

WEARABLE BREAST PUMP

FIELD

This invention relates to a wearable breast pump.

5 BACKGROUND

Conventional powered breast pumps require women to be in a private area such as a nursing room to express breast milk. When using a conventional breast pump, a woman will first clean and assemble the parts of the breast pump. She will then align a breast shield of the breast pump with the nipple and start the vacuum pump. During the process of milk expression, the
10 woman will have to hold on to the breast shield to keep it on the breast to maintain the vacuum. On average, milk expression takes at least 15 mins. During this time, the woman is restricted to the private area and without free hands to perform working tasks and other daily activities. This poses a problem for busy women. There is thus a need to provide a device to allow women hands-free milk expression that is user friendly and maximises milk collection.

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SUMMARY

According to a first aspect, there is provided a wearable breast pump for milk expression comprising: a main unit housing therein an electronic suction pump, electronics configured to control the electronic suction pump and a battery; a breast shield configured to form a vacuum
20 seal with a breast around a nipple of a user, the breast shield assembled with the main unit by inserting a neck of the breast shield into a back surface of the main unit; a milk chamber provided below the main unit and magnetically attachable to the main unit; and a milk bag configured to be contained within the milk chamber and magnetically attachable to the main unit, the milk bag in fluid connection with the neck of the breast shield when the milk bag is
25 magnetically attached to the main unit and the neck is inserted into the main unit, wherein when the wearable breast pump is operated with the vacuum seal formed around the nipple, the electronic suction pump draws milk from the breast and the milk is caught in the milk bag.

The milk chamber and the milk bag may be detachable from the main unit while the wearable
30 breast pump is supported by a brassiere worn by the user and the breast shield remains in vacuum seal around the nipple.

The milk chamber may be configured to be in fluid connection with the neck of the breast shield when no milk bag is used and the milk chamber is magnetically attached to the main
35 unit and the neck is inserted into the main unit for direct containment of expressed milk in the milk chamber.

The neck of the breast shield may be in fluid connection with a smaller end of a truncated cone of the breast shield such that a central longitudinal axis of the neck is angled downwardly from a central rotational axis of the truncated cone when the central rotational axis of the truncated cone is horizontal.

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The wearable breast pump may further comprise a connector provided to connect an opening of the milk bag with the main unit, wherein the main unit comprises a front case, a back case and a bottom plate having a through hole therein, wherein magnets provided on a lower surface of the bottom plate are attracted to magnets provided on an upper surface of the milk bag connector.

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The connector may comprise a disc-shaped cap provided with an upstanding spout configured to fit into the through hole provided in the bottom panel.

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The through hole may be provided with upstanding surrounding walls extending into the main unit and a distal end of the neck may engage inner surfaces of the upstanding surrounding walls of the through hole when the neck is inserted into the main unit.

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The wearable breast pump may further comprise a milk container configured to be magnetically attachable to the main unit, the milk container in fluid connection with the neck of the breast shield when the milk container is magnetically attached to the main unit and the neck is inserted into the main unit, the milk container having an opening configured to attach a teat thereto for direct feeding of a baby with milk from the milk container.

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The connector may be further configured to connect the opening of the milk container with the main unit.

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The milk container may be detachable from the main unit while the wearable breast pump is supported by a brassiere worn by the user and the breast shield remains in vacuum seal around the nipple.

BRIEF DESCRIPTION OF FIGURES

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In order that the invention may be fully understood and readily put into practical effect, there shall now be described by way of non-limitative example only embodiments of the present invention, the description being with reference to the accompanying illustrative drawings.

FIG. 1(a) is a front perspective view of an exemplary wearable breast pump.

FIG. 1(b) is a back perspective view of the exemplary wearable breast pump.

FIG. 2 is a front view of the wearable breast pump of FIG. 1.

FIG. 3 is a front perspective view of the wearable breast pump of FIG. 1 with a detached milk chamber and a detached milk bag.

FIG. 4 is a front perspective view of a milk bag of the wearable breast pump of FIG. 1.

5 FIG. 5 is a front perspective exploded assembly view of the wearable breast pump of FIG. 1.

FIG. 6 is a front and back perspective view of a breast shield of the wearable breast pump of FIG. 1.

FIG. 7 is a schematic cross-sectional illustration of the breast shield of FIG. 6 showing a downwardly angled neck.

10 FIG. 8A is a perspective view of a first alternative exemplary embodiment of the milk bag.

FIG. 8B is a perspective view of a second alternative exemplary embodiment of the milk bag.

FIG. 9 is a front perspective exploded assembly view of an alternative exemplary embodiment of the wearable breast pump.

15 **DETAILED DESCRIPTION**

Examples of embodiments of a wearable breast pump 100 will be described below with reference to FIGS. 1 to 9. The same reference numerals are used across the figures to denote the same or similar parts.

20 The presently disclosed wearable breast pump 100 is a discreet and hands-free solution for women to express milk. The pump 100 is supported by a brassiere during use without any tubing or wiring extending from the pump 100 and without requiring the woman to hold on to any part of the pump 100. This makes the wearable breast pump 100 discreet while the support of the brassiere maintains compression between the pump 100 and the breast to
25 ensure airtightness and maintain a necessary vacuum seal between the nipple and the pump 100 during the pumping function. In one exemplary embodiment of use, one wearable breast pump 100 is placed over each breast such that two pumps 100 are simultaneously worn in the brassiere to express milk from both breasts at the same time. In this way, women can be hands-free to pump milk while they continue with their work tasks and other daily activities.

30 As shown in FIG. 1, a front surface 101 of the breast pump 100 is preferably designed with the contours of the human breast and a back surface 102 of the breast pump 100 is provided with an inset breast shield 507 configured to be placed over the breast and to receive the nipple therein. The breast shield 507 is configured to create a vacuum seal with the breast around the nipple of the user. On the front surface 101, user interfacing features 20 may be
35 provided as shown in FIG. 2. The user interfacing features 20 may comprise a power button 204 for turning on and off the pump 100, a function button 203 for choosing a wide variety of functions such as starting milk expression, initiating Bluetooth pairing of the pump 100 with a

smart device (e.g., a smart phone) and so on, and indicator lights 201 and 202. The indicator lights 201, 202 are preferably provided on a right and left side respectively of the pump 100 to indicate which breast the pump 100 is being recorded as expressing milk from by a mobile application installed in the smart device with which the pump 100 is paired.

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In general, as can be seen in FIG. 3, the pump 100 comprises two main parts: a main unit 301 and a lower compartment comprising a milk chamber 512 provided below the main unit 301. A sterile disposable milk bag 40 as shown in FIG. 4 may be removably provided in the milk collection chamber 512 as shown in FIG. 3. When milk is expressed, milk flows into the lower compartment of the wearable breast pump 100 where the disposable milk bag 40 is attached to the main unit 301 and into the milk bag 40.

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The milk chamber 512 is detachably attached to the main unit 301 via permanent magnets. This allows the milk chamber 512 to be easily detached from the main unit 301 while the breast shield 507 remains in compressive contact with the breast (as supported by the brassiere) without breaking the vacuum seal between the breast shield 507 and the breast. Easy detachment of the milk chamber 512 allows a full milk bag 40 to be readily replaced with a new empty milk bag 40 and for milk expression to immediately commence once the milk bag 40 has been replaced without requiring repositioning of the breast shield 507 over the nipple. Eliminating the need for repositioning the breast shield 507 over the nipple is advantageous because positioning the breast shield 507 over the nipple requires some time to adjust the position of the breast shield 507 correctly in order to ensure that a proper vacuum seal is achieved between the breast and the breast shield 507 for milk expression to be able to take place.

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As shown in FIG. 5A, the main unit 301 comprises a main unit front case 502, a main unit back case 505 and a main unit bottom panel 508 that may be securely snap fitted together to define a volume in which an electronic pump 600 and electronics 503 for controlling the electronic pump 600 are housed. The electronics 503 may include a printed circuit board assembly (PCBA) as well as a light pipe 504 that are each attached to the back case 505 by means of screws. A battery (not shown, preferably rechargeable) is also provided to power the electronic pump 600. The front case 502, back case 505, light pipe 504 and bottom panel 508 are preferably injection moulded. The bottom panel 508 may optionally be further screwed to the front case 502 and back case 505 for greater security. The power button 204 and function button 203 may be provided together in an overmould button 501 that is fitted through a plastic overmould process onto the front case 502. The light pipe 504 directs light to the indicator lights 201, 202 as described above, and preferably also directs light to the function button 203

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to indicate start/stop of the pump 100 as well as directing light to the power button 204 to indicate whether the pump 100 is turned on or off.

A connector 401 is provided to fit securely over an opening 402 of the milk bag 40 to connect the milk bag 40 with the main unit 301. The connector 401 may comprise a generally disc-shaped cap provided with an upstanding spout 4011 configured to fit into a through hole provided in the bottom panel 508 of the main unit 301 in order to form a fluid connection between the milk bag 40 and the breast shield 507 when the milk bag 40 and the breast shield 507 have been assembled with the main unit 301. The through hole in the bottom panel 508 is preferably provided with upstanding surrounding walls 5081 that extend into the main unit 301. A valve 509 (e.g., a duck bill valve) may be placed in the spout 4011 to allow a vacuum to be formed between the nipple and a tunnel 5071 of the breast shield 507 when creating the suction force required for milk expression. The connector 401 is further magnetically attached to the main unit 301. In an exemplary embodiment, this may be achieved by providing magnets on an upper surface of the connector 401 and corresponding magnets on a bottom surface of the bottom panel 508. After the milk bag 40 has been locked with the main unit 301, the milk chamber 512 is magnetically attached to the main unit 301 to further secure and protect the milk bag 40 and to complete assembly of the breast pump 100 as shown in FIG. 1. Magnets for attaching the milk chamber 512 to the main unit 301 may be provided on an upper rim 5120 of the milk chamber 512 and a lower peripheral surface of the bottom panel 508.

The milk chamber 512 and milk bag 40 preferably have a shape that is roughly a quarter of a sphere, as can be seen in FIGS. 3-5. This maximises volume to internal surface area ratio given the overall shape of the wearable breast pump 100 that generally conforms with that of the breast, thereby reducing wastage of milk adhering to the inner surfaces of the milk bag 40 or milk chamber 512 and simplifying cleaning of the milk chamber 512.

As shown in FIG. 6, the breast shield 507 generally comprises a truncated cone 5071 in fluid connection with a generally cylindrical neck 5072 at a smaller end of the truncated cone 5071. A flat surrounding flange 5073 may be provided around a larger end of the truncated cone 5071 to prevent the back case 505 (which is not washed after use) from coming into contact with the breast. In this way, any part of the breast pump 100 that comes into contact with the breast can be readily washed after use. The breast shield 507 is preferably injection moulded using an FDA skin compatibility grade material. The breast shield 507 is preferably snap locked with the back case 505 during use, and is configured to be readily removed from the back case 505 for washing and cleaning.

To releasably attach the breast shield 507 with the back case 505 of the main unit 301, the

back case 505 may be provided with a tube 520 extending from the back surface 102 of the pump 100 into the volume of the main unit 301 defined between the front case 507 and the back case 505. The tube 520 is configured to slidably receive the neck 5072 of the breast shield 507 therein, and may be provided with a spring plunger 513 comprising a displaceable ball (not shown) that is biased by the spring plunger 513 radially towards the central longitudinal axis of the tube 520. The ball is configured to engage a depression 5075 provided in a groove 5076 formed on an exterior wall of the neck 5072 of the breast shield 507 to lock the breast shield 507 in position relative to the back case 505 when the neck 5072 has been properly inserted into the tube 520. As the ball is also displaceable away from the central longitudinal axis of the tube 520, the breast shield 507 may be removed from the back case 505 by pulling on the breast shield 507 away from the back case 505 to disengage the ball from the depression 5075. The groove 5076 on the exterior wall of the neck 5072 helps to correctly align the breast shield 507 with the main unit 301 by slidably engaging the ball during assembly of the breast shield 507 with the main unit 301 during insertion of the neck 5072 into the tube 520.

In a preferred embodiment, as shown in FIG. 7, the neck 5072 of the breast shield 507 is in fluid connection with the truncated cone 5071 such that a central longitudinal axis L_n of the neck 5072 is angled downwardly (by an angle α) from a central rotational axis L_c of the truncated cone 5071 when the central rotational axis L_c is horizontal. In this way, expressed milk in the neck 5072 naturally flows downwardly towards the milk chamber away from the truncated cone 5071. Even when the breast pump 100 is removed from the breast, any milk that may be in the neck 5072 is at less risk of flowing out onto the truncated cone 5071 due to the downward angled position of the neck 5072 relative to the truncated cone 5071.

As can be seen in FIG. 6(a), a distal end 527 of the neck 5072 is provided with a through hole and the distal end 527 may be further angled downwards to engage the inner surfaces of the upstanding surrounding walls 5081 of the hole of the bottom panel 508. In this way, the distal end 527 of the neck 502 is surrounded by the upstanding surrounding walls 5071 of the hole so that milk passing from the neck 5072 out of the main unit 301 through the through hole is prevented from coming into contact with any structures housed in the volume defined by the front case 502, the back case 505 and the bottom panel 508.

When the pump 100 is operated with the vacuum seal formed around the nipple, the electronic suction pump 600 draws milk from the breast and the milk is caught in the milk bag 40. The wearable breast pump 100 is a closed system where suction created by the electronic suction pump 600 is transmitted to the breast via an anti-backflow diaphragm 506 that prevents milk

from coming into contact with the interior components housed in the volume defined by the front case 502 and back case 505 when the electric pump 600 is creating the suction. The diaphragm 506 may be of silicone made by injection moulding. The diaphragm 506 is supported on a generally annular diaphragm support 5074 provided on the breast shield 507 such that when the pump 100 is fully assembled for milk expression, a front surface of the diaphragm 506 is in fluid communication with the suction pump 600 while a back surface of the diaphragm 506 is in fluid communication with the neck 5072 of the breast shield 507 via the diaphragm support 5074. Fluid communication between the neck 5072 and the suction pump 500 is completely obstructed by the diaphragm 506. Movement of the diaphragm 506 away from the neck 5072 as a result of suction created by the suction pump 600 on the front surface of the diaphragm results in a suction force arising in the neck 5072 of the breast shield 507 that extracts milk from the breast through the openings of the nipple in the neck 5072.

In use, the wearable breast pump 100 requires only a one-time assembly of the pump 100 and a one-time alignment of the breast shield 507 with the nipple, the breast pump 100 being held in place against the breast by placing the breast pump 100 inside a brassiere. While wearing and using the wearable breast pump 100, the user can turn on the pump 100 and start expressing milk via controls on a mobile application. Each pump 100 both left and right at the same time can be controlled individually. The mobile application allows control of the mode and strength of the pump sequence. At the end of the milk expression, the pump 100 measures the volume of milk collected and records the information in the mobile application. Alternatively, the pump 100 can also be operated without mobile application by pressing the power button 204 to turn on the pump 100 and the Start/Pause button 203 to start or pause the pump sequence. When used without the mobile app, the pump 100 may be configured to run on a default sequence with a fixed pumping strength and cycle pattern. Information about the milked collect will be sent to the mobile application the next time the pump 100 is operated by the mobile application.

In an exemplary embodiment, the expressed milk is collected in the milk bag 40 that is in the milk chamber 512. The milk bag 40 may be used to store the collected milk therein such that it is removed when full and replaced with a new milk bag 40. Alternatively, milk collected in the milk bag 40 may be transferred into a storage container and the milk bag 40 reused for further milk collection. Further alternatively, the expressed milk may be directly collected in the milk chamber 512 without use of any milk bag 40. As mentioned above, by magnetically attaching the milk chamber 512 to the main unit 301, the milk chamber 512 may be readily removed from the main unit 301 for access to the milk bag 40 placed therein or to transfer milk collected in the milk chamber 512 directly without having to remove the breast pump 100 from

the breast. Similarly, by magnetically attaching the milk bag 40 to the bottom panel 508 of the main unit, the milk bag 40 may be readily removed from the breast pump 100 and a new milk bag 40 readily attached to the breast pump 100 for use. In this way, an established working vacuum seal between the breast shield 507 and the breast need not be broken whenever the milk chamber 512 or the milk bag 40 is removed from the main unit 301 so that milk expression can be quickly resumed when the milk bag 40 and the milk chamber 512 have been reattached to the main unit 301 via the provided magnets.

In an exemplary embodiment as shown in FIGS. 3-5, an opening of the milk bag 40 to which the connector 401 is attached may comprise a standard plastic bottle neck 402 where a teat can be attached to the milk bag 40, thus allowing direct feeding from the milk bag 40 without requiring milk to be transferred from the milk bag 40 into a feeding bottle, thereby reducing the risk of spills.

To simplify production of the milk bag 40, in a first alternative embodiment as shown in FIG. 8A, the milk bag 40 may, when full, have a rectangular vertical cross-section while having a horizontal cross-section of a shape corresponding to the bottom panel 508 of the main unit 301. In a second alternative embodiment as shown in FIG. 8B, the milk bag 40 may comprise, when empty, two rectangular flat sheets of food-safe packaging material that are sealed together at their edges with a top opening comprising the standard plastic bottle neck 402.

As depicted in FIG. 9, the pump 100 may be further configured to selectably allow expressed milk to be directly collected in a milk container 516 without use of any milk bag 40 or milk chamber 512. The milk container 516 is configured to replace both the milk bag 40 and the milk chamber 512 and is configured to be magnetically attached to the main unit 301 to complete assembly of the breast pump 100 as shown in FIG. 9. Magnets for attaching the milk container 516 to the main unit 301 are preferably similarly provided on an upper rim 5160 of the milk container 516 as those provided on the upper rim 5120 of the milk chamber 512, for attachment with the magnets already provided on the lower peripheral surface of the bottom panel 508 as described above. In this way, the milk container 516 when full may be readily removed from the main unit 301 for replacing with an empty milk container 516 or with an empty milk bag 40 in the milk chamber 512 without having to remove the breast pump 100 from the breast.

The milk container 516 is preferably provided to serve also as a feeding bottle by configuring an opening 526 of the milk container 516 to comprise a plastic bottle neck 526 where a teat can be attached to the milk container 516. This allows direct feeding from the milk container

516 without requiring milk to be transferred from the milk container 516 into another feeding bottle, thereby reducing the risk of spills. The opening 526 of the milk container 516 is preferably also configured to allow the connector 401 as described above to fit securely over the opening 526 of the milk container 516 to connect the milk container 516 to the main unit 301.

The milk container 516 preferably has a shape that is roughly a quarter of a sphere with a flattened bottom surface, as can be seen in FIG. 9. This maximises volume to internal surface area ratio given the overall shape of the wearable breast pump 100 that generally conforms with that of the breast. The depicted shape thus reduces wastage of milk adhering to the inner surfaces of the milk container 516 and simplifies cleaning of the milk container 516. The flattened bottom surface allows the milk container 516 to stand without falling over on a table top or other surface, thus minimizing spills. Appreciably, the configuration of the milk container 516 is not limited to the embodiment shown in FIG. 9 and the milk container 516 may have any other appropriate shape, size and configuration as may be desired so long as it is magnetically attachable to the main unit 301.

By providing the milk container 516 as an optional alternative to the milk bag 40 and the milk chamber 512, users of the pump 100 have a choice as to whether to express milk into a milk bag 40 or into the milk container 516 or even the milk chamber 512 directly. For example, when expressing milk for longer term storage, a user may prefer to express milk into the milk bag 40 which takes up less refrigerator or freezer storage space; when expressing milk that is soon to be fed to a baby, the user may prefer to express milk into the milk container 516 for ease of directly feeding from the milk container 516. The user may alternatively wish to express milk into the milk chamber 512 for subsequent transfer to another storage container or feeding bottle. The presently disclosed wearable breast pump 100 thus provides flexibility and storage options for the user to select according to her own preference and usage requirements.

Whilst there has been described in the foregoing description examples of embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations and combination in details of design, construction and/or operation may be made without departing from the present invention. For example, while the main unit has been described above as comprising a housing that includes a front case, a back case and a bottom plate that define a volume therein and the milk bag is magnetically attached to the bottom plate, in other embodiments, a housing of the main unit can comprise only two parts. For example, in alternative embodiments, the bottom plate may be integrally formed with one of

the front case or the back case, or, the front case and the back case may be integrally formed. While three different embodiments of the milk bag have been depicted in the figures, the milk bag may comprise other shapes and configurations that also fit within the milk chamber when the pump is assembled for use.

CLAIMS

1. A wearable breast pump for milk expression comprising:
 - a main unit housing therein an electronic suction pump, electronics configured to control
 - 5 the electronic suction pump and a battery;
 - a breast shield configured to form a vacuum seal with a breast around a nipple of a user, the breast shield assembled with the main unit by inserting a neck of the breast shield into a back surface of the main unit;
 - a milk chamber provided below the main unit and magnetically attachable to the main unit;
 - 10 and
 - a milk bag configured to be contained within the milk chamber and magnetically attachable to the main unit, the milk bag in fluid connection with the neck of the breast shield when the milk bag is magnetically attached to the main unit and the neck is inserted into the main unit,
 - 15 wherein when the wearable breast pump is operated with the vacuum seal formed around the nipple, the electronic suction pump draws milk from the breast and the milk is caught in the milk bag.
2. The wearable breast pump of claim 1, wherein the milk chamber and the milk bag are
- 20 detachable from the main unit while the wearable breast pump is supported by a brassiere worn by the user and the breast shield remains in vacuum seal around the nipple.
3. The wearable breast pump of any one of the preceding claims, wherein the milk chamber is configured to be in fluid connection with the neck of the breast shield when no milk bag
- 25 is used and the milk chamber is magnetically attached to the main unit and the neck is inserted into the main unit for direct containment of expressed milk in the milk chamber.
4. The wearable breast pump of any one of the preceding claims, wherein the neck of the breast shield is in fluid connection with a smaller end of a truncated cone of the breast
- 30 shield such that a central longitudinal axis of the neck is angled downwardly from a central rotational axis of the truncated cone when the central rotational axis of the truncated cone is horizontal.
5. The wearable breast pump of any one of the preceding claims, further comprising a
- 35 connector provided to connect an opening of the milk bag with the main unit, wherein the main unit comprises a front case, a back case and a bottom plate having a through hole

therein, wherein magnets provided on a lower surface of the bottom plate are attracted to magnets provided on an upper surface of the milk bag connector.

5 6. The wearable breast pump of claim 5, wherein the connector comprises a disc-shaped cap provided with an upstanding spout configured to fit into the through hole provided in the bottom panel.

10 7. The wearable breast pump of claim 6 or claim 7, wherein the through hole is provided with upstanding surrounding walls extending into the main unit and wherein a distal end of the neck engages inner surfaces of the upstanding surrounding walls of the through hole when the neck is inserted into the main unit.

15 8. The wearable breast pump of any one of the preceding claims, further comprising a milk container configured to be magnetically attachable to the main unit, the milk container in fluid connection with the neck of the breast shield when the milk container is magnetically attached to the main unit and the neck is inserted into the main unit, the milk container having an opening configured to attach a teat thereto for direct feeding of a baby with milk from the milk container.

20 9. The wearable breast pump of claim 8 when dependent on any one of claims 5 to 7, wherein the connector is further configured to connect the opening of the milk container with the main unit.

25 10. The wearable breast pump of any one of claims 8 and 9, wherein the milk container is detachable from the main unit while the wearable breast pump is supported by a brassiere worn by the user and the breast shield remains in vacuum seal around the nipple.

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