

Claims

1. A method for operating a breastpump unit for expression of human breastmilk, the breastpump unit having:
 - 5 a. a pump assembly for generating vacuum pressure,
 - b. a reservoir for receiving breastmilk, and
 - c. a breast shield for sealing application to a breast to be pumped, the breast shield having a flexible inner chamber for receiving a nipple of the breast and a second chamber, in particular an outer chamber
10 extending about the outside of the inner chamber and which at least partially surrounds a nipple that is inserted into the inner chamber,

the method comprising a cycle that is characterized by the steps, in order of:

 - i. evacuating the inner chamber and the reservoir by the pump assembly
15 to a first vacuum pressure,
 - ii. connecting the second chamber to the pump assembly and to the reservoir and evacuating the second chamber to a second vacuum pressure, in which the second vacuum pressure is higher or greater than the first vacuum pressure, and
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 - iii. at least partly releasing the vacuum from the second chamber to a lower vacuum pressure, in particular lower than the first vacuum pressure.
2. A method according to claim 1, the first vacuum pressure being a substantially constant pressure.
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3. A method according to claim 1 or 2, the second chamber being connected to the vacuum pump and to the reservoir once the inner chamber has been evacuated to the first vacuum pressure.
- 30 4. A method according to any one of claims 1 to 3, the second vacuum pressure being at least 25% higher than the first vacuum pressure.

5. A method according to any one of claims 1 to 3, the second vacuum pressure being approximately 75% higher than the first vacuum pressure.
- 5 6. A method according to any one of claims 1 to 3, the second vacuum pressure being approximately -200 to -480mmHg, more preferably -280 to -420mmHg, more preferably -380mmHg, and the first vacuum pressure being approximately -70 to -350mmHg, more preferably -120 to -250mmHg, more preferably 200mmHg.
- 10 7. A method according to any one of claims 1 to 6, the first chamber including an entry portion into which a nipple can be inserted, the entry portion having an at rest or relaxed state in which it applies compressive pressure to the nipple and the entry portion expanding during step ii to reduce or completely release the compressive pressure.
- 15 8. A method according to claim 7, the entry portion returning to the at rest or relaxed state during step iii.
- 20 9. A method according to any one of claims 1 to 8, the lower pressure of step iii being atmospheric pressure.
- 25 10. A method according to any one of claims 1 to 9, the first vacuum pressure and the second vacuum pressure being held constant for a predetermined period in step iii. prior to step iii.
- 30 11. A method according to any one of claims 1 to 10, the duration of step i. being about 540ms, the duration of step ii. being about 440ms and the duration of step iii. being about 540ms.
12. A method according to any one of claims 1 to 11,
 - a. in step i., the inner chamber and the reservoir being connected in series to the inlet of the vacuum pump via a switching valve and the second chamber being connected to atmosphere,

- b. in step ii., switching the valve to switch the second chamber into connection with the inlet of the vacuum pump and to switch the inner chamber and the reservoir into connection with the outlet of the vacuum pump.

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13. A method according to any one of claims 1 to 11,

- a. in step i., the inner chamber and the reservoir being connected in series to the inlet of the vacuum pump via a first valve, and the second chamber being connected to atmosphere via a second valve
- 10 b. in step ii., the first and second valves being closed and inner chamber and the reservoir being connected in series to the outlet of the vacuum pump via a third valve and the second chamber being connected to the inlet of the vacuum pump via a fourth valve.

15 14. A method according to any one of claims 1 to 11, including a switching valve, in particular a solenoid valve, whereby:

- a. in step i., connecting the inner chamber and the reservoir in series to the inlet of the vacuum pump and connecting the second chamber to atmosphere, and
- 20 b. in step ii., switching the valve to switch the second chamber into connection with the inlet of the vacuum pump and to switch the inner chamber and the reservoir into connection with the outlet of the vacuum pump.

25 15. A method according to any one of claims 1 to 11, including a single vacuum pump, whereby:

- a. in step i., the inner chamber and the reservoir being connected in series to the inlet of the vacuum pump via a first valve, and the second chamber being connected to atmosphere via a second valve, and
- 30 b. in step ii., the first and second valves being closed and inner chamber and the reservoir being connected in series to the outlet of the vacuum pump via a third valve and the second chamber being connected to the inlet of the vacuum pump via a fourth valve.

16. A method according to any one of claims 1 to 11, a pair of vacuum pumps arranged so that the inner chamber and the reservoir are connected in series to the inlet of a first of the vacuum pumps and the second chamber is connected to the inlet of a second of the vacuum pumps via a first valve, a pressure line extends between the inlet of the first vacuum pump and the outlet of the second vacuum pump and includes a second valve, the method including
- a. in step i., opening the first valve to atmosphere and closing the second valve to fluid passage, operating the first pump to evacuate the inner chamber and the reservoir to the first vacuum pressure, and
 - b. in step ii., closing the first valve to atmosphere and opening the second valve to fluid passage and operating the second pump to evacuate the second chamber.
17. A breastpump unit for expression of human breastmilk, the breastpump unit having:
- a. a vacuum pump for generating pressure,
 - b. a reservoir for receiving breastmilk, and
 - c. a breast shield for sealing application to a breast to be pumped, the breast shield having a flexible inner chamber for receiving a nipple of the breast and a second chamber, in particular an outer chamber extending about the outside of the inner chamber and which at least partially surrounds a nipple that is inserted into the inner chamber,
- the breastpump unit being operable in a cycle in which :
- i. the vacuum pump evacuates the inner chamber and the reservoir to a first vacuum pressure,
 - ii. the outer chamber connects to the vacuum pump and to the reservoir so that the outer chamber is evacuated to a second vacuum pressure, in which the second vacuum pressure is higher than the first vacuum pressure, and
 - iii. vacuum in the outer chamber is at least partly released to a lower pressure, in particular lower than the first vacuum pressure.

18. A breastpump unit according to claim 17, the inner chamber being defined by a flexible inner liner that includes an entry portion for receipt of a nipple and the second chamber being defined by a a stiff or rigid outer liner, the inner and outer liners defining the second chamber between them.
19. A breastpump unit according to claim 18, the entry portion having an internal diameter that is smaller than the outside diameter of the nipple that the breastpump unit is to be used with and the entry portion being expandable upon the introduction of vacuum in the inner chamber.
20. A breastpump unit according to any one of claims 17 to 19, the vacuum pump having an inlet and an outlet and the breastpump unit including a valve assembly inserted in the pressure lines extending from the inlet and the outlet, the valve assembly being operable to switch the inner chamber and the reservoir from pressure connection to the inlet of the vacuum pump to the outlet of the vacuum pump, and to switch the outer chamber from pressure connection to the outlet of the vacuum pump to the inlet of the vacuum pump.
21. A breastpump unit according to claim 20, the valve assembly being a switching valve, such as a 3/3 solenoid valve, or a 4/3 solenoid valve.
22. A breastpump unit according to claim 20, the valve assembly comprising four valves, each disposed in a separate pressure line.
23. A breastpump unit according to any one of claims 17 to 22, including first and second vacuum pumps in which the inlet of a first of the vacuum pumps connects to the reservoir and to the inner chamber and the outlet connects to atmosphere and the inlet of a second of the vacuum pumps connects to the second chamber and the the outlet connects to atmosphere.