METHOD AND APPARATUS FOR DEFOAMING AND COLLECTING A LIQUID

A method and a device of sucking and conveying various types of liquids and, without adding any air of any other gas or gas mixture to the liquid, to collect the liquid in a closed container or receiver (32), or to directly transfer the liquid to another liquid system whereby a liquid/air/gas mixture is sucked by means of a suction nozzle (2), and is brought to pass a separation and defoaming filter (3) to a de-air receiver (4) in which the liquid is allowed to slowly flow along the walls of the receiver or along an inclined plane (25) and to be collected at the bottom of the receiver (4), whereas the air which has followed the liquid into the system, and which, in the form of air bubbles may have been included in the liquid, is allowed to leave the liquid at the upper part of the receiver (2), whereafter the liquid, after a predetermined volume of liquid has been collected at the bottom of the receiver (4) is drained through a valve (27, 28) at the bottom of the receiver, preferably by automatic opening and closing of said valve.
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METHOD AND APPARATUS FOR DEFOAMING AND COLLECTING
A LIQUID.

The present invention generally relates to a method and an apparatus to collect
and/or convey various types of liquids, to be stored air or gas free in a closed
package or receiver or to be directly led into another receiver. The invention is
useful, among other things, for handling of blood, whereby the collected blood can
directly be returned to the blood system of living human beings or animals without
any contact with human hands and without any risk of contamination during the
operation and preferably under sterile conditions.

The invention can be used when handling various types of liquids and for many
purposes, particularly when handling liquids, which tend to foam when handled,
liquids which contain not desirable or harmful particles or impurities, or liquids
which become damaged, oxidize or gelify etc. when the liquid comes into contact
with the air or the gas.

The method and the apparatus can be used e.g. when food-stuffs such as milk,
cream, oils, fruit drinks, juices etc. are handled,
when oils and corrosive or environment-hazardous liquids of various types are
handled, when it is important that the liquid will not come into contact human skin
or be discharged into the environment or into drains. when blood is handled in
connection with medical surgical operations, when various types of waste liquors
etc. are sucked.

The invention has been developed particularly in connection with handling of
blood, and it will in the following text mainly be described in connection with such a
handling.

Blood is always a liquid in short supply and large amounts of blood are used
during blood transfusions, e.g. in connection with surgical operations. Blood is
expensive to collect, to test as well as to store. There is also a risk of transmission
of jaundice, HIV- infection and other diseases during blood transfusions.

In connection with certain operations the patient may lose large quantities of
blood, sometimes as much as several liters. This blood normally is wasted and the
patient has to receive the corresponding amount of blood through transfusions.

Attempts have been made in different ways to solve the problem of supplying
blood. There are e.g. methods of purifying and anticoagulation-treating blood,
which has been partially coagulated, but these methods are expensive and time-
consuming, and the transfusion product is inferior. Also, autotransfusions are used
now, whereby a patient is letting his own blood as a blood-donor a few weeks
before a planned operation, and said patient, in case a need arises, having his own
blood restored during or subsequent to the operation. However, this method needs
planning and cannot be applied when emergency operations are needed. Normally,
the patient also must be reasonably healthy, when he is a blood-donor, and
equipment for possible purification, catalogueing and storage of the patient's blood
is required in the actual localities. This method has so far only been rarely used.

The object of the invention therefore is to make it possible to collect the blood of
a patient, and in case of need of blood transfusion, in the first place, to return the
patient's own collected blood to him or the blood which he bleeds from his blood
vessel system after a tissue injury and/or during the surgical operation (autologuous
transfusion).

Three main problems arise when doing this:
- when blood is sucked from a wound surface, large amounts of air or another gas
  or gas mixture inevitably are sucked jointly with the blood, which results in
  an air/gas admixture with a strong frothing, which like the contact of the
  blood with foreign substances and free air or gas contributes to an initiation
  of the coagulation system activation of the blood;
- air/gas and froth (foam) will be dominant for the content of the storage unit, which
  accelerates the coagulation and besides prevents a direct returning of the
  blood to the patient, both due to the air contents itself and also due to the
  fact that the enzyme system and the cells of the blood are activated by the
  interface between blood and air bubbles;
- the collected material may contain not desirable tissue fragments from the
  operation wound (clots, muscle particles, fat, bone etc.), which activate the
  enzyme system of the blood; this activation as well as the admixture of not
desirable and in this connection dangerous tissue fragments prevent a direct
return of the collected blood to the patient.

The above-mentioned problems can be solved according to the present invention by a method and a device, by means of which the patient autologously can be given blood in that
- the blood which disappears or has disappeared is suction collected during or after the surgical operation;
- the blood/air/gas mixture is brought, in a closed system, to pass a defoaming and separation filter, in which the blood froth is disintegrated and not desirable particles are separated, whereas the blood is allowed to pass;
- the blood flows into a receiver, in which the blood is allowed to slowly flow downwards along e.g inclined planes or along the walls of the receiver mounted in the receiver, whereby air bubbles included in the blood are allowed to escape to the upper part of the receiver;
- the blood is collected in the lower part of the receiver, which in its bottom is provided with a manually or automatically operating valve, which is being opened or opens up resp. when a certain amount of blood has been collected at the bottom of the receiver, the blood flowing into a collecting vessel or is directly returned to the blood system of the patient, said valve is being closed or closes resp. again when the blood level in the lower part of the receiver has been lowered to such an extent, that there may be a risk that air and gas will follow the blood into the collecting vessel; and
- the collection of the blood in the vessel is done entirely without any admixture of air or any other gas by means of a certain negative pressure, which acts on a completely air-void flexible container, and the suction of air from the upper part of the receiver is done by means of a suction system with a pressure, which is higher than the pressure on the flexible (or elastic) collecting container;
- the sucked blood/air/gas-mixture may automatically and in proportion to the amount of sucked blood be given an admixture of an anticoagulant agent, e.g., a citrate of a type which is active and known per se, controlled by a differentiated pressure in the system, whereby the pressure in the anticoagulant apparatus is lower than the pressure of the defoaming and separation filter means and of the blood recipient.

Characterizing features and advantages of the present invention will be set forth in the following detailed description of an embodiment of the invention, which is illustrated in the accompanying drawings.
In the drawings Fig. 1 shows diagrammatically and substantially simplified a device designed to carry out the method according to the invention, shown before the device is used to collect a liquid. Figures 2 and 3 show two alternative embodiments of a defoaming and collection apparatus included in the device according to figure 1. Figure 4 shows the device according to Fig. 1 in operation during the liquid collecting. Figure 5 shows a device of the same type as that of figure 1 but formed with means for automatically supplying an additive to the sucked liquid at a stage before the suction operation starts. Figure 6 shows the device of figure 5 during the function of sucking liquid, and figure 7, finally, diagrammatically shows a further alternative apparatus for defoaming/deaerizing the liquid and for dozing of an anticuagulant.

The device shown in Fig. 1 comprises five main parts, which operate with a certain pre-set pressure gradient, namely a main negative pressure P3 (suction), which acts on some of the parts, and a certain higher pressure P2 (relatively lower suction action), which acts on other parts of the device, which will be explained in the following text, as well as a third still higher pressure P1, which can be the atmospheric pressure and at which the liquid or the liquid/air/gas mixture is sucked into the device.

The main parts of the device have in Fig. 1 been indicated as blocks with dashed lines, although the parts can be competely or partially integrated to a continuous disposable device. The parts are as follows: 1) a suction system with a a pilot valve and a manometer or pressure gauge, designed to provide both a negative pressure with a lower pressure level P3 and a higher pressure level P2 and connected to the various parts of the device by means of conduit systems and designed to provide a suction action from an area having a still higher pressure P1; 2) a suction nozzle designed to suck a liquid at an atmospheric or normal pressure P1, preferably atmospheric pressure or normal pressure P1, and which is influenced by said relatively high pressure level P2; 3) a separation and defoaming filter, which is connected to the suction nozzle 1 and which is influenced by the relatively higher pressure level P2; 4) a receiver with inclined planes and with a bottom valve for draining the liquid and operated by a pressure of said higher pressure level P2; 5) a system having one or more collecting vessels and directly connected to the receiver 4 and operated by a pressure of said lower pressure level P3 and having means for emptying the collection vessel or vessels or means for directly transferring liquid from one receiver to any other means, e.g.
returning the liquid to a patient.

The suction system 1 comprises a tube or hose 7 which is connected to a suitable
negative pressure source P3 (not shown), which can be any conventional or
available negative pressure source or which can be an air ejection pump or the like.
Conduit 7 is through a first branch conduit 9 connected to a certain part of
collecting vessel 5 and through a second branch conduit 10 to de-air receiver 4 via a
choke/pilot valve 11, which chokes the gas flow in this branch conduit and
consequently also in receiver 4 to a predetermined extent, i.e. to obtain a higher
pressure P2 (suction action lower) in receiver 4 than in those parts which are
influenced by pressure P3.

In order to be able to preset and read pressure gradient P2-P3 a manometer or
pressure gauge 12 is connected between the conduits 9 and 10 having pressures P3
and P2 respectively. In the illustrated case the manometer is a water seal
manometer, the pressure gradient being measured in mm water column, but it can
just as well be any type of manometer or water gauge as shown in figure 7. Pressure
gradient P2-P3 is controlled by setting the pilot valve and is adjusted in such a way,
read on the water seal or the manometer, that an automatically operating outlet valve
which can be connected in the bottom of the receiver 4 normally is closed and opens
up only when a certain liquid volume is obtained in the lower part of receiver 4 and
closes before the liquid level in the receiver has decreased so much that a risk exists
that air or another gas or gas mixture will pass the valve. The upper and the lower
limits of pressure gradient P2-P3 is a very important factor for the function and the
safety of the device. The water seal or a similar device used instead is a guarantee
for a reliable control of pressure gradient P2-P3.

The artisan knows very well that the two different negative pressures P3 and P2
respectively alternatively can be obtained from two external negative pressure
sources for the different pressure levels, pilot valve 11 being left out and pressure
P2 of the higher pressure level being propagate directly into conduit 10 to venting
receiver 4.

Suction nozzle 2 can be any known nozzle, designed to suck a liquid in the open
air or in any other gas or in a gas mixture. The nozzle in the embodiment shown in
figure 1 is connected to venting receiver 4 via separation and defoaming filter 3 and
acts with pressure P2, possibly reduced to some extent due to the restriction, which
may exist in filter 3.

Figures 2 and 3 show two alternative embodiments in which the defoaming filter
3 is formed integral with de-air recipient 4.
Separation and defoaming filter 3 comprises a closed container 13 with a filter insert 14 mounted therein of a type which is capable of both filtering off particles, tissues etc. from the liquid and also is capable of disintegrating foam by separating air from blood in the foam, whereby the liquid passes through the filter. Filter insert 14 divides up the container into two parts, an upper container part 15, designed to collect foam and particles and a lower part 16, from which the liquid flows to de-air receiver 4. Suction nozzle 2 leads to upper container part 15, and an outlet or connection tube 17 from lower container part 16 leads to receiver 4. Filter 13 suitably is mounted slightly downwardly inclined towards outlet tube 17. Higher pressure P2 acts in filter 13 and is transmitted via connection tube 17 from the upper part of receiver 4.

The de-air recipient 4 comprises a closed container 24, in the upper part of which the connection tube 17 for the liquid opens, and which is formed with any type of a plane along which the liquid can flow, e.g. a system of inclined planes 25 as shown in figure 1 along which the liquid or liquids are allowed to flow slowly downwards whereby the air which is admixed in the liquid is given the possibility of leaving to the upper part 26 of the unit 24. The inclined plane can be a system of inclined plates or a spiral-shaped track or preferably it is a helical tube or a helically arranged flexible hose having such a dimension that the liquid medium fills a portion of the cross-section, the air having a chance to escape upwards.

Also, it is possible to lead the liquid towards the walls of the receiver and thereby let it flow downwards along said walls. It is also possible that the air is allowed to leave the liquified after the liquid has been collected at the lower part of the recipient 24. In the upper part of the container branch conduit 10 also opens, which constitutes an aeration tube for air, which can escape directly outwards through pilot valve 11 and suction hose 7.

In the bottom of receiver 24 there is a valve, which can be a manual valve of an automatically operating valve. In case the liquid will be directly transferred to another liquid system, the valve can be a manual valve and can be connected to a hose or a conduit 31a.

An automatically operating valve can comprises a valve seat 27, in which a valve cone of any type is seated, in the illustrated case a displacement valve ball 28. Valve ball 28 is designed with such a mass and such a lifting force in relation both to the pressure P2 in the evacuation conduit 10 and also the pressure P3 from from the outlet 31 of the receiver 24, that it will open up, when a certain amount of liquid column has been collected on the bottom of the receiver and will close, before the
liquid column has been drained completely. Thereby the risk is eliminated that air
will be sucked through the valve seat and into the hose of the liquid system, e.g. the
patient, or into the collecting container or containers 5.

The valve alternatively can be an electrically, pneumatically or hydraulically
actuatable stop valve, which is operationally connected to an electric, optical or
capacitive level sensor, which is mounted inside or outside the receiver and which
opens up and closes the valve for a certain predetermined high and low respectively
liquid level in the receiver. Such an apparatus is diagrammatically illustrated in
figure 7.

In the illustrated case the device, as an alternative to the hose 31a for directly
transmitting the liquid to another liquid system, is designed with two liquid
containers 29 and 30, connected in parallel, which are identical and connected to
receiver 4 through a drain conduit 31, which starts at valve seat 27. Each liquid
container contains a flexible bag 32, which is enclosed in a shape- permanent casing
33. Bag 32 is with its upper part directly connected to drain conduit 31 via a branch
conduit 34, 35 with stop valve 36, 37. The lower part of bag 32 has a drain conduit
38 with a stop valve 39. The shape-permanent casing 33, which stands under
pressure P3, is connected to branch conduit 9 via a stop valve 40, which when it is
opened up give the space between casing 33 and bag 32 the lower pressure P3 and
thereby causes a suction action on the bag and a suction downwards of liquid from
receiver 5, when its bottom valve 28 is opened up. Shape-permanent casing 33 has a
second tube joint 41 with a stop valve 42 in order to give the space between casing
33 and bag 32 a positive pressure in order to remove all the air from bag 32, which
in Fig. 1 is shown in its flat compressed air-void condition, which is the starting
point for liquid suction.

Figure 2 shows a combined defoaming an de-air apparatus, in which a
defoaming unit 13' with a separation filter 14' is mounted inside the de-air receiver
24'. The filter is formed as a cone which is widened in the direction downwards,
and in which the filter 14' forms the upper part of the apparatus and is sealingly
connected to the walls of the receiver 24', and in which the walls of the chamber
16' formed underneath the filter 14' is shaped like a kind of sub- cone 43 the outer
periphery of which is located on a slight distance from the receiver walls, so that
liquid, which flows down along the sub-cone, is guided along the walls of the
receiver 24'. In this case the liquid is sucked directly into the chamber 44 above the
filter 14' through a conduit 45 from the suction nozzle. The de-air conduit 10' opens
at the top of the sub-cone 32.
Figure 3 shows a still alternative embodiment of a combined defoaming and de-air unit in which the filter is formed as an upright filter cylinder which is mounted concentrically inside the de-air receiver, and in which the liquid, e.g. the blood, enters through a conduit 45 in the inner chamber 44" of the filter cylinder 14". The de-air conduit 10" is, like the drain conduit 31", mounted in the outer chamber 46 outside the filter 14", and the liquid is sucked through the filter 14" and into the outer chamber 46, from which the liquid is drained through the conduit 31". The air is evacuated through the de-air conduit 10".

Fig. 4 shows the device of Fig. 1 in operation when used to suck a liquid, e.g. blood, through suction nozzle 2. The function is as follows:

Suction hose 7 is connected to a source of negative pressure P3, which pressure is propagated through branch conduit 9 to the collecting vessel 6. Via pilot valve 11 a higher pressure P2 (less suction) is propagated to receiver 5 and via the latter also through separation and defoaming filter 3 to suction nozzle 2, in which a pressure is obtained, which is at least approximatively the same as pressure P2.

Valve 36 to the one container bag 32, the left bag in the drawings, is opened up and valve 40 to container casing 33 is opened up, whereby a pressure P3 being obtained between bag 32 and casing 33.

Suction nozzle 2 is lowered towards or into the liquid to be sucked. The liquid must be influenced by a pressure P1, which is higher than pressures P3 and P2, and generally the liquid is influenced by the atmospheric pressure in the open air. Usually a mixture of air and liquid drops or a continuous liquid column is sucked into nozzle 2. In case nozzle 2 contains liquid, the free air stream through the nozzle is stopped and the pressure decreases (the suction action increases) in hose 45 to filter 3, and this means that pressure P2' is so much less than the counter pressure P3 in the flexible receiver bag 20 that the liquid, e.g. blood, flows into the separation and defoaming filter 3, which which tissue particles, e.g. coagulum muscle particles, bone particles and fat etc. is separated on the upper surface of the filter 14, and on which surface also blood foam is desolved, which foam may have been formed during the passage of the air/liquid mixture through the suction nozzle 2, and the conduit as far as to the filter 13 whereas the liquid passes through the filter 14 and is passed into the reciever 4 through conduit 17.

The liquid is then allowed, due to its own gravitation, to slowly flow downwards along the inclined plane(s) 25 or along the walls of the receiver 24, the air which has come along with the liquid into receiver 4 and the air bubbles which are included in the liquid being allowed to be separated. The air escapes from the upper
part 26 of the receiver through de-air conduit 10, which is influenced by the higher pressure P2 and then out through suction hose 7. Liquid is collected successively in the lower part of the receiver 24, and when the liquid has reached a certain predetermined volume valve ball 28 is lifted and liquid is sucked downwards into container bag 32 through the influence of pressure P3 on container bag 32, which pressure is lower than pressure P2 in the receiver.

When the liquid level in receiver 4 has been lowered to a predetermined level, set in order to prevent a stream of air into drain conduit 31 and container bag 32, valve ball 28 closes again, balanced both by the mass of the ball and also by pressure gradient P2-P3, and a new unit volume of liquid is collected in the same way at the bottom of the receiver.

In case bag 32 in one of the liquid containers will be full, valves 36 and 40 are closed and the corresponding valves in the other, the shown right-hand liquid container are opened up, this second container being filled with liquid in the same way. Filled liquid bag 32 can be emptied into a handling bag, and the liquid be directly fed to the patient, possibly via a blood processor, or to a cold storage device, to be used at a later date.

In many cases, for instance when a so called heart-lung-machine is used, the collected blood can with advantage be directly transferred from the receiver 4 to the vein reservoir of the machine and from this reservoir to the patient.

Filled bag 32 in the collecting vessel can be emptied through gravitational flow, but the drainage can also be done by applying a positive pressure in the chamber between casing 33 and bag 32 via connection conduit 41.

The apparatus shown in figures 5 and 6 is also formed with an apparatus 6 for dosing of any type of additives for the suction collected liquid, and said apparatus is fed with pressure of the lower pressure level P3, i.e. the stronger suction, through the branch conduit 8 from the suction hose 7. The dosage material can be in the form of a liquid, a gel, a powder or in the form of granules as long as said material can be sucked into and mixed with the sucked liquid, and it may for instance be an anti-oxidant, an anti-coagulant and/or a disinfectant for blood, an emulsifier for water and oil etc.

The apparatus has two or more dosing units, connected parallely or in series, in case is is desired to mix several different additives into the sucked liquid.

The dosing apparatus is mounted at a position between suction nozzle 2 and filter 13 a dosage device 4, and on a higher level than suction nozzle 2 and filter 3, and it is connected to the conduit 45 between the suction nozzle 2 and the filter
through a connecting tube 18 having a pilot valve 19, by means of which the flow of
dosage medium can be regulated. The dosage device comprises a flexible container
or a bag 20, which is enclosed in a rigid casing 21, which via branch conduit 8 is
influenced by lower pressure P3. Container 20 can be filled through a conduit 22
with a stop valve 23. The pressure between casing 21 and container 20 is lower than
the pressure in suction nozzle 2, and the result thereof is that no dosage medium is
sucked from the bag 20 into the suction nozzle until the pressure of the suction
nozzles is lowered, and said pressure is being lowered when when a liquid in drop
form or in the form of a liquid column enters the nozzle and chokes a free entry of
air into the nozzle. In this situation dosage medium enters the suction nozzle and is
mixed with liquid. The amount of dosage medium sucked into the nozzle is,
surprisingly, close to proportional to the amount of liquid sucked into the nozzle.

It is assumed that pilot valve 19 to dosage device 4 in advance has been set in
such a way, that low pressure P3 in dosage device 4 prevents dosage liquid from
flowing into conduit between suction nozzle 2 and filter 13, in case the suction
nozzle does not contain any liquid. When liquid is sucked into conduit between
suction nozzle 2 and filter 3 pressure activity in this conduit is accordingly increased
and this makes dosage agent in a certain amount in proportion to the amount of
liquid sucked from suction nozzle 2 being sucked through the conduit 18 and further
into filter 13. The device is then ready to be used.

In the embodiment of the invention, in which the device is used to collect blood,
the dosage medium can e.g. be a so called citrate solution, which, as the artisan
knows, is used to bind the ionized calcium in the blood and in this way prevent the
coagulation of the blood. The dosage medium also can be any other liquid agent or a
mixture of agents having an active influence on the sucked liquid or designed to
facilitate the disintegration of the foam or with any other functions. By admixing a
disinfectant combined with a citrate solution also relatively strongly infected blood
can be disinfected and can be reused. As is known, a contact with foreign
substances such as walls in flow conduits and apparatuses may activate the cells of
the blood and it enzyme system, e.g. the coagulation system and the cells of the
blood, which will strongly and harmfully affect the quality of the blood. In order to
eliminate these problems when treating blood by means of the described device it
may be good - if considered necessary of preferable - that the walls in suction nozzle
2, filter 3, connection tube 17, de-air receiver 24 as well as on inclined planes 25 be
provided with a coating of resistant heparin, which is capable of inhibiting the
mechanisms, which activate the coagulation system of the blood as well as changes
of or in the cells of the blood. Several heparinizing methods and similar methods are
known, one of them being protected i.e. by European patent No. 86.186.

In order to achieve a satisfactory result, when a citrate solution is dosed in
blood, the dimensions of connection tube 18 of the citration device, in such a way,
that citrate bag 20 doses an amount of citrate solution, which is equal to 10-20 % of
the amount of blood, which flows into suction nozzle 2.

The apparatus shown in figure 7 basically coincides with the apparatus shown in
figures 5 and 6, and those parts of the apparatus which correspond to said earlier
described apparatus have been given the same reference numerals with a prim-index
('. The latter apparatus structurally differs from the earlier apparatus in that the
separation and defoaming filter 3 and the de-air recipient 4 are built integral to form
a common unit. The anticoagulant from the dosing device is, in this case, collected
in a funnel formed container at the upper side of the filter 14', where the
anticoagulant is mixed with the blood entering the container 13' tangentially like a
cyclone. After having been filtered and defoamed the blood flows down along the
walls of the container 13' and into several successive collection compartments 47
having overflow walls 48 before entering the drainage conduit 31.

Figure 7 also shows that a valve can preferably be arranged close to the end of
the suction nozzle 2 since it may happen that fragments get stuck at the inlet of the
suction nozzle so that said nozzle becomes blocked. In order to prevent dosage
medium from thereby entering the blood mixing portion of the apparatus it is
important that the suction nozzle can easily be evacuated. As known the valve in the
suction nozzle cas e.g. be formed as a finger hole in the nozzle tube as shown in a
detail picture of figure 7.
REFERENCE NUMERALS

1 suction system
2 suction nozzle
3 filter
4 de-air receiver
5 collecting vessel
6 dosage device

Part 1

7 suction hose
8 branch conduit
9 branch conduit
10 branch conduit
11 pilot valve
12 manometer

Part 3

13 container
14 filter plate (insert)
15 upper part
16 lower part
17 tube (3 to 5)

Part 6

18 tube house (6 to 3)
19 pilot valve
20 container
21 casing
22 conduit
23 valve

Part 4

24 container
25 inclined plane, spiral
26 upper part
27 valve seat
28 valve ball

Part 5

29 liquid container
30 liquid Container
31 drain conduit
32 bag
33 casing
34 branch conduit
35 branch conduit
36 stop valve
37 stop valve
38 drain conduit
39 stop valve (in 38)
40 stop valve (in 9)
41 tube connection
42 stop valve (in 41)
43 sub-cone
44 inner chamber
45 suction house
46 outer chamber
47 collection compartment
48 overflow wall
CLAIMS

1. A method of sucking and conveying various types of liquids and, without adding air of any other gas or gas mixture to the liquid, to collect the liquid in a closed container or receiver (32), or to directly transfer the liquid to another liquid system (31a) without any contact with a human hand and without the risk of contaminating the liquid during the handling thereof, preferably also under sterile conditions, characterized in that a liquid or a liquid/air/gas mixture is sucked by means of a suction nozzle (2), and is brought to pass a filter (3) to a de-air receiver (4) in which the liquid is allowed to slowly flow along an inclined plane (25) or along the walls of the receiver (4) and is collected at the bottom of the receiver (4), whereas the air which has followed the liquid into the system, and which, in the form of air bubbles may have been included in the liquid, is allowed to leave the liquid m whereafter the liquid, after a predetermined volume of liquid has been collected at the bottom of the receiver (4) is drained through a valve (27, 28) or a similar means at the bottom of the receiver and into an air-emptied container (32), or is air- or gas-free directly communicated to another liquid system, and the valve (27, 29) or a similar means is closed before all liquid has been drained from the receiver (4), whereby it is prevented that air enters the receiver (4).

2. A method according to claim 1, characterized in that the liquid, prior to or in connection to the introduction in the de-air receiver (5) will flow through a filter, designed as a separation and defoaming filter (3), in which various types of particles are separated and in which foam is disintegrated, whereas the liquid flows through the filter (3) and is collected at the bottom of the de-air receiver (4).

3. A method according to claim 1 or 2, characterized in that the system is operated with air having a negative pressure at two different pressure levels, namely one lower pressure level P3 (suction action) in order to obtain a suction action on a flexible container (32) for a final collection of the liquid and a higher pressure level P2 in order to obtain a corresponding suction action in the de-air receiver (4) and via this receiver also in the separation and defoaming filter (3) as well as in the suction nozzle (2), and whereby the liquid is sucked from a third, still higher pressure level P1, which maybe is the atmospheric pressure.

4. A method according to claim 1, 2 or 3, characterized in that the pressure gradient P2-P3 between the two pressure levels is selected in such a way in relation to the mass of and the lifting force on respectively a displacement valve ball (28) in
a valve seat (27) in the bottom of the de-air receiver (4), that the valve will be
automatically balanced and will open up, only when a certain amount of liquid has
been collected in the lower part of the receiver (4) and will close, before the liquid
in the receiver (4) has been completely drained.

5. Method according to any of the preceding claims, characterized in that an
additive is successively, automatically and in proportion to the amount of sucked
liquid added to the liquid by means of a dosage device (6) and is mixed with said
liquid at a place upstream the separation and defoaming filter (3), said dosage device
(6) preferably being located close to the suction nozzle (2).

6. Method according to claim 5, characterized in that the pressure gradient P2-
P3 between the two negative pressure levels is chosen such, in relation to the flow
capacity in the dosage device (6) that no dosage medium is delivered until there is a
liquid in the suction nozzle (2, 45), and so that the amount of entering dosage
medium is proportional to the amount of liquid sucked by the suction nozzle (2).

7. A device designed to carry out the method according to any of the preceding
patent claims and to suck and to convey various types of liquids and, without an
admixture of air or any other gas or gas mixture, to collect the liquid in an ultimate
package or receiver (32) or to directly transfer the sucked liquid to another liquid
system (31a), characterized in that the device is formed as a closed system
comprising a de-air receiver (4) - which is influenced by a predetermined negative
pressure P2

and which is connected to a suction nozzle for sucking liquid from a higher
pressure level Pa, preferably atmospheric pressure,

- which is formed with walls or with one or more inclined planes (25) along which
the sucked liquid or liquid/air/gas mixture is allowed to flow slowly,
whereas the air/gas included in the liquid
is allowed to escape,

- and which at the bottom thereof is formed with a valve (27, 28), e.g. a balanced
valve or a valve controlled by a level sensor and arranged to open up only
when a certain volume of liquid is present in the lower part of the receiver
(4) and to close before the liquid volume has been drained completely for, at
the opening of the valve (27, 28) - without any admixture of air/gas - supply
the collected liquid to an air emptied, flexible collection bag (32) or to
directly (31a) supply the collected liquid to another liquid system.

8. A device according to claim 7, characterized in that flexible container
bag (32) is enclosed in a solid, sealing casing (33), in that the space between the
container bag (32) and the casing (33), and thereby also the valve (26, 27) of the de-air receiver (4), is under a predetermined pressure P3, in that the inner of the de-air receiver (4) is under a slightly higher pressure P2 than the pressure of the container bag (32), and in that the valve comprises a valve seat (27) having a valve cone (28) which opens and closes respectively depending on the volume of liquid which is present in the bottom of the de-air receiver (4).

9. A device according to claim 8, characterized in that the valve cone is a displacement valve ball (28) which is balanced both by the pressure gradient P2-P3 on the ball and by the mass of the ball (28) and its lifting force in liquid.

10. A device according to claim 8, characterized in that the valve cone is actuated electrically, pneumatically or hydraulically and is controlled to open up and to close respectively by means of an electrical, optical or another sensor of the liquid level in the de-air filter (5).

11. A device according to claim 9, characterized in that the pressure gradient over the valve ball (28) is obtained from a common source (7) of negative pressure, the lower pressure P3 directly influencing the container bag (32) and consequently also the valve (28) at the bottom of the de-air receiver (4) in order to close it, and, indirectly, via a pilot valve (11), influencing the upper container part (26) in the de-air receiver (4) by means of the relatively higher pressure P2.

12. A device according to any of claims 7-11, characterized in that the de-air receiver (4) includes or is directly connected to a separation and defoaming filter (3) provided above the liquid collection part of said receiver (4), which filter (3) comprises a filter insert (14), and in that said filter (3) is directly connected to the suction nozzle (2) and is formed both for separating particles from the sucked liquid or liquid/air/gas mixture and for disintegrating foam which may have been formed during the suction of the liquid/air/gas mixture.

13. A device according to any of claims 7-12, characterized in that the inclined plane (25) in the de-air receiver (4) can be a continuous system of inclined discs, or a spiral-shaped track or a helical tube having sufficient cross-sectional dimensions for air bubbles included in the liquid to be able to escape to and be evacuated from the upper part (26) of the de-air receiver (4).

14. A device according to any of claims 7-13, characterized in that the negative pressure is received from a common pressure place (7) having the lower negative pressure level P3, and in that the higher pressure level P2 is obtained by choking the
pressure by means of a pilot valve (11) in a branch conduit (10), and in that the
device comprises a manometer or a pressure indicator between the conduits (9, 10)
having the two pressure levels, whereby the pressure gradient P2-P3 is controlled to
the desired pressure difference by means of the pilot valve (11).

15. A device according to any of claims 7-14, characterized in that the dosage
device (6) for the additive is mounted above the filter (3), and in that the dosage
device (4), through a tube (18) with a pilot valve (19), is connected to the suction:
conduit (45) from the suction nozzle (2) at a place in the direction of flow upstreams
of the separation and defoaming filter (3), and in that the dosage device comprises a
flexible bag (20) which bag (20) (20) is sealingly enclosed in a rigid casing (21)
which is subjected to the lower pressure P3, and in that the dosage device (4) is
is balanced in such a way by the pressure gradient P2-P3 that no dosage agent will
be introduced in the suction nozzle hose (45) as long as no liquid is present is said
hose (45), whereas dosage agent will be introduced in the suction nozzle hose (45)
as soon as liquid in the form of dropw of a liquid column is present in said hose
(45), whereby the amount of added dosage agent will be proportional to the amount
of sucked liquid.

16. A device according to any of claims 7-15 for handling of blood,
characterized in that, if considered necessary, at least some of the walls of the
suction nozzle (2), the filter (3), the connection conduit (17) from the filter (3), the
de-air receiver (4) and the inclined planes (25) thereof, which come into contact
with the sucked liquid, are surface covered with a medium which does not influence
the sucked liquid, e.g. by a heparinizing method, so that said surfaces are made
blood compatible, and so that said surfaces do not activate the enzyme system of the
blood (the coagulation system) or the cells.
1. A method of sucking and conveying various types of liquids and, without adding air of any other gas or gas mixture to the liquid, to collect the liquid in a container or receiver (32), or to directly transfer the liquid to another liquid system (31a) without any contact with a human hand and without the risk of contaminating the liquid during the handling thereof, preferably also under sterile conditions, characterized in that a liquid or a liquid/air/gas mixture is sucked by means of a suction nozzle (2), and is brought to a de-air receiver (4) in which the liquid is allowed to slowly flow along an inclined plane (25) or along the walls of the receiver (4) whereas the air which may have followed the liquid into the system, and which, in the form of air bubbles may have been trapped in the liquid, is allowed to leave the liquid whereafter the liquid, after a predetermined volume of liquid has been collected in the receiver (4), is drained through a valve (27, 28) or a similar means in the receiver and is passed into an air-emptied container (32), or is air- or gas-freely directly communicated to another liquid system.

2. A method according to claim 1, characterized in that the liquid, prior to or in connection to the introduction in the de-air receiver (5), will flow through a filter, designed as a separation and defoaming filter (3), in which various types of particles are separated and in which foam is disintegrated, whereas the liquid flows through the filter (3) and is collected at the bottom of the de-air receiver (4).

3. A method according to claim 1 or 2, characterized in that the system is operated with air having a negative pressure at two different negative pressure levels, namely one relatively lower pressure level P3 (relatively high suction action) in order to obtain a suction action on a
flexible container (32) for a final collection of the liquid and one relatively higher pressure level P2 (relatively less suction action) in order to obtain a corresponding suction action in the de-air receiver (4) and via this receiver also in the separation and defoaming filter (3) as well as in the suction nozzle (2), and whereby the liquid is sucked from a third, still higher pressure level P1, which may be the atmospheric pressure.

4. A method according to claim 3, characterized in that the pressure gradient P2-P3 between the two pressure levels is selected in such a way in relation to the mass of and the lifting force on respectively a displacement valve ball (28) in a valve seat (27) at the bottom of the de-air receiver (4), that the valve will be automatically balanced and will open up, only when a certain amount of liquid has been collected in the lower part of the receiver (4) and will close, before the liquid in the receiver (4) has been completely drained.

5. Method according to any of the preceding claims, characterized in that a dosage agent (an additive) is successively, automatically and in relation to the amount of sucked liquid added to the liquid by means of a dosage device (6) and is mixed with said liquid at a place upstream the separation and defoaming filter (3), said dosage device (6) preferably being located close to the suction nozzle (2).

6. Method according to claim 5, characterized in that the pressure gradient P2-P3 between the two negative pressure levels is chosen such, in relation to the flow capacity in the dosage device (6), that no dosage agent (additive) is delivered until there is a liquid in the suction nozzle (2, 45), and so that the amount of entering dosage medium is in relation to the amount of liquid sucked by the suction nozzle (2).

7. A device designed to carry out the method according to any of the preceding claims and to suck and to convey various types of liquids and, without any admixture of air or
any other gas or gas mixture, to collect the liquid in an ultimate package or receiver (32) or to directly transfer the sucked liquid to another liquid system (31a), characterized in that the device comprises a de-air receiver (4), which is influenced by a predetermined negative pressure P2, which is connected to a suction nozzle for sucking liquid from a higher pressure level P1, preferably atmospheric pressure, which is formed with walls or with one or more inclined planes (25) along which the sucked liquid or liquid/air/gas mixture is allowed to flow slowly, whereas the air/gas included in the liquid is allowed to escape, and which is formed with a valve (27, 28), e.g. a balanced valve or a valve arranged to open up only when a certain volume of liquid is present in the receiver (4) and to thereafter close for, at the opening of the valve (27, 28) - without any admixture of air/gas - supply the collected liquid to an air emptied collection bag (32) or to directly (31a) supply the collected liquid to another liquid system.

8. A device according to claim 7, characterized in that a flexible liquid receiving bag (32) is seamlessly enclosed in a solid casing (33), in that the space between the liquid receiving bag (32) and the casing (33), and thereby also the valve (26, 27) of the de-air receiver (4), is under a predetermined pressure P3, in that the inner of the de-air receiver (4) is under a slightly higher pressure P2 than the pressure of the liquid receiving bag (32), and in that the valve comprises a valve seat (27) having a valve cone (28) which opens and closes respectively depending on the volume of liquid which is present at the bottom of the de-air receiver (4).

9. A device according to claim 8, characterized in that the valve cone is a displacement valve ball (28) which is balanced both by the pressure gradient P2-P3 on the ball and by the mass of the ball (28) and its lifting force in liquid.

10. A device according to claim 8, characterized in
that the valve cone is actuated electrically, pneumatically or hydraulically and is controlled to open up and to close respectively by means of an electrical, optical or another sensor of the liquid level in the de-air filter (5).

11. A device according to claim 9, characterized in that the pressure gradient over the valve ball (28) is obtained from a common source (7) of negative pressure, the lower pressure P3 directly influencing the liquid receiving bag (32) and consequently also the valve (28) at the bottom of the de-air receiver (4) in order to close it, and, indirectly, via a throttle valve (11), influencing the upper container part (26) in the de-air receiver (4) by means of the relatively higher pressure P2.

12. A device according to any of claims 7-11, characterized in that the de-air receiver (4) includes or is directly connected to a separation and defoaming filter (3) provided above the liquid collection part of said receiver (4), which filter (3) comprises a filter insert (14), and in that said filter (3) is directly connected to the suction nozzle (2) and is designed both for separating particles from the sucked liquid or liquid/air/gas mixture and for disintegrating foam which may have been formed during the suction of the liquid/air/gas mixture.

13. A device according to any of claims 7-12, characterized in that the inclined plane (25) in the de-air receiver (4) can be a continuous system of inclined discs, or a spiral-shaped track or a helical tube having sufficient cross-sectional dimensions for air bubbles included in the liquid to be able to escape to and be evacuated from the upper part (26) of the de-air receiver (4).

14. A device according to any of claims 7-13, characterized in that the negative pressures of the two levels are received from a common pressure place (7) having the lower negative pressure level P3, and in that the relatively higher pressure level P2 is obtained by choking the pressure by means of a throttle valve (11) in a branch
conduit (10), and in that the device comprises a manometer or a pressure indicator between the conduits (9, 10) having the two pressure levels, whereby the pressure gradient $P_2-P_3$ is controlled to the desired pressure difference by means of the pilot valve (11).

15. A device according to any of claims 7-14, characterized in that the dosage device (6) for the additive is mounted above the filter (3), and in that the dosage device (4), through a tube (18) with a throttle valve (19), is connected to the suction conduit (45) from the suction nozzle (2) at a place in the direction of flow upstream of the separation and defoaming filter (3), and in that the dosage device comprises a flexible bag (20) which bag (20) (20) is sealingly enclosed in a rigid casing (21) which is subjected to the lower pressure $P_3$, and in that the dosage device (4) is balanced in such a way by the pressure gradient $P_2-P_3$ that no dosage agent will be introduced in the suction nozzle hose (45) as long as no liquid is present is said hose (45), whereas dosage agent will be introduced in the suction nozzle hose (45) as soon as liquid in the form of drops or in the form of a liquid column is present in said hose (45), whereby the amount of added dosage agent will be related to the amount of sucked liquid.

16. A device according to any of claims 7-15 for handling of blood, characterized in that, if considered necessary, at least some of the walls of the suction nozzle (2), the filter (3), the connection conduit (17) from the filter (3), the de-air receiver (4) and the inclined planes (25) thereof, which come into contact with the sucked liquid, are surface covered with a medium which does not influence the sucked liquid, e.g. by a heparinizing method, so that said surfaces are made blood compatible, and so that said surfaces do not activate the enzyme system of the blood (the coagulation system) or the cells.
**INTERNATIONAL SEARCH REPORT**

**International Application No.** PCT/SE 92/00047

**I. CLASSIFICATION OF SUBJECT MATTER** (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: A 61 M 1/02, 1/00

**II. FIELDS SEARCHED**

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Documentation searched other than minimum documentation to the extent that such documents are included in fields searched.

SE, DK, FI, NO classes as above

**III. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<th>Citation of Document with indication, where appropriate, of the relevant passages</th>
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<td>EP, A2, 0351980 (PFIZER HOSPITAL PRODUCTS GROUP INC) 24 January 1990, see column 4, line 54 - column 6, line 5; figures 1,2</td>
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**IV. CERTIFICATION**

Date of the Actual Completion of the International Search: 5th May 1992

Date of Mailing of this International Search Report: 1992-05-08

International Searching Authority: SWEDISH PATENT OFFICE

Signature of Authorized Officer: Inger Löfgren
ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 92/00047

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 28/03/92. The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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