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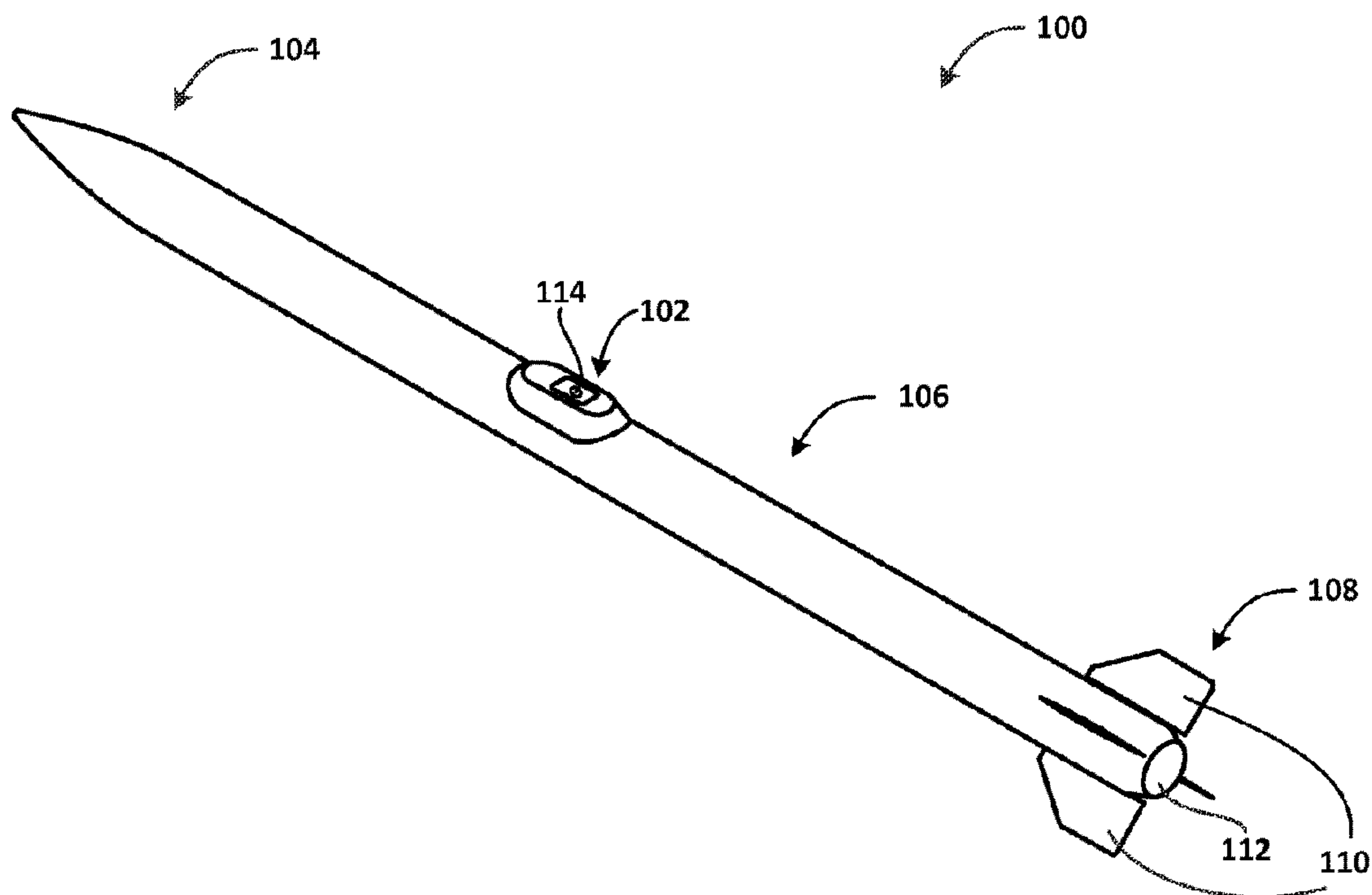
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(57) Abrégé/Abstract:

Concepts and technologies are disclosed herein for shape memory alloy weapon fairings. The shape memory alloy weapon fairings are formed from a shape memory alloy and are configured to change shape in response to temperature changes. At a first temperature, the shape memory alloy weapon fairing has a first shape and at a second temperature, the shape memory alloy has a second shape. Upon deployment of a weapon including the shape memory alloy weapon fairing, the shape memory alloy weapon fairing is heated by the weapon and/or air friction. The shape memory alloy weapon fairing changes shape in response to the temperature change and provides a fairing for one or more structures of the weapon. In some implementations, the fairing covers a protuberance or other connection mechanism of the weapon.



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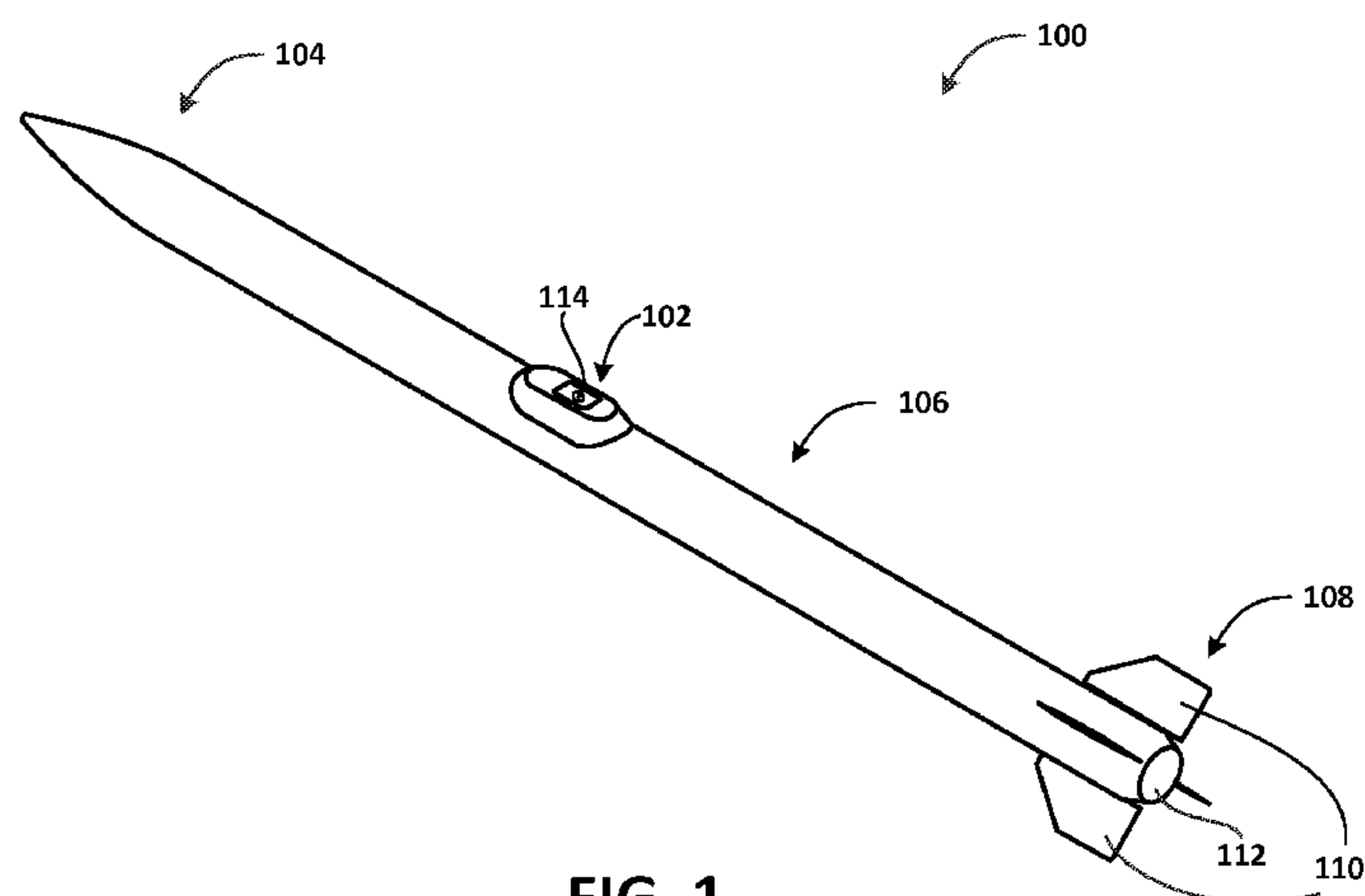


FIG. 1

(57) Abstract: Concepts and technologies are disclosed herein for shape memory alloy weapon fairings. The shape memory alloy weapon fairings are formed from a shape memory alloy and are configured to change shape in response to temperature changes. At a first temperature, the shape memory alloy weapon fairing has a first shape and at a second temperature, the shape memory alloy has a second shape. Upon deployment of a weapon including the shape memory alloy weapon fairing, the shape memory alloy weapon fairing is heated by the weapon and/or air friction. The shape memory alloy weapon fairing changes shape in response to the temperature change and provides a fairing for one or more structures of the weapon. In some implementations, the fairing covers a protruberance or other connection mechanism of the weapon.



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SHAPE MEMORY ALLOY FAIRINGS

TECHNICAL FIELD

The present disclosure relates generally to fairings and, more particularly, to shape memory alloy fairings.

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BACKGROUND

Fairings are structures often included in airborne structures to provide a smooth surface, or to redirect airflow, for reducing drag during flight. Fairings are sometimes included on aircraft, for example, at or near stabilizers, wings, various structure junctions, landing gear, flaps, fins, rudders, and other structures. Fairings are also used in other airborne structures such as rockets, space vehicles, and the like. In some applications, fairings are used to cover couplings or other connection points between deployable and/or configurable structures such as movable wings, flaps, vents, tanks, bombs, missiles, and the like.

Some deployable structures such as missiles and bombs, however, often do not include fairings due to space limitations and/or other considerations. With respect to air-to-air and/or air-to-ground weapons such as missiles and bombs, for example, a connection point is formed between a lug or other connection mechanisms on the weapon and a connection mechanism on the aircraft. After the weapon is deployed, the lug or other coupling structures on the weapon typically are exposed. These exposed connection mechanisms can create drag, thereby reducing speed, range, and/or other performance characteristics of the weapon.

As such, in some instances it may be desirable to provide a fairing or other structure for covering the connection mechanism and/or for diverting air around the exposed connection mechanism. Providing a fairing or other structure to reduce drag induced by exposed connection mechanisms that can move into place after deployment of the weapon can require numerous moving parts, power supplies, gears, and/or other mechanisms, thereby affecting an already weight-sensitive platform, further degrading performance of the weapon.

5 It is with respect to these and other considerations that the disclosure made herein is presented.

SUMMARY

It should be appreciated that this Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This
10 Summary is not intended to be used to limit the scope of the claimed subject matter.

According to one aspect, an airborne structure includes a support surface and a shape memory alloy fairing disposed adjacent to the support surface. The shape memory alloy fairing has a first shape at a first temperature and a second shape at a second temperature. In some embodiments, the shape memory alloy fairing is configured to
15 provide a fairing for an attachment mechanism of the airborne structure at the second temperature and when having the second shape.

According to another aspect, a shape memory alloy weapon fairing includes an attachment surface configured to contact a support surface of a weapon. The shape memory alloy weapon fairing can be disposed adjacent to the support surface and can have a first shape
20 at a first temperature and a second shape at a second temperature. The shape memory alloy weapon fairing is configured to provide a fairing for an attachment mechanism of the weapon at the second temperature and when having the second shape.

According to yet another aspect, a method for forming a shape memory alloy weapon fairing includes obtaining a shape memory alloy weapon fairing blank, the blank being
25 configured in a first configuration. The method further includes deforming the blank via a first deformation process to obtain a second configuration of the blank, the second configuration of the blank corresponding to a shape of the shape memory alloy weapon fairing. The method further includes deforming the first shape to obtain a third configuration, the third configuration being substantially similar to the first configuration,
30 and disposing the shape memory alloy weapon fairing blank to a weapon.

5 According to yet another aspect, an airborne structure for use with a connection mechanism to connect the airborne structure to a vehicle, the airborne structure comprising: a support surface between opposing ends of the airborne structure and adjacent the connection mechanism; and a shape memory alloy fairing disposed adjacent to the support surface, the shape memory alloy fairing having a first shape at a first
10 temperature conforming to the support surface and a second shape protruding perpendicular to airflow at a second temperature that diverts airflow around the connection mechanism thereby reducing drag associated with the connection mechanism.

According to yet another aspect, a shape memory alloy fairing for a connection mechanism to connect an airborne structure to a vehicle, the shape memory alloy fairing comprising: a
15 first shape at a first temperature exposing the connection mechanism to airflow and a second shape protruding from the airborne structure perpendicular to the airflow at a second temperature that diverts airflow around the connection mechanism thereby reducing drag associated with the connection mechanism.

According to yet another aspect, a method for forming a shape memory alloy fairing for an
20 airborne structure, the method comprising: providing a shape memory alloy blank; deforming the shape memory alloy blank into a pre-deployment configuration of the shape memory alloy weapon fairing; deforming the pre-deployment configuration to obtain a deployment configuration of the shape memory alloy fairing protruding from the airborne structure perpendicular to airflow; conforming the shape memory alloy fairing to an airborne
25 structure in the pre-deployment configuration; transitioning the shape memory alloy fairing into the deployment configuration; and in response to the transitioning step, diverting air around a connection mechanism coupled to the airborne structure.

According to yet another aspect, a method for deploying an airborne structure with an aircraft, comprising: providing a pre-deformed shape memory alloy fairing having a first
30 shape; conforming the shape memory alloy fairing to an exterior body and between opposing ends of the airborne structure; connecting the airborne structure to the aircraft with a connection mechanism while the shape memory alloy fairing is in the first shape; and transitioning the shape memory alloy fairing into a second shape to divert airflow around the connection mechanism protruding perpendicular to the airflow such that drag is
35 reduced while the aircraft is airborne.

- 5 According to yet another aspect, an airborne structure comprising: a support surface; an attachment mechanism adjacent to the support surface for attaching the airborne structure to a vehicle; and a shape memory alloy fairing disposed around the attachment mechanism, the shape memory alloy fairing having a first shape at a first temperature and a second shape at a second temperature.
- 10 According to yet another aspect, a method for forming a shape memory alloy fairing, the method comprising: obtaining a shape memory alloy fairing blank, the shape memory alloy fairing blank being configured in a first configuration; deforming the shape memory alloy fairing blank via a first deformation process to obtain a second configuration of the shape memory alloy fairing blank , the second configuration of the shape memory alloy fairing
- 15 blank corresponding to a shape of the shape memory alloy fairing; deforming the first configuration to obtain a third configuration, the third configuration being substantially similar to the first configuration; and disposing the shape memory alloy fairing blank to an airborne structure, wherein the airborne structure comprising a support surface and an attachment mechanism adjacent to the support surface, the shape memory alloy fairing
- 20 blank disposed around the attachment mechanism.

The features, functions, and advantages discussed herein can be achieved independently in various embodiments of the present invention or may be combined in

- 5 yet other embodiments, further details of which can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a perspective view of a weapon, according to an illustrative embodiment.

- 10 FIGURES 2A-2B are plan views illustrating aspects of a shape memory alloy weapon fairing in a pre-deployment configuration, according to an illustrative embodiment.

FIGURE 3 is a perspective view of a tool and die for forming a shape memory alloy weapon fairing, according to an illustrative embodiment.

- 15 FIGURES 4A-4B is an assembly drawing illustrating additional aspects of a shape memory alloy weapon fairing in a deployed configuration, according to an illustrative embodiment.

FIGURE 5 is a flow diagram illustrating aspects of a method for determining position of a structure, according to an illustrative embodiment.

20 DETAILED DESCRIPTION

- The following detailed description is directed to shape memory alloy weapon fairings. The shape memory alloy weapon fairings are formed from a shape memory alloy such as nitinol and are configured to cover a lug and/or other connection mechanisms formed on an airborne structure. As used herein and in the claims, the term “airborne structure” and variants thereof is used to refer to any aerodynamic vehicle or other structure including, but not limited to, aircraft, space vehicles, rockets, missiles, bombs, guided bombs, projectiles, other weapon systems, sonic, subsonic, supersonic, and hypersonic projectiles and/or vehicles, and/or similar structures. The shape memory alloy weapon fairing also can be used in conjunction with non-airborne structures such as high-speed land vehicles and/or other structures, though these embodiments are not illustrated in the FIGURES for the sake of brevity. In various embodiments described herein, the shape memory alloy weapon fairings are configured for use on weapons such as missiles and bombs.
- 25
- 30

5 The shape memory alloy weapon fairings are configured in a pre-deployment shape and attached or connected to a support surface of the weapon or other structure. In some embodiments, the support surface includes the skin of a weapon, an outer surface of another airborne structure, or the like. Upon deployment of the weapon, the shape memory alloy weapon fairing is heated by dedicated or undedicated heat sources within
10 the weapon and/or by air friction encountered by the weapon during flight. The internal heat source and/or heat generated by air friction can heat the shape memory alloy weapon fairing to or past a transition temperature, whereat the shape memory alloy weapon fairing changes shape to a deployment configuration. Thus, the shape memory alloy weapon fairing can be used to reduce drag associated with a weapon lug and/or
15 other connection mechanisms without requiring moving mechanical parts, power sources, and/or other related structures. As such, performance of the weapon can be improved without adding a significant amount of weight to the weapon platform. These and other advantages and features will become apparent from the description of the various embodiments below.

20 In the following detailed description, references are made to the accompanying drawings that form a part hereof and that show, by way of illustration, specific embodiments or examples. In referring to the drawings, like numerals represent like elements throughout the several figures.

FIGURE 1 schematically illustrates a weapon **100** incorporating a shape memory alloy weapon fairing **102**, according to an illustrative embodiment. The weapon **100** can include, but is not limited to, various airborne structures such as missiles, bombs, guided bombs, rail gun projectiles, subsonic, sonic, and supersonic projectiles, ordnances, propelled grenades, other weapons, and the like. For purposes of illustrating and describing the concepts and technologies disclosed herein, the weapon
25 **100** is illustrated as a missile. It should be understood that this embodiment is illustrative, and should not be construed as being limiting in any way.

The weapon **100** includes a front end **104**. As is understood by one skilled in the art, the front end **104** can include various guidance systems such as an inertial reference unit ("IRU") or an inertial measurement unit ("IMU"), infrared sensors, armament
35 sections such as warheads, a control section for controlling movement of various structures of the weapon **100**, other structures and systems, and the like. During flight

5 of the weapon **100**, the front end **104** corresponds to a leading end of the weapon **100** and is the portion of the weapon **100** that first makes contact with a target (not illustrated) during an engagement.

The weapon **100** also includes a body **106**. The body **106** can include various control systems, guidance systems, and/or armaments instead of, or in addition to, the front
10 end **104**. According to some implementations, the body **106** also includes propellant and/or an engine for propelling the weapon **100** toward a target upon deployment. Thus, the body **106** can include solid or liquid propellants and/or other materials and/or structures.

The weapon **100** also includes a tail end **108**. The tail end **108** includes, but is not
15 limited to, one or more wings or fins (“fins”) **110**, an engine outlet **112**, and/or other structures, though this is not necessarily the case. The tail end **108** also can include other structures that are not illustrated for the sake of simplicity, such as connection mechanisms, vents, wings, canards, and the like. Similarly, though not shown in FIGURE **1**, the front end **104** and/or the body **106** can include canards, wings, and/or
20 fins, if desired.

In the embodiment illustrated in FIGURE **1**, the shape memory alloy weapon fairing **102** covers a lug, umbilical connector, protuberance, and/or other connection mechanism (“lug”) **114** of the weapon **100**. The shape memory alloy weapon fairing **102** is illustrated in FIGURE **1** in a deployed configuration, as will be described and illustrated
25 in more detail below with reference to FIGURES **2A-4B**. As such, it should be understood that the shape and configuration of the weapon **100** and the shape memory alloy weapon fairing **102** illustrated in FIGURE **1** is illustrative and should not be construed as being limiting in any way.

As shown in FIGURE **1**, the shape memory alloy weapon fairing **102** can be connected
30 or attached to a support surface **116** of the weapon **100**. The support surface **116** can correspond, in various implementations, to an outer surface of an aircraft or other vehicle, to an outer skin of a missile, bomb, or other armament such as the weapon **100**, and/or to other surfaces to which the shape memory alloy weapon fairing **102** is connected or attached. It therefore should be understood that the embodiment

5 illustrated in FIGURE 1 is illustrative, and should not be construed as being limiting in any way.

Turning now to FIGURES 2A and 2B, aspects of a shape memory alloy weapon fairing 102 are described in detail. In particular, FIGURES 2A and 2B are plan views of an illustrative shape memory alloy weapon fairing blank ("blank") 200 from which a shape
10 memory alloy weapon fairing 102 can be formed, according to some illustrative embodiments. The blank 200 is formed, in various implementations, from a shape memory alloy, also referred to as smart metals, memory metals, memory alloys, smart alloys, and/or other terms and phrases. In various embodiments, the blank 200 is
15 formed from as sheet of nitinol, though various other shape memory alloys of copper, zinc, aluminum, nickel, titanium, palladium, and/or other materials can be used as well. The choice of material for the blank 200 can be made based upon various design considerations such as operating temperature ranges, desired transition temperatures, desired transition times, combinations thereof, and the like.

More particularly, in some embodiments, the blank 200 is formed from binary nitinol. In
20 one illustrative embodiment, the blank 200 is formed from "nitinol 55," a binary form of nitinol that is 55% by weight nickel. It should be understood that this embodiment is illustrative, and should not be construed as being limiting in any way. For example, in some contemplated embodiments, the blank 200 is formed from one or more alloys, wherein in one or more of the alloys are shape memory alloys and wherein one or
25 more of the alloys are not shape memory alloys such as steel, brass, and the like. As such, it will be understood that the blank 200 can be formed from a combination of materials and/or alloys such that the various portions or regions of the blank 200 react to different transition temperatures and/or transition at different times relative to other portions or regions of the blank 200. These and other embodiments are described in
30 more detail herein.

The blank 200 shown in FIGURE 2A includes an edge 202 for defining an outer shape of the shape memory alloy weapon fairing 102. The edge 202 also can correspond to an attachment surface of a shape memory alloy weapon fairing 102 that contacts the weapon 100 when attached to weapon 100. The blank 200 also includes, in some
35 embodiments, one or more apertures 204, which are described in more detail below with reference to FIGURES 3 and 5. Briefly, the apertures 204 can be used as guides

5 during forming of the shape memory alloy weapon fairing **102** and/or to provide one or more through holes via which the weapon **100** is connected to an aircraft and/or other platform. The apertures **204** can serve additional or alternative functions and/or can be omitted, if desired. As such, the illustrated embodiment should be understood as being illustrative, and should not be construed as being limiting in any way.

10 The blank **200** also includes a top portion **206**. While the top portion **206** corresponds in FIGURE **2A** to a portion of the blank **200**, the top portion **206** can be configured to provide a tiered portion of the shape memory alloy weapon fairing **102** when in the deployed configuration, as will be illustrated and described in more detail below with reference to FIGURES **4A** and **4B**. As will be appreciated with additional reference to
15 FIGURE **2B**, the blank **200** can be flat before forming and in when configured in a pre-deployment configuration, as will be described herein in more detail.

Turning now to FIGURE **3**, additional aspects of the shape memory alloy weapon fairing **102** are described in detail, according to an illustrative embodiment. More particularly, FIGURE **3** illustrates a perspective view of a tool and die set **300** for
20 forming the shape memory alloy weapon fairing **102**, according to some embodiments. As shown, the tool and die set **300** can include a mold or tool ("mold") **302** and a die **304**.

The mold **302** can, but does not necessarily, include one or more guide rods **306** for use during forming of a part, corresponding in the illustrated embodiment to a shape
25 memory alloy weapon fairing **102**. More particularly, the apertures **204** of the blank **200** can be passed over the guide rods **306**, and the die **304** can have corresponding apertures **308** that are passed over the guide rods **306** to guide the die **304** into a seated position with the mold **302**. It will be appreciated that a forming process can be completed by driving the die **304** into the seated position with the mold **302** and by
30 disposing the blank **200** between the die **304** and the mold **302**.

As such, a forming process can be used to form the blank **200** into a part, corresponding in the illustrated embodiment to a shape memory alloy weapon fairing **102**, that approximates the shape of the mold **302** and the die **304**, as the mold **302** and the die **304** can have complimentary shapes. Furthermore, it should be
35 understood that during a forming process such as that described above, various heat

5 treatment processes can be completed, if desired to form a deployed shape and to thereby “store” the shape in the shape memory alloy. Forming shapes with shape memory alloys are generally understood and as such will not be described herein in additional detail. The deployed shape of the shape memory alloy weapon fairing **102** is illustrated and described below with reference to FIGURES **4A** and **4B**.

10 Turning now to FIGURES **4A** and **4B**, additional aspects of the shape memory alloy weapon fairing **200** are described in detail, according to an illustrative embodiment. In particular, FIGURE **4A** is a top plan view of the shape memory alloy weapon fairing **102** in a deployed configuration, and FIGURE **4B** is a front or rear plan view of the shape memory alloy weapon fairing **102** illustrated in FIGURE **4A**. As illustrated and
15 described above with reference to FIGURES **1-3**, the shape memory alloy weapon fairing **102** shown in FIGURES **4A** and **4B** can be formed from the blank **200** shown in FIGURE **2** by a forming process such as a forming process utilizing the tool and die set **300** illustrated above in FIGURE **3**.

As shown in FIGURES **4A** and **4B**, the shape memory alloy weapon fairing **102**
20 includes an edge **202** and a top portion **206**. As discussed above, the top portion **206** can provide a tiered shape to the shape memory alloy weapon fairing **102**. It can be appreciated with reference to FIGURES **1** and **4A-4B** that the top portion **206** can be configured to provide a smooth surface around a lug **114** or other connection mechanism of the weapon **100**. As such, the shape memory alloy weapon fairing **102**
25 can be used to reduce drag associated with the lug **114** or other connection mechanism of the weapon **100**, thereby improving range, speed, acceleration, trajectory, and/or other performance characteristics of the weapon **100**.

According to various embodiments of the concepts and technologies disclosed herein, the shape memory alloy weapon fairing **102** can be formed into the deployed shape shown in FIGURES **4A** and **4B** via various processes and/or operations. After
30 obtaining the deployed shape of the shape memory alloy weapon fairing **102**, the shape memory alloy weapon fairing **102** can be manipulated to a pre-deployment shape such as the shape of the blank **200** illustrated in FIGURE **2**. According to some embodiments, the pre-deployment shape of the shape memory alloy weapon fairing
35 **102** approximates the shape of the skin of the weapon **100** and/or another surface, structure, or portion of a surface of structure of the weapon **100**. As such, the shape

5 memory alloy weapon fairing **102** can be attached or connected to the weapon **100** in a pre-deployed shape.

It can be appreciated that during operation of the weapon **100**, heat generated by the weapon and/or by friction between the weapon **100** and the air, for example, can heat the shape memory alloy weapon fairing **102** to a transition temperature associated with
10 the shape memory alloy weapon fairing **102**. As such, the shape memory alloy weapon fairing **102** can be transitioned from the pre-deployment shape to the deployed shape without machinery, moving parts, power supplies, and/or other components.

In one contemplated embodiment, the shape memory alloy weapon fairing **102** transitions from a pre-deployment configuration to a deployed configuration within one
15 to two seconds of launch due to heat generated by exhaust of the weapon and/or by air friction. In some embodiments, the transition temperature of the shape memory alloy weapon fairing **102** is between one hundred and eight hundred degrees Celsius, depending upon the particular material used to form the shape memory alloy weapon fairing **102**. As noted above, the transition temperature associated with the shape
20 memory alloy weapon fairing **102**, and therefore the transition time associated with the shape memory alloy weapon fairing **102** can be varied widely by varying the material used to form the shape memory alloy weapon fairing **102**.

In some embodiments, the material used to form the shape memory alloy weapon fairing **102** is chosen based upon anticipated operating temperatures and/or
25 temperature ranges associated with the shape memory alloy weapon fairing **102**. For example, if a weapon **100** is to be deployed on an aircraft in a desert environment, the material used to form the shape memory alloy weapon fairing **102** may be chosen to provide a higher transition temperature as extremely high temperatures can be experienced by aircraft parked on desert-based tarmacs and/or in vicinity of other
30 aircraft exhaust sources, and the like. It should be understood that this embodiment is illustrative, and should not be construed as being limiting in any way.

Similarly, the material used to form the shape memory alloy weapon fairing **102** can be varied to lower the transition temperature of the shape memory alloy weapon fairing
102 in cold environments, if desired. As such, the shape memory alloy weapon fairing
35 **102** can be configured to transition from martensite to austenite at relatively low

5 temperatures relative to shape memory alloy weapon fairing **102** deployed in desert or other high-temperature environments. In one embodiment, the shape memory alloy weapon fairing **102** begins to transition at seventy degrees Celsius and finished transitioning at ninety degrees Celsius. It should be understood that this embodiment is illustrative, and should not be construed as being limiting in any way. These and
10 other aspects of the material chosen for the shape memory alloy weapon fairing **102** can be selected based on a variety of design constraints, and are not described in further detail herein.

The shape memory alloy weapon fairing **102** can be attached or connected to the weapon **100** using a variety of materials and/or mechanisms. For example, the shape
15 memory alloy weapon fairing **102** can be connected to the weapon **100** using mechanical mechanisms such as rivets, clamps, screws, and the like. Additionally, or alternatively, the shape memory alloy weapon fairing **102** can be connected to the weapon **100** using chemical adhesives. Still further, various welding, laser welding, and/or other attachment processes can be used to connect the shape memory alloy
20 weapon fairing **102** to the weapon **100**.

In some embodiments, the shape memory alloy weapon fairing **102** is attached to the weapon **100** via a fixed attachment, whereby the shape memory alloy weapon fairing **102** is bonded directly to the skin of the weapon **100**. In other embodiments, the shape memory alloy weapon fairing **102** is attached to the weapon **100** via a sliding or rotating
25 attachment. As such, the shape memory alloy weapon fairing **102** can slide out from under the skin of the weapon **100** or rotate relative to the skin of the weapon **100**. It should be understood that various mechanical structures may be included or required to rotate or slide the shape memory alloy weapon fairing **102** relative to the skin of the weapon **100**. These structures, however, are not illustrated or described herein in
30 detail. In yet other embodiments, a combination of fixed and sliding/rotating attachments are used. For example, a leading edge of the shape memory alloy weapon fairing **102** can be attached to the skin of the weapon **100**, and the side edges and the trailing edge can be joined to the weapon **100** with a sliding or rotating attachment.

35 In some implementations, adhesives are used to join the shape memory alloy weapon fairing **102** to the weapon **100**. For example, the skin of the weapon **100** can be

5 treated via a laser surface treatment, thereby improving an epoxy bond to NiTi by about ten percent. In other implementations, ultrasonic soldering is used to provide a simple, low cost, and effective method of joining the shape memory alloy weapon fairing **102** to the weapon **100**. In yet other embodiments, laser welding is used to weld the shape memory alloy weapon fairing **102** to the weapon **100**. In yet other
10 embodiments, successive layers of metal tape are bonded to the shape memory alloy weapon fairing **102** to bond the shape memory alloy weapon fairing **102** to the weapon **100** using a low temperature process. It should be understood that the above connection processes and materials are illustrative, and should not be construed as being limiting in any way.

15 Although the above description illustrates and describes embodiments of the concepts and technologies disclosed herein with respect to one-way transformations of the shape memory alloy weapon fairing **102**, it should be understood that the concepts and technologies disclosed herein are not so limited. In particular, various implementations of the concepts and technologies disclosed herein include two-way transformations of
20 the shape memory alloy weapon fairing **102**. In some implementations, two-way transformations of the shape memory alloy weapon fairing **102** are used to provide two-way changes to the shape memory alloy weapon fairing **102**. Two-way transformations of shape memory alloys are generally understood and will therefore not be explained herein in further detail.

25 Turning now to FIGURE 5, aspects of a method **500** for forming a shape memory alloy weapon fairing will be described in detail, according to an illustrative embodiment. It should be understood that the operations of the method **500** disclosed herein are not necessarily presented in any particular order and that performance of some or all of the operations in an alternative order(s) is possible and is contemplated. The operations
30 have been presented in the demonstrated order for ease of description and illustration. Operations may be added, omitted, and/or performed simultaneously, without departing from the scope of the appended claims. It also should be understood that the illustrated method **500** can be ended at any time and need not be performed in their respective entirety.

35 The method **500** begins at operation **502**, wherein a blank **200** is obtained. As described above with reference to FIGURES **2A-3**, the blank **200** can be obtained from

5 a sheet of material. For example, a blank **200** can be stamped out of a sheet of material using a die cut process or other suitable process. As such, obtaining the blank **200** can include forming the apertures **204** and/or various edges of the blank **200** as illustrated and described above.

10 From operation **502**, the method **500** proceeds to operation **504**, wherein the blank **200** is configured in the deployed configuration, *i.e.*, the shape memory alloy weapon fairing **102**. As described above, the shape memory alloy weapon fairing **102** can be obtained via performing various processes on the blank **200**. For example, the blank **200** can be formed in to the shape memory alloy weapon fairing **102** using a forming process using a tool and die set such as the tool and die set **300** illustrated in FIGURE 3.

15 Additionally, or alternatively, the shape memory alloy weapon fairing **102** can be obtained via performance of various heat treatments, machining processes, combinations thereof, and the like.

From operation **504**, the method **500** proceeds to operation **506**, wherein the shape memory alloy weapon fairing **102** is deformed to obtain the pre-deployment configuration. As explained herein, the shape memory alloy weapon fairing **102** can be hammered, stamped, pressed, and/or otherwise deformed from the deployed shape to the pre-deployment shape. As such, the operation **506** can include various mechanical and/or other processes for deforming the shape memory alloy weapon fairing **102**.

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From operation **506**, the method **500** proceeds to operation **508**, wherein the shape memory alloy weapon fairing **102** is attached or connected to the weapon **100**. As explained at length above, the shape memory alloy weapon fairing **102** can be attached to the weapon **100** using a variety of mechanical or chemical adhesives or connectors such as epoxies or other resins, welding or other thermal bonding processes, straps or other mechanical connectors, and/or other mechanisms. The determination as to how the shape memory alloy weapon fairing **102** is connected to the weapon **100** can be a matter of design choice, and as such, can be chosen based upon any number of considerations including, but not limited to, an environment in which the weapon **100** is to be used, space availability or restrictions at the skin of the weapon **100**, and the like.

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- 5 Although not illustrated in FIGURE 5, it should be understood that after the shape memory alloy weapon fairing **102** is attached or connected to the weapon **100**, that the weapon **100** can be delivered for use. In various embodiments, the weapon **100** is delivered to an appropriate facility for connection to an aircraft or other structure. The weapon **100** can be deployed by the aircraft or another suitable structure, as is known.
- 10 From operation **508**, the method **500** proceeds to operation **510**. The method **500** ends at operation **510**.

Based on the foregoing, it should be appreciated that concepts and technologies for shape memory alloy weapon fairings are provided herein. Although the subject matter presented herein has been described in language specific to structural features and
15 methodological acts, it is to be understood that the invention defined in the appended claims is not necessarily limited to the specific features or acts described herein. Rather, the specific features and acts are disclosed as example forms of implementing the claims.

The subject matter described above is provided by way of illustration only and should
20 not be construed as limiting. Various modifications and changes may be made to the subject matter described herein without following the example embodiments and applications illustrated and described, and without departing from the true spirit and scope of the present invention, which is set forth in the following claims.

What is claimed is:

1. An airborne structure for use with a connection mechanism to connect the airborne structure to a vehicle, the airborne structure comprising:
 - a support surface between opposing ends of the airborne structure and adjacent the connection mechanism; and
 - a shape memory alloy fairing disposed adjacent to the support surface, the shape memory alloy fairing having a first shape at a first temperature conforming to the support surface and a second shape protruding perpendicular to airflow at a second temperature that diverts airflow around the connection mechanism thereby reducing drag associated with the connection mechanism.
2. The airborne structure of claim 1, wherein the shape memory alloy fairing is formed from a shape memory alloy.
3. The airborne structure of claim 2, wherein the shape memory alloy comprises nitinol.
4. The airborne structure of claim 3, wherein the nitinol comprises binary nitinol.
5. The airborne structure of claim 4, wherein the binary nitinol comprises about fifty five percent by weight nickel.
6. The airborne structure of claim 4, wherein the second temperature is a transition temperature.
7. The airborne structure of any one of claims 1 to 6, wherein the shape memory alloy fairing is attached to the support surface with a chemical adhesive.
8. The airborne structure of any one of claims 1 to 6, wherein the shape memory alloy fairing is mechanically connected to the support surface.
9. The airborne structure of any one of claims 1 to 6, wherein the shape memory alloy fairing is thermally bonded to the support surface.

10. The airborne structure of any one of claims 1 to 9, wherein the airborne structure comprises a missile, and wherein the missile is configured for attachment to an aircraft.
11. A shape memory alloy fairing for a connection mechanism to connect an airborne structure to a vehicle, the shape memory alloy fairing comprising:
 - a first shape at a first temperature exposing the connection mechanism to airflow
 - and a second shape protruding from the airborne structure perpendicular to the airflow at a second temperature that diverts airflow around the connection mechanism thereby reducing drag associated with the connection mechanism.
12. The shape memory alloy fairing of claim 11, wherein the shape memory alloy fairing is formed from binary nitinol.
13. The shape memory alloy fairing of claim 12, wherein the second temperature is a transition temperature, and wherein the transition temperature comprises a temperature within a range of about seventy degrees Celsius to about ninety degrees Celsius.
14. The shape memory alloy fairing of any one of claims 11 to 13, wherein the airborne structure is a weapon.
15. The shape memory alloy fairing of claim 14, wherein the weapon comprises a missile.
16. A method for forming a shape memory alloy fairing for an airborne structure, the method comprising:
 - providing a shape memory alloy blank;
 - deforming the shape memory alloy blank into a pre-deployment configuration of the shape memory alloy weapon fairing;
 - deforming the pre-deployment configuration to obtain a deployment configuration of the shape memory alloy fairing protruding from the airborne structure perpendicular to airflow;
 - conforming the shape memory alloy fairing to an airborne structure in the pre-deployment configuration;
 - transitioning the shape memory alloy fairing into the deployment configuration; and
 - in response to the transitioning step, diverting air around a connection mechanism coupled to the airborne structure.

17. The method of claim 16, wherein the shape memory alloy blank is configured to provide a fairing for an attachment mechanism of the airborne structure when the shape memory alloy blank is heated to a transition temperature.
18. The method of claim 16 or 17, wherein deforming the shape memory alloy blank into the pre-deployment configuration comprises deforming the shape memory alloy blank using a tool and die.
19. The method of claim 18, wherein deforming the shape memory alloy blank into the pre-deployment configuration further comprises heat-treating the shape memory alloy fairing.
20. The method of any one of claims 16 to 19, wherein the shape memory alloy fairing is formed from a shape memory alloy.
21. A method for deploying an airborne structure with an aircraft, comprising:
providing a pre-deformed shape memory alloy fairing having a first shape;
conforming the shape memory alloy fairing to an exterior body and between opposing ends of the airborne structure;
connecting the airborne structure to the aircraft with a connection mechanism while the shape memory alloy fairing is in the first shape; and
transitioning the shape memory alloy fairing into a second shape to divert airflow around the connection mechanism protruding perpendicular to the airflow such that drag is reduced while the aircraft is airborne.
22. An airborne structure comprising:
a support surface;
an attachment mechanism adjacent to the support surface for attaching the airborne structure to a vehicle; and
a shape memory alloy fairing disposed around the attachment mechanism, the shape memory alloy fairing having a first shape at a first temperature and a second shape at a second temperature.
23. The airborne structure of claim 22, wherein in the first shape, the shape memory alloy fairing conforms to the support surface of the airborne structure, and in the second

shape, the shape memory alloy fairing is configured to divert airflow around the attachment mechanism.

24. The airborne structure of claim 22 or 23, wherein the shape memory alloy fairing is formed from a shape memory alloy.

25. The airborne structure of claim 24, wherein the shape memory alloy comprises nitinol.

26. The airborne structure of claim 25, wherein the nitinol comprises binary nitinol.

27. The airborne structure of claim 26, wherein the binary nitinol comprises about fifty five percent by weight nickel.

28. The airborne structure of claim 26, wherein the second temperature is a transition temperature.

29. The airborne structure of any one of claims 22 to 28, wherein the shape memory alloy fairing is attached to the support surface with a chemical adhesive.

30. The airborne structure of any one of claims 22 to 28, wherein the shape memory alloy fairing is mechanically connected to the support surface.

31. The airborne structure of any one of claims 22 to 28, wherein the shape memory alloy fairing is thermally bonded to the support surface.

32. The airborne structure of any one of claims 22 to 31, wherein the airborne structure comprises a missile, and wherein the missile is configured for attachment to an aircraft at the attachment mechanism.

33. The airborne structure of any one of claims 22 to 32, wherein the shape memory alloy fairing is configured to provide a fairing for the attachment mechanism of the airborne structure at the second temperature and when having the second shape.

34. A method for forming a shape memory alloy fairing, the method comprising:
obtaining a shape memory alloy fairing blank, the shape memory alloy fairing blank being configured in a first configuration;
deforming the shape memory alloy fairing blank via a first deformation process to obtain a second configuration of the shape memory alloy fairing blank, the second configuration of the shape memory alloy fairing blank corresponding to a shape of the shape memory alloy fairing;
deforming the first configuration to obtain a third configuration, the third configuration being substantially similar to the first configuration; and
disposing the shape memory alloy fairing blank to an airborne structure, wherein the airborne structure comprising a support surface and an attachment mechanism adjacent to the support surface, the shape memory alloy fairing blank disposed around the attachment mechanism.
35. The method of claim 34, wherein the shape memory alloy fairing blank is configured to conform to the support surface of the airborne structure before the shape memory alloy fairing is heated, and provide a fairing for the attachment mechanism of the airborne structure when the shape memory alloy fairing blank is heated to a transition temperature.
36. The method of claim 34 or 35, wherein deforming the shape memory alloy fairing blank via the first deformation process comprises deforming the shape memory alloy fairing blank using a tool and die.
37. The method of any one of claims 34 to 36, wherein the shape memory alloy fairing is formed from a shape memory alloy.

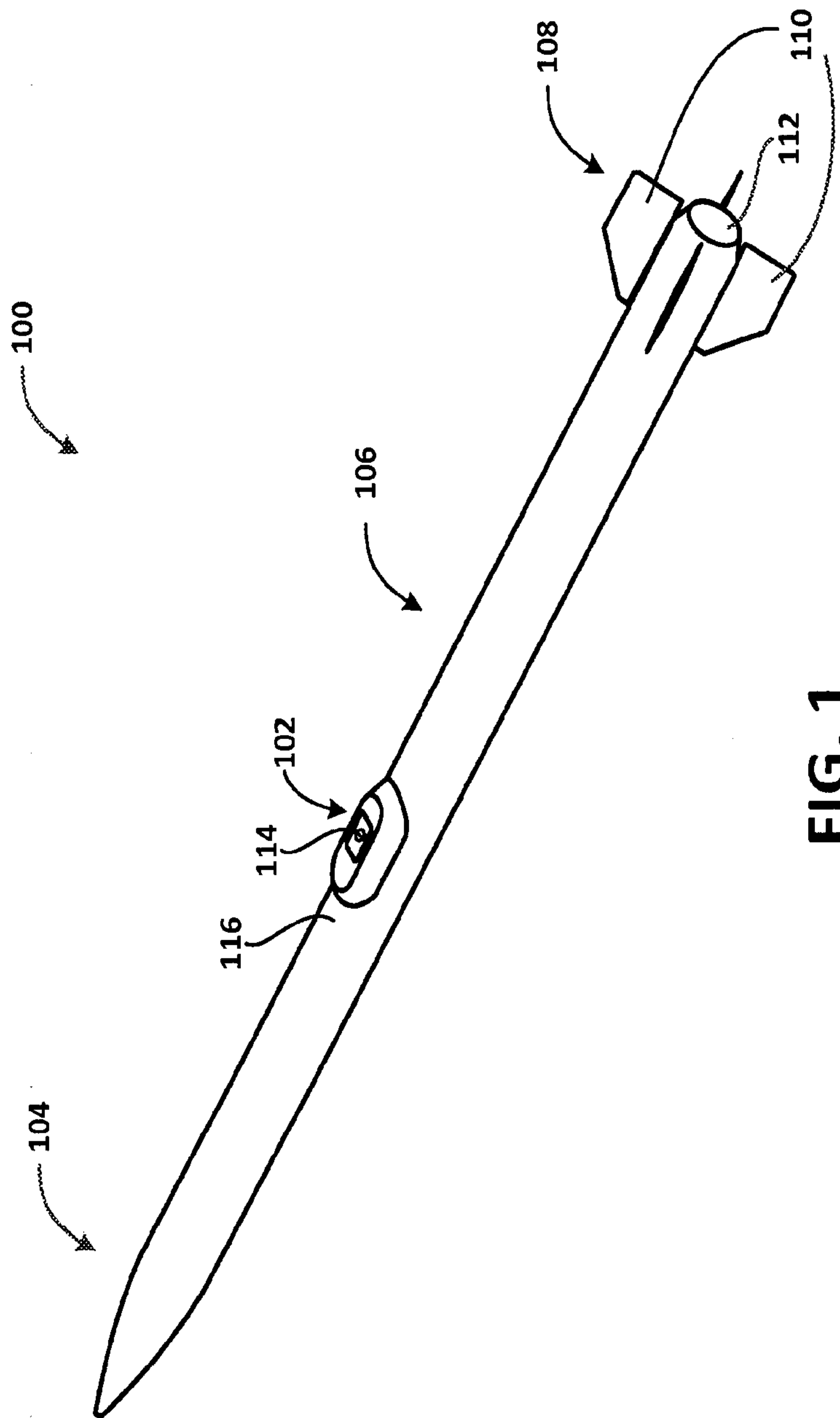
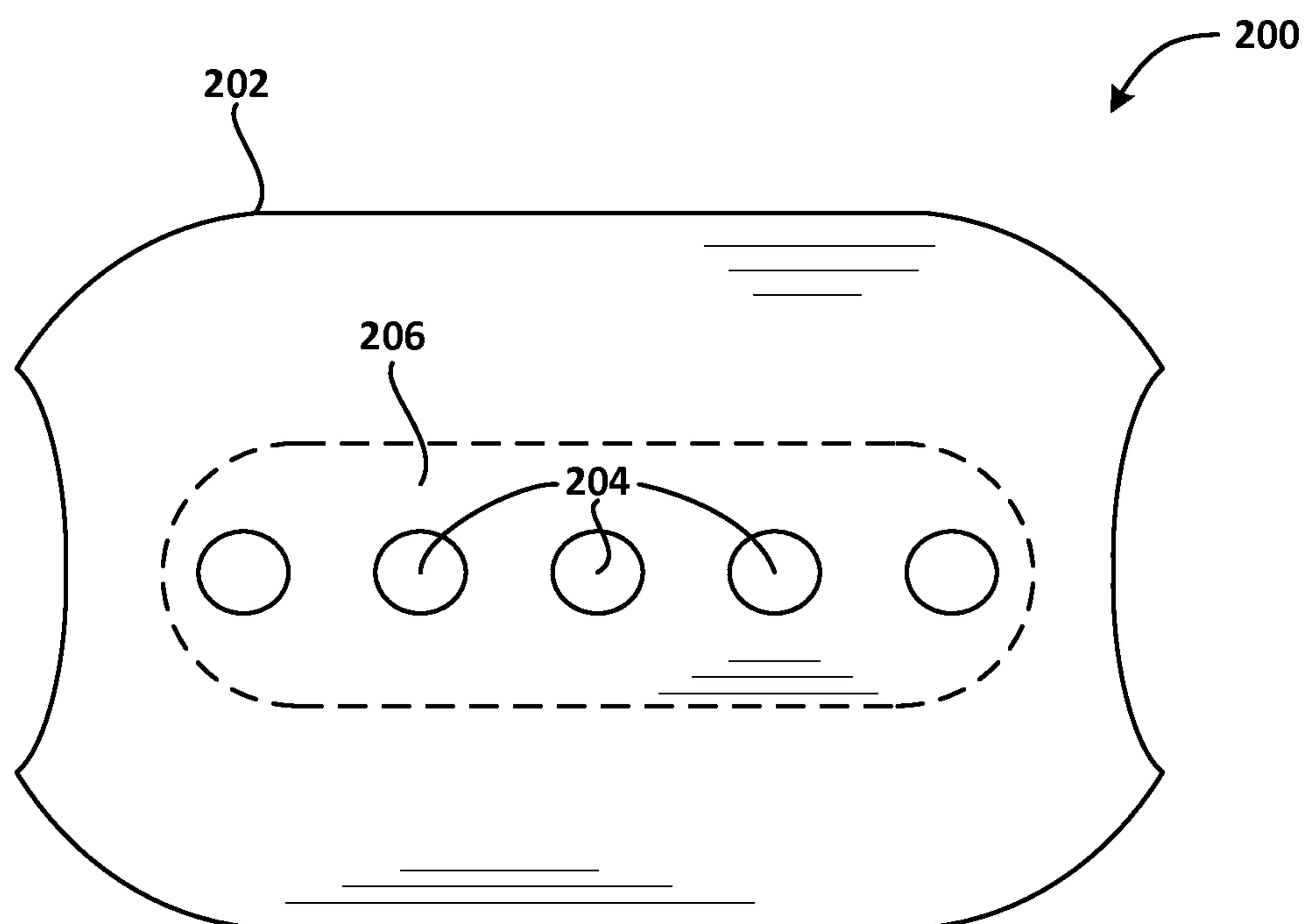
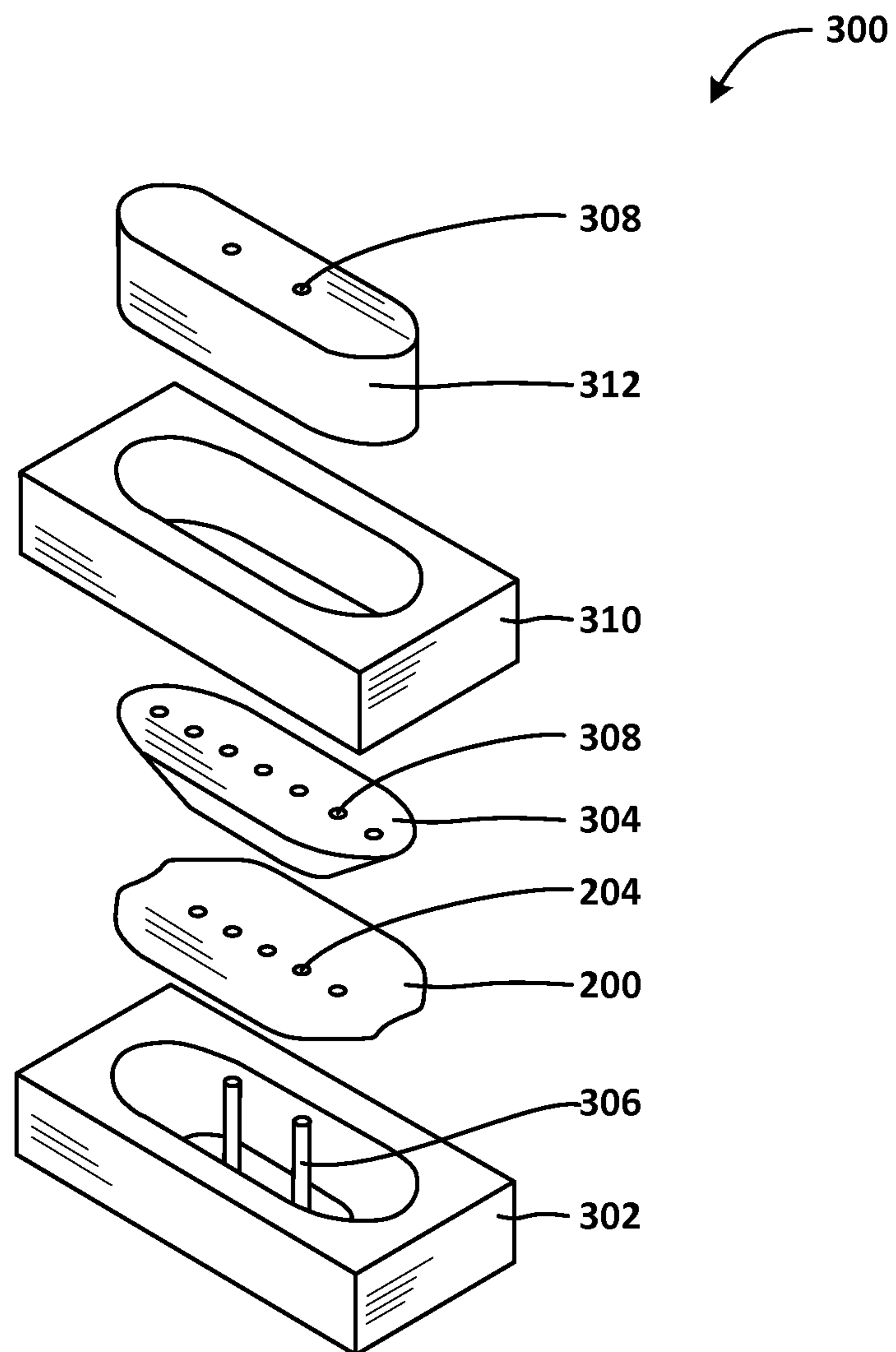
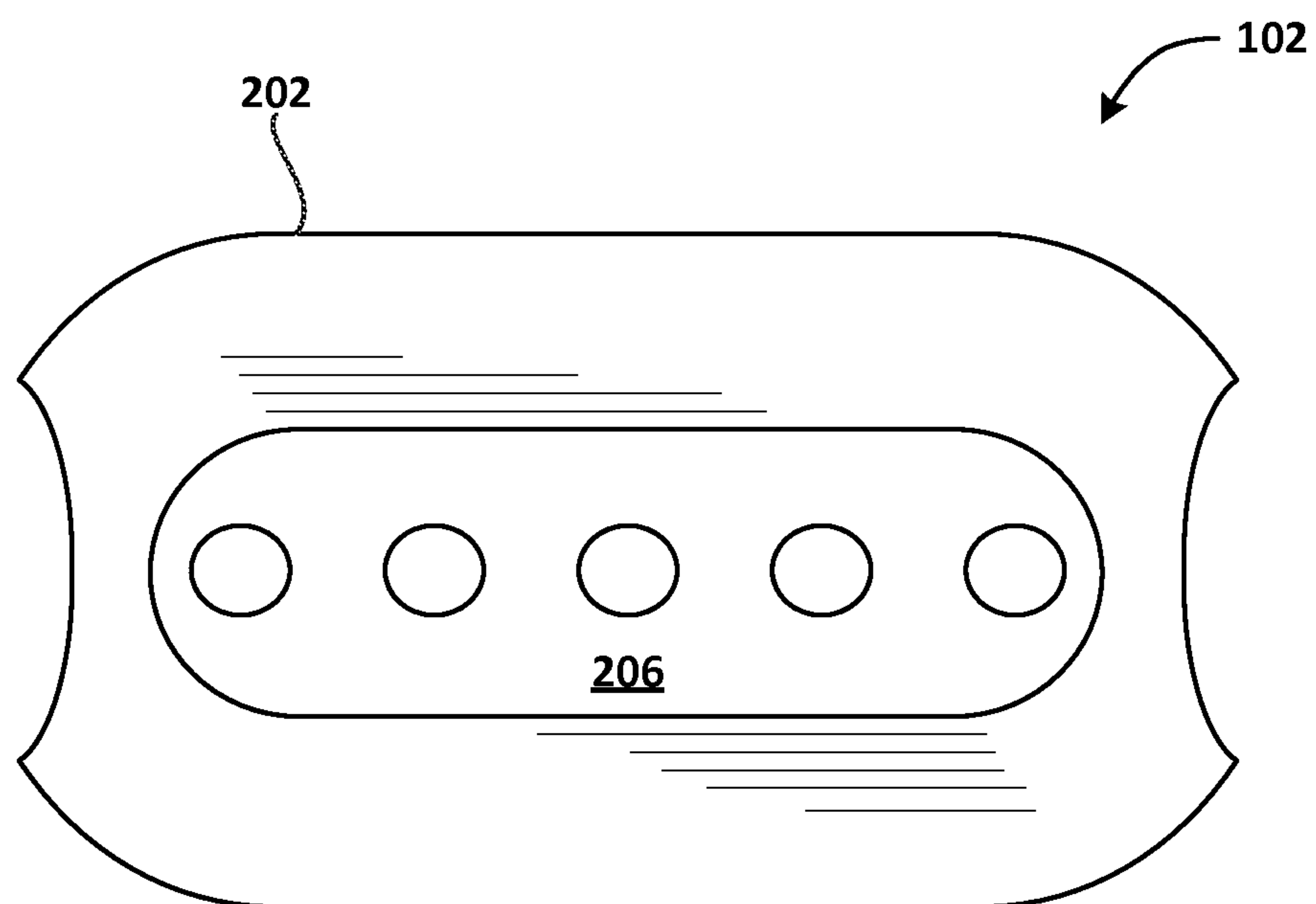
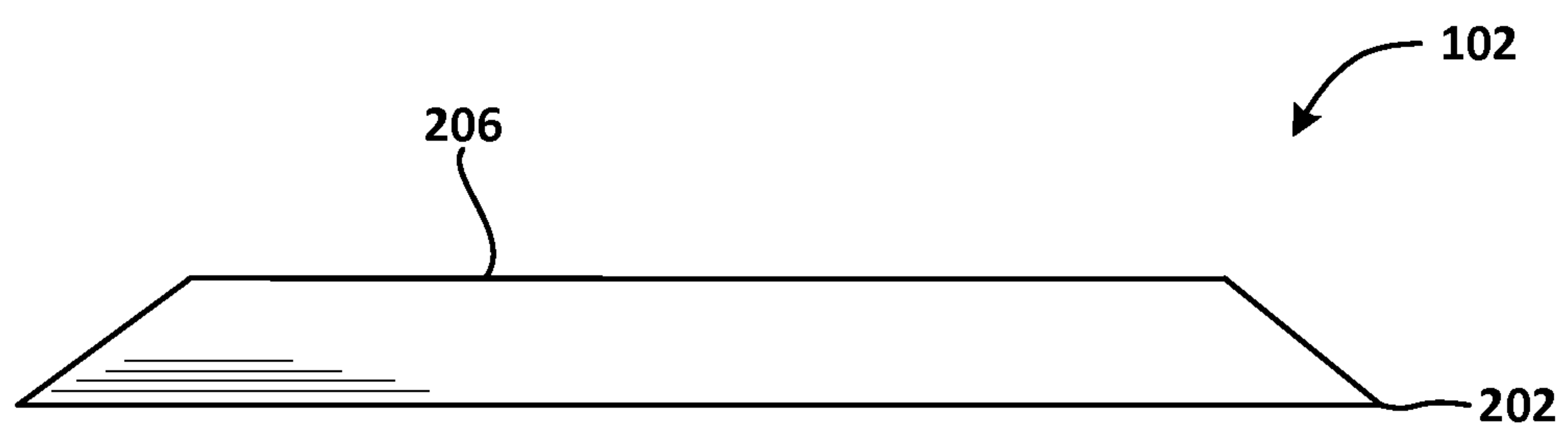
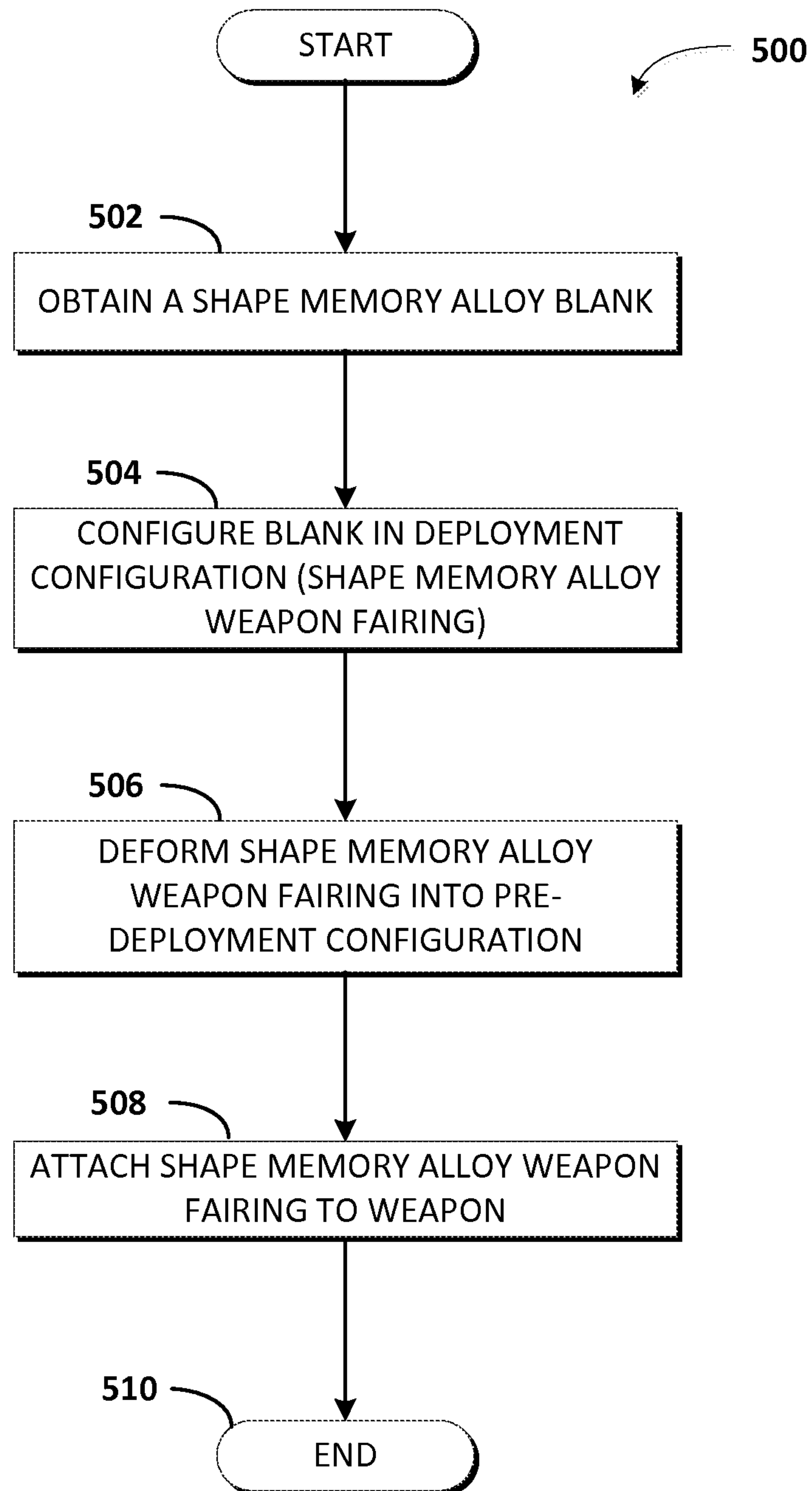


FIG. 1

**FIG. 2A****FIG. 2B**

**FIG. 3**

**FIG. 4A****FIG. 4B**

**FIG. 5**

