TITLE

SUCTION PUMP UNIT

TECHNICAL AREA

The present invention relates to a suction pump unit according to the preamble of claim 1, as well as to a method for operating a suction pump unit according to the preamble of claim 18. The suction pump serves in particular for use as a breast pump for extracting human breast milk.

PRIOR ART

Suction pump units are sufficiently known in prior art. They are used for extracting breast milk, but also in the medical field for extracting body liquids or fluids. Examples for the latter include extraction processes during and after surgical procedures, wound drainage, thorax drainage, and the suctioning of body fat.

While pumping breast milk, a vacuum pump is used to create a vacuum in a breast shield applied to the mother's breast, which causes the breast milk to be extracted from the breast. In order to enable as painless a suction as possible that corresponds to the sucking rhythm of the infant, a chronologically changing vacuum is applied to the breast shield. Suction curves that comprise a rapid rise in the vacuum to atmospheric pressure or to some other base value have proven especially effective in practice. Figure 12 shows a corresponding pressure progression.

It was shown that a rise in pressure in an excess pressure range can be advantageous, as may be gleaned

US 2010/0121265 describes a breast pump for extracting breast milk with solenoid valves.

The pressure changes achievable by means of known suction pump units with the assistance of an excess pressure source take place relatively slowly. However, rapid changes in pressure are required to enable as natural an extraction as possible. A demand for suction curves with rapidly changing pressure ratios also exists in the other areas of application mentioned above for medical suction pump units.

DESCRIPTION OF THE INVENTION

Therefore, an object of the invention is to provide a suction pump unit and a method for operating such a suction pump unit that enables a rapid and reliable reduction in the applied vacuum, even when using an excess pressure source.

This object is achieved with a suction pump unit having the features of claim 1, and a method for operating a suction pump unit having the features of claim 18.

The suction pump unit according to the invention comprises a vacuum port, an excess pressure port and a switching valve. The switching valve comprises a valve body with two inputs, wherein a first of the inputs is connected with the vacuum port, and a second of the inputs is connected with the excess pressure port. The switching valve further comprises an output with a through hole, wherein the output can be moved relative to the inputs from the first input to the second input and back. Therefore, it can be switched back and forth between these two inputs. As a result, the through hole alternately establishes a fluid-communicating connection with one of the inputs. According to the

CLAIMS

1. A suction pump unit with a vacuum port, an excess pressure port and a switching valve (2, 9), wherein the switching valve (2, 9) comprises a valve body (20, 21, 95) with two inputs (22, 23; 950, 951), wherein a first of the inputs (22, 950) is connected with the vacuum port, and a second of the inputs (23, 951) is connected with the excess pressure port, and wherein the switching valve (2, 9) comprises an output (26, 96) with a through hole, wherein the output (26, 96) can be moved relative to the inputs (22, 23; 950, 951) from the first input (22, 950) to the second input (23, 951) and back, as a result of which the through hole alternately establishes a fluid-communicating connection with one of the inputs (22, 23, 950, 951), characterized in that the through hole of the output (26, 96) is released and ventilated during at least part of the movement between the two inputs (22, 23; 950, 951).

2. The suction pump unit according to claim 1, wherein the output (26, 96) can be lifted relative to the two inputs (22, 23; 950, 951) while moving between the two inputs (22, 23; 950, 951), wherein the through hole of the output (26, 96) is released and ventilated in the lifted state.

3. The suction pump unit according to one of claims 1 or 2, wherein the valve body (20, 21; 95) is fixed in place in the suction pump unit, and the output (26, 96) can move.

4. The suction pump unit according to one of claims 1 to 3, wherein the movement of the output (26, 96) relative to the two inputs (22, 23; 950, 951)

involves a combination of being shifted along a straight line in a first direction and being lifted in a second direction perpendicular to the first direction.

5. The suction pump unit according to one of claims 1 to 4, wherein the output (26, 96) has secured to it an output line (4) of the suction pump unit, which can be moved together with the output (26, 96).

6. The suction pump unit according to one of claims 1 to 5, wherein it comprises a single vacuum pump (1), wherein the vacuum pump (1) comprises the vacuum port, and wherein it further comprises an exhaust which forms the excess pressure port.

7. The suction pump unit according to one of claims 1 to 6, wherein the two inputs (22, 23; 950, 951) are arranged next to each other in a plane.

8. The suction pump unit according to one of claims 1 to 7, wherein the two inputs (22, 23; 950, 951) are arranged in a sliding plate (94) with a planar surface, and the output (26, 96) rests upon this sliding plate (94) once the fluid-communicating connection with the inputs (22, 23; 950, 951) has been established.

9. The suction pump unit according to one of claims 1 to 8, wherein the switching valve (2) comprises two electromagnets with one coil (20, 21) each, wherein each coil (20, 21) is interspersed by a ferromagnetic, hollow core (22, 23), wherein the two cores (22, 23) form the two inputs, and wherein the output comprises a permanent magnet (26).

10. The suction pump unit according to claim 9, wherein the permanent magnet is a ring (26) and forms the through hole.

11. The suction pump unit according to one of claims 9 or 10, wherein the inputs (22, 23) of the valve body are covered by a lid (25), which opens up a hollow space (25) over the inputs (22, 23), wherein the output (26) is movably held in this hollow space (250).

12. The suction pump unit according to claim 11, wherein the hollow space (250) is subjected to ambient air.

13. The suction pump unit according to one of claims 11 or 12, wherein the hollow space (250) comprises a height that exceeds a thickness of the output (26).

14. The suction pump unit according to one of claims 9 to 13, wherein the two coils (20, 21) are held in a shared yoke (27), wherein the yoke (27) is arranged at an end of the valve body lying opposite the output (26).

15. The suction pump unit according to one of claims 1 to 8, wherein the switching valve (2) comprises two plates (94, 95) that are arranged parallel to each other and can be shifted parallel to each other, wherein the output (96) is held in a first of these plates (94), and the two inputs (950, 951) are situated in a second of these plates (95).

16. The suction pump unit according to claim 15, wherein the two plates (94, 95) are connected with

each other to form a parallelogram by means of flexural elements, in particular leaf springs (92, 93) or surface elements (98) with film hinges (980).

17. The suction pump unit according to one of claims 15 or 16, wherein at least one of these two plates (94, 95) can be moved in the direction of its plate plane through the exertion of force, and wherein this motion makes it possible to move the output (96) relative to the two inputs (950, 951), back and forth between the two inputs (950, 951).

18. A method for operating a suction pump unit according to one of claims 1 to 17, wherein the suction pump unit comprises a vacuum port, an excess pressure port and a switching valve (2, 9), wherein the switching valve (2, 9) comprises a valve body (20, 21, 95) with two inputs (22, 23; 950, 951), wherein a first of the inputs (22, 950) is connected with the vacuum port, and a second of the inputs (23, 951) is connected with the excess pressure port, and wherein the switching valve (2, 9) comprises an output (26, 96) with a through hole,
wherein the output (26, 96) is moved relative to the inputs (22, 23; 950, 951), back and forth between two inputs (22, 23; 950, 951),
wherein the through hole alternately establishes a fluid-communicating connection with one of the inputs (22, 23, 950, 951) during the movement of the output (26, 96),
characterized in that the through hole of the output (26, 96) is released and ventilated during the movement between the two inputs (22, 23; 950, 951).

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DESCRIPTION OF THE INVENTION

Therefore, an object of the invention is to provide a suction pump unit and a method for operating such a suction pump unit that enables a rapid and reliable reduction in the applied vacuum, even when using an excess pressure source.

The suction pump unit according to the invention comprises a vacuum port, an excess pressure port and a switching valve. The switching valve comprises a valve body with two inputs, wherein a first of the inputs is connected with the vacuum port, and a second of the inputs is connected with the excess pressure port. The switching valve further comprises an output with a through hole, wherein the output can be moved relative to the inputs from the first input to the second input and back. Therefore, it can be switched back and forth between these two inputs. As a result, the through hole alternately establishes a fluid-communicating connection with one of the inputs. According to the

The claims defining the invention are as follows:

1. A suction pump unit with a vacuum port, an excess pressure port and a switching valve, wherein the switching valve comprises a valve body with a first input and a second input, wherein the first input is connected with the vacuum port, and the second input is connected with the excess pressure port, and wherein the switching valve comprises an output with a through hole, wherein the output can be moved relative to the inputs from the first input to the second input and back, as a result of which the through hole alternately establishes a fluid-communicating connection with one of the first input or the second input, wherein the through hole of the output is released and ventilated during at least part of the movement between the two inputs, and wherein the switching valve comprises a first electromagnet with a first coil and a second electromagnet with a second coil, wherein each coil is interspersed by a ferromagnetic, hollow core, wherein a first core forms the first input and a second core forms the second input, and wherein the output comprises a permanent magnet.

2. The suction pump unit according to claim 1, wherein the output can be lifted relative to the first input and the second input while moving between the two inputs, wherein the through hole of the output is released and ventilated in the lifted state.

3. The suction pump unit according to claim 1 or 2, wherein the valve body is fixed in place in the suction pump unit, and the output can move.

4. The suction pump unit according to any one of claims 1 to 3, wherein the movement of the output relative to the two inputs involves a combination of being shifted along a straight line in a first direction and being lifted in a second direction perpendicular to the first direction.

5. The suction pump unit according to any one of claims 1 to 4, wherein the output has secured to it an output line of the suction pump unit, which can be moved together with the output.

6. The suction pump unit according to any one of claims 1 to 5, wherein it comprises a single vacuum pump, wherein the vacuum pump comprises the vacuum port, and wherein it further comprises an exhaust which forms the excess pressure port.

7. The suction pump unit according to any one of claims 1 to 6, wherein the two inputs are arranged next to each other in a plane.

8. The suction pump unit according to any one of claims 1 to 7, wherein the first input and the second input are arranged in a sliding plate with a planar surface, and the output (rests upon this sliding plate once the fluid-communicating connection is established with one of the first input or the second input.

9. The suction pump unit according to claim 1, wherein the permanent magnet is a ring and forms the through hole.

10. The suction pump unit according to any one of claims 1 to 9, wherein the first input and the second input of the valve body are covered by a lid, which opens up a hollow space over the first

input and the second input, wherein the output is movably held in this hollow space.

11. The suction pump unit according to claim 10, wherein the hollow space is subjected to ambient air.

12. The suction pump unit according to any one of claims 10 to 11, wherein the hollow space comprises a height that exceeds a thickness of the output.

13. The suction pump unit according to any one of claims 1 to 12, wherein the two coils are held in a shared yoke, wherein the yoke is arranged at an end of the valve body lying opposite the output.

14. A method for operating a suction pump unit, wherein the suction pump unit comprises a vacuum port, an excess pressure port and a switching valve, wherein the switching valve comprises a valve body with two inputs, wherein a first of the inputs is connected with the vacuum port, and a second of the inputs is connected with the excess pressure port, and wherein the switching valve comprises an output with a through hole,
wherein the switching valve comprises a first electromagnet with a first coil and a second electromagnet with a second coil, wherein each coil is interspersed by a ferromagnetic, hollow core, wherein a first core forms the first input and a second core forms the second input, and wherein the output comprises a permanent magnet;
moving the output relative to the two inputs such that the output moves back and forth between the two inputs,

the through hole alternately establishing a fluid-communicating connection with one of the two inputs during the movement of the output, and

releasing and ventilating the through hole of the output during the movement between the two inputs.

15. A suction pump unit comprising:

a suction pump comprising a vacuum port and an exhaust;

a switching valve comprising a valve body and a lid, wherein the valve body comprises a sliding plate, a first electromagnet defining a first hollow core, and a second electromagnet defining a second hollow core, wherein the sliding plate defines a first through hole in axial alignment with the first core and a second through hole in axial alignment with the second core, wherein the lid is disposed on the sliding plate, wherein the lid defines a hollow space between the sliding plate and an inwardly directed surface of the lid, wherein the hollow space is sized and shaped to permit a magnetic ring defining a through hole to be moved between the first through hole to the second through hole of the sliding plate, and wherein the magnetic ring is passively ventilated while moving between the first through hole and the second through hole of the sliding plate;

a suction line with a first end and a second end, wherein the first end of the suction line is coupled to the vacuum port and the second end of the suction line is coupled to the switching valve;

a pressure line with a first end and a second end, wherein the first end of the pressure line is coupled to the exhaust and the second end of the pressure line is coupled to the switching valve;

an electronic controller in communication with the suction pump and the switching valve.

16. A suction pump unit comprising:

a suction pump comprising a vacuum port and an exhaust;

a switching valve comprising a first plate and a second plate connected by two flexible parts, wherein an outlet is coupled to and centrally located in the first plate, wherein the second plate defines a first through hole and a second through hole, wherein the switching valve is in the shape of a parallelogram when the outlet forms a fluid communicating connection with one of the first through hole or the second through hole, wherein the two flexible parts shift the first plate under the application of force such that the outlet is capable of moving back and forth between the first through hole and the second through hole, wherein the outlet is lifted above the second plate and passively ventilated while moving between the first through hole and the second through hole;

a suction line with a first end and a second end, wherein the first end of the suction line is coupled to the vacuum port and the second end of the suction line is coupled to the switching valve;

a pressure line with a first end and a second end, wherein the first end of the pressure line is coupled to the exhaust and the second end of the pressure line is coupled to the switching valve; and

a drive coupled to a driving rod, wherein the driving rod is coupled to or abuts the first

plate.

17. A suction pump unit comprising:
a vacuum port;

an excess pressure port; and

a switching valve, wherein the switching valve comprises a valve body with a first input and a second input, wherein the first input is connected with the vacuum port, and the second input is connected with the excess pressure port, and wherein the switching valve comprises an output defining a through hole, wherein the output can be moved relative to the inputs from the first input to the second input and back, such that the through hole alternately establishes a fluid-communicating connection with one of the first input or the second input, wherein the through hole of the output is released and ventilated during at least part of the movement of the output between the first input and the second input, and wherein the output can be lifted relative to the first input and the second input while moving between the two inputs, wherein the through hole of the output is released and ventilated in the lifted state.

18. A suction pump unit comprising:

a vacuum port;

an excess pressure port; and

a switching valve, wherein the switching valve comprises a valve body with a first input and a

second input, wherein the first input is connected with the vacuum port, and the second input is connected with the excess pressure port, and wherein the switching valve comprises an output defining a through hole, wherein the output can be moved relative to the inputs from the first input to the second input and back, such that the through hole alternately establishes a fluid-communicating connection with one of the first input or the second input, wherein the through hole of the output is released and ventilated during at least part of the movement of the output between the first input and the second input, and wherein the valve body is fixed in place in the suction pump unit, and the output is movable.

19. The suction pump unit according to claim 18, wherein the switching valve comprises two plates that are arranged parallel to each other and can be shifted parallel to each other, wherein the output is held in a first of these plates, and the two inputs are situated in a second of these plates.

20. The suction pump unit according to claim 19, wherein the two plates are connected with each other to form a parallelogram by means of flexural elements.

21. The suction pump unit according to claim 20, wherein the flexural elements are leaf springs or surface elements with film hinges.

22. The suction pump unit according to claim 19 or 20, wherein at least one of the two plates can be moved in the direction of its plate plane through the exertion of force, and wherein this motion makes it possible to move the output relative to the two inputs, back and forth between the two inputs.