorative element and the connection element and is easily formed on a decorative element.

[0029] The depth of each recess may be no greater than about 20%, no greater than about 15%, no greater than about 10%, or no greater than about 5% of the diameter of the decorative element in the plane (p).

[0030] The distance between the or each pair of diametrically opposed recesses in the plane (p) may be at least about 60%, at least about 66%, at least about 70%, at least about 80% or at least about 90% of the maximum width of the tapered end in that plane (p), the maximum width of the tapered end being the maximum distance between any two diametrically opposed points on the outer surface of the tapered end. This ensures the tapered end remains intact after the recesses are formed on the tapered end.

[0031] The step of securing the sacrificial cap to the decorative element may comprises applying an adhesive to the at least one recess of the decorative element, and positioning the sacrificial cap over the decorative element such that the at least one recess is received in the chamber of the sacrificial cap and an interior wall of the sacrificial cap defining the chamber contacts the adhesive (and optionally pressing the interior surface of the chamber against the decorative element). The step of heating the decorative element, sacrificial body and investment material may comprise heating the decorative element, sacrificial body and investment material until the sacrificial body and the adhesive burns out. The adhesive may be applied to the at least one recess until the adhesive completely fills the at least one recess. The adhesive may be any suitable adhesive, such as Locite Super Kleber Gel or UHU plus.

[0032] The step of heating the decorative element, sacrificial body and investment mould may comprise heating the decorative element, sacrificial body and investment mould to between approximately 750°C and 1,150°C, to between approximately 800°C and 1,050°C or between approximately 850°C and 1,000°C.

[0033] The decorative element, sacrificial body and investment mould are heated for between 8 and 14 hours, suitably between 10 and 12 hours.

[0034] The step of solidifying the liquid material to form the connection element attached to the decorative element comprises cooling the liquid material. The liquid material may be cooled at any appropriate cooling rate, for example, depending on the type of material used. In embodiments, the step of cooling the liquid material may comprise cooling the liquid material at a maximum cooling rate of about 5°C, 4°C, 3°C, 2°C, 1.5°C, 1.0°C or 0.5°C per minute; preferably, in some embodiments, at a maximum cooling rate of about 2°C per minute.

[0035] The liquid material may be a molten metal such as silver, gold or brass. The connection element may be a metal such as silver, gold or brass. The liquid material may also be a molten polymer. The connection element may be a solidified polymer. The step of solidifying the liquid material to form the connection element may therefore comprise polymerisation of the liquid material.

[0036] The step of providing a sacrificial body having a first end and a second end may comprise providing a first end comprising a sacrificial cap and a second end comprising a sacrificial arm and a sacrificial stem. The sacrificial arm may have a proximal end and a distal end. The sacrificial arm may be connected at its proximal end to the first end of the sacrificial body and may be connected at its distal end to the sacrificial stem. The step of forming an investment mould may comprise forming an investment mould over the sacrificial body and the decorative element so as to encompass at least the decorative element, the sacrificial cap and the sacrificial arm. At least a portion of the sacrificial stem is beneficially free of investment so as to define the opening in the mould.

[0037] The sacrificial body in the form of a sacrificial tree may comprise a plurality of sacrificial arms fixedly attached the sacrificial stem, each sacrificial arm being connected to a sacrificial cap secured to a decorative element. The sacrificial tree may comprise 4 or more; 8 or more; 12 or more; or 20 or more sacrificial arms. In some embodiments a plurality of sacrificial caps may be attached to each sacrificial arm. In some embodiments a plurality of decorative elements may be attached to each sacrificial cap. This bulk process allows a plurality of connection elements to be attached to a plurality of decorative elements with ease.

[0038] The method may comprise the steps of: providing a plurality of decorative elements each having at least one recess; providing a sacrificial body in the form of a sacrificial tree, the sacrificial tree comprising a first end and a second end, the first end comprising a plurality of sacrificial caps each defining an open chamber configured to receive at least a portion of a decorative element that includes the at least one recess, and the second end comprising a plurality of sacrificial arms and a sacrificial stem, each sacrificial arm having a proximal end and a distal end, and each sacrificial arm being connected at its proximal end to at least one of the plurality of sacrificial caps and at its distal end to the sacrificial stem; securing each of the plurality of decorative elements to a sacrificial cap such that the portion of each decorative element that includes the at least one recess is received in the chamber of a sacrificial cap; forming an investment mould over the sacrificial tree and the plurality of decorative elements so as to encompass at least each decorative element, each sacrificial cap and each sacrificial arm, and wherein at least a portion of the sacrificial stem of the second end of the sacrificial body is free of investment so as to define the opening in the mould; heating the decorative element, the sacrificial body and the investment mould until the sacrificial body burns out and forms a plurality of interconnected cavities within the investment mould, each cavity comprising the shape of a sacrificial cap and the at least one recess of each of the plurality of decorative

elements; filling the plurality of cavities with a liquid material through the opening of the mould; solidifying the liquid material to form a plurality of connection elements each attached to at least one of the decorative elements; and removing the investment mould.

[0039] A method of attaching a connection element to each of a plurality of decorative elements, the method comprising the steps of: providing a plurality of decorative elements each having at least one recess; providing a sacrificial body in the form of a sacrificial tree, the sacrificial tree comprising a first end and a second end, the first end comprising a plurality of sacrificial caps each defining an open chamber configured to receive at least a portion of a decorative element that includes the at least one recess, and the second end comprising a plurality of sacrificial arms and a sacrificial stem, each sacrificial arm having a proximal end and a distal end, and each sacrificial arm being connected to at least one of the plurality of sacrificial caps and at its distal end to the sacrificial stem; securing each of the plurality of decorative elements to a sacrificial cap such that the portion of each decorative element that includes the at least one recess is received in the chamber of a sacrificial cap; forming an investment mould over the sacrificial tree and the plurality of decorative elements so as to encompass at least each decorative element, each sacrificial cap, and each sacrificial arm, and wherein at least a portion of the sacrificial stem is free of investment so as to define the opening in the mould; heating the decorative element, sacrificial body and investment mould until the sacrificial body burns out and forms a plurality of interconnected cavities within the investment mould, each cavity comprising the shape of a sacrificial cap and the at least one recess of each of the plurality of decorative elements; filling the plurality of cavities with a liquid material through the opening of the mould; solidifying the liquid material to form a plurality of connection elements each attached to at least one of the decorative elements; and removing the investment mould.

[0040] The or each sacrificial arm may be separate and distinct from (disconnected to) the sacrificial stem when the sacrificial body is first provided. The method may further comprise a step, after the step of securing the or each decorative element to a sacrificial cap, of (fixedly) connecting the or each sacrificial arm at a distal end thereof to the sacrificial stem, for example, by means of soldering. While the step of fixedly attaching the sacrificial arm to the sacrificial stem could be undertaken either before or after the step of securing the sacrificial cap to the decorative element, it is advantageous to perform this step (immediately) after the step of securing the sacrificial cap to the decorative element so that the step of attaching the sacrificial cap to the decorative element may be performed more easily. Alternatively, the or each sacrificial arm may be integrally formed with the sacrificial cap.

[0041] Alternatively, e.g. in lower through-put applications, the second end of the sacrificial body may comprise (only) a sacrificial arm. The step of forming an investment mould comprises forming an investment mould over the sacrificial body and the decorative element so as to encompass at least the decorative element and the sacrificial cap. At least a portion of the sacrificial arm may be kept free of investment during the step of forming an investment mould over the sacrificial body and decorative element so as to define the opening in the mould. This method may be advantageous when needing to connect a connection element to each of a small number of decorative elements.

[0042] At least a portion of the sacrificial arm or sacrificial stem / tree (such as a base thereof) is beneficially prevented from being immersed in the liquid investment.

[0043] The step of forming an investment mould may comprise arranging the or each decorative element and the sacrificial body (or tree) in a flask ensuring that at least a portion of the second end of the sacrificial body (e.g. a portion of the sacrificial stem or arm) is not contained within a volume of the flask, filling the volume of the flask with liquid investment until the or each decorative element and at least the first end of the sacrificial body are immersed in the liquid investment, and solidifying the liquid investment to form the investment mould within the flask. In embodiments, the or each decorative element and the sacrificial body may be placed in a flask and the flask filled with liquid investment ensuring that at least a portion of the second end of the sacrificial body (e.g. a portion of the sacrificial arm or stem) is not immersed in liquid investment.

[0044] The decorative element and the sacrificial cap may be arranged in the flask by suspending the sacrificial body at the sacrificial arm (or stem) above the flask.

[0045] In the case where no part of the or each sacrificial arm (or stem) is contained within the volume of the flask, the or each cavity that is formed advantageously only comprises the shape of a sacrificial cap and at least one recess. The or each connection element that is formed does therefore not include a projection portion.

[0046] In the case where only a portion of the or each sacrificial arm (and no stem) is contained within the volume of the flask, the or each cavity that is formed may comprise the shape of a sacrificial cap, at least one recess and a portion of a sacrificial arm. The or each connection element that is formed may therefore comprise a projection portion in the shape of a portion of the sacrificial arm.

[0047] In the case where each sacrificial arm and a portion of the sacrificial stem is contained within the volume of the flask, the or each cavity that is formed may comprise the shape of a sacrificial cap, at least one recess, a sacrificial arm and at least a portion of a sacrificial stem. The or each connection element that is formed may therefore comprise a projection portion in the shape of a sacrificial arm and at least a portion of a sacrificial stem.

[0048] The or each solid connection element formed may, therefore, comprise a projection portion in the shape of a portion of a sacrificial arm or in the shape of

a sacrificial arm and a portion of a sacrificial stem that was encased in the investment material. Where it is not desired to incorporate the projection portion into the finished attachment element, the projection portion may be removed from the connection element. The removed material may be reused, e.g. by melting it down and recasting.

[0049] The or each sacrificial arm may be adjacent to / integrally formed with the first end of the sacrificial body. The or each sacrificial arm may be adjacent to / integrally formed with the sacrificial cap. The or each sacrificial arm may extend away from the sacrificial cap.

[0050] In one preferred embodiment, the first end of the sacrificial body comprises a sacrificial aperture portion / section between a sacrificial cap and a sacrificial arm. The aperture section may comprise an aperture extending through a width of the aperture section. In embodiments, the aperture portion / section may be integrally formed with the sacrificial cap.

[0051] In embodiments, the aperture portion/ section may be integrally formed with the sacrificial arm.

[0052] The step of forming an investment mould may comprise forming an investment mould over the sacrificial body and the decorative element so as to encompass at least the decorative element, the sacrificial cap and the sacrificial aperture portion / section. Thus, each cavity that is formed may also comprise the shape of the aperture portion / section defining an aperture. A connection element may thus be formed that comprises a connection aperture that extends through a width of the connection element.

[0053] The sacrificial body may be configured such that the connection element comprises an aperture for providing a means of attachment to another object (e.g. a jewellery piece).

[0054] The step of removing the investment mould may comprise immersing the or each decorative element, the connection element attached to the or each decorative element, and the investment mould in a solvent so as to dissolve the investment mould. The step of removing the investment mould may comprise immersing the flask comprising the or each decorative element, the connection element attached to the or each decorative element and the investment mould in a solvent so as to dissolve the investment mould, and removing the or each decorative element and the connection element attached to the or each decorative element from the flask.

[0055] The investment material is advantageously dissolvable in a solvent. The investment may be plaster. The solvent may be water.

[0056] The invention also extends to an article comprising a decorative element and a connection element attached thereto; wherein the decorative element comprises at least one recess (e.g. in the outer surface thereof) and the connection element comprises at least one extension portion that extends into the at least one recess.

[0057] The connection element and the at least one extension portion are integrally formed.

[0058] The decorative element may comprise a tapered end, the at least one recess being located at (e.g. in the outer surface of) the tapered end.

[0059] The decorative element may comprise a tapered end which extends along a longitudinal axis (L) of the decorative element. The at least one recess may be located at (e.g. in the outer surface of) the tapered end and may comprise at least one pair of recesses, each pair of recesses being diametrically opposed on the outer surface of the tapered end. The connection element beneficially encloses at least a portion of (e.g. the outer surface of) the tapered end comprising the at least one pair of recesses.

[0060] In this or other aspects of the invention there is provided an article that is obtainable by a method according to the invention.

[0061] The connection element may comprise a connection aperture that extends through a width of the connection element.

[0062] The decorative element may be a gemstone. The gemstone may be genuine or synthetic. The decorative element may be substantially made of glass ceramics. The decorative element may be substantially made of cubic zirconia, synthetic ruby, genuine topaz. The decorative element may be substantially briolette-shaped or droplet-shaped.

[0063] The connection element may be a metal such as silver, gold, platinum or brass.

[0064] The invention further extends to a decorative element comprising at least one recess. The decorative element may comprise a tapered end, the at least one recess being located at the tapered end. The tapered end may extends along a longitudinal axis (L) of the decorative element, and the least one recess may comprise at least one pair of recesses, each pair of recesses being diametrically opposed on the outer surface of the tapered end and, suitably, extending circumferentially around at least a portion of the tapered end. In some embodiments the at least one recess comprises at least one pair of blind bores.

[0065] Features of any one aspect or embodiment of the invention may be used, alone or in appropriate combination, with any other aspects and embodiments as may be appropriate.

Brief Description of the Drawings

[0066] The following figures, Figures 1 to 5, have already been described above by way of background to the invention:

Figure 1 is a front view of a decorative element of the prior art;

Figure 2 is a front view of the decorative element of Figure 1, wherein the decorative element comprises a connection aperture;

Figure 3 is a front view of the decorative element of Figure 1 and a connection element attached to the decorative element with adhesive;

Figure 4 is a front view of the decorative element of Figure 1 having a blind hole and a connection element having a protuberance adapted to fit within the blind hole; and

Figure 5 is a front view of a jewellery piece comprising the decorative element and connection element of Figure 4, the connection element being attached to the decorative element with adhesive;

[0067] The above and other aspects of the invention will now be described, by way of example only, with reference to the remainder of the accompanying drawings, in which:

Figure 6 is a front view of a decorative element according to an embodiment of the invention;

Figure 7 is a front view of the decorative element of Figure 6 and a connection element attached to the decorative element;

Figure 8 is side view of the decorative element and connection element of Figure 7;

Figure 9 a flow diagram illustrating a method according to the invention for connecting a connection element to the decorative element of Figure 6;

Figure 10 is a perspective view of a first end of a sacrificial body having a chamber configured to receive a portion comprising the recesses of a decorative element of Figure 6;

Figure 11 is a cross-sectional front view of the decorative element of Figure 6 and a first end of a sacrificial body secured thereto, a portion comprising the recesses of the decorative element being received into a chamber of the sacrificial cap;

Figure 12 is a side view of the decorative element of Figure 6;

Figure 13 is a top-down view of the decorative element of Figure 6;

Figure 14 is a perspective view of the decorative element of Figure 6 and a sacrificial body in accordance with an embodiment, wherein the sacrificial body comprises a first end secured to the decorative element comprising a sacrificial cap and a sacrificial arm connected to the cap (left); and a sacrificial stem that is distinct and separate from the sacrificial arm (right);

Figure 15 is a cross-sectional top-down view of the decorative element and sacrificial body of Figure 14, wherein the sacrificial arm has been secured to the sacrificial stem to form a sacrificial tree;

Figure 16 is a cross-sectional top-down view of the decorative element and sacrificial tree of Figure 15, wherein the decorative element and sacrificial tree have been arranged in a flask;

Figure 17 is a cross-sectional top-down view of the decorative element and sacrificial tree of Figure 16, wherein the flask has been filled with investment material and the sacrificial tree has been burnt out to leave a cavity;

Figure 18 is a cross-sectional front view of a decorative element of Figure 6 with a connection element attached to the decorative element, wherein the connection element has a projection portion;

Figure 19 is a cross-sectional front view of the decorative element and the connection element of Figure 18, wherein the projection portion has been removed from the connection element;

Figure 20 is a cross-sectional top-down view of the decorative element and sacrificial tree of Figure 16; wherein a plurality of sacrificial arms, each connected to a decorative element, is attached to the sacrificial stem;

Figure 21 is a cross-section front view of the decorative element of Figure 6 and a sacrificial body in accordance with a second embodiment, wherein the sacrificial body comprises a first end secured to the decorative element and a second end having a sacrificial arm connected to the first end of the sacrificial body;

Figure 22 is a cross-section front view of the decorative element and sacrificial body of Figure 21, wherein the decorative element and sacrificial body have been arranged in a flask and the flask has been filled with investment material;

Figure 23 is a cross-section front view of the decorative element and sacrificial body of Figure 21, wherein the sacrificial body has been burnt out; and

Figure 24 is a cross-sectional front view of a decorative element of Figure 6 and a connection element attached to the decorative element, the connection element having a projection portion.

Detailed Description of the Invention

[0068] The invention relates to a decorative element

110 such as gemstone (see Figure 6), and a method of attaching a connection element or mount 130 to the decorative element 110. The invention also relates to the product of such methods, i.e. a decorative element 110 and a attachment or connection element (or mount) 130 that is attached to the decorative element 110 (see Figures 7 and 8).

[0069] The attachment / connection element or mount 130 can have any suitable form which meets with the desired use of the device and which can be attached to the decorative element 110. Thus, the connection element 130 is typically arranged so as to permit the decorative element 110 (via the connection element 130) to be used as an item of jewellery and/or to be itself attached to a jewellery piece (not shown). For example, the jewellery piece may be an (or part of an) earring, necklace or bracelet. To connect the connection element 130 to the jewellery piece, the connection element 130 may comprise, for example, a connection aperture 132 that extends through a width of the connection element 130, thus allowing a jewellery piece or part thereof (e.g. a hook), to be fastened thereto. Of course, many other examples of jewellery pieces and means of connecting the decorative element 110 and connection element 130 of the invention to such a jewellery piece can be readily appreciated by the skilled person.

[0070] The method of attaching a connection element 130 to a decorative element 110 according to the invention will first be provided with reference to Figure 9. As described herein, according to the invention, the method may comprise a casting process.

[0071] In step 201, the decorative element 110 is provided. The decorative element 110 comprises an outer surface 140 - in this embodiment comprising facets 141, and a pair of recesses 122 in said outer surface 140. According to this embodiment the recesses are elongate (see e.g. Figures 12 and 13) and extend across the outer surface 140, so as to form grooves in the outer surface 140 of the decorative element 110. However, in alternative embodiments, any appropriately shaped recess may be used; for example, the recesses may be one or more blind bores or holes which may be of any suitable shape or configuration (suitably cylindrical) or combinations thereof. The recesses 122 are configured to allow a secure connection between the connection element 130 and the decorative element 110, as will now be explained.

[0072] In step 202, a sacrificial body 150 is provided. The sacrificial body 150 is solid when being handled, but can be burnt out, or vaporised, at temperatures used in a moulding process as described herein. To this end, the sacrificial body 150 may be made of a wax. However, any suitable wax or alternative material may be used, according to user preferences and appropriate method parameters.

[0073] The sacrificial body 150 comprises a first end 151 (see Figure 10) comprising a sacrificial cap 152 and a second end 153 (see Figures 14 and 21) which may comprise a sacrificial arm 158 and a sacrificial stem 159 (as shown in the embodiment of Figure 14) or a sacrificial arm 158 only (as shown in the embodiment of in Figure 21). The sacrificial cap 152 defines an open chamber 154 configured / shaped to receive at least a portion of the decorative element 110, which portion received by the chamber 154 of the sacrificial cap 152 includes recesses 122.

[0074] Steps 201 and 202 can of course be undertaken in any order.

[0075] In step 203, the sacrificial cap 152 is placed onto the decorative element 110 such that at least the portion of the decorative element 110 that includes the recesses 122 is received into the chamber 154 of the sacrificial cap 152, as shown in Figure 11. As such, the recesses 122 are also received into / enclosed within the chamber 154 of the sacrificial cap 152. Hence, the sacrificial cap 152 extends over the portion of the decorative element 110 that includes the recesses 122. The sacrificial cap 152 is then securely fixed to the decorative element 110 in this position, thereby closing the chamber 124.

[0076] In step 204, an investment mould 170 is formed around at least the first end 151 of the sacrificial body 150, including the sacrificial cap 152 defining the chamber 154, as well as over at least a portion of the decorative element 110. The portion of the decorative element 110 enclosed by the investment material is at least that portion adjacent to the sacrificial cap 152, so as to form a continuous investment enclosing the junction between the decorative element 110 and the portion of the sacrificial cap 152 defining the outer boundary of the open chamber 154. At least a portion of the second end 153 of the sacrificial body 150 remains free of investment material, such that an opening 172 in the mould 170 is formed on removal of the sacrificial cap 152 (as shown, for example, in Figure 23). The way in which this is achieved will be explained below.

[0077] The investment mould 170 can be formed from any suitable mould material. In some embodiments, the investment mould 170 is made of plaster. In some embodiments, the investment mould is selected to be dissolvable in water for ease or removal at the end of the casting process (see step 208); however, other means of removing the mould (and hence other mould materials) can be readily envisaged and are encompassed within the scope of the invention.

[0078] In step 205, the decorative element 110, the sacrificial body 150 fixed thereto and the investment mould 170 that has been formed around the decorative element 110 and the sacrificial body 150 are heated until the sacrificial body 150 burns out through the opening 172 in the mould 170. To this end, the decorative element 110, the sacrificial body 150, and the investment mould 170 are heated to a temperature of between approximately 550 °C and 800°C, and are heated by no more than 200 °C per hour. The heating time can be selected according to the amount of material that must be removed, and the type of material used.

[0079] As a result, a cavity 174 is formed within the investment mould 170. The cavity comprises at least the form defined by the surface of the first end 151 of the sacrificial body 150 and includes the recesses 122, and may take any desirable form and configuration. Thus, the external shape of the first end 151 of the sacrificial body 150 determines the shape and configuration of the mount / connection element 130.

[0080] During the next two steps, steps 206 and step 207, the connection element 130 is cast in the investment mould 170.

[0081] At step 206, the cavity 174 of the investment mould 170 is filled with a liquid material. To this end, the liquid material is fed through the opening 172 in the investment mould 170. In doing so, the liquid material fills the cavity 174, including the pair of recesses 122 defined within the cavity 174 of the investment mould 170.

[0082] In step 207, the liquid material is left to cool and harden / solidify. In embodiments the liquid material is a molten material, such as molten metal, such that it may be solidified by cooling. It will be appreciated, however, that the means of solidifying the liquid material can depend on the material selected to form the connection element 130. For example, liquid materials can be solidified by other means, such as polymerisation, e.g. where the liquid material comprises monomeric and/or polymeric compounds to form a polymeric connection element. In one embodiment, the liquid material is cooled at a maximum cooling rate of 2°C per minute to avoid thermic stresses. When the cooling rate is lower than 2°C per minute, production time increases.

[0083] Once the liquid material has hardened it forms a solid connection element 130 that is typically rigid and attached / coupled to the decorative element 110. The connection element 130 has an outer shape corresponding to the shape of the cavity 174 within the investment mould 170, and at least one inwardly directed extension portion 114 that extends into the recesses 122, thus forming a mating fit and secure coupling between the connection element 130 and the decorative element 110. The at least one extension portion 114 is integrally formed with the remainder of the connection element 130, so as to achieve a suitably strong attachment. According to this particular embodiment, two recesses 122 are provided and, hence, two complementary extension portions 114 are formed to fit within the respective recesses. However, any number or configuration of recesses 122 can be provided (as already noted), and suitable complementary extension portions 114 will be formed accordingly.

[0084] The connection element 130 may be made of any material that is suitable for casting. It should typically also be able to form a strong connection with the decorative element 130 once cast, and be suitable for the desired end use - for example, for use in jewellery. In some embodiments, the liquid material / connection element 130 may be molten / solid silver, molten / solid gold or molten / solid brass, or any other suitable molten / solid metal. As noted, in other embodiments the connection element 130 may be formed of a polymeric / plastics material.

[0085] In the next step, step 208, the investment mould 170 is removed. According to one embodiment, the material of the mould 170 is selected to be a plaster, such that the mould 170 can be removed by dissolving in water. Removal of the mould 170 results in a combination of the decorative element 110 with the connection element 130 securely fixed thereto, for example, as shown in Figures 7 and 8.

[0086] The above-stated method advantageously produces a very secure and strong mechanical connection between the connection element 130 and the decorative element 110. Indeed, the connection is so strong that it may only be undone by breaking the decorative element 110 apart, and does not rely on an adhesive. This strength is (at least in part) due to the way in which the at least one extension portion 114 of the connection element 130 extends entirely within the recesses 122 of the decorative element 110, forming a secure positive fit. Such an attachment is much stronger than one that makes use of an adhesive, which can deteriorate or be lost over time.

[0087] The above-described method also is particularly advantageously when used to attach a connection element 130 to a tapered end 112 of a decorative element 110, i.e. to a portion of a decorative element 110 that reduces in thickness towards an extremity 113 thereof, such as briolette-shaped gemstone or a droplet-shaped gemstone.

[0088] Beneficially, to attach a connection element 130 to a briolette-shaped gemstone or other gemstone having a tapered end, the at least one recess 122 of the decorative element 110 is suitably located in the tapered portion of the decorative element 110, e.g. at the tapered end 112.

[0089] A lateral displacement of the at least one recess 122 from the extremity 113 of the tapered end 112 of the decorative element 110 is, of course, desired so that a true recess (i.e. having a raised wall between the base of the recess 122 and the outer surface 140 of the decorative element 110 is formed; and the proximity of the recess 122 to the extremity 113 may be selected accorded to the desired aesthetics and the desired strength of the resultant combination of decorative element 110 and connection element 130.

[0090] Forming a connection between the connector element 130 and decorative element 110 in the manner of the invention is particularly beneficial as it avoids the need to drill a hole 18 through the tapered end 112 of a decorative element 110, which can weaken the decorative element 110 and result in breakage of the decorative element 110, especially when the tapered end 112 is narrow.

[0091] Further optional and/or advantageous features of the above-described method are provided below.

[0092] As regards the decorative elements 110 for use in step 201, it will be appreciated that the strength and

security of the connection between the connection element 130 and the decorative element 110 depends on the number, the shape and the location of the at least one recess 122 in the outer surface 140 of the decorative element 110.

[0093] To ensure a secure connection between the connection element 130 and the decorative element 110, the decorative element 110 must contain a least one recess 122. The at least one recess 122 desirably has a depth of at least about 0.1 mm, such as between about 0.1 mm and 2 mm; between about 0.1 mm and 1.5 mm; between 0.1 mm and 1 mm; between about 0.15 mm and 0.8 mm; between about 0.2 mm and 0.8 mm, between about 0.2 mm and 0.6 mm or between about 0.3 mm and 0.6 mm. Accordingly, in some embodiments the depth of the recess may be about 0.1 mm, 0.15 mm about 0.2 mm, about 0.25 mm, about 0.3 mm, about 0.4 mm or about 0.5 mm.

[0094] The width (axial height) of the recess may be at least about 0.2 mm for example, up to about 2.5 mm, up to about 2 mm, up to about 1.5 mm or up to about 1 mm, such as between about 0.2 mm and 3 mm; between about 0.3 mm and 3 mm; or between about 0.5 mm and 3 mm. In some embodiments, the width of the recess is between about 0.25 and 2 mm, between about 0.3 mm and 1.5 mm; or between about 0.4 mm and 1 mm. In some embodiments the width of the recess is between about 0.2 mm and 0.5 mm.

[0095] In some embodiments, the at least one recess 122 may comprise at least one small substantially-round blind bore (not shown) and/or at least one groove (or channel) 123 that extends across the outer surface 140 of the decorative element 110 (as shown in Figures 12 and 13). Both grooves 123 and bores result in strong form-fitting connections between connection elements 130 and decorative elements 110. The above depths and widths (diameters) apply to embodiments where the at least one recess comprises one or more blind bores or one or more (elongate) grooves or channel.

[0096] In some embodiments, grooves 123 may be preferred over blind bores. Such grooves may, for example, be readily formed with a diamond applied saw.

[0097] A groove 123 may be provided that extends all of the way around the decorative element 110 forming a continuous loop (not shown) around the decorative element 110. Such a loop will provide for a strong form-fitting connection between a connection element 130 (once formed in accordance with the invention) and a decorative element 110. However, a plurality of (e.g. two, three or four) finite recesses 122 on the decorative element 110 may be more convenient and results in a strong and secure connection.

[0098] When the decorative element 110 has a tapered end 112, it can be advantageous to locate the at least one recess 122 close to an extremity 113 of the tapered end 112, so as to ensure a positive-locking connection at the tapered end 112 which does not need to obscure an undesirably large proportion of the decorative element. Advantageously, however, the at least one recess is laterally displaced from the extremity 113 by an amount such that a true recess can be formed; a positive cooperation between the connection element 130 and decorative element 110 can be ensured such that the connection element 130 is retained on the decorative element 110 even when a lateral force is applied in the direction of the extremity 113; and such that the decorative element 110 is not undesirably weakened by locating the recess 122 in a particularly narrow region of the decorative element 110.

[0099] In an embodiment where the tapered end 112 is substantially conical and extends along a longitudinal axis L (such as when the decorative element 110 is a briolette-shaped gemstone or a droplet-shaped gemstone), the at least one recess 122 may be positioned in the outer surface of the tapered end 112 in a plane p perpendicular to the longitudinal axis L, as shown in Figure 6.

[0100] In such embodiments, the at least one recess 122 may beneficially take the form of at least one elongate groove 123 that extends curvedly around the outer surface of the tapered end 112 in the plane p, as shown in Figures 12 and 13. This arrangement is advantageous because the grooves 123 are easy to realise using a diamond applied saw.

[0101] Alternatively, or additionally, the at least one recess 122 (in the form of at least one groove 123 or otherwise) may comprise at least one pair of recesses 122, each pair of recesses 122 being diametrically opposed on the outer surface of the tapered end 112, as shown in Figures 6 and 13. This arrangement is beneficial since it ensures that the connection between the decorative element 110 and the connection element 130 is symmetrically balanced around the longitudinal axis L.

[0102] In embodiments, the tapered end 112 comprises exactly two, i.e. a pair of, diametrically opposed grooves 123 on the outer surface of the tapered end 112, as shown in Figures 6 and 13. This embodiment may be particularly advantageous since the arrangement is both easily-realised and ensures a secure and symmetrically-distributed connection.

[0103] Each of the one or more pairs of diametrically opposed recesses 122 may preferably be arranged in a plane p perpendicular to the longitudinal axis L such that the linear distance between the base of each of the recesses (as measured along the plane p and through the central axis of the decorative element) is at least about 60% of the maximum width of the tapered end 112 in the plane p, the maximum width of the tapered end 112 being the maximum distance between any two diametrically opposed points on the outer surface of the tapered end 112. This configuration has been shown to substantially mitigate the risk of the decorative element 110 breaking when the at least one recess 122 is formed. In other embodiments the linear distance between each pair of recesses (as defined above) may be at least about 70%, at least about 80% or at least about 90% of the maximum

width of the tapered end 112 in that plane p. Alternatively, the depth of each recess may be no greater than about 20%, no greater than about 15%, no greater than about 10% or no greater than about 5% of the diameter of the decorative element in the plane p through the at least two recesses.

[0104] In general, the decorative element 110 may be a genuine or a synthetic gemstone. For example, the decorative element 110 may be substantially made of glass ceramics, cubic zirconia, a synthetic ruby, a genuine topaz or any other material that is suitable for being formed with the at least one recesses 122 described above. In particular, the decorative element 130 is suitable for use in jewellery; but other uses may be envisaged.

[0105] The first end 151 of the sacrificial body 150 for use in step 202 will now be described in more detail, with reference to Figure 10.

[0106] The open chamber 154 of the sacrificial cap 152 may be any suitable shape to receive at least the desired portion of the decorative element 110 that comprises the at least one recess 122. To this end, the open chamber 154 may be substantially bell-shaped or conical, depending on the portion of the decorative element 110 to be enclosed by the sacrificial cap 152. Such shapes are particularly suitable when the decorative element 110 comprises a tapered end 112 and the at least one recess 122 is located in the portion of the outer surface 140 of the decorative element 110 that defines the tapered end 112. Thus, the inner surface of the chamber 154 within the sacrificial cap 152 is adapted to cooperate with the outer surface 40 of the decorative element 110 to be enclosed.

[0107] Since the shape of an outer surface of the first end 151 of the sacrificial body 150 (particularly the outer surface of the sacrificial cap 152) defines the shape of the outer surface of the connection element 130 once formed, the outer surface of the first end 151 of the sacrificial cap 152 is beneficially shaped in accordance with the desired shape of the connection element 130.

[0108] To form a connection element 130 with a connection aperture 132 that extends through the connection element 130 entirely, the sacrificial cap 152 may suitably be provided with an aperture section 156 having an aperture 157 that extends through a width of the aperture section 156 (as shown in Figures 10 and 11). The aperture section 156 may be integrally formed with the sacrificial cap 152, suitably at the opposite end of the cap 152 to the opening of the chamber 154, such that the aperture 157 is formed above the decorative element 110.

[0109] As used herein, the outer surface of at least the sacrificial cap 152 of the first end 151 of the sacrificial body 150 defines the shape and configuration of the connection element 130 once moulded. Thus, when forming the investment mould 170 (at part of step 204), it is important that the investment mould 170 encases the entire sacrificial cap 152 (including both the portion of the sacrificial cap 152 defining the chamber 154 and the aperture section 156, if included) that defines the necessary features of the connection element 130.

[0110] Referring to step 203, to securely fix the sacrificial cap 152 to the decorative element 110, according to beneficial embodiments, the at least one recess 122 of the decorative element 110 may be filled - advantageously completely filed - with a suitable adhesive. As described above, the interior surface of the open chamber 154 of the sacrificial cap 152 is then positioned over the outer surface of the portion of the decorative element 110 that includes the at least one recess 122 that are filled with adhesive. The sacrificial cap 152 is then pressed onto the appropriate surface of the decorative element 110, ensuring a fixed connection between the interior wall defining the open chamber 154 of the sacrificial cap 152 and the outer surface of the decorative element 110.

[0111] Any suitable adhesive may be used in accordance with the invention. To be suitable for the application, such an adhesive should provide a sufficiently strong connection between the sacrificial cap 152 and the decorative element 110 during the investment mould forming step (step 204) but also, any adhesive must be capable of being burnt out, or vaporised, along with the sacrificial cap 152 during the heating step (step 205), e.g. in the temperature range of 550 °C to 800 °C, so that the at least one recess 122 may be filled without the liquid material during the casting steps (steps 206 and 207). In this way, the adhesive is sacrificial too, and so the adhesive and the sacrificial body 150 constitute a sacrificial attachment. The temperature and length of time of the burning out process may, of course, take into account the properties of the mould and the decorative element 110, which should remain undamaged by the heating step. To this end, the adhesive may be, for example, Locite Super Kleber Gel or UHU plus.

[0112] The function of the second end 153 of the sacrificial body 150 in ensuring that an opening 172 in the mould 170 is formed to allow removal of the sacrificial attachment by vaporisation will now be described with reference to Figures 14 to 24.

[0113] In a first embodiment, the second end 153 of the sacrificial body 150 comprises a sacrificial arm 158 and a sacrificial stem 159, as shown in Figure 14. In step 202, when the sacrificial body 150 is provided, the sacrificial arm 158 is not integral with the sacrificial stem 159, i.e. the sacrificial arm 158 and the sacrificial stem 159 are distinct and separate, as shown in Figure 14. However, in other embodiments the second end 153 of the sacrificial body may be an integral component.

[0114] The sacrificial arm 158 has a proximal end 160 that adjoins the first end 151 of the sacrificial body 150, and a distal end 161 opposite the proximal end 160. In the depicted embodiment, the sacrificial arm 158 is connected to, and integrally formed with, the first end 151 of the sacrificial body 150 at the proximal end 160 of the sacrificial arm 158. The sacrificial arm 158 therefore extends away from the sacrificial cap 152. In some embod-

iments the sacrificial arm 158 may be formed separately from the first end 151 of the sacrificial body 150 and thereafter connected thereto.

[0115] When the first end 151 of the sacrificial body 150 comprises an aperture section 156, the proximal end 160 of the sacrificial arm 158 is suitably connected to the aperture section 156 (as depicted), such that the aperture section 156 is positioned between the sacrificial cap 152 and the sacrificial arm 158. When no aperture section 156 is present, the proximal end 160 of the sacrificial arm 158 is directly connected to the sacrificial cap 152.

[0116] The sacrificial stem 159 is, in the depicted embodiment, substantially cylindrical; however, in any embodiments of the invention the sacrificial stem 159 could me formed in any convenient shape. As depicted, the sacrificial stem 159 is connected to a base portion 162 at one end to support the sacrificial stem 159 and a tip 163 opposite the base portion 162.

[0117] In embodiments, after securely fixing the sacrificial cap 152 to the decorative element 110 in step 203, the method comprises the step of attaching the distal end 161 of the sacrificial arm 158 to the sacrificial stem 159, as shown in Figure 15. Attaching the sacrificial arm 158 to the sacrificial stem 159 may be performed in any suitable manner; for example, by soldering. The sacrificial arm 159 and the connected sacrificial cap 152 and decorative element 110 generally extend away from the sacrificial stem 159 after being fixedly attached, such that the sacrificial body 150 may be considered to take the form of a tree. One or more sacrificial arms 158 may be attached to each sacrificial stem 159. The number of sacrificial arms 158 may be determined on the basis of production demand and/or size constraints. For example, as depicted in Figure 20, four sacrificial arms 158 may be connected to the sacrificial stem 159 in a plane at evenly spaced angles relative to the sacrificial stem 159 (e.g. 90°).

[0118] During the next step, step 204, the investment mould 170 is formed over the sacrificial tree 150 and the decorative element 110 - however, at least a portion of the sacrificial stem 159 is importantly not encased in the investment mould 170, thereby defining an opening 172 in the mould 170. To this end, the sacrificial body 150 in the form of a tree is arranged in a casting flask 164 with a volume (as shown in Figure 16). A liquid investment material is then poured into the flask 164 with the sacrificial tree 150 arranged therein until at least the decorative element 110, the sacrificial cap 152, the first end 151 of the sacrificial body 150, and the sacrificial arm 158 are immersed in the liquid investment. The liquid investment may be added to the flask in any suitable quantity provided that at least a portion of the sacrificial body 150 remains free of investment so as to define an opening in the solid investment mould. Conveniently, a portion of the sacrificial stem 159, e.g. at least a portion of the base 162 and/or the tip 163 remains free of investment. Of course, there is not necessarily any requirement for the sacrificial tree 150 to be placed in the flask before the liquid investment, and so in embodiments the sacrificial tree 150 may be placed into a flask 164 that has been already at least partially filled with liquid investment material.

[0119] According to this embodiment, therefore, at least a portion of the sacrificial stem 159 is suitably not immersed in the liquid investment such that the sacrificial tree 150 is not entirely coated with liquid investment. In the region of the sacrificial stem 159 which is uncoated, the opening 172 of the investment mould 170 is formed. The liquid investment is then allowed to solidify (e.g. by cooling) and a continuous layer of investment mould 170 is formed around, and affixed to, the decorative element 110 and the sacrificial tree 150.

[0120] The entire assembly is then heated to vaporise the sacrificial boy 150 (and any adhesive), as previously described, such that the sacrificial body 150 is burnt out through the opening 172 which forms in the investment (step 205). Removal of the sacrificial tree 150 (and investment) forms a cavity 174 in the investment mould 170 which comprises amongst other things, the shape of the sacrificial cap 152 (to enable casting of the connection element 130), the at least one recess 122 in communication with the volume defining the shape of the connection element 130, the sacrificial arm 158, and at least a part of the sacrificial stem 159.

[0121] A liquid material is then poured into the mould, via the opening 172, to fill the cavity 174 and allowed to solidify. After casting steps 206 and 207, a connection element 130 is formed that comprises an projection portion 134 in the shape of the sacrificial arm 158 and at least a part of the sacrificial stem 159, as shown in Figure 18.

[0122] At step 208, the investment mould 170 is removed. Any suitable means may be employed to remove the investment mould 170. In one convenient embodiment, the investment mould (optionally including the flask 164) is immersed in a solvent. A preferred solvent for an investment mould 170 in accordance with the invention is water. For example, the investment mould 170 dissolves in the suitable solvent (e.g. water), and the decorative element 110 and connection element 130 attached thereto can then be removed from the solvent (and flask 164). An investment mould 170 made of plaster may dissolve when left to soak in water for an hour; although the length of time of exposure can be adjusted as necessary. Removal of the investment may in embodiments be expedited, for example, by additionally subjecting the plaster to a jet of water of other suitable solvent.

[0123] The projection portion 134, which is typically not desired to be part of the finished (decorative) article may be removed from the connection element 130 as shown in Figure 19. To this end, the projection portion 134 may be sawn off or otherwise removed by any convenient process. The portion of the connection element 130 from which the projection 134 was removed may then be treated to improve the finish of the article, for example, by

polishing.

[0124] In one variation (e.g. with reference to Figure 20), a plurality of sacrificial arms 158, each connected to a decorative element 110 (via a sacrificial cap 152), are attached to a sacrificial stem 159. An investment mould 170 may then be formed around the resulting sacrificial tree 150, to allow a plurality of connection elements 130 to be formed on a plurality of decorative elements 110 during one casting operation. Although the embodiment of Figure 20 depicts an arrangement of four sacrificial arms 158 evenly spaced around a sacrificial stem 159, it should be appreciated that the sacrificial tree can take any convenient form, and any suitable number of sacrificial arms 158 may be attached to a sacrificial stem 159. In other embodiments a plurality of sacrificial caps 152 may also, or alternatively, be attached to each sacrificial arm 158, or directly to each sacrificial stem 159. In such a casting operation, therefore, the form of the sacrificial tree 150 may be adapted to fit a flask 164, or the shape of the flask 164 may be adapted according to the desired shape of the sacrificial tree 150 comprising decorative elements 110. For example, the flask 164 may beneficially be substantially cylindrical so as to support the greatest number of decorative elements 110 arranged circumferentially around a central sacrificial stem 159. In this way, the volume of liquid investment required may be minimised.

[0125] In an alternative embodiment, the second end 153 of the sacrificial body 150 comprises a sacrificial arm 158 (but no sacrificial stem 159), for example, as shown in Figure 21.

[0126] The sacrificial arm 158 has a proximal end 160 and a distal end 161 opposite the proximal end 160. In step 202, when the sacrificial body 150 is provided, the sacrificial arm 158 is connected to, and conveniently integrally formed with the first end 151 of the sacrificial body 150 at the proximal end 160 of the sacrificial arm 158, as depicted, such that the sacrificial arm 158 extends away from the sacrificial cap 152.

[0127] When the first end 151 of the sacrificial body 150 comprises an aperture section 156, the proximal end 160 of the sacrificial arm 158 is connected to, and may be integrally formed with the aperture section 156 such that the aperture section 156 is positioned between the sacrificial cap 152 and the sacrificial arm 158. When there is no aperture section 156, the proximal end 160 of the sacrificial arm 158 is directly connected to, and may be integrally formed with, the sacrificial cap 152.

[0128] During the step of forming the investment mould 170 around the first end 151 of the sacrificial cap 152 (as part of step 204), it is also important that the investment mould 170 does not encase at least a portion of the sacrificial arm 158. To facilitate this step, at least the most distal end 161 of the sacrificial arm 158 may be excluded from the investment mould. In doing so, an opening 172 of the investment mould 170 is formed such that at least a portion of the sacrificial arm 158 extends through and, therefore, defines the opening 172 in the investment mould 170. A suitable portion of the sacrificial arm 158 can be excluded from the mould by any suitable means: for example, the region may not be encased in the liquid investment material; or the investment material may be removed before or after the investment has hardened to form a mould. Similarly, in the preceding sacrificial tree embodiment, a portion of solid investment may in some embodiments be removed from the mould in order to expose a portion of the sacrificial stem 159 or base 162, to allow the sacrificial tree 150 to be burned out of the mould.

[0129] So as to ensure a distal end region 161 of the sacrificial arm 158 is not encased in the liquid investment material during the investment mould forming step (step 201), in embodiments, the decorative element 110 and the sacrificial body 150 secured thereto may be arranged in a casting flask 180 containing liquid investment such that the first end 151 of the sacrificial body 150 is contained within the liquid investment and at least the distal end region 161 of the sacrificial arm 158 is not contained within the liquid investment. In some embodiments this may be conveniently achieved by suspending at least the distal end region 161 of the sacrificial arm 158 above the volume defined by the flask 180.

[0130] The volume of the flask 180 is then filled with the liquid investment material until the decorative element 110 and at least the first end 151 of the sacrificial body 150 are immersed in the liquid investment, as shown in Figure 22. At least a portion of the second end 153 of the sacrificial body 150 is hence not immersed in the liquid investment such that the sacrificial body 150 is not entirely coated with liquid investment. Of course, in some embodiments the sacrificial body 150 and decorative element 110 may be placed in a flask 180 that has been pre-filled with liquid investment.

[0131] In other embodiments the entirety of the sacrificial body 150 may be coated with investment material and the investment material covering at least a portion of the second end 153 of the sacrificial body 150 (i.e. the sacrificial arm 158) may be removed before or after hardening of the investment. In other embodiments none of the second end 153 of the sacrificial body 150 may be coated in investment.

[0132] As shown in Figure 23, after the sacrificial body 150 is burnt out in step 205 (as previously described), a cavity 174 in the investment mould 170 is formed comprising the shape of the sacrificial cap 152 in direct communication with the at least one recess 122, and at least a portion of the sacrificial arm 158. After casting steps 206 and 207, wherein the cavity 174 of the investment mould 170 is filled with a liquid material and then allowed to solidify, a connection element 130 is formed that comprises an projection portion 134 in the shape of at least the portion of the sacrificial arm 158 that was covered in investment mould 170. Hence, a continuous layer of investment mould 170 is formed around, and affixed to, the decorative element 110 and the first end 151 of the sacrificial body 150.

[0133] During step 208, the investment mould 170 is

removed, e.g. by immersing the flask 164 comprising the investment mould 170 in water (as previously described). The investment mould 170 dissolves in the water, and the decorative element 110 and the connection element 130 attached thereto can be removed from the flask 164, as shown in Figure 24.

[0134] Again, as described above, the projection portion 134 (when superfluous to the desired form of the connection element 130) is removed from the connection element 130 by any suitable means.

[0135] Methods for forming the first end 151 of the sacrificial body 150 and the sacrificial arm 158 will now be described.

[0136] To form the first end 151 of the sacrificial body 150 and the sacrificial arm 158 out of wax so that they are integrally formed, it is necessary first to heat wax up until it melts and then to mould the liquid wax into the shape that is required. To this end, it can be advantageous to make use of a rubber mould (not shown) that comprises a cavity defining the desired shape of the connection element 130 (and hence, of the sacrificial cap 150). The cavity of the mould may then be filled with melted wax, which is then allowed to cool and solidify.

[0137] Alternatively, the first end 151 and the sacrificial arm 158 can be formed by adhering a dummy connection element (not shown) that has the shape of the required connection element 130, with a dummy projection element (not shown) to the decorative element 110, and then applying the melted wax to cover at least a portion of the decorative element 110, the dummy connection element and the dummy projection element. The dummy connection element with the dummy projection element can be made of wood for example. To form a cap aperture 157 in an aperture portion 156 of the first end 151 of the sacrificial body 150, a dummy connection element can be formed having an aperture (not shown) that extends through the width of the dummy connection element.

[0138] In other embodiments, it may be preferable to manipulate the liquid wax manually (or otherwise) to form the required shape of the sacrificial cap 152.

[0139] While it is preferable to integrally form the first end 151 of the sacrificial body 150 and the sacrificial arm 158 out of a continuous piece of wax for strength benefits, one alternative is to form each of the first end 151 of the sacrificial body 150 and the sacrificial arm 158 separately and then to join them together, for example, by soldering.

[0140] While some means for forming the sacrificial body 150 have been described above, it should be appreciated that any suitable process for forming the sacrificial body 150 may be used, as desired.

[0141] Many variations of the invention are possible without departing from the spirit and scope of the invention as set out in the claims.

Claims

1. A method of attaching a connection element to a decorative element; the method comprising the steps of:

providing a decorative element having at least one recess;
providing a sacrificial body having a first end and a second end, the first end comprising a sacrificial cap defining an open chamber configured to receive at least a portion of the decorative element that includes the at least one recess;
securing the sacrificial cap to the decorative element such that the portion of the decorative element that includes the at least one recess is received in the chamber of the sacrificial cap;
forming an investment mould over the sacrificial body and the decorative element so as to encompass at least the sacrificial cap and at least a portion of the decorative element adjacent to the sacrificial cap, and wherein at least a portion of the second end of the sacrificial body is free of investment so as to define an opening in the mould;
heating the decorative element, sacrificial body and investment mould until the sacrificial body burns out and forms a cavity within the investment mould, the cavity comprising the shape of the sacrificial cap and the at least one recess;
filling the cavity with a liquid material through the opening of the mould;
solidifying the liquid material to form a connection element attached to the decorative element; and
removing the investment mould.

2. The method of claim 1, wherein the decorative element comprises a tapered end and the at least one recess is located at the tapered end.

3. The method of claim 1 or claim 2, wherein the at least one recess has a depth of at least about 0.1 mm; between about 0.1 mm and 2.0 mm; between about 0.1 mm and 1.5 mm; between about 0.1 mm and 1.0 mm; between about 0.15 mm and 0.8 mm; between about 0.2 mm and 0.8 mm; between about 0.2 mm and 0.6 mm or between about 0.3 mm and 0.6 mm.

4. The method of any preceding claim, wherein the decorative element comprises a tapered end which extends along a longitudinal axis (L), and the at least one recess is located at the tapered end and comprises at least one pair of recesses, each pair of recesses being diametrically opposed on the outer surface of the tapered end.

5. The method of any preceding claim, wherein the at least one recess comprises one or more blind bores and/or one or more elongate grooves that extend across the outer surface of the decorative element.

6. The method of any preceding claim, wherein the at least one recess comprises a pair of elongate grooves, each of the elongate grooves being diametrically opposed on the outer surface of the decorative element

7. The method of claim 4, or either of claims 5 and 6 when dependent on claim 4, wherein the depth of each recess is no greater than about 20%, no greater than about 15%, no greater than about 10%, or no greater than about 5% of the diameter of the decorative element in the plane (p).

8. The method of any preceding claim, wherein the step of securing the sacrificial cap to the decorative element comprises applying an adhesive to the at least one recess of the decorative element, and positioning the sacrificial cap over the decorative element such that the at least one recess is received in the chamber of the sacrificial cap and an interior wall of the sacrificial cap defining the chamber contacts the adhesive, and wherein the step of heating the decorative element, sacrificial body and investment material comprises heating the decorative element, sacrificial body and investment material until the sacrificial body and the adhesive burns out.

9. The method of any preceding claim, wherein the step of heating the decorative element, sacrificial body and investment mould comprises heating the decorative element, sacrificial body and investment mould to between approximately 700°C and 1,150°C.

10. The method of any preceding claim, wherein the step of solidifying the liquid material to form the connection element attached to the decorative element comprises cooling the liquid material.

11. The method of any preceding claim, wherein the step of providing a sacrificial body having a first end and a second end comprises providing a first end comprising a sacrificial cap and a second end comprising a sacrificial arm and a sacrificial stem, the sacrificial arm having a proximal end and a distal end and wherein the sacrificial arm is connected at its proximal end to the first end of the sacrificial body and at its distal end to the sacrificial stem; and wherein the step of forming an investment mould comprises forming an investment mould over the sacrificial body and the decorative element so as to encompass at least the decorative element, the sacrificial cap and the sacrificial arm, and wherein at least a portion of the sacrificial stem is free of investment so as to define the opening in the mould.

12. The method according to any preceding claim, which comprises the steps of: providing a plurality of decorative elements each having at least one recess; providing a sacrificial body in the form of a sacrificial tree, the sacrificial tree comprising a first end and a second end, the first end comprising a plurality of sacrificial caps each defining an open chamber configured to receive at least a portion of a decorative element that includes the at least one recess, and the second end comprising a plurality of sacrificial arms and a sacrificial stem, each sacrificial arm having a proximal end and a distal end, and each sacrificial arm being connected at its proximal end to at least one of the plurality of sacrificial caps and at its distal end to the sacrificial stem; securing each of the plurality of decorative elements to a sacrificial cap such that the portion of each decorative element that includes the at least one recess is received in the chamber of a sacrificial cap; forming an investment mould over the sacrificial tree and the plurality of decorative elements so as to encompass at least each decorative element, each sacrificial cap and each sacrificial arm, and wherein at least a portion of the sacrificial stem of the second end of the sacrificial body is free of investment so as to define the opening in the mould; heating the decorative element, the sacrificial body and the investment mould until the sacrificial body burns out and forms a plurality of interconnected cavities within the investment mould, each cavity comprising the shape of a sacrificial cap and the at least one recess of each of the plurality of decorative elements; filling the plurality of cavities with a liquid material through the opening of the mould; solidifying the liquid material to form a plurality of connection elements each attached to at least one of the decorative elements; and removing the investment mould.

13. The method of any preceding claim, wherein the step of removing the investment mould comprises immersing the or each decorative element, the connection element attached to the or each decorative element, and the investment mould in a solvent so as to dissolve the investment mould.

14. An article comprising a decorative element and a connection element attached thereto; wherein the decorative element comprises at least one recess and the connection element comprises at least one extension portion that extends into the at least one recess.

15. The article of claim 14, wherein the decorative element comprises a tapered end which extends along a longitudinal axis (L) of the decorative element, and the at least one recess is located at the tapered end and comprises at least one pair of recesses, each pair of recesses being diametrically opposed on the outer surface of the tapered end, and wherein the connection element encloses at least a portion of the

tapered end comprising the at least one pair of recesses.

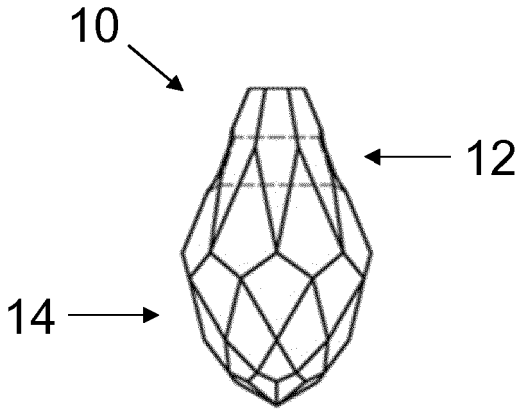


Fig. 1 (Prior art)

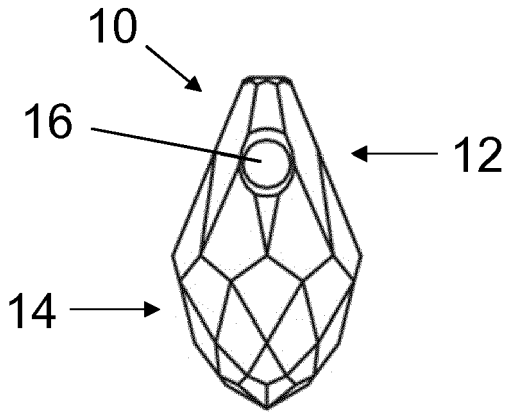


Fig. 2 (Prior art)

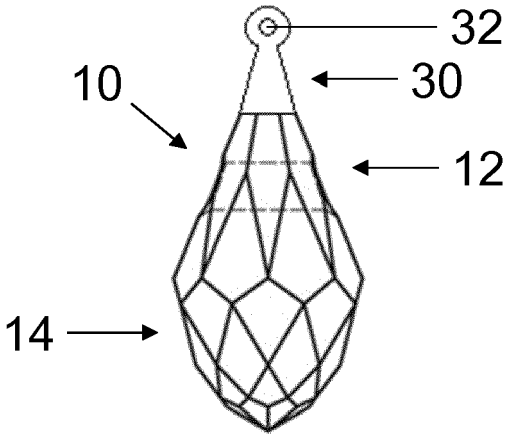


Fig. 3 (Prior art)

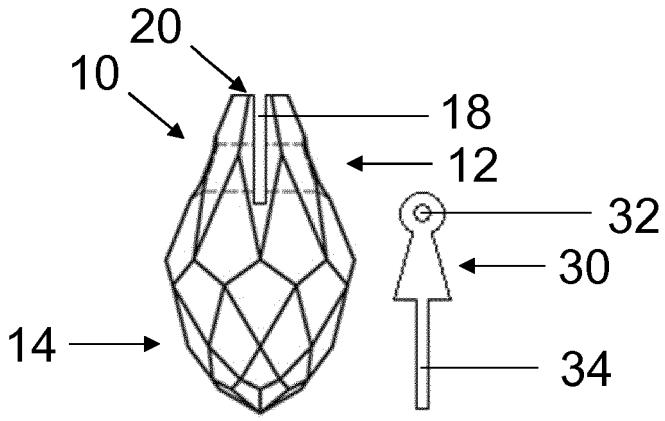


Fig. 4 (Prior art)

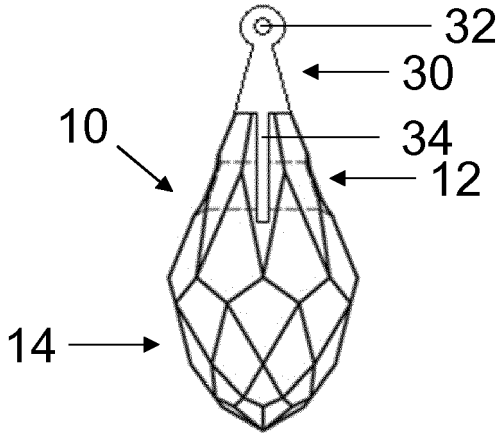


Fig. 5 (Prior art)

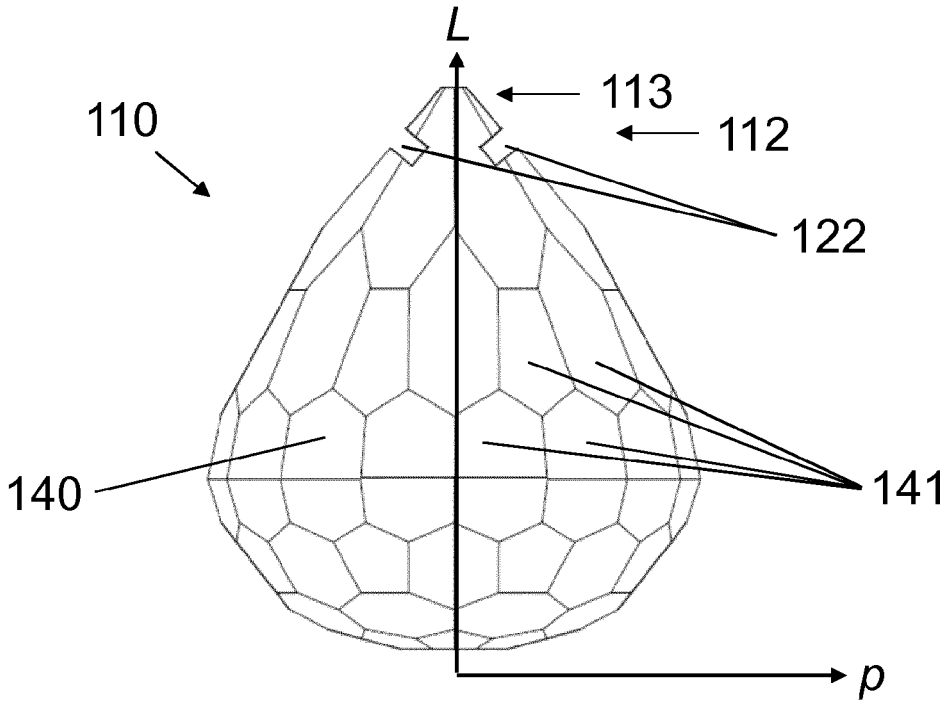


Fig. 6

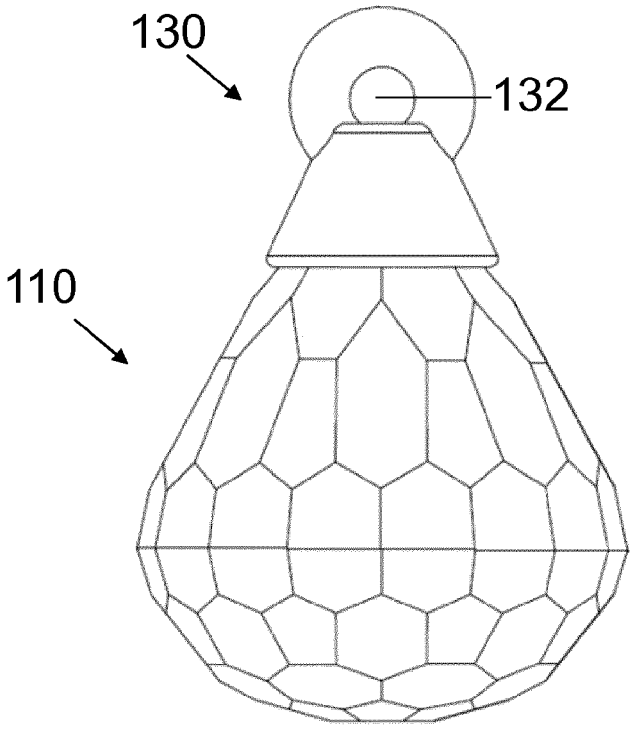


Fig. 7

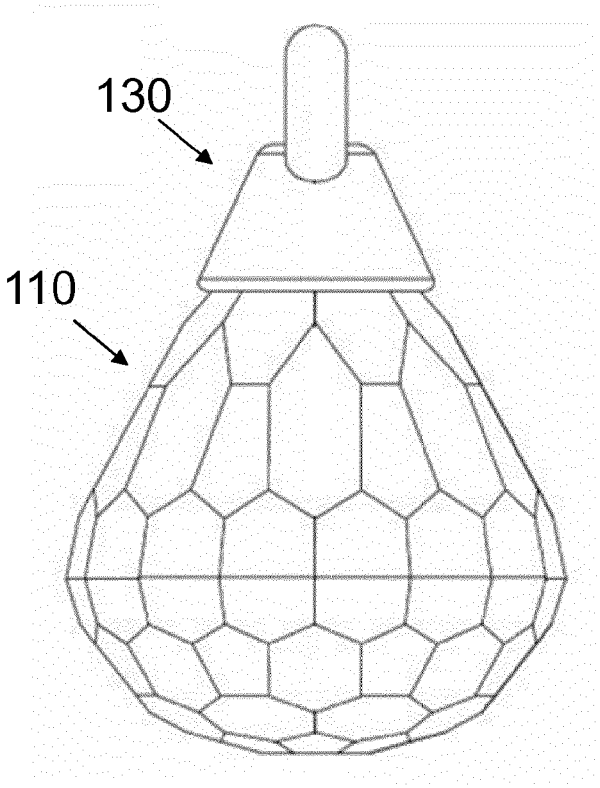
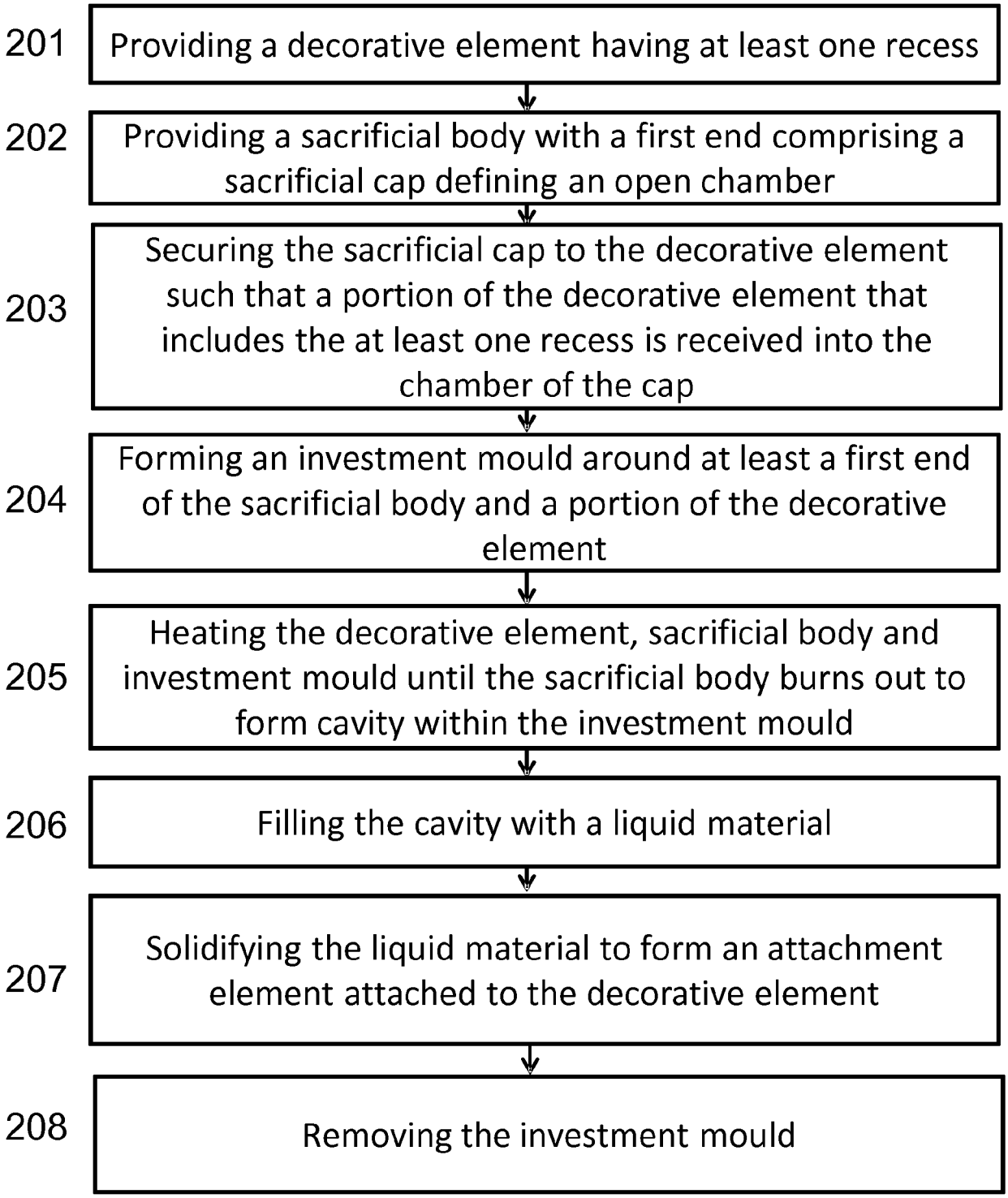


Fig. 8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Providing a decorative element having at least one recess
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Providing a sacrificial body with a first end comprising a sacrificial cap defining an open chamber
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Securing the sacrificial cap to the decorative element such that a portion of the decorative element that includes the at least one recess is received into the chamber of the cap
204
Forming an investment mould around at least a first end of the sacrificial body and a portion of the decorative element
205
Heating the decorative element, sacrificial body and investment mould until the sacrificial body burns out to form cavity within the investment mould
206
Filling the cavity with a liquid material
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Solidifying the liquid material to form an attachment element attached to the decorative element
208
Removing the investment mould

Fig. 9

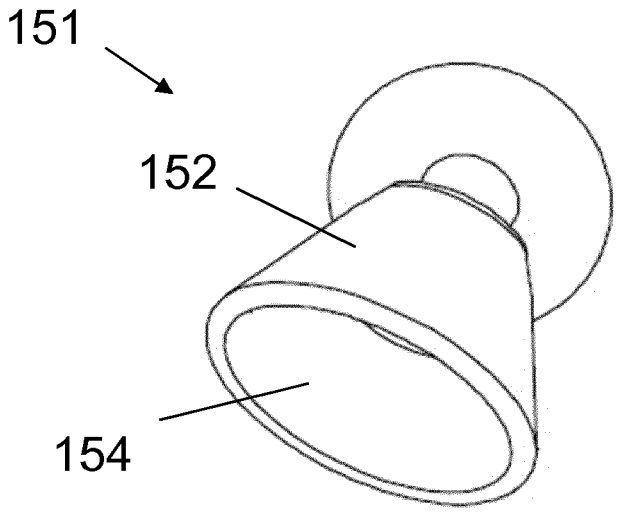

Fig. 10

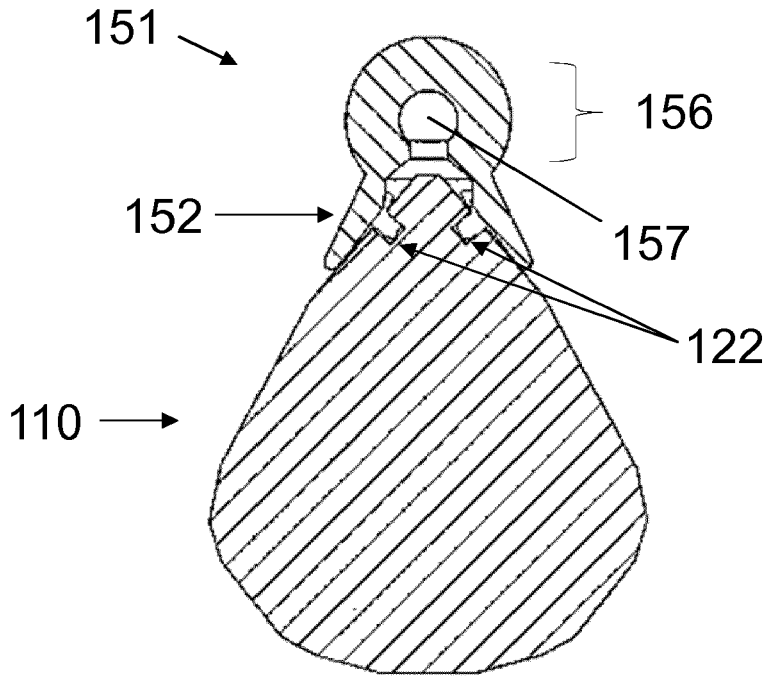

Fig. 11

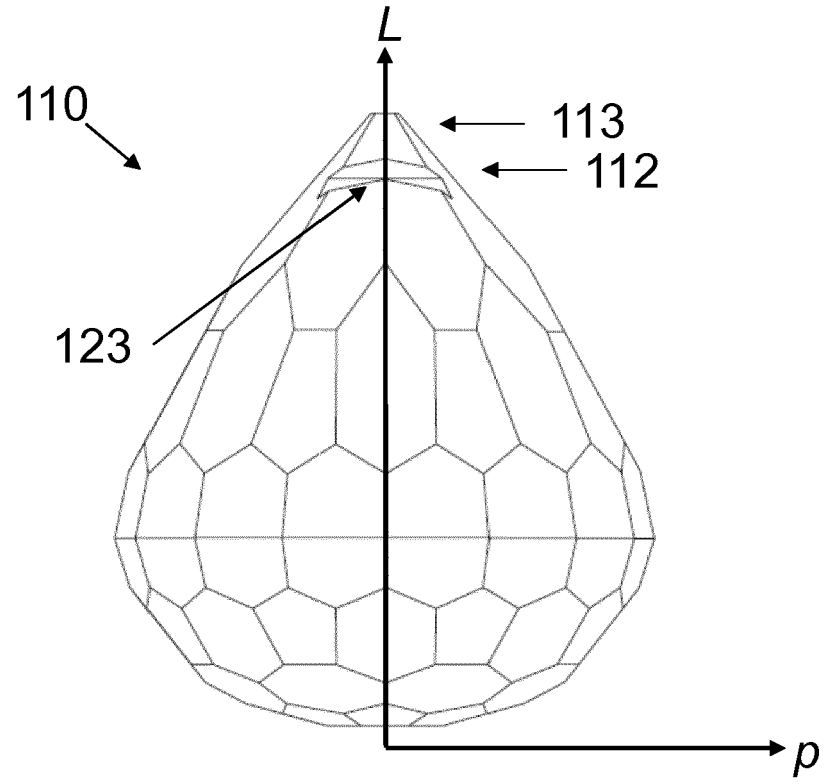

Fig. 12

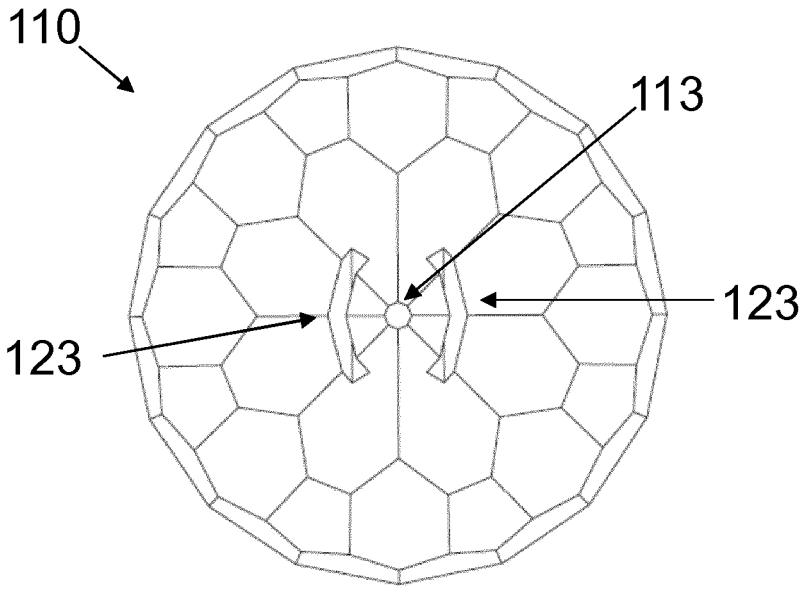

Fig. 13

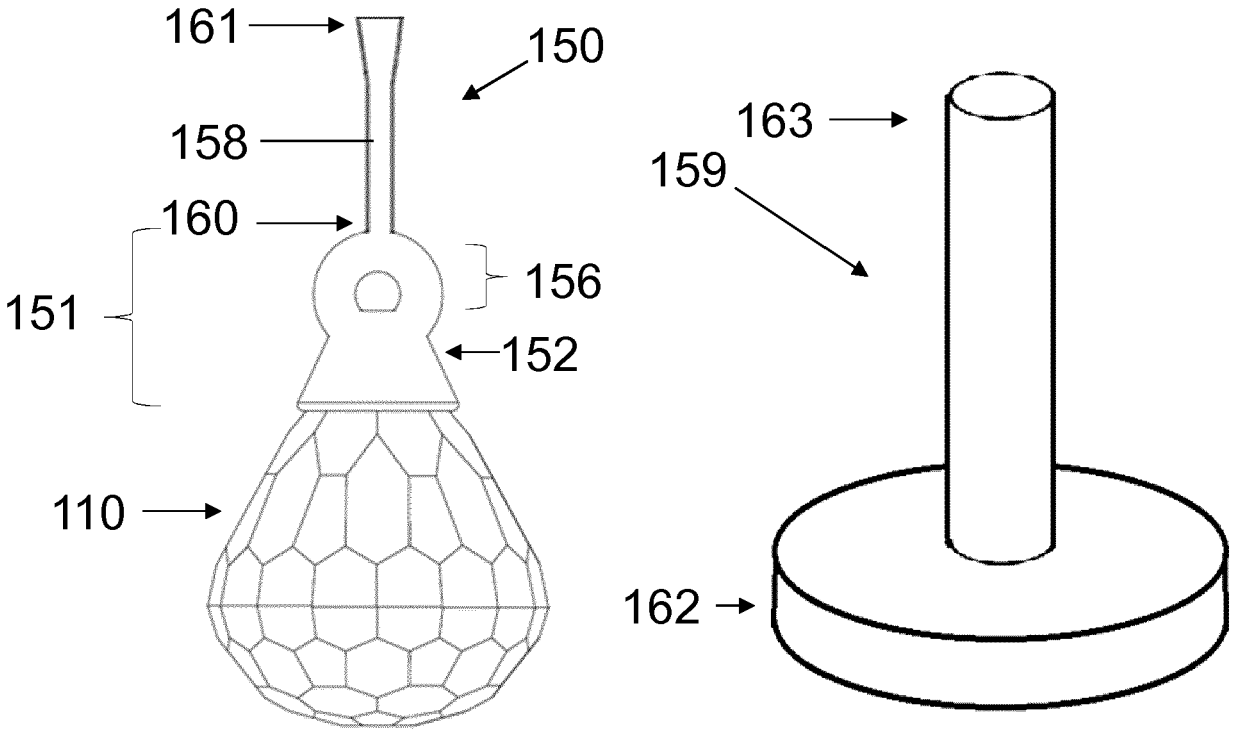
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Fig. 14

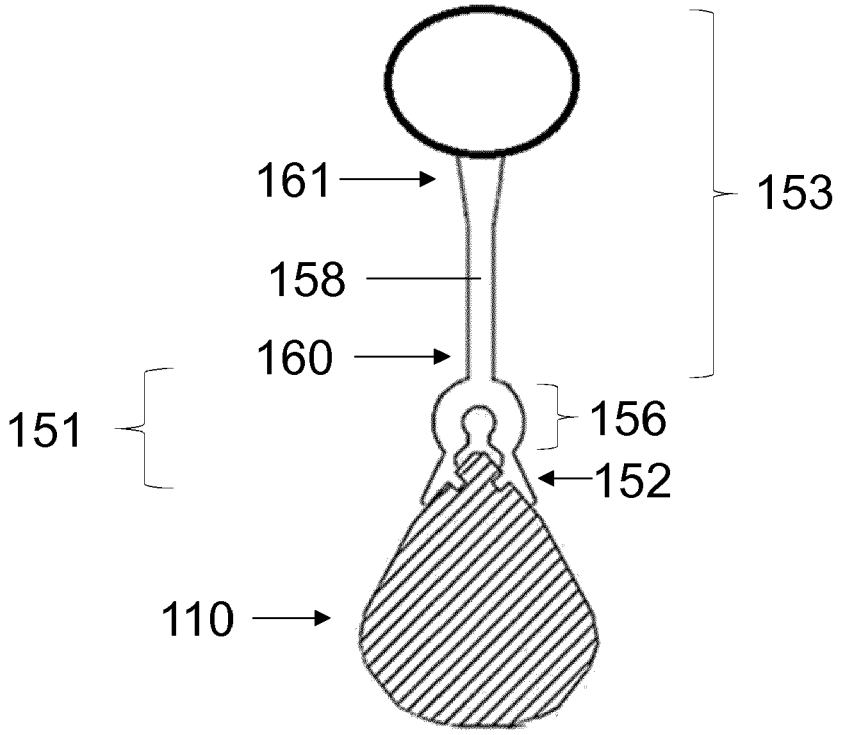
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Fig. 15

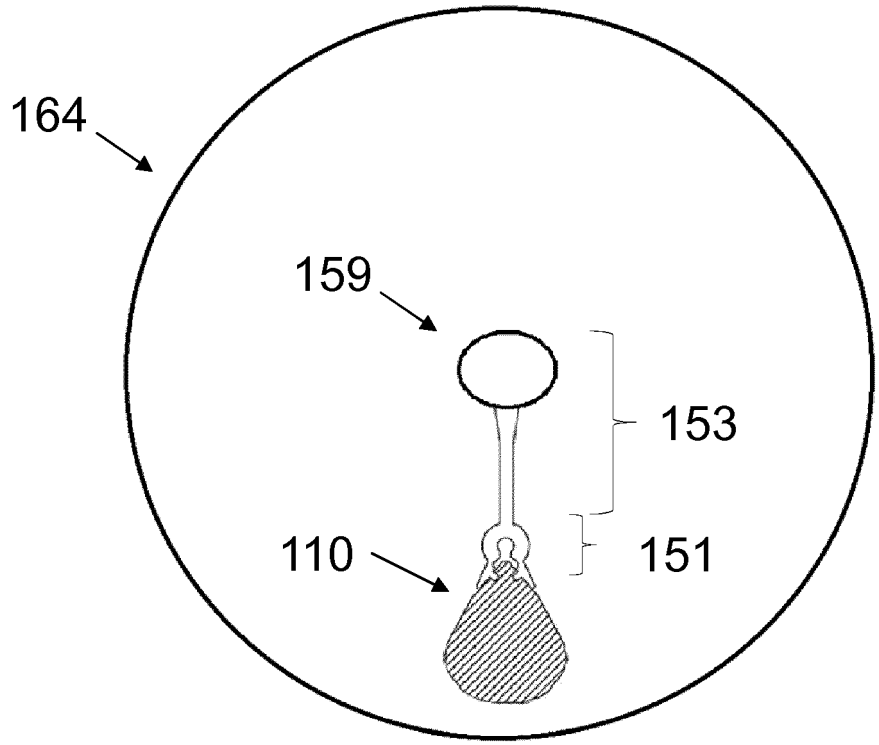

Fig. 16

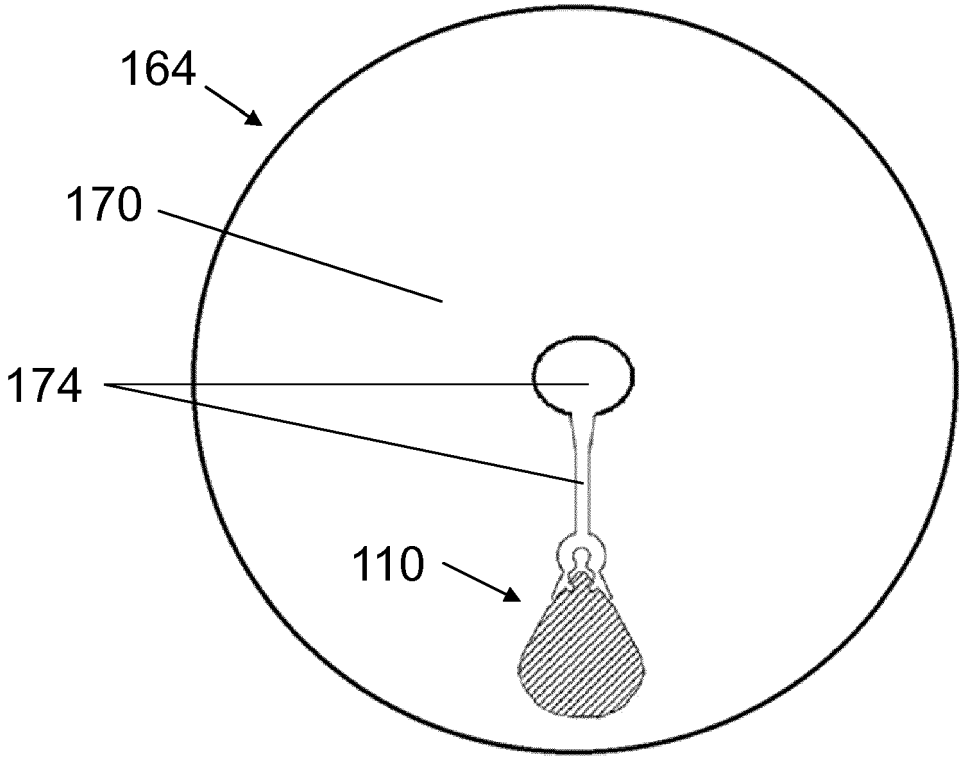

Fig. 17

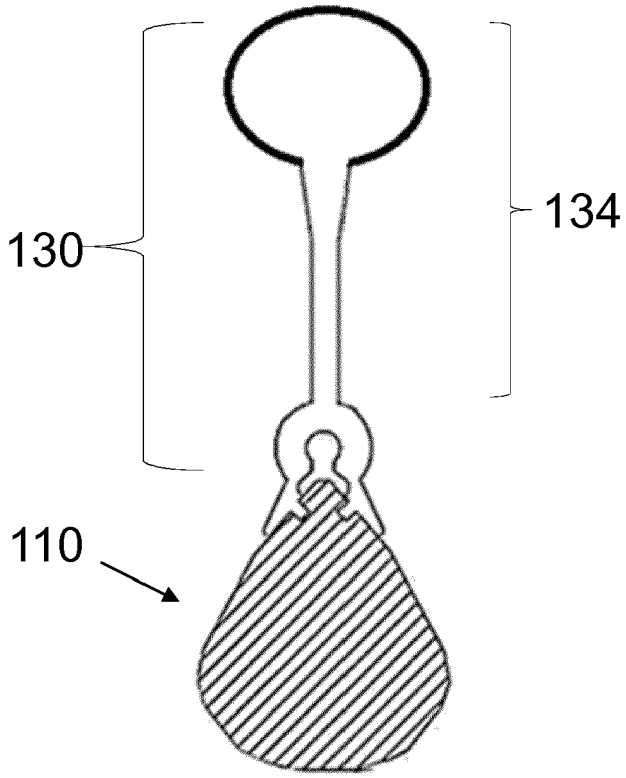

Fig. 18

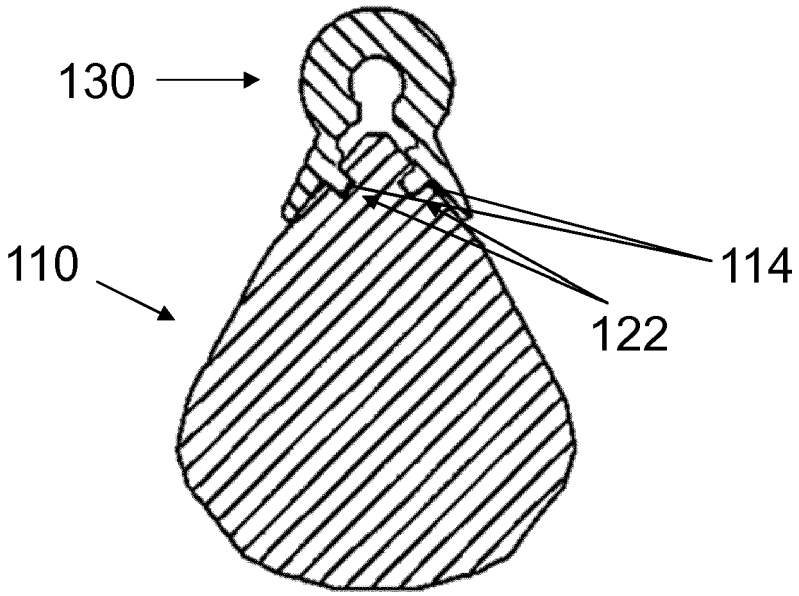

Fig. 19

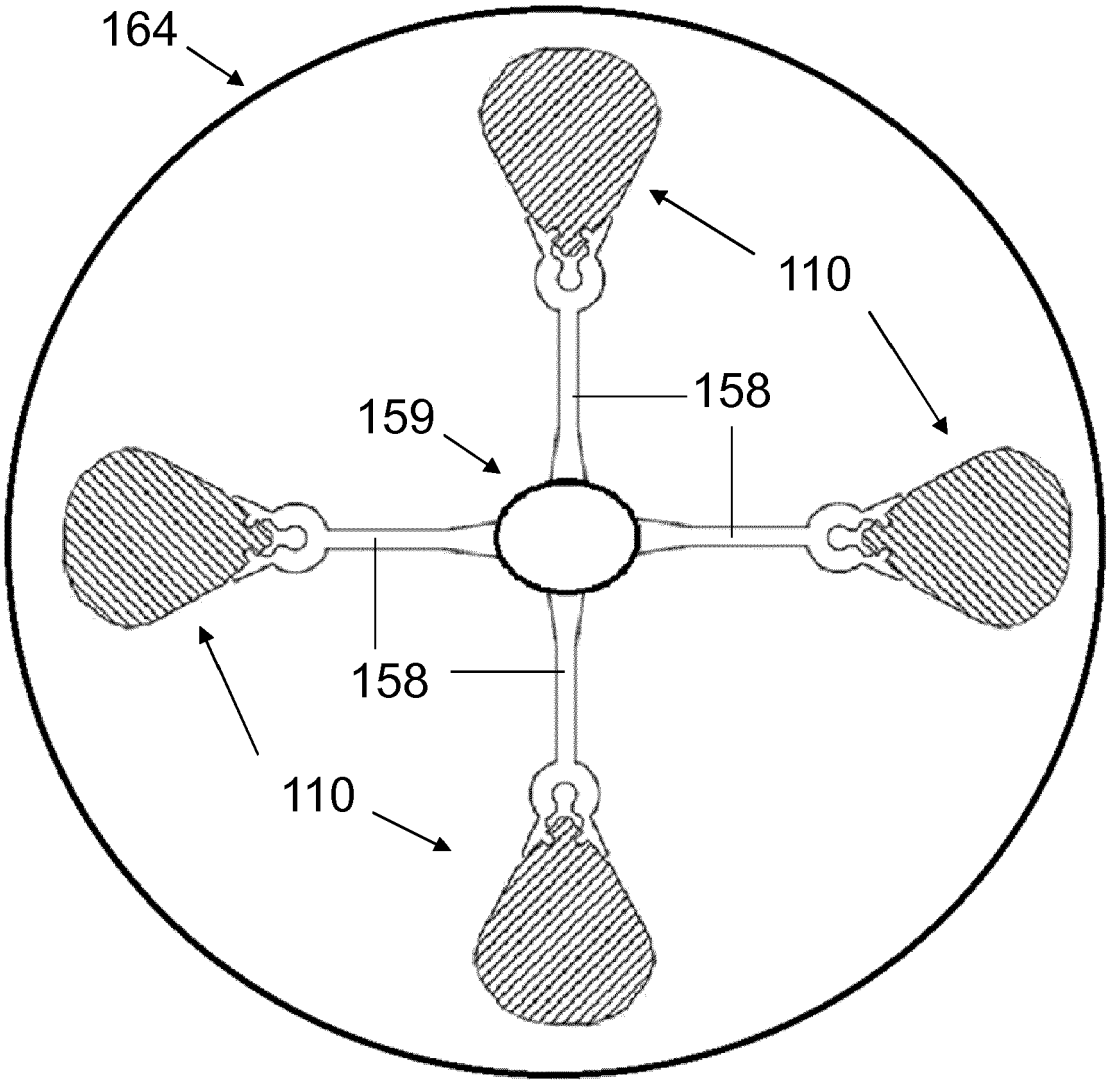

Fig. 20

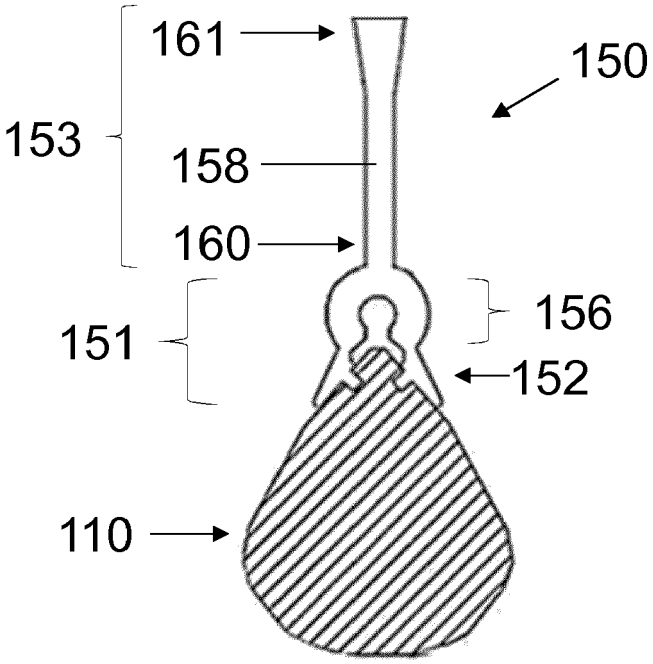

Fig. 21

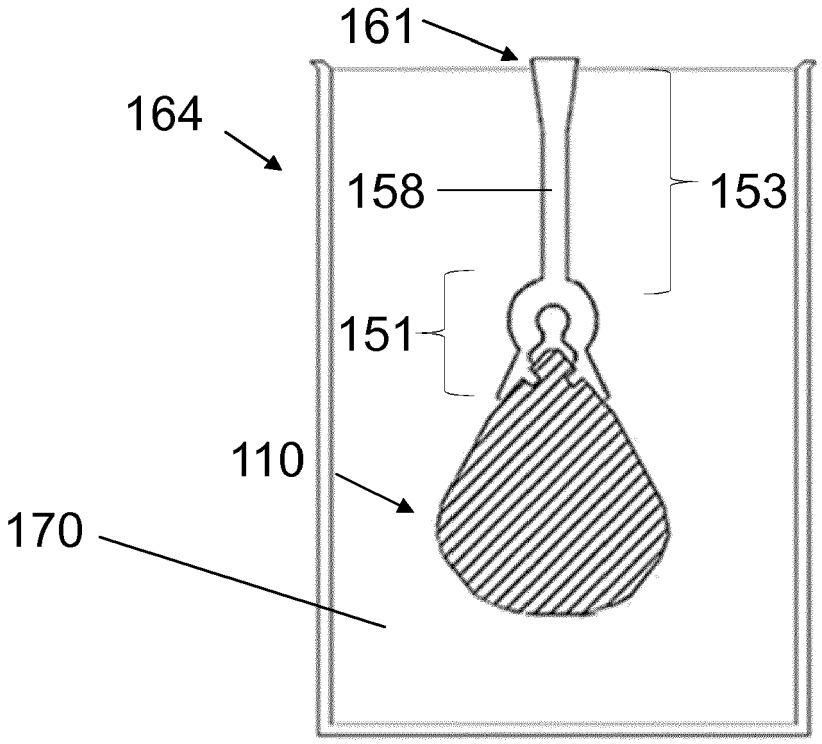

Fig. 22

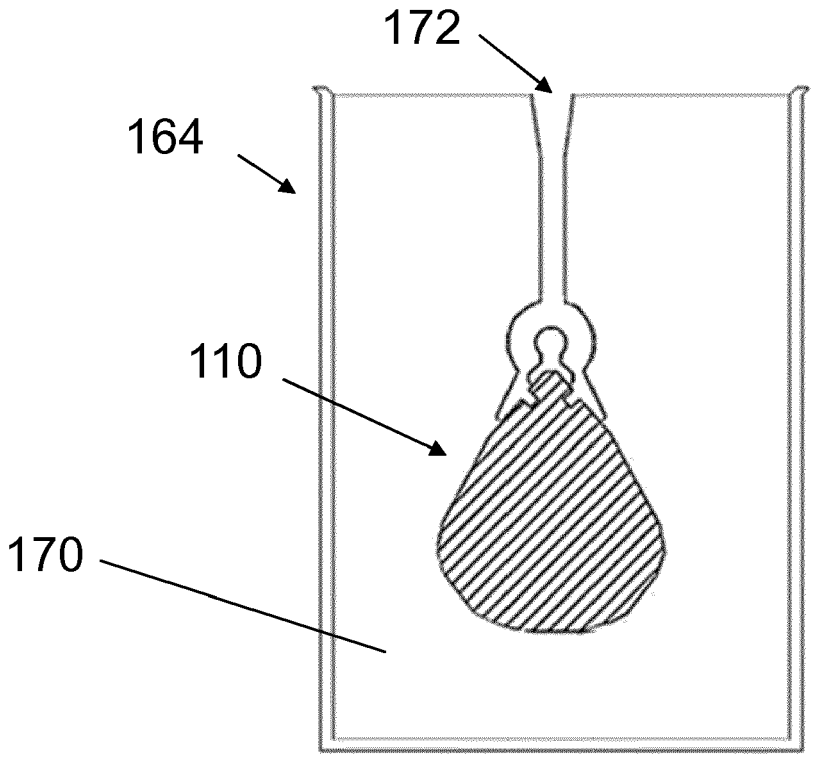

Fig. 23

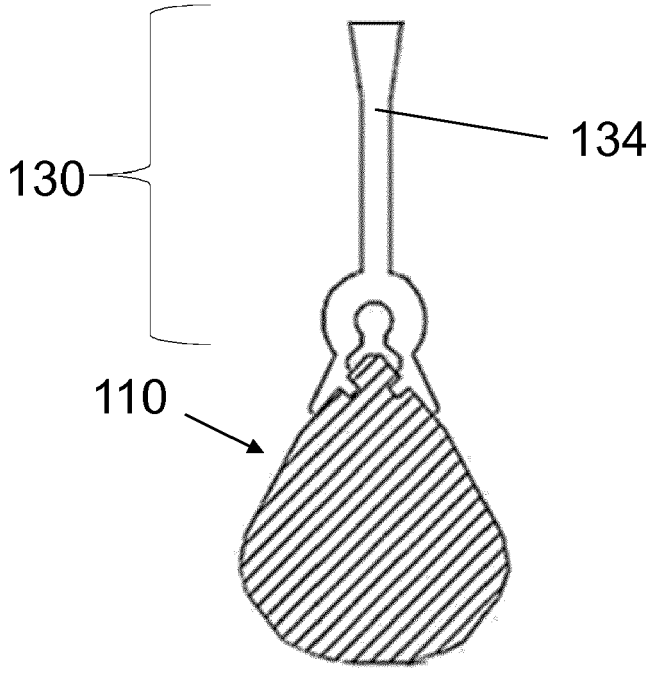

Fig. 24

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EUROPEAN SEARCH REPORT

Application Number
EP 19 17 7142

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	US 2014/174125 A1 (LAUPER STEPHANE [CH] ET AL) 26 June 2014 (2014-06-26) * figures 3,5 * -----	14,15	INV. A44C27/00 A44C17/04 A44C17/02
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TECHNICAL FIELDS SEARCHED (IPC)

A44C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	14 October 2019	van Voorst, Frank

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 17 7142

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82