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(54) **INFRARED TRANSPARENT FOAM COMPOSITE FOR DEEP SUBAMBIENT COOLING OF VIRTUALLY ANY SURFACE**

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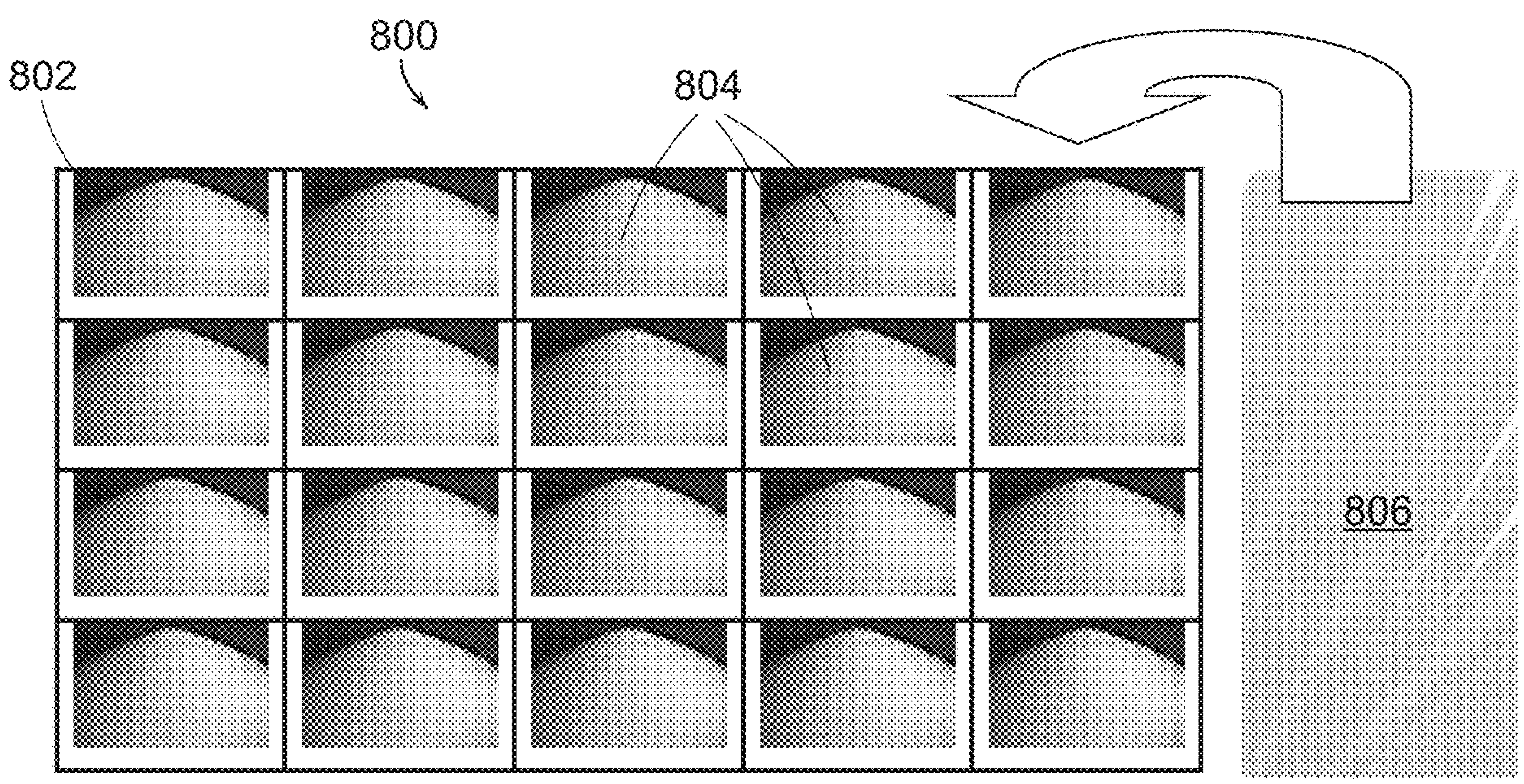
CPC ***F28F 21/06*** (2013.01)

(57) **ABSTRACT**

A cooling system having an IR transparent foam or aerogel, made from an IR transparent material, and an optomechanical frame that serves to concentrate emitted radiation to the most transparent part sky to improve the net cooling power and serve as a mechanical support to the foam or aerogel.



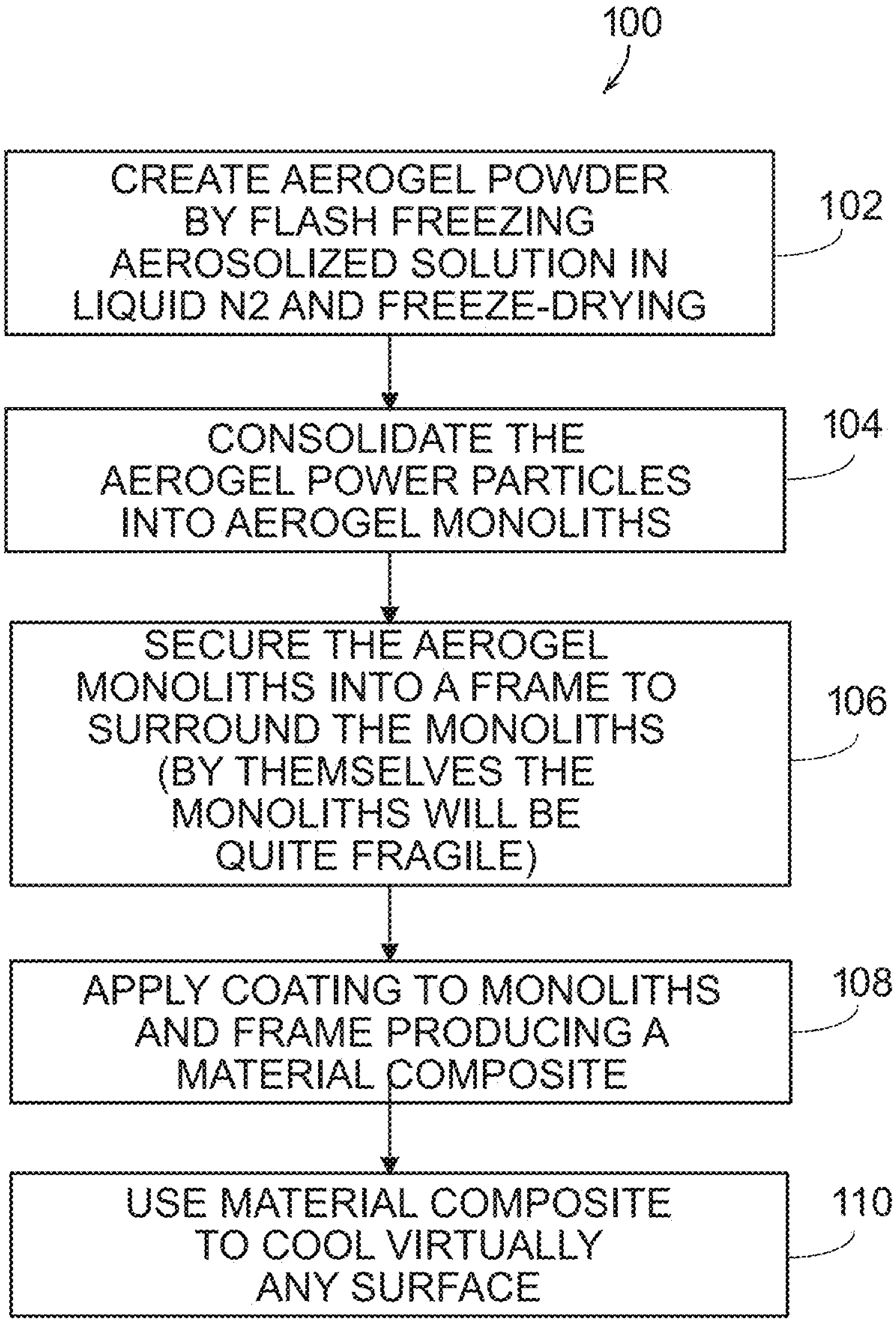

100
CREATE AEROGEL POWDER BY FLASH FREEZING AEROSOLIZED SOLUTION IN LIQUID N2 AND FREEZE-DRYING
102
CONSOLIDATE THE AEROGEL POWER PARTICLES INTO AEROGEL MONOLITHS
104
SECURE THE AEROGEL MONOLITHS INTO A FRAME TO SURROUND THE MONOLITHS (BY THEMSELVES THE MONOLITHS WILL BE QUITE FRAGILE)
106
APPLY COATING TO MONOLITHS AND FRAME PRODUCING A MATERIAL COMPOSITE
108
USE MATERIAL COMPOSITE TO COOL VIRTUALLY ANY SURFACE
110

FIG. 1

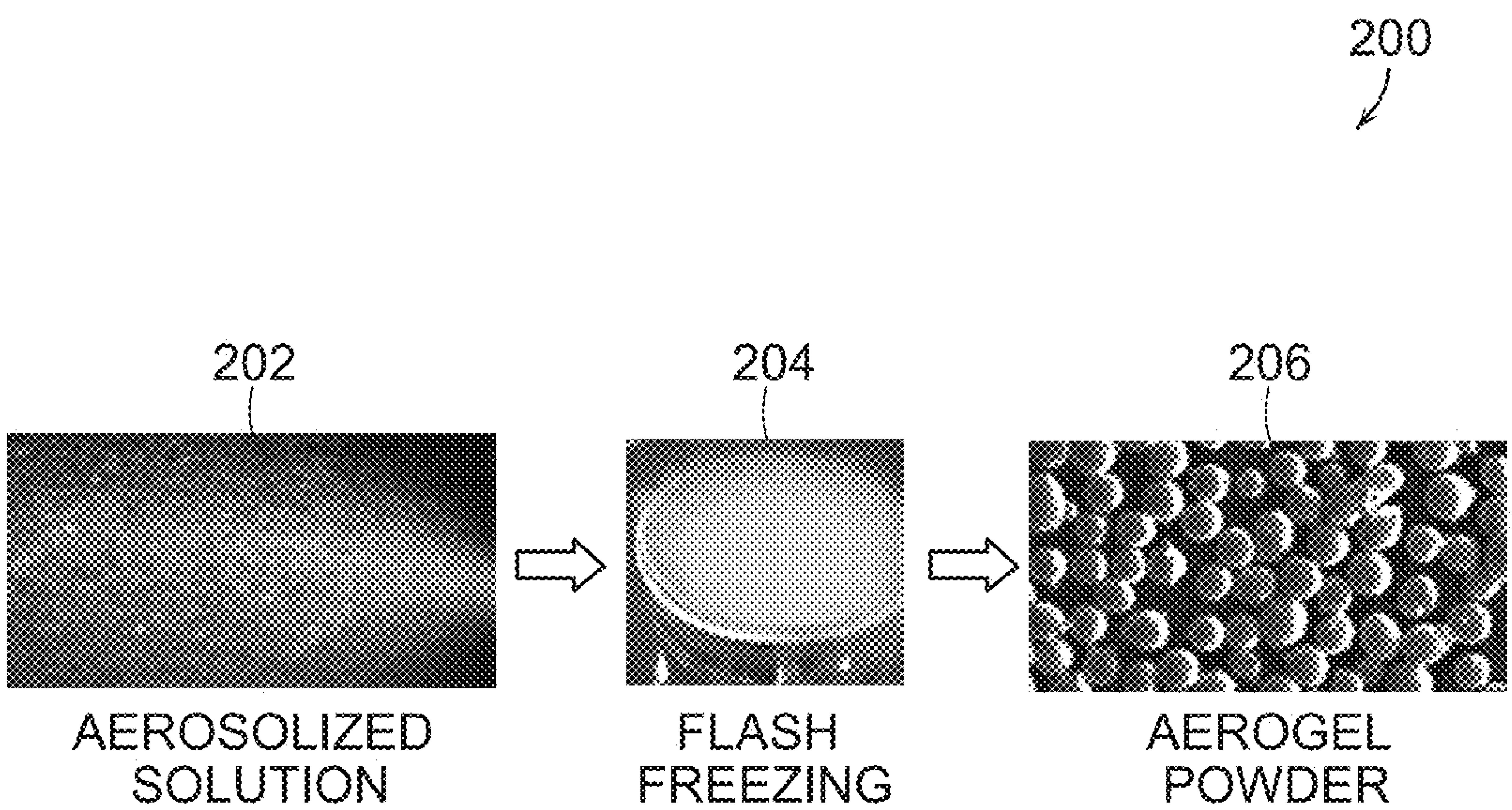

200
202
204
206
AEROSOLIZED
SOLUTION
FLASH
FREEZING
AEROGEL
POWDER

FIG. 2

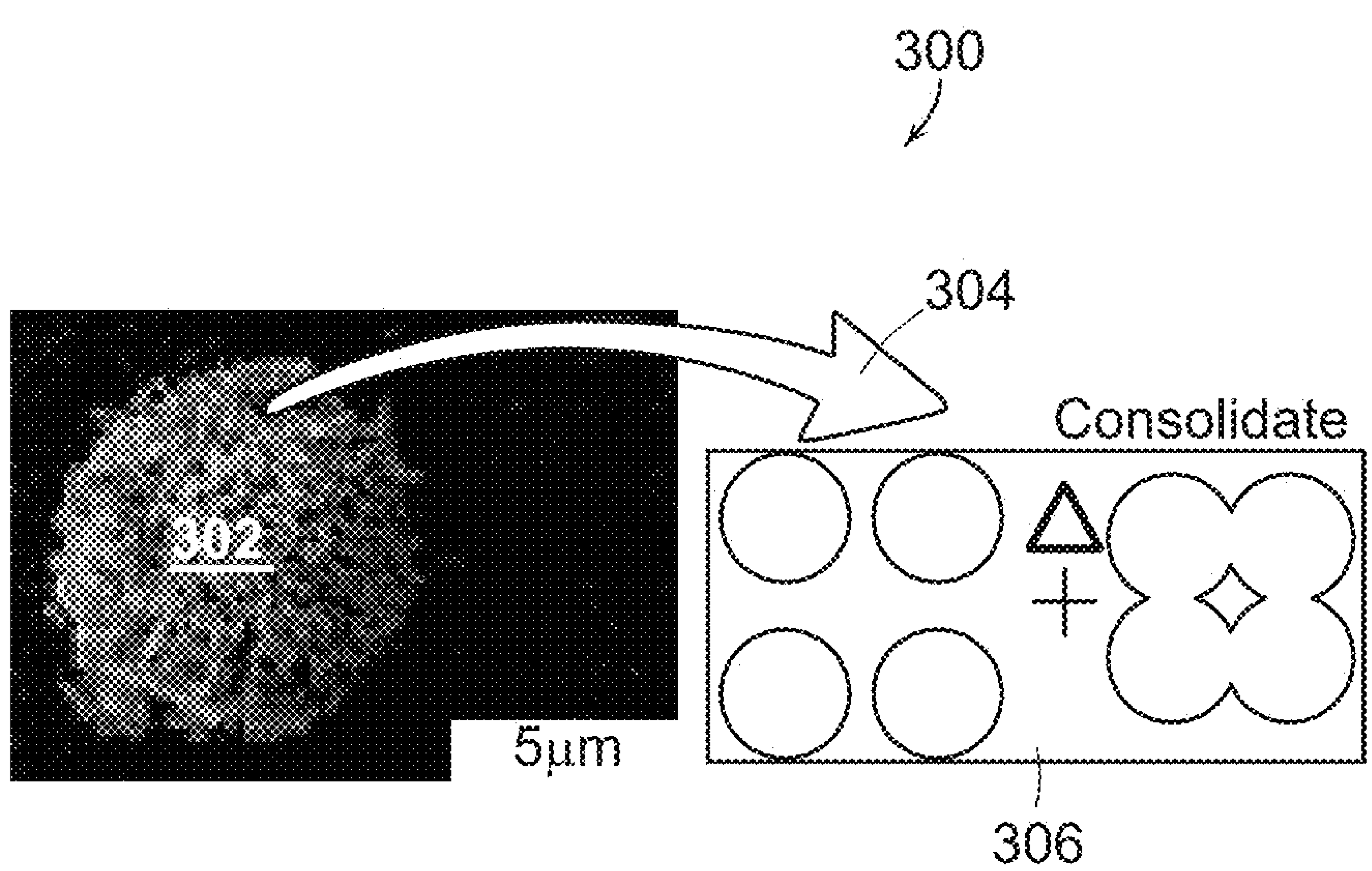

300
304
302
Consolidate
5μm
306

FIG. 3

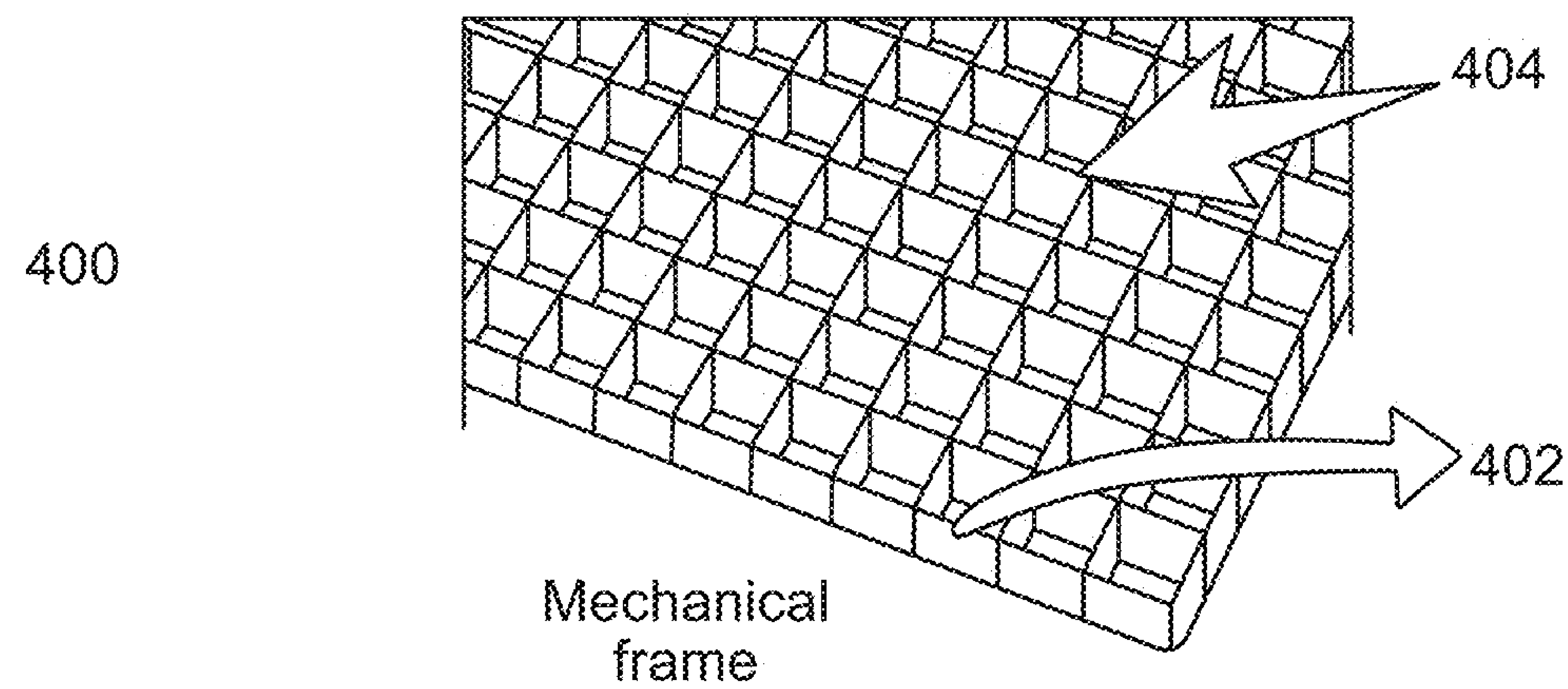


FIG. 4

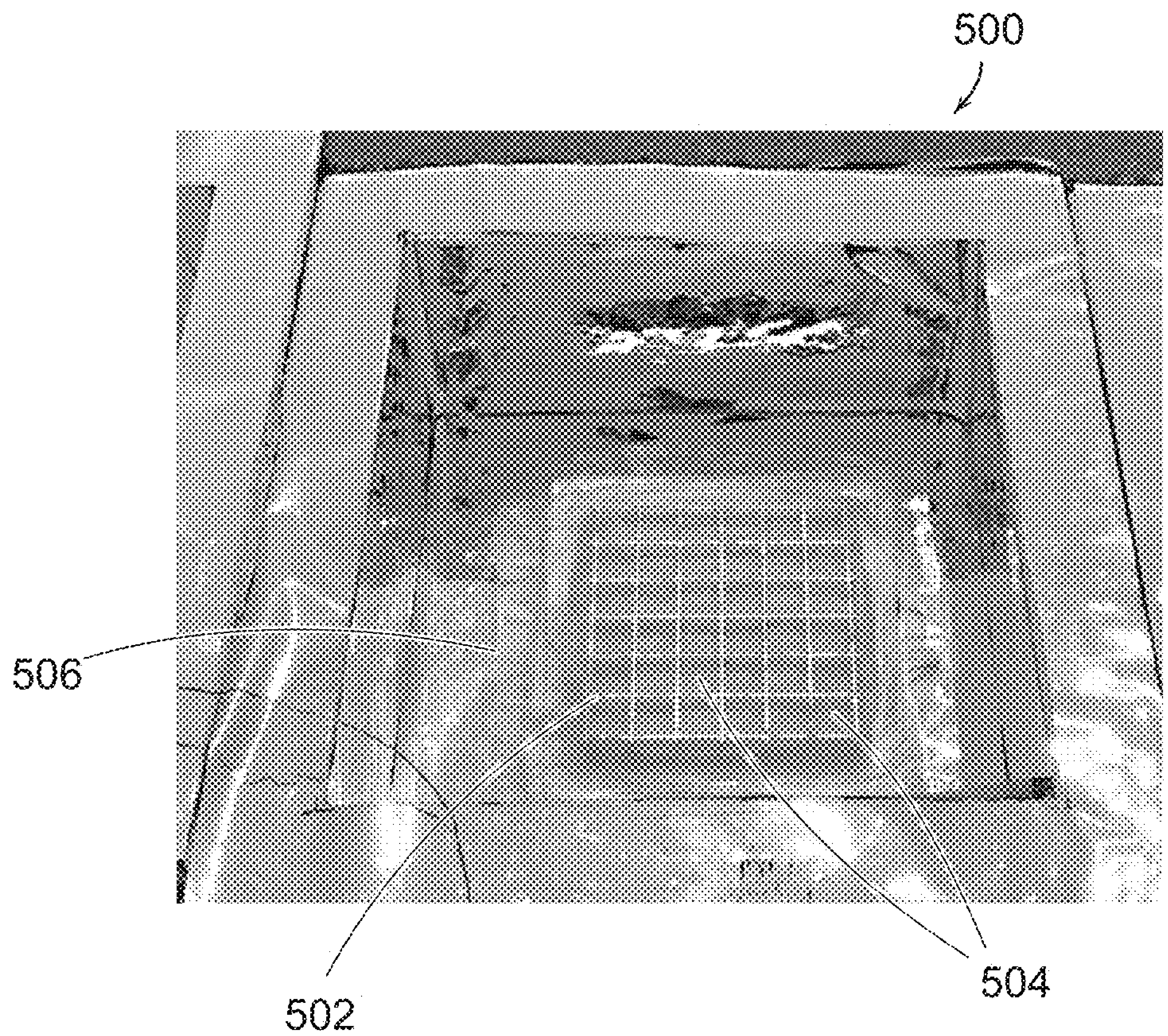


FIG. 5

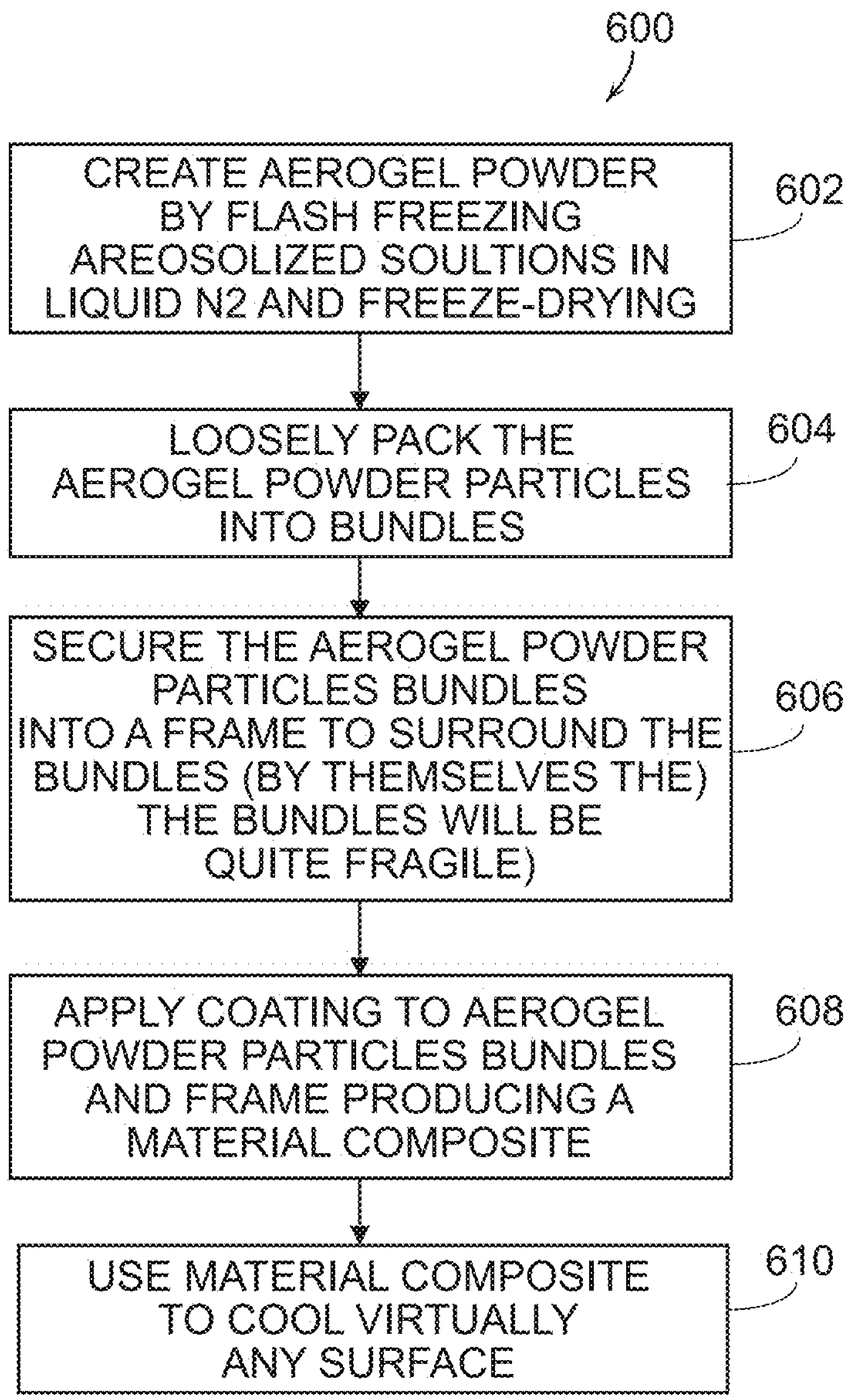

600
CREATE AEROGEL POWDER BY FLASH FREEZING AREOSOLIZED SOULTIONS IN LIQUID N2 AND FREEZE-DRYING
602
LOOSELY PACK THE AEROGEL POWDER PARTICLES INTO BUNDLES
604
SECURE THE AEROGEL POWDER PARTICLES BUNDLES INTO A FRAME TO SURROUND THE BUNDLES (BY THEMSELVES THE) THE BUNDLES WILL BE QUITE FRAGILE)
606
APPLY COATING TO AEROGEL POWDER PARTICLES BUNDLES AND FRAME PRODUCING A MATERIAL COMPOSITE
608
USE MATERIAL COMPOSITE TO COOL VIRTUALLY ANY SURFACE
610

FIG. 6

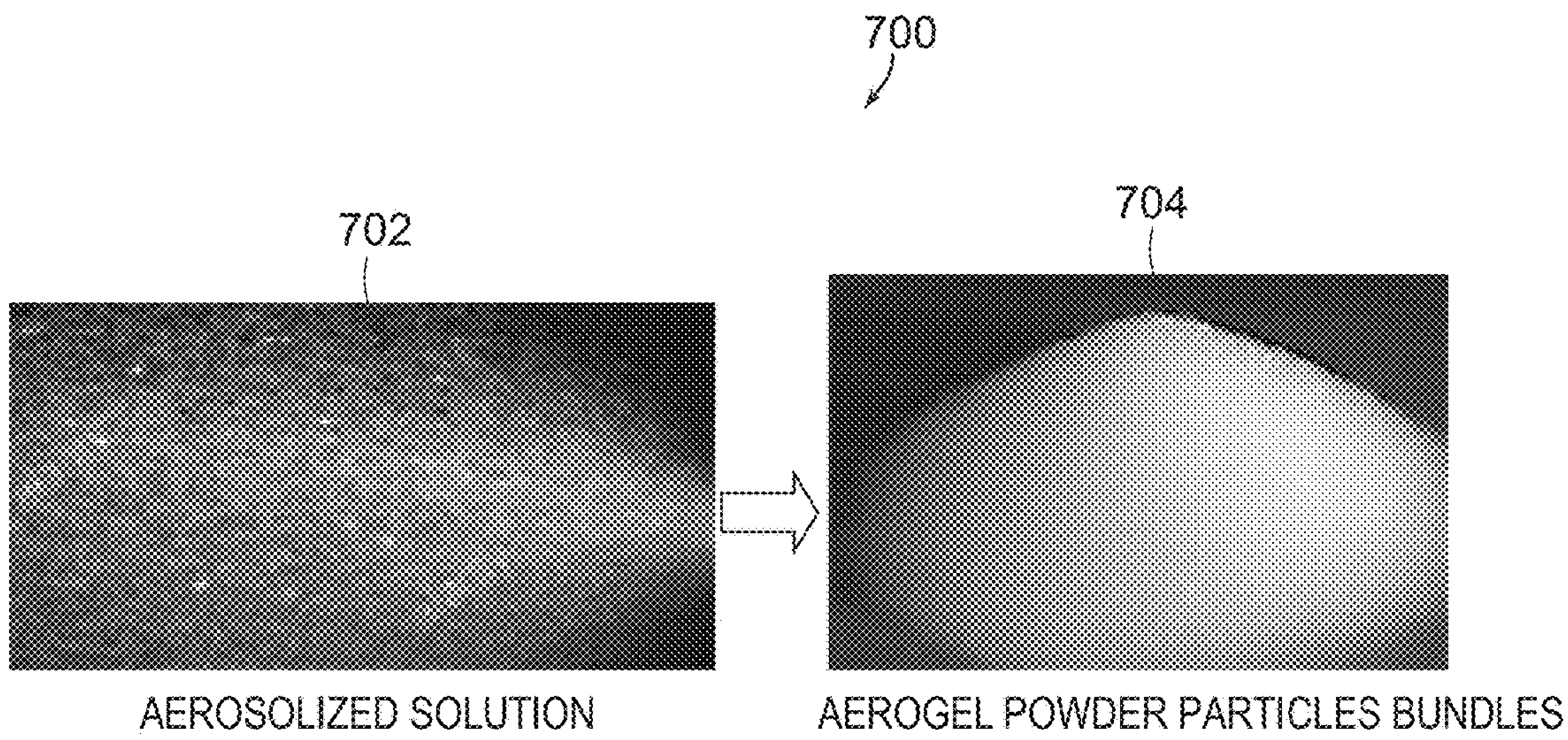

700
702
704
AEROSOLIZED SOLUTION
AEROGEL POWDER PARTICLES BUNDLES

FIG. 7

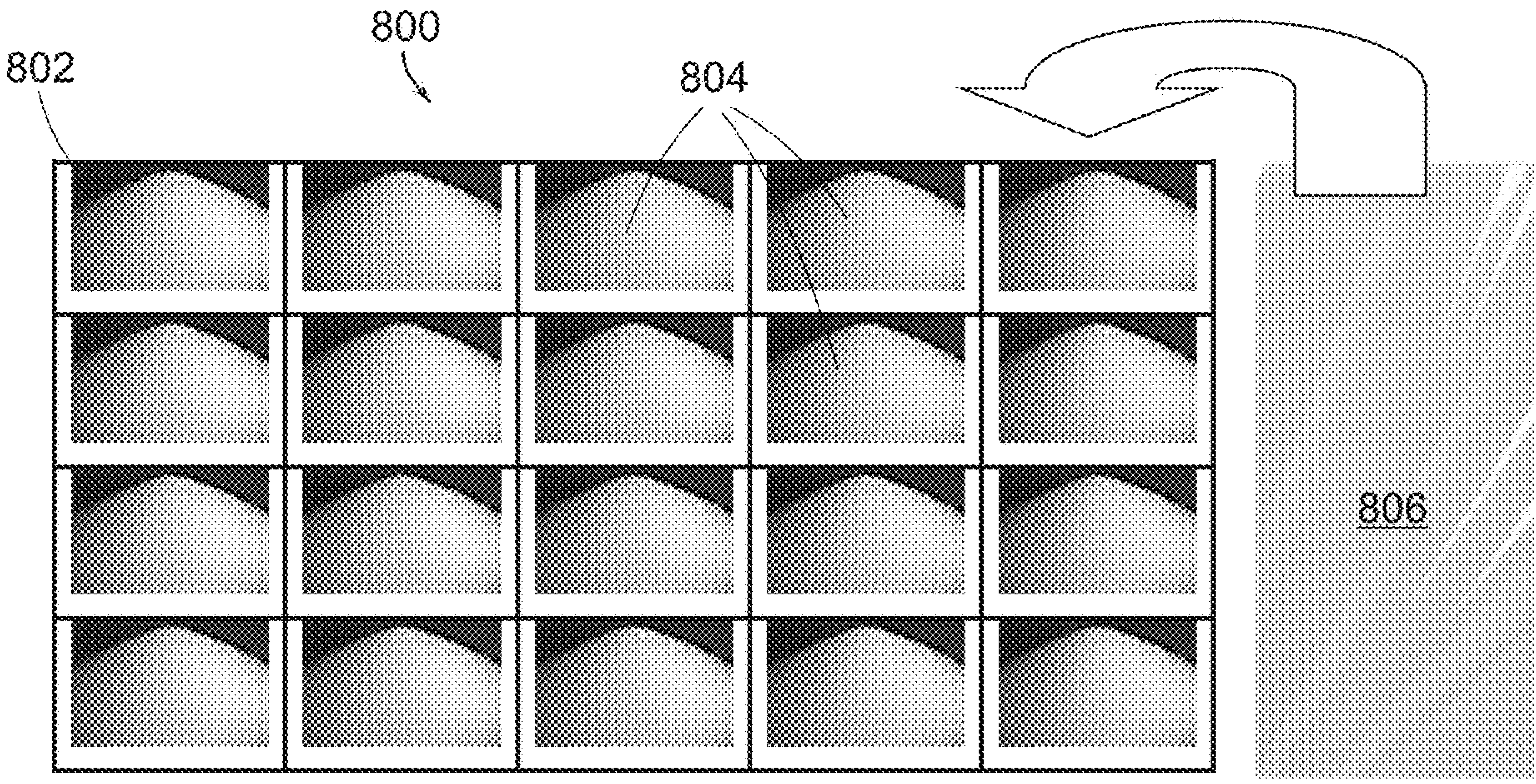

802
800
804
806

FIG. 8

INFRARED TRANSPARENT FOAM COMPOSITE FOR DEEP SUBAMBIENT COOLING OF VIRTUALLY ANY SURFACE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and benefit under 35 U.S.C. § 119(e) of U.S. Provisional Patent Application No. 63/261,788 filed Sep. 29, 2021 entitled "Infrared Transparent Foam Composite for Deep Subambient Cooling of Virtually Any Surface," the content of which is hereby incorporated by reference in its entirety for all purposes.

STATEMENT AS TO RIGHTS TO APPLICATIONS MADE UNDER FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

[0002] This invention was made with Government support under Contract No. DE-AC52-07NA27344 awarded by the United States Department of Energy. The Government has certain rights in the invention.

BACKGROUND

Field of Endeavor

[0003] The present disclosure relates to cooling.

State of Technology

[0004] This section provides background information related to the present disclosure which is not necessarily prior art.

[0005] Thermal radiative heat loss occurs continuously for any surface facing the sky. Radiation from a surface can escape to space because the atmosphere is transparent to infrared (IR) radiation with wavelengths between 8 and 13 μm (which encompasses the peak of thermal radiation at room temperature). In practice, a surface undergoes radiative heat exchange with the sky, which has a very low apparent temperature. This radiative cooling effect occurs on every sky-facing surface and can even allow sub-ambient temperatures to be reached. In fact, daily ambient temperature swings between night and day are due to (1) surface cooling via infrared (IR) radiation escaping into the cold of space and (2) surface heating from solar absorption outpacing the aforementioned IR cooling. Therefore, it is possible to achieve sub-ambient cooling during the day if pathways that heat a radiating surface can be avoided, such as avoiding the absorption of sunlight.

[0006] This kind of daytime sub-ambient cooling effect has been demonstrated by numerous materials (i.e. emitters) that are highly effective at reflecting or blocking to solar radiation (reducing solar absorption), and also highly emissive in the 8-13 μm band (i.e. they lose as much heat to space as possible). These radiating surfaces typically reach a few degrees below ambient temperature (<2-10° C.). Small temperature differences are a typical result because the radiative cooling effect is negated by parasitic heating from the surrounding warmer air (once a surface gets cold, it starts heating back up from the warmer surroundings). Therefore, if parasitic heat gains are minimized or eliminated, much lower temperatures are possible with increased cooling power. In fact, theoretical work has shown that cooling up to 60° C. below ambient is possible under optimal conditions. In short, if a cooling surface is sufficiently insulated from its surroundings while still allowing IR radiation to escape to space, much more effective radiative cooling can be realized.

[0007] One recent demonstration of this effect showed that a vacuum chamber with an IR transparent (ZnSe) window can reach 43° C. below ambient temperature when using a strong IR emitter. However, while this method was very effective at cooling, this approach is not scalable to large areas which is necessary for most practical cooling applications, such as air conditioning (many m^2 are needed). To reduce costs, an inexpensive IR material is needed that can insulate large areas of cooling emitters. Polyethylene (PE) aerogels have been fabricated to this end for improved performance over un-insulated emitters, and while they are effective, PE aerogels will not survive typical outdoor conditions due to sunlight degradation and they are somewhat costly to produce. PE films only last weeks to months in direct sunlight before completely falling apart. Additionally, ultraviolet (UV) light from the sun degrades the plastic drastically reduces IR transmission within a few days, which reduces the ability to allow an underlying surface to cool.

SUMMARY

[0008] Features and advantages of the disclosed apparatus, systems, and methods will become apparent from the following description. Applicant is providing this description, which includes drawings and examples of specific embodiments, to give a broad representation of the apparatus, systems, and methods. Various changes and modifications within the spirit and scope of the application will become apparent to those skilled in the art from this description and by practice of the apparatus, systems, and methods. The scope of the apparatus, systems, and methods is not intended to be limited to the particular forms disclosed and the application covers all modifications, equivalents, and alternatives falling within the spirit and scope of the apparatus, systems, and methods as defined by the claims.

[0009] Applicant's apparatus, systems, and methods accomplishes the requirements of: (1) losing heat to space and (2) preventing heating from sunlight and ambient surroundings by being (a) infrared transparent in the 8-13 μm wavelength range, (b) highly optically reflective to reduce heating from sunlight in the 300 nm-2500 nm range (solar spectrum), and (c) thermally insulating to avoid heating from surrounding air. The various embodiments Applicant's apparatus, systems, and methods provides a material composite that enables sub-ambient radiative cooling of virtually any sky-facing surface, when the disclosure is placed on top in close contact. Applicant's apparatus, systems, and methods work similar to a solar heater vacuum tube, but instead of providing heating, it provides cooling by maintaining a temperature difference between a surface and ambient air. In a preferred embodiment Applicant's apparatus, systems, and methods comprises of an IR transparent foam or aerogel, made from an inexpensive IR transparent material, such as common table salt (NaCl, KCl), and an optomechanical frame (multiple designs are possible) that physically protect the delicate IR transparent foam, and can serve to concentrate emitted radiation to the most transparent part sky (near vertical) to improve the net cooling power and serve as a mechanical support to the foam. NaCl and other water soluble salts have many of the desired properties for this application (high transmittance in 8-13 μm band) but are typically not considered for outdoor use. The insulating foam contains a certain size distribution and porosity to add optical reflectance and maintain strength, while continuing to provide high thermal resistance for insulating power and high IR transparency in the 8-13 μm band. In the preferred embodiment the water-soluble foam/aerogel can be coated with a hydrophobic coating and/or anti-caking agents (i.e. potassium ferrocyanide) to minimize moisture absorption and negative effects from outdoor weather. Additionally, a UV-stabilized, IR transparent plastic film with thin-film water-vapor transmission barriers can be used to encapsulate the whole device to serve as an improved moisture barrier, mitigating the issue of water-solubility and hygroscopicity.

[0010] Applicant's apparatus, systems, and methods can be used to cool virtually any surface for such uses as electricity-free air conditioning, remote refrigeration, potable water collection, etc. It could be used to cool buildings or vehicles directly, recycle evaporated process water (cooling towers) and could condense potable water from the air in arid areas and serve for disaster relief when electricity is not available. Coupling it with a heat exchanger and fluid storage, it could be used to supplement and improve the efficiency of HVAC systems, or deep-freezer units by providing a low temperature heat sink for rejecting heat.

[0011] The apparatus, systems, and methods are susceptible to modifications and alternative forms. Specific embodiments are shown by way of example. It is to be understood that the apparatus, systems, and methods are not limited to the particular forms disclosed. The apparatus, systems, and methods cover all modifications, equivalents, and alternatives falling within the spirit and scope of the application as defined by the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The accompanying drawings, which are incorporated into and constitute a part of the specification, illustrate specific embodiments of the apparatus, systems, and methods and, together with the general description given above, and the detailed description of the specific embodiments, serves to explain the principles of the apparatus, systems, and methods.

[0013] FIG. **1** illustrates one embodiment of Applicant's apparatus, systems, and methods.

[0014] FIG. **2** provides additional details of a portion of Applicant's apparatus, systems, and methods shown in FIG. **1**.

[0015] FIG. **3** is a graph that provides additional details of Applicant's apparatus, systems, and methods shown in FIGS. **1** and **2**.

[0016] FIG. **4** is an illustration of another embodiment of Applicant's apparatus, systems, and methods.

[0017] FIG. **5**. shows Applicant's consolidated material positioned on a sky-facing surface.

[0018] FIG. **6** is a descriptive illustration of one embodiment of a mechanical frame used in Applicant's apparatus, systems, and methods.

[0019] FIG. **7** is a descriptive illustration of another embodiment of a mechanical frame used in Applicant's apparatus, systems, and methods.

[0020] FIG. **8** is a descriptive illustration of yet another embodiment of a mechanical frame used in Applicant's apparatus, systems, and methods.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

[0021] Referring to the drawings, to the following detailed description, and to incorporated materials, detailed information about the apparatus, systems, and methods is provided including the description of specific embodiments. The detailed description serves to explain the principles of the apparatus, systems, and methods. The apparatus, systems, and methods are susceptible to modifications and alternative forms. The application is not limited to the particular forms disclosed. The application covers all modifications, equivalents, and alternatives falling within the spirit and scope of the apparatus, systems, and methods as defined by the claims.

[0022] The inventors have developed apparatus, systems, and methods that allow virtually any underlying surface to be able to cool to sub-ambient temperatures with improvements over the above materials in that they are inexpensive, scalable, and robust to sunlight. This required properties the current invention providing three properties, 1) they are highly reflective to solar radiation (minimizing heat gain during the day), 2) they are highly thermally insulating (minimizing heat gain, around the clock), and 3) they are transparent to the 8-13 μm band, allowing radiation to escape to space and effectively cool the surface. These three properties allow the current invention to be placed atop virtually any surface, allowing it to cool to sub-ambient temperature. Additionally, because of the method of manufacture and the materials used, the current invention is very low-cost, and scalable solution to realizing large-scale daytime radiative cooling.

[0023] Improved cooling has been shown to occur by limiting the radiative exchange with the sky to the most transparent regions (45° to the zenith). This angular selectivity effectively reduces radiative exchange with the warmer parts of the sky (angles toward the horizon) and improves the net cooling power from an emitting surface. This is usually accomplished with geometrically placed reflecting materials that surround the emitting surface, such as a conical reflector, but can be accomplished by other means such as photonic-crystal, where the surface emission does not follow the typical Lambert's cosine law.

[0024] Applicant's apparatus, systems, and methods uses solution-processed, freeze-dried foams/aerogels from common salts to produce an insulating material that is optically reflective, thermally insulating, and infrared transparent. The utility of using common salts to produce these materials is three-fold, 1) they are inexpensive materials and the methods described herein make the materials inexpensive to produce, 2) the materials are robust to UV light and long-term exposure to UV does not degrade their performance, and 3) they can be packaged into mechanical frames that can further improve cooling performance through angular selectivity of the frame (i.e. geometrical reflectors built into the frame).

[0025] Referring now to the drawings, and in particular to FIG. **1**, an illustrative diagram provides a descriptive illustration of one embodiment of Applicant's apparatus, systems, and methods. The embodiment is identified generally by the reference numeral **100**. The components of Applicant's apparatus, systems, and methods **100** are listed below:

[0026] Reference Numeral No. **102**—A support or substrate,

[0027] Reference Numeral No. **104**—White paint,

[0028] Reference Numeral No. **106**—Black paint,

[0029] Reference Numeral No. **108**—Black paint and panel,

[0030] Reference Numeral No. **110**—Syringe pump,

[0031] Reference Numeral No. **112**—Salt solution,

[0032] Reference Numeral No. **114**—Ultrasonic spray head,

[0033] Reference Numeral No. **116**—Droplets,

[0034] Reference Numeral No. **118**—Liquid nitrogen,

[0035] Reference Numeral No. **120**—Frozen droplets,

[0036] Reference Numeral No. **122**—Freeze drying unit,

[0037] Reference Numeral No. **124**—50 mm Styrofoam, and

[0038] Reference Numeral No. **126**—Aluminum coated mylar.

[0039] The description of the steps of the Applicant's apparatus, systems, and methods embodiment **100** having been completed, the operation and additional description of the Applicant's apparatus, systems, and methods embodiment **100** will now be considered in greater detail. Applicant's apparatus, systems, and methods provide electricity-free, around-the-clock, deep sub-ambient radiative cooling.

[0040] Applicants fabricate thermally insulating material either an IR transparent foam or aerogel and package it into panels. In a one embodiment the thermally insulating material is an aerogel. Aerogels are the optimal size to scatter visible light (solar reflective), but small enough not to scatter infrared radiation (IR transparent). Aerogels are also the most thermally insulating solid currently known. Superhydrophobic coatings are commonly applied to some types of aerogels and can provide stability against moisture and rain. Additional encapsulation with a suitable IR transparent material can provide additional protection against moisture.

[0041] As illustrated in FIG. **1**, a syringe pump **110** provides a salt solution **112** to an ultrasonic spray head **114**. The ultrasonic spray head **114** provides droplets **116** that are immersed in liquid nitrogen **118**. This forms frozen droplets **120**. The frozen droplets **120** are transferred to a freeze drying unit **122**. The freeze drying unit **122** provides dried frozen droplet panels are transferred to an Aluminum coated mylar material surface **126** that rests on a 50 mm Styrofoam material **124** that is supported by a support or substrate **102**.

[0042] The support or substrate **102** also supports a panel of white paint **104** and a panel of black paint **106**. The material composite of black paint and panel **108**, the panel of white paint **104**, and the panel of black paint **106** are positioned on sky-facing surface.

[0043] Referring now to FIG. **2**, additional details of Applicant's apparatus, systems, and methods shown in FIG. **1** are provided. The inventors prepared a test apparatus **200** and obtained test data. As illustrated in FIG. **2**, the test apparatus **200** includes a support or substrate **102** that supports a panel of white paint **104**, a panel of black paint **106**, and a material composite of black paint and panel **108**. The components of Applicant's test apparatus **200** shown in FIG. **2** are listed below:

[0044] Reference Numeral No. **102**—A support or substrate,

[0045] Reference Numeral No. **104**—White paint,

[0046] Reference Numeral No. **106**—Black paint,

[0047] Reference Numeral No. **108**—Black paint and panel,

[0048] Reference Numeral No. **124**—50 mm Styrofoam, and

[0049] Reference Numeral No. **126**—Aluminum coated mylar.

[0050] The description of Applicant's test apparatus **200** having been completed, additional description of the Applicant's test apparatus will now be considered in greater detail. Applicant's test apparatus **200** provides cooling for virtually any surface. Applicant's test apparatus **200** includes a panel of white paint **104**, a panel of black paint **106**, and the composite of black paint and panel **108**. Applicant's test apparatus **200** includes a support or substrate **102** with a 50 mm Styrofoam material support **124** and an Aluminum coated mylar material support **126**. The composite of black paint and panel **108** includes an IR transparent foam or aerogel made from an IR transparent material. The panel of white paint **104**, the panel of black paint **106**, and the composite of black paint and panel **108** are positioned on a sky-facing surface.

[0051] Referring now to FIG. **3**, a graph provides test data of Applicant's apparatus, systems, and methods. Applicant's test apparatus provides cooling for virtually any surface. Applicant's test apparatus produced data that is illustrated in the graph of FIG. **3**. The graph of FIG. **3** charts temperature vs time. The curve **102** show ambient temperature. The curve **104** show the temperature of the white paint. The curve **106** show the temperature of the black paint. The curve **108** show the temperature of the composite of black paint and panel. The graph of FIG. **3** shows that composite of black paint and panel provides better cooling.

[0052] Referring now to FIG. **4**, an illustrative diagram provides a descriptive illustration of another embodiment of Applicant's apparatus, systems, and methods. This embodiment is identified generally by the reference numeral **400**. The components of Applicant's apparatus, systems, and methods **400** are listed below:

[0053] Reference Numeral No. **402**—Aerogel,

[0054] Reference Numeral No. **404**—Coat the aerogel in a vacuum chamber,

[0055] Reference Numeral No. **406**—Provide a mechanical frame,

[0056] Reference Numeral No. ***408a***—Transfer the coated aerogel directly into the mechanical frame,

[0057] Reference Numeral No. ***408a***—Consolidate the aerogel into monoliths and transfer the consolidated monoliths into the mechanical frame,

[0058] Reference Numeral No. **410**—Use an encapsulating film to encapsulate the aerogel in the mechanical frame, and

[0059] Reference Numeral No. **412**—produce a composite material,

[0060] The description of the steps of the Applicant's apparatus, systems, and methods embodiment **400** having been completed, the operation and additional description of the Applicant's apparatus, systems, and methods embodiment **400** will now be considered in greater detail.

[0061] Initially, Applicants provide an aerogel powder **402**. The aerogel powder **402** is coated in a vacuum chamber **404**. A mechanical frame **406** id provided. Alternatively, the coated aerogel powder is (1) transferred ***408a*** directly into the mechanical frame **406** or (2) consolidated into monoliths and transfer the consolidated monoliths into the mechanical frame **406**. An encapsulating film **410** is used to encapsulate the aerogel and mechanical frame. The aerogel and mechanical frame encapsulated in a film provides a composite material **412**. The composite material **412** forms a mechanically robust, weather-stable panel that will enable deep, sub-ambient cooling from any surface in a cheap and scalable manner Applicant's apparatus, systems, and methods can be used to cool virtually any surface for such uses as electricity-free air conditioning, remote refrigeration, potable water collection, etc. It can be used to cool buildings or vehicles directly, recycle evaporated process water (cooling towers) and can condense potable water from the air in arid areas and serve for disaster relief when electricity is not available. Coupling it with a heat exchanger and fluid storage, it could be used to supplement and improve the efficiency of HVAC systems, or deep-freezer units by providing a low temperature heat sink for rejecting heat.

[0062] Referring now to FIG. **5**, Applicant's consolidated material is shown positioned on a sky-facing surface as designated by the reference numeral **500**. As illustrated in FIG. **5**, the consolidated material **500** is positioned in a support or substrate **506**. The aerogel **504** is contained in the mechanical frame **502**. Applicant's apparatus, systems, and methods provides a material composite **500** that enables sub-ambient radiative cooling of virtually any sky-facing surface, when the disclosure is placed on top in close contact. Applicant's apparatus, systems, and methods work similar to a solar heater vacuum tube, but instead of providing heating, it provides cooling by maintaining a temperature difference between a surface and ambient air.

[0063] Referring now to FIG. **6**, is a descriptive illustration of one embodiment of a mechanical frame used in Applicant's apparatus, systems, and methods. This embodiment of a mechanical frame is identified generally by the reference numeral **600**. The components of this embodiment a mechanical frame are listed below:

[0064] Reference Numeral No. **602**—mechanical frame,

[0065] Reference Numeral No. **604**—Salt aerogel, and

[0066] Reference Numeral No. **606**—Straight wall of mechanical frame,

[0067] The description of Applicant's mechanical frame apparatus, systems, and methods embodiment **600** having been completed, the operation and additional description of the Applicant's mechanical frame apparatus, systems, and methods embodiment **600** will now be considered in greater detail. Initially, the mechanical frame **602** is provided. The mechanical frame **602** in this embodiment has a straight wall **604**. The salt aerogel is contained in the mechanical frame **602**.

[0068] Referring now to FIG. **7**, is a descriptive illustration of another embodiment of a mechanical frame used in Applicant's apparatus, systems, and methods. This embodiment of a mechanical frame is identified generally by the reference numeral **700**. The components of this embodiment a mechanical frame are listed below:

[0069] Reference Numeral No. **702**—mechanical frame,

[0070] Reference Numeral No. **704**—Salt aerogel, and

[0071] Reference Numeral No. **706**—conical wall of mechanical frame,

[0072] The description of Applicant's mechanical frame apparatus, systems, and methods embodiment **700** having been completed, the operation and additional description of the Applicant's mechanical frame apparatus, systems, and methods embodiment **700** will now be considered in greater detail. Initially, the mechanical frame **702** is provided. The mechanical frame **702** in this embodiment has a conical wall **704**. The salt aerogel is contained in the mechanical frame **702**.

[0073] Referring now to FIG. **8**, is a descriptive illustration of yet another embodiment of a mechanical frame used in Applicant's apparatus, systems, and methods. This embodiment of a mechanical frame is identified generally by the reference numeral **800**. The components of this embodiment a mechanical frame are listed below:

[0074] Reference Numeral No. **802**—mechanical frame,

[0075] Reference Numeral No. **804**—Salt aerogel, and

[0076] Reference Numeral No. **806**—Compound parabolic concentrator wall of mechanical frame,

[0077] The description of Applicant's mechanical frame apparatus, systems, and methods embodiment **800** having been completed, the operation and additional description of the Applicant's mechanical frame apparatus, systems, and methods embodiment **800** will now be considered in greater detail. Initially, the mechanical frame **802** is provided. The mechanical frame **802** in this embodiment has a compound parabolic concentrator wall **804**. The salt aerogel is contained in the mechanical frame **802**.

[0078] Therefore, it will be appreciated that the scope of the present application fully encompasses other embodiments which may become obvious to those skilled in the art. In the claims, reference to an element in the singular is not intended to mean "one and only one" unless explicitly so stated, but rather "one or more." All structural and functional equivalents to the elements of the above-described preferred embodiment that are known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the present claims. Moreover, it is not necessary for a device to address each and every problem sought to be solved by the present apparatus, systems, and methods, for it to be encompassed by the present claims. Furthermore, no element or component in the present disclosure is intended to be dedicated to the public regardless of whether the element or component is explicitly recited in the claims. No claim element herein is to be construed under the provisions of 35 U.S.C. 112, sixth paragraph, unless the element is expressly recited using the phrase "means for."

[0079] While the apparatus, systems, and methods may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that the application is not intended to be limited to the particular forms disclosed. Rather, the application is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the application as defined by the following appended claims.

1. An apparatus for cooling, comprising:

a composite that is

infrared transparent in the 8-13 m wavelength range,

that is optically reflective to reduce heating from sunlight, and

that is thermally insulating to avoid heating from surrounding air.

2. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel.

3. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel.

4. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel, wherein said IR transparent foam or aerogel produces emitted radiation, and wherein said frame is positioned to concentrate said emitted radiation to the most transparent part sky to improve cooling.

5. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and wherein said frame is an optomechanical frame.

6. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and wherein said IR transparent foam or aerogel is IR transparent NaCl or other IR transparent salts.

7. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and wherein said IR transparent foam or aerogel is IR transparent foam.

8. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and wherein said IR transparent foam or aerogel is IR transparent aerogel powder.

9. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and wherein said IR transparent foam or aerogel is IR transparent NaCl or other salt aerogel.

10. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and wherein said IR transparent foam or aerogel is IR transparent aerogel monoliths.

11. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and further comprising a covering for said IR transparent foam and said frame.

12. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and further comprising a covering including a water vapor transmission barrier for said IR transparent foam and said frame.

13. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and further comprising a covering with a water vapor transmission barrier covering for said IR transparent foam and said frame.

14. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and further comprising an IR transparent plastic film covering with a water vapor transmission barrier for said IR transparent foam and said frame.

15. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and further comprising a UV-stabilized, IR transparent plastic film covering with a water vapor transmission barrier for said IR transparent foam and said frame.

16. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and further comprising a vacuum sealed UV-stabilized, IR transparent plastic film covering with a water vapor transmission barrier for said IR transparent foam and said frame.

17. The apparatus for cooling of claim **1** wherein said composite comprises an IR transparent foam or aerogel and a frame that holds said IR transparent foam or aerogel and further comprising a vacuum sealed UV-stabilized, IR transparent plastic film covering for said IR transparent foam and said frame and a desiccant within said vacuum sealed UV-stabilized, IR transparent plastic film covering with a water vapor transmission barrier.

18. A method of cooling, comprising the steps of:

creating IR transparent powder, and

securing said IR transparent powder into a frame to provide a material composite, and

using said material composite to cool virtually any surface.

19. The method of cooling of claim **18** wherein said step of creating IR transparent powder comprises creating an IR transparent foam.

20. The method of cooling of claim **18** wherein said step of creating IR transparent powder comprises creating an IR transparent aerogel.

21. The method of cooling of claim **18** wherein said step of creating IR transparent powder comprises flash freezing aerosolized solutions in liquid nitrogen via liquid nitrogen or other methods and freeze-drying said aerosolized solutions.

22. The method of cooling of claim **18** wherein said IR transparent powder is made of NaCl, KCl, CsI, Ge, ZnSe, ZnS, or BaF2 infrared transparent material.

23. The method of cooling of claim **18** wherein said IR transparent powder is made of NaCl transparent material.

24. The apparatus for cooling of claim **18** wherein said IR transparent powder has a particle size where it is effective at scattering optical light but not scattering longer IR wavelength between 8-13 um (<1 um particle size, lambda/10).

25. The apparatus for cooling of claim **18** wherein said IR transparent powder produces emitted radiation and wherein said frame is positioned to concentrate said emitted radiation to the most transparent part sky to improve cooling.

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