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(54) **BREAST PUMP COMPRISING HEATING CUP**

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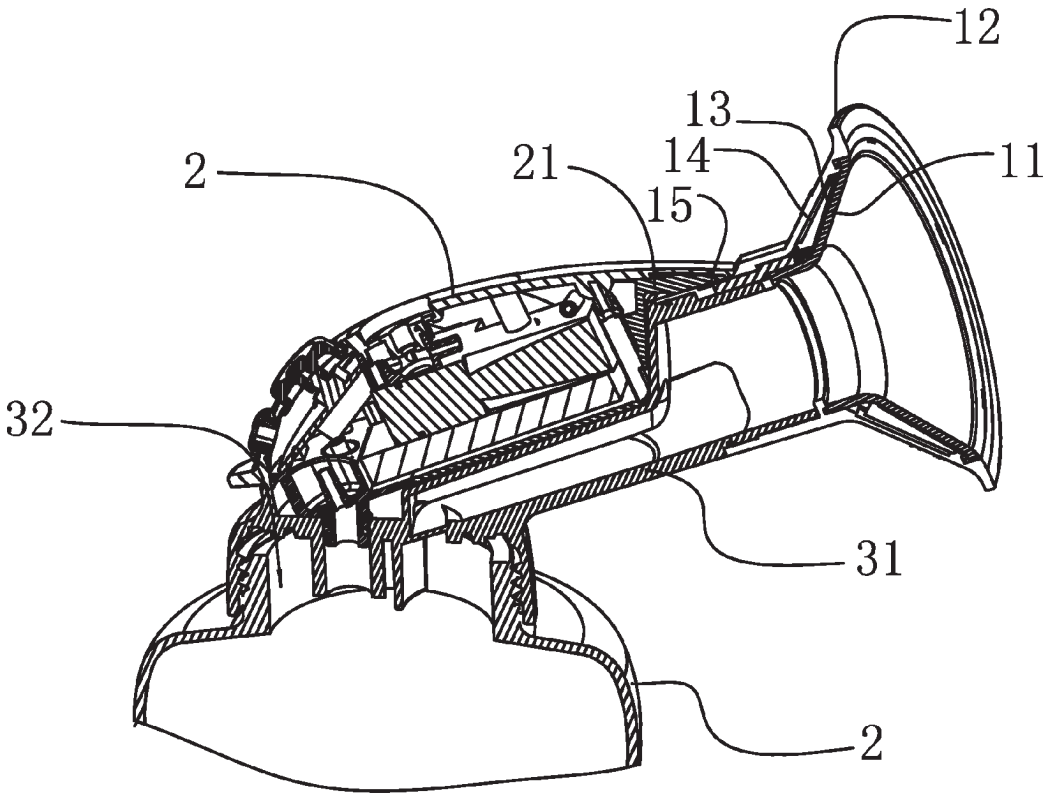
(57) **ABSTRACT**

A breast pump including a container, a host unit disposed above and communicating with the container, an electric heating cup disposed at the front end of the host unit and communicating with the container, an electric heating element, and heat insulation. The electric heating cup includes an inner cover and an outer cover which are integrated. The electric heating element and the heat insulation are disposed between the inner cover and the outer cover. The heat insulation is disposed between the electric heating element and the outer cover. Positive and negative electrodes of the electric heating element are connected to conducting plates disposed in the inner side of the outer cover via connection wires. The conducting plates extend to the outer side of the outer cover and are in electric connection to contact chips disposed at the lower front end of the host unit.



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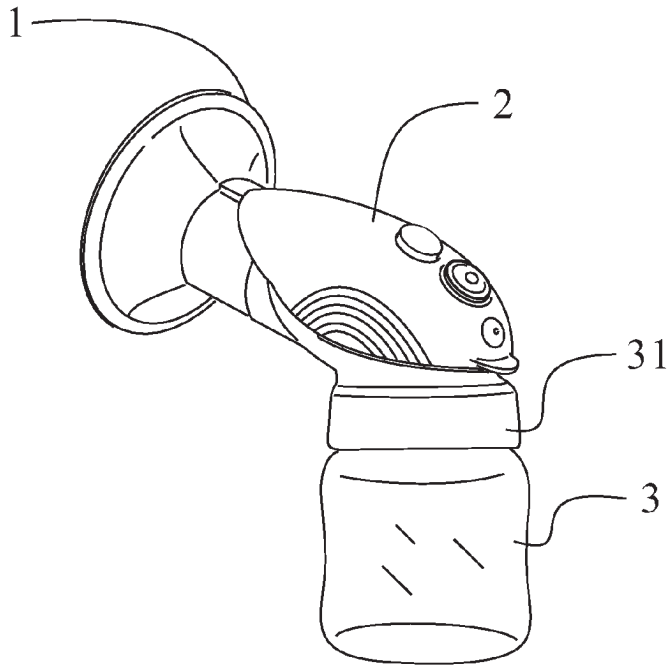

FIG. 1

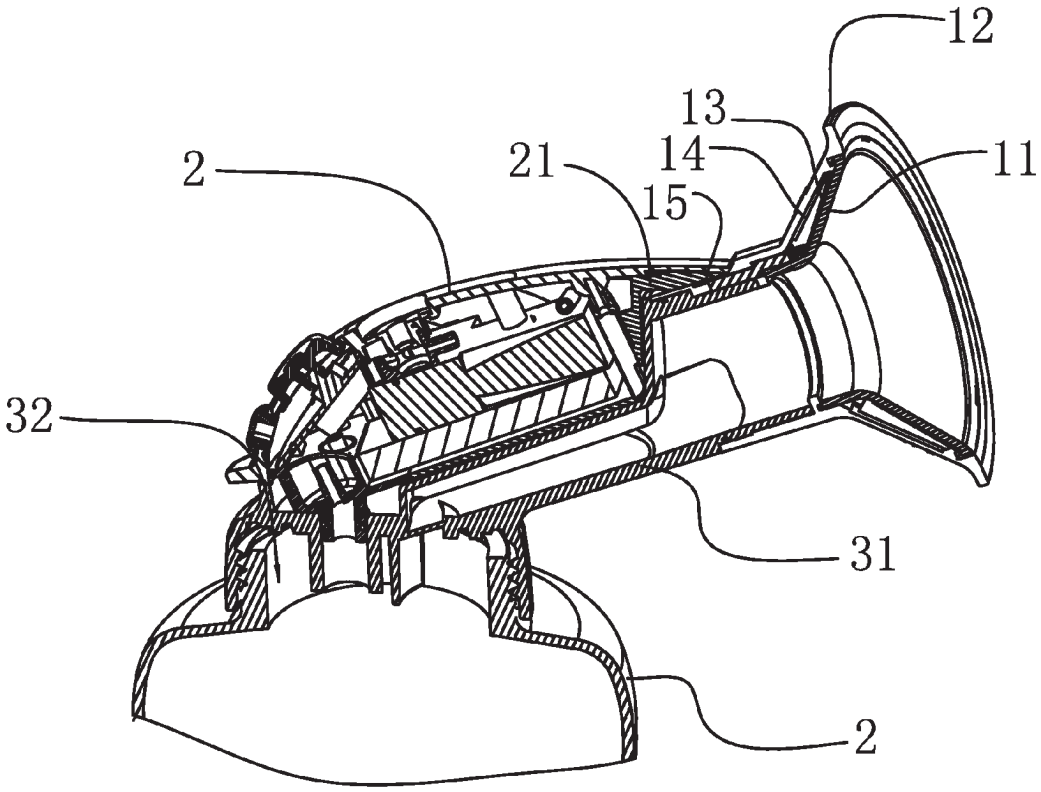

FIG. 2

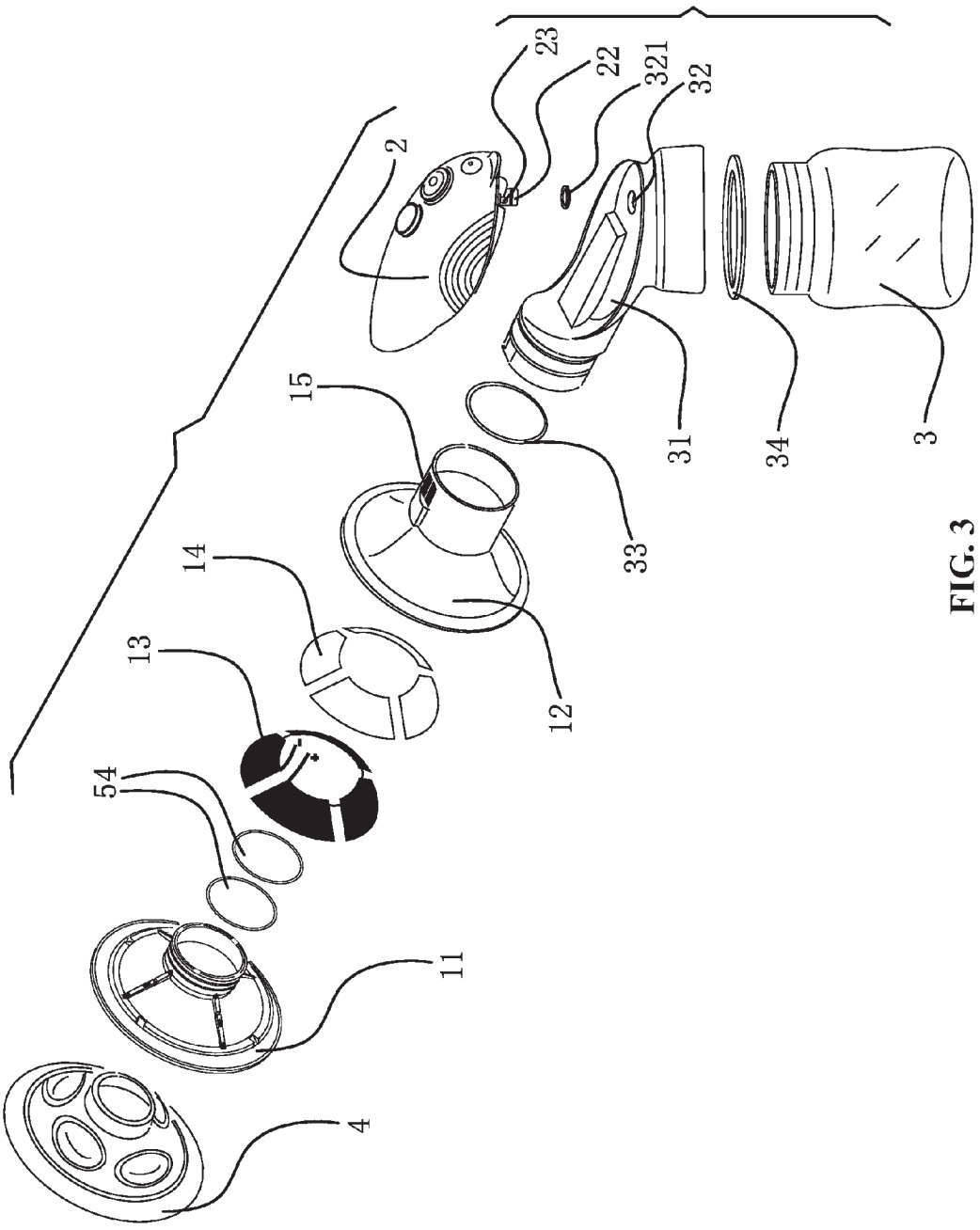

FIG. 3

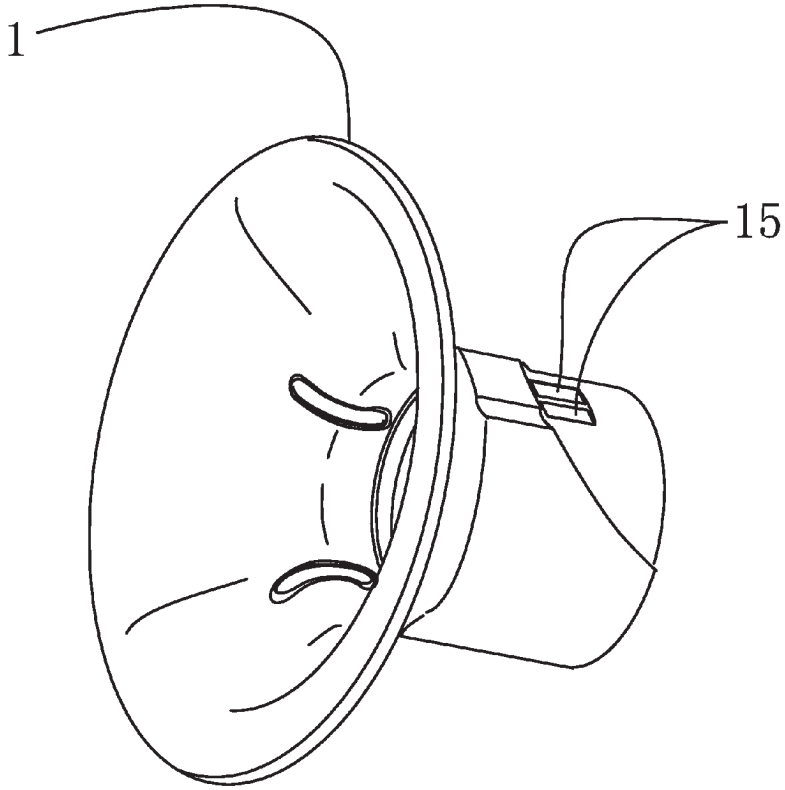

FIG. 4

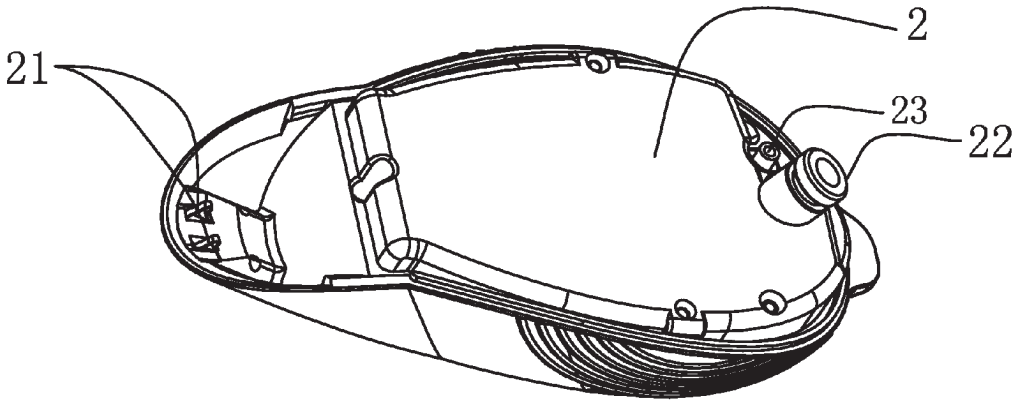

FIG. 5

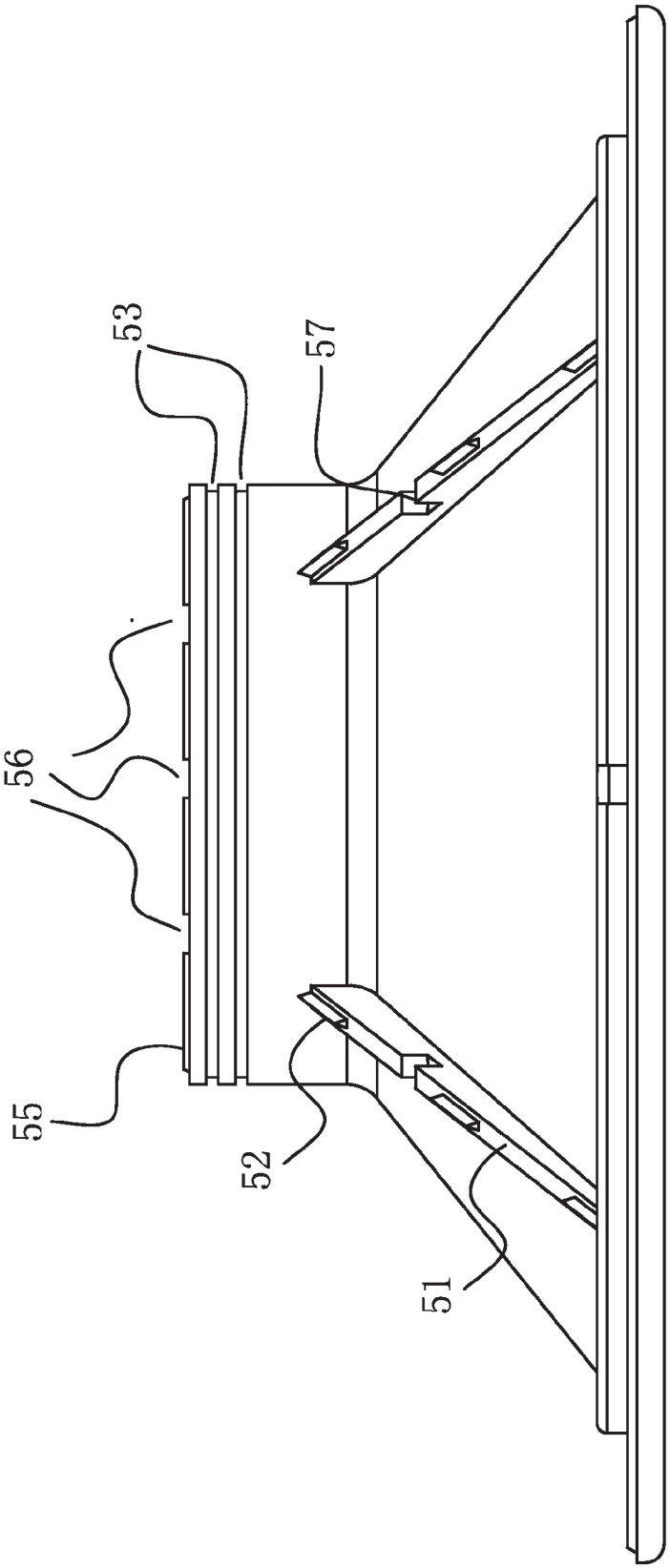

FIG. 6

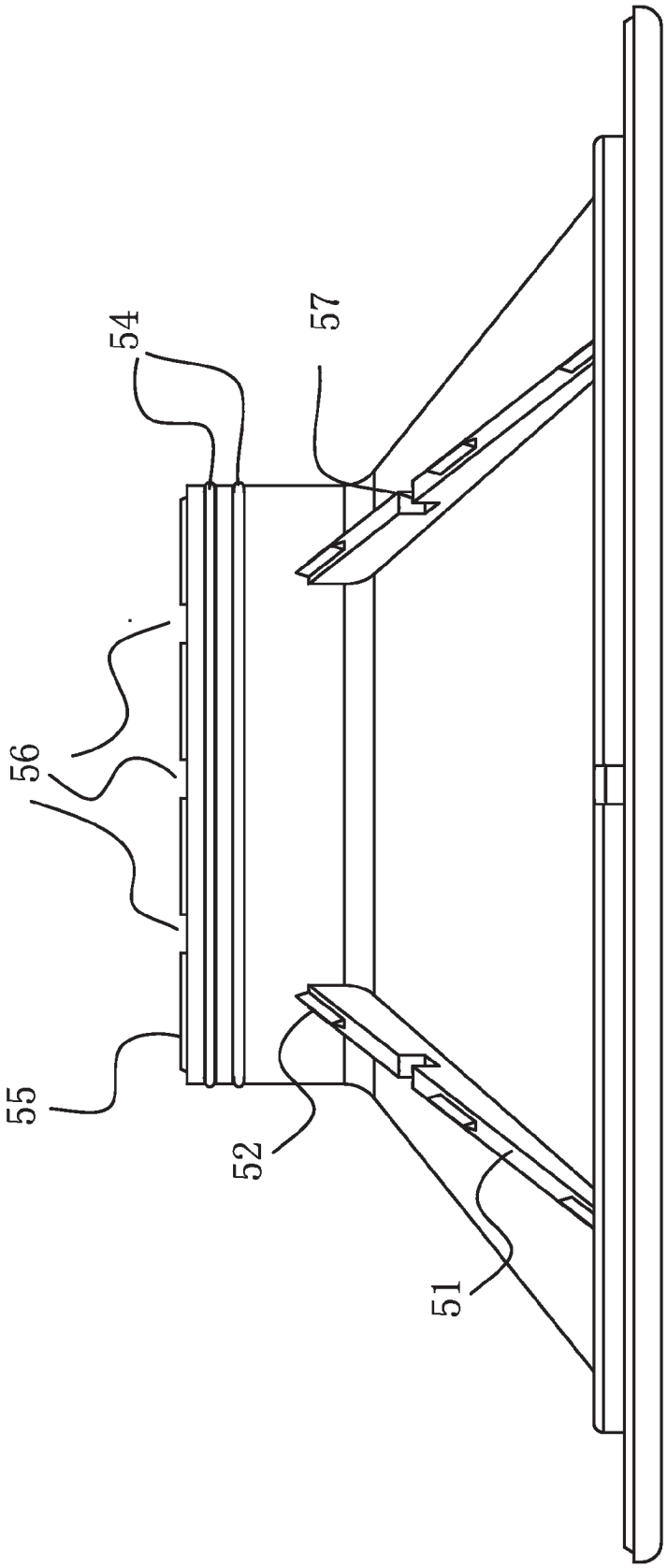

FIG. 7

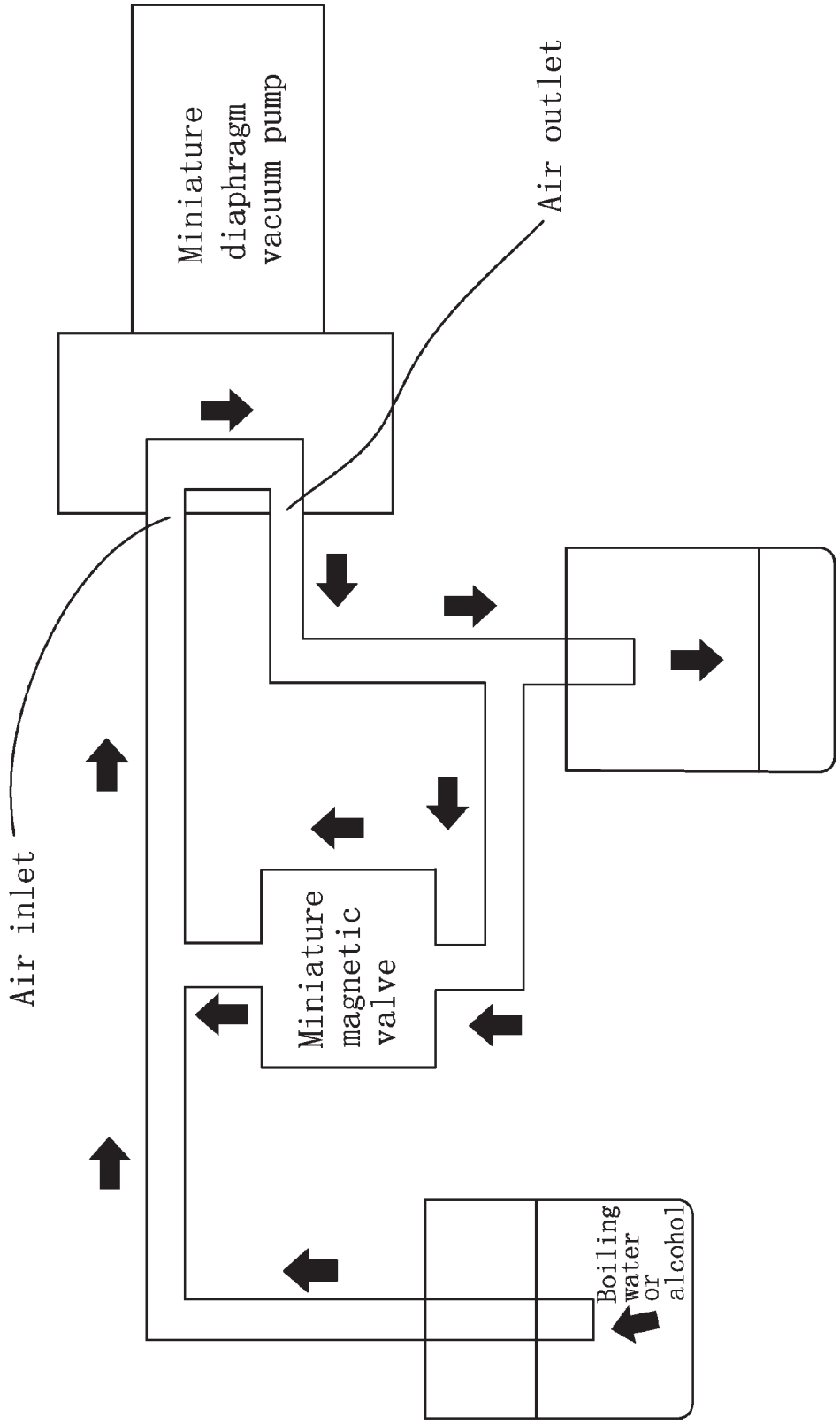
Miniature diaphragm vacuum pump
Air outlet
Air inlet
Miniature magnetic valve
Boiling water or alcohol

FIG. 8

BREAST PUMP COMPRISING HEATING CUP

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of International Patent Application No. PCT/CN2013/000947 with an international filing date of Aug. 12, 2013, designating the United States, now pending, and further claims priority benefits to Chinese Patent Application No. 201210290386.5 filed Aug. 15, 2012. The contents of all of the aforementioned applications, including any intervening amendments thereto, are incorporated herein by reference. Inquiries from the public to applicants or assignees concerning this document or the related applications should be directed to: Matthias Scholl P.C., Attn.: Dr. Matthias Scholl Esq., 245 First Street, 18th Floor, Cambridge, Mass. 02142.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to a breast pump comprising an electric heating cup.

[0004] 2. Description of the Related Art

[0005] A typical breast pump employs carbon fiber, which is disposed outside the bell mouth thereof, as a heating element. The temperature of the heating element is controlled by an external temperature sensor. Thus, the breast pump has a complex structure and manufacturing process. In addition, the heating element is subject to the natural properties of the carbon fiber, which often has disadvantages such as nonuniform hot spots, irregular resistance variation, and the occurrence of focal temperature. Furthermore, conventional breast pumps are difficult to clean and sterilize thoroughly, as the abundant particles of fat and protein of the aerosolized milk tends to precipitate and accumulate in the inner walls of air path including pipes and diaphragms and gas drums of the pumps, which go bad in hours and bacteria thrives to be a source of pollution to the fresh milk in the container and a health risk to the mother's breasts.

SUMMARY OF THE INVENTION

[0006] In view of the above-described problems, it is one objective of the invention to provide a breast pump that has a stable and compact structure, features a constant and safe heat supply, and is convenient to clean and sterilize.

[0007] To achieve the above objective, in accordance with one embodiment of the invention, there is provided a breast pump comprising a container, a host unit disposed above and communicating with the container, an electric heating cup disposed at a front end of the host unit and communicating with the container, an electric heating element, and heat insulation. The electric heating cup comprises an inner cover and an outer cover which are integrated; the electric heating element and the heat insulation are disposed between the inner cover and the outer cover; the heat insulation is disposed between the electric heating element and the outer cover; positive and negative electrodes of the electric heating element are connected to conducting plates disposed in an inner side of the outer cover via connection wires, respectively; the conducting plates extend to an outer side of the outer cover and are in electric connection to contact chips disposed at a lower front end of the host unit.

[0008] In a class of this embodiment, the breast pump further comprises a connecting piece. The connecting piece is disposed above the container and a lower end thereof is in seal connection to the container; a conduit protrudes from a front end of the connecting piece and is in fixed seal connection to the electric heating cup; the connecting piece comprises a through hole; the host unit is fixed on the connecting piece and comprises a suction pipe; the suction pipe is inserted into the through hole and the connecting piece is in seal connection to the container.

[0009] In a class of this embodiment, the host unit comprises a miniature diaphragm vacuum pump, a miniature magnetic valve, and an air loop comprising an air inlet and an air outlet; an air inlet of the miniature diaphragm vacuum pump and an air outlet of the miniature magnetic valve communicate with each other and both are connected to the air inlet of the air loop; an air inlet of the magnetic valve and an air outlet of the miniature diaphragm vacuum pump are both connected to the air outlet of the air loop.

[0010] In a class of this embodiment, the air inlet of the air loop is a suction pipe.

[0011] In a class of this embodiment, the electric heating element is an electric heating film, which is fixed on one side of the inner cover facing the outer cover; the heat insulation is fixedly attached to one side of the electric heating film facing the outer cover; one end of the conducting plates is disposed between the inner cover and the outer cover, and is connected to the electric heating film via connection wires; and the other end of the conducting plates is exposed out of the outer cover.

[0012] In a class of this embodiment, the electric heating film comprises a plurality of sheets affixed at intervals on the side of the inner cover facing the outer cover, and the sheets are connected in parallel with one another and connected to the conducting plates.

[0013] In a class of this embodiment, the inner cover and the outer cover are both made of food-grade hard plastic material free of bisphenol amine.

[0014] In a class of this embodiment, the electric heating film is made of polytetrafluoroethylene-based temperature-constant far infrared electric heating material.

[0015] In a class of this embodiment, the conducting plates and the contact chips are gold-plated copper sheets.

[0016] In a class of this embodiment, two face-to-face walls of the inner cover and the outer cover comprise a plurality of reinforcing ribs matching with one another; the reinforcing ribs of the inner cover comprises a plurality of ultrasonic welding protrusions; the reinforcing ribs of the outer cover comprises a groove, which corresponds to the ultrasonic welding protrusions of the inner cover; the inner cover comprises a cylindrical protrusion at a center thereof, and the cylindrical protrusion comprises at least one groove for mounting an O-shaped silicone seal ring and an ultrasonic welding collar comprising a plurality of gaps.

[0017] Advantages of the invention are summarized as follows.

[0018] The breast pump comprises the electric heating cup comprising the inner cover and the outer cover, and the electric heating element clamped between the inner cover and the outer cover, all of which are fabricated into an integrated structure by secondary injection molding, ultrasonic welding technology, and lathe grinding and polishing processing. The electric heating element is fixed between the inner cover and the outer cover, so it is not easy to detach, convenient for cleaning, and has impact and beautiful appearance. The conducting plates of the electric heating cup are fixed on the outer cover through secondary injection molding and are in electric

connection to the contact chips at the lower front end of the host unit. Thus, the structure is simple, compact, stable and convenient for use and mass production. The resulting electric heating cup is made of opaque material, so the users cannot see the electric heating element and connection wires, providing the users with the sense of safety. Lathe grinding and polishing processing make the edge of the cup, where the inner cover and outer cover ultrasonic welded together, looks like one integrated and seamless part without any joint line visible, providing the users with the sense of hygiene.

[0019] In addition, the reinforcing ribs disposed on the inner walls of both inner cover and outer cover of the electric heating cup, ultrasonic welding protrusions, grooves, O-shaped silicone seal ring, and gaps on the cylindrical protrusion of the inner cover, on one hand, cooperate with each other to enable the inner cover and the outer cover to be connected firmly whereby forming an integrated structure, on the other hand, the resulting structure is sealed and waterproof in boiling water. In the process of boiling the electric heating cup for sterilization, air between the inner cover and the outer cover tends to inflate, thereby deforming the O-shaped silicone ring, so that the heated air breaks through the sealing of the O-shaped silicone ring and is released through the gaps. Thus, the space between the inner cover and the outer cover is approximately in the vacuum state under high temperatures, thereby preventing the electric heating cup from deforming or broken. When the heated air with high pressure releases through the gaps, air bubbles emerging in the boiling water, water is prevented to get inside of the electric heating cup. Thus, high-grade waterproof achieves, so long as the cup is taken out of the water when it is still boiling, for cooling water may be siphoned inside to the cup.

[0020] The host unit comprises a miniature diaphragm vacuum pump, a miniature magnetic valve, and an air loop comprising an air inlet and an air outlet. The suction pipe of the host unit mentioned above also acts as the air inlet of the air loop. An air inlet of the miniature diaphragm vacuum pump and an air outlet of the miniature magnetic valve communicate with each other and both are connected to the air inlet of the air loop; an air inlet of the magnetic valve and an air outlet of the miniature diaphragm vacuum pump are both connected to the air outlet of the air loop. To clean the breast pump, the air inlet of the air loop and the air outlet of the air loop each are connected to straws. The straw of the air inlet is inserted into a container containing medical alcohol, and the straw of the air outlet is inserted into a hollow container. Start the breast pump in the cleaning mode, the medical alcohol fluid is siphoned to every space of the air loop under the drive of the vacuum pump, whereby completely disinfecting the breast pump, each cleaning lasts for only about 10 seconds, and finally the effluent is collected by the hollow container. On this occasion, the vacuum pump acts as a water pump temporarily. After that, move the air inlet away from the medical alcohol and remain the breast pump working for a while, the alcohol residue evaporates quickly and the air loop and the diaphragm vacuum pump remain dry to protect the mechanical properties of the diaphragm vacuum pump and insure the service life of the breast pump.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] FIG. **1** is a stereogram of a breast pump in accordance with one embodiment of the invention;

[0022] FIG. **2** is a local sectional view of a breast pump in accordance with one embodiment of the invention;

[0023] FIG. **3** is a local exploded view of a breast pump in accordance with one embodiment of the invention;

[0024] FIG. **4** is a stereogram of an electric heating cup of a breast pump in accordance with one embodiment of the invention;

[0025] FIG. **5** is a stereogram of a host unit of a breast pump in accordance with one embodiment of the invention;

[0026] FIG. **6** is a schematic diagram of an inner cover of a breast pump in accordance with one embodiment of the invention;

[0027] FIG. **7** is a schematic diagram of an inner cover of a breast pump equipped with at least one O-shaped silicone seal ring in accordance with one embodiment of the invention; and

[0028] FIG. **8** is a work flow chart for cleaning an air loop of a breast pump in accordance with one embodiment of the invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0029] For further illustrating the invention, experiments detailing of a breast pump are described below. It should be noted that the following examples are intended to describe and not to limit the invention.

[0030] As shown in FIGS. **1-6**, a breast pump of the invention comprises a container **3**, a host unit **2** disposed above and communicating with the container, an electric heating cup **1** disposed at the front end of the host unit **2** and communicating with the container **3**. The host unit **2** comprises a miniature diaphragm vacuum pump, a miniature magnetic valve configured to generate vacuum negative pressure, an air loop comprising an air inlet and an air outlet, an integrated circuit board, and a rechargeable lithium polymer battery for supply power for the breast pump. The front end of the electric heating cup **1** is in the shape of a horn, and its diameter is slightly larger than that of a mother's areola, so that the electric heating cup **1** better contacts the areola. The rear end of the electric heating cup **1** has an inner diameter larger than that of a mother's nipple, which, preferably, is twice the outer diameter of the nipple, forming a "nipple tunnel". The rear end of the electric heating cup **1** is a straight pipe with a round cross section and has certain length thereby ensuring enough space for nipple and protecting the nipple from squeezing.

[0031] Preferably, the breast pump comprises a connecting piece **3** at the top thereof. The connecting piece **31** is disposed above the container **3** and the lower end thereof is in seal connection to the container **3** by thread screw. A silicone flat washer **34** is disposed between the connecting piece and the container **3**. A conduit protrudes from a front end of the connecting piece **31** and is in fixed seal connection to the rear end of the electric heating cup **1**. The opening of the conduit is a straight pipe with a round cross section, on which at least one O-shaped silicone seal ring **33** is disposed. The connecting piece **31** comprises a through hole **32**. The host unit **2** is fixed on the connecting piece **31** and comprises a suction pipe **22**. The suction pipe **22** is also disposed with an O-shaped silicone seal ring. The suction pipe **22** is inserted into the through hole **32** and is in seal connection to the connecting piece **31**, while the connecting piece **31** is in seal connection to the container **3**. The front end of the connecting piece **31** is connected to the rear end of the electric heating cup **1** via plugging, screw thread, or bayonet screwing.

[0032] The electric heating cup **1** comprises an inner cover **11** and an outer cover **12**, as shown in FIG. **3**. The electric heating element and the heat insulation **14** are disposed

between the inner cover **11** and the outer cover **12**. The electric heating element is an electric heating film, electric heating wire, or other electric heating materials. Preferably, the electric heating element is an electric heating film **13**, which is fixed on one side of the inner cover **11** facing the outer cover **12**; the heat insulation **14** is fixedly attached to one side of the electric heating film **13** facing the outer cover **12**. The heat insulation **14** is disposed between the electric heating element and the outer cover **12**; positive and negative electrodes of the electric heating element are connected to conducting plates **15** disposed in an inner side of the outer cover **12** via connection wires, respectively; the conducting plates **15** extend to an outer side of the outer cover **12** and are in electric connection to contact chips **21** disposed at a lower front end of the host unit **2**. Preferably, one end of the conducting plates **15** is disposed between the inner cover **11** and the outer cover **12**, and is connected to the electric heating film **13** via connection wires; and the other end of the conducting plates **15** is exposed out of the outer cover **12**.

[0033] When the electric heating cup **1** is connected to the front end of the connecting piece **31**, the host unit **2** is clasped on the connecting piece **31**, so that the contact chips **21** disposed at the lower front end of the host unit **2** well contact the conducting plates **15**. Thus, the power source of the host unit supplies power for the electric heating cup **1** via the contact chips **21** and the conducting plates **15**.

[0034] The inner cover **11** and the outer cover **12** and the connecting piece are all made of food grade hard plastic material free of bisphenol amine, for example, polypropylene (PP), preferably, TRITAN copolymer from Eastman Chemical Company of U.S.A. Optionally, thermoplastic engineering plastic with high temperature resistance of exceeding 207° C., such as polyphenylene sulfone resin (PPSU), is also practicable.

[0035] The host unit comprises a miniature diaphragm vacuum pump, a miniature magnetic valve, and an air loop comprising an air inlet and an air outlet **23**. The suction pipe **22** of the host unit mentioned above also acts as the air inlet of the air loop. An air inlet of the miniature diaphragm vacuum pump and an air outlet **23** of the miniature magnetic valve communicate with each other and both are connected to the air inlet of the air loop; an air inlet of the magnetic valve and an air outlet of the miniature diaphragm vacuum pump are both connected to the air outlet **23** of the air loop. To clean the breast pump, the air inlet of the air loop and the air outlet of the air loop each are connected to straws. The straw of the air inlet is inserted into a container containing medical alcohol, and the straw of the air outlet is inserted into a hollow container. The breast pump is disposed with an integrated circuit board with a controller IC. A control program is made to provide several different modes of sucking by regulating the scale of working time of the miniature magnetic valve while the miniature diaphragm vacuum pump works all the time. The cleaning mode is set to open the miniature magnetic valve when the vacuum pump keeps working. Start the breast pump in the cleaning mode, the medical alcohol fluid is siphoned to every space of the air loop under the drive of the vacuum pump, whereby completely disinfecting the breast pump, each cleaning lasts for about 10 seconds, and finally the effluent is collected by the hollow container. On this occasion, the vacuum pump acts as a water pump temporarily. After that, move the air inlet away from the medical alcohol and remain the breast pump working for a while, the alcohol residue evaporates quickly and the air loop and the diaphragm vacuum pump remain dry to protect the mechanical properties of the diaphragm vacuum pump and insure the service life of the breast pump.

[0036] Upon manufacturing the electric heating cup **1**, the outer cover **12** is prepared using the secondary injection molding technology. First, two conducting plates **15** are molded by injection together to form an insert, which is further molded by injection with the outer cover **12**, so that the conducting plates **15** and the outer cover **12** are integrated. Specifically, one end of the conducting plates **15** is disposed at the inner side of the outer cover **12**, and the other end of the conducting plates **15** is exposed out of the outer cover **12**. The exposed part of the conducting plates **15** is in seamless connection to the outer side of the outer cover **12**, and both are in the same plane without height difference. Thereafter, the electric heating film **13** and the heat insulation **14** are fixed on one side of the inner cover **11** facing the outer cover **12**, and the positive and negative electrodes of the electric heating film **13** are connected to the conducting plates with connecting wires, respectively. In the presence of ultrasonic wave, the inner cover **11** and the outer cover **12** of the electric heating cup **1** are welded and sealed to form an integrated structure. Look from the outside cover, no connection wires and socket connectors can be observed. Only two conducting plates **15** disposed in parallel on the outer side of the outer cover **12** can be observed. That the contact chips **21** disposed at the lower front end of the host unit **2** are connected to the conducting plates **15** on the outer cover **12** by contact makes the breast bump have a simple structure, convenient power supply and beautiful appearance.

[0037] Preferably, the electric heating film **13** is made of polytetrafluoroethylene-based temperature-constant far infrared electric heating material, has a working voltage of 7.4 V DC and a thickness of 0.2-0.5 mm. The electric heating film **13** comprises a plurality of sheets affixed at intervals, between the reinforcing ribs, on the side of the inner cover **11** facing the outer cover **12**. Preferably, the electric heating film **13** employs 4 sheets having a size of 15 mm×30 mm. The sheets are connected in parallel with one another via conductive copper foils and wires. The conductive copper foils are fixed on each sheet through conductive adhesives, preferably. The sheets can be fixed on the inner wall of the inner cover **13** through conventional thin double-sided adhesive tape and are connected in parallel with one another with wires by soldering and connected to the conducting plates **15** by connecting wires by soldering as well. The heat insulation **14** is, preferably, flexible foam sheet with back adhesive and having a thickness of 2 or 3 mm, which can be firmly attached to the electric heating film **13**, thereby preventing the detaching of the electric heating film from the inner cover, protecting the far infrared energy from emitting outside to the outer cover **12**, so that the far infrared energy is concentrated to irradiate to the mother's areola, thereby ensuring good thermal therapy effect and saving electric energy.

[0038] The working voltage of the electric heating film **13** is 7.4 VDC, the resistance thereof is about 30 ohm, and the power thereof is about 1.8 W. Such low power enables the host unit to employ a miniature rechargeable lithium polymer battery, so that the breast pump is small and convenient for carrying and using. In addition, the working temperature of the electric heating cup is constantly at 38-42° C., which is the optimal temperature for the thermal therapy for a mother's areola, So, no matter in winter or summer, the use of the breast pump makes users feel warm and comfortable as if baby

suckling. Mothers have used "wet heat" to the breasts to expand the tissue and ducts and start the flow of milk before pumping with conventional breast pumps, in the situation of breast engorgement. The far infrared energy from the electric heating cup thereof makes things much easier and better and perhaps acts as a signal to trigger milk production and release as well.

[0039] Optionally, a detachable silicone protection pad **4** is disposed at the inner side of the electric heating cup **1**. The silicone protection pad **4** has adapted curve surface with the electric heating cup and comprises convex points for massage, thereby improving the usage comfort.

[0040] The breast pump comprises the electric heating cup comprising the inner cover and the outer cover, and the electric heating element clamped between the inner cover and the outer cover, all of which are fabricated into an integrated structure by secondary injection molding and ultrasonic welding technology. The electric heating element is fixed between the inner cover and the outer cover, so it is not easy to detach, convenient for cleaning and sterilizing, and has impact and beautiful appearance.

[0041] The conducting plates are fixed on the outer cover **12** through secondary injection molding and are in electric connection to the contact chips at the lower front end of the host unit. Thus, the structure is simple, compact, stable and convenient for use and mass production. The resulting electric heating cup is made of opaque material, so the users cannot see the electric heating element and connection wires, providing the users with the sense of safety.

[0042] Preferably, the conducting plates **15** and the contact chips **21** are a gold-plated copper sheet. The gold-plated copper sheet has excellent electrical conductivity, and looks shining, easy to clean and difficult to rust, which ensures the beautiful appearance of the product.

[0043] In addition, two face-to-face walls of the inner cover and the outer cover comprise a plurality of reinforcing ribs **51** matching with one another; the reinforcing ribs of the inner cover comprises a plurality of ultrasonic welding protrusions **52**; the reinforcing ribs of the outer cover comprises grooves, which correspond to the ultrasonic welding protrusions of the inner cover; the inner cover comprises a cylindrical protrusion at a center thereof, and the cylindrical protrusion comprises at least one groove **53** for mounting an O-shaped silicone seal ring **54** and an ultrasonic welding collar **55** comprising a plurality of gaps **56**. The reinforcing ribs **51** of the inner cover also comprise gaps **57** for allowing the conductive wires to pass through.

[0044] While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

The invention claimed is:

1. A breast pump, comprising:

a) a container;

b) a host unit;

c) an electric heating cup;

d) an electric heating element; and

e) heat insulation;

wherein

the host unit is disposed above and communicates with the container;

the electric heating cup is disposed at a front end of the host unit and communicates with the container;

the electric heating cup comprises an inner cover and an outer cover which are integrated;

the electric heating element and the heat insulation are disposed between the inner cover and the outer cover;

the heat insulation is disposed between the electric heating element and the outer cover;

positive and negative electrodes of the electric heating element are connected to conducting plates disposed in an inner side of the outer cover via connection wires, respectively; and

the conducting plates extend to an outer side of the outer cover and are in electric connection to contact chips disposed at a lower front end of the host unit.

2. The breast pump of claim **1**, further comprising a connecting piece, wherein

the connecting piece comprises a through hole and is disposed above the container, and a lower end of the connecting piece is in seal connection to the container;

the connecting piece comprises a conduit at a front end thereof and is in fixed seal connection to the electric heating cup through the conduit;

the host unit comprises a suction pipe and is fixed on and in seal connection with the connecting piece by inserting the suction pipe into the through hole; and

the suction pipe is inserted into the through hole so that the host unit, the connecting piece, and the container are tightly connected.

3. The breast pump of claim **1**, wherein the host unit comprises a miniature diaphragm vacuum pump, a miniature magnetic valve, and an air loop comprising an air inlet and an air outlet; an air inlet of the miniature diaphragm vacuum pump and an air outlet of the miniature magnetic valve communicate with each other and both are connected to the air inlet of the air loop; an air inlet of the magnetic valve and an air outlet of the miniature diaphragm vacuum pump are both connected to the air outlet of the air loop.

4. The breast pump of claim **3**, wherein the air inlet of the air loop is a suction pipe.

5. The breast pump of claim **1**, wherein the electric heating element is an electric heating film, which is fixed on one side of the inner cover facing the outer cover; the heat insulation is fixedly attached to one side of the electric heating film facing the outer cover; one end of the conducting plates is disposed between the inner cover and the outer cover, and is connected to the electric heating film via connection wires; and the other end of the conducting plates is exposed out of the outer cover.

6. The breast pump of claim **5**, wherein the electric heating film comprises a plurality of sheets affixed at intervals between the reinforcing ribs on the side of the inner cover facing the outer cover, the sheets are connected in parallel with one another and all connected to the conducting plates.

7. The breast pump of claim **1**, wherein the inner cover and the outer cover are both made of hard plastic material free of bisphenol amine.

8. The breast pump of claim **6**, wherein the electric heating film is made of polytetrafluoroethylene-based temperature-constant far infrared electric heating material.

9. The breast pump of claim **1**, wherein the conducting plates and the contact chips are gold-plated copper sheets.

10. The breast pump of claim **1**, wherein two face-to-face walls of the inner cover and the outer cover comprise a plurality of reinforcing ribs matching with one another; the rein-

forcing ribs of the inner cover comprises a plurality of ultrasonic welding protrusions; the reinforcing ribs of the outer cover comprises grooves, which corresponds to the ultrasonic welding protrusions of the inner cover; the inner cover comprises a cylindrical protrusion at a center thereof, and the cylindrical protrusion comprises at least one groove for mounting an O-shaped silicone seal ring and an ultrasonic welding collar comprising a plurality of gaps.

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