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(54) SURFACE TREATING MACHINE WITH CONTROLLED DELIVERY

OBERFLÄCHENBEHANDLUNGSMASCHINE MIT KONTROLLIERTER ABGABE

MACHINE DE TRAITEMENT DE SURFACE À DISTRIBUTION CONTRÔLÉE

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Description

Field of the invention

[0001] The present invention relates to surface treating machines of the type having a surface treatment element configured to treat the surface with liquid.

[0002] Among such machines there are comprised both those of ride-on type and of walk-behind type, which can be either motorized or pushed, with surface treatment element in the form of either a brush, disc, pad, spraying member.

Description of the prior art

[0003] Machines exist for treating surfaces with liquid that provide the application of the liquid by means of a treatment element, taking the liquid from a reservoir on board of the machine.

[0004] Once ended the liquid, the operator has to bring normally the machine to a point of replenishment, for filling again the reservoir.

[0005] In some cases the dirty liquid is collected from the surface by the same machine, for example by a suction system, which drains the liquid by suction up to a collection container on board of the machine. When the reservoir is emptied also the collection container is normally full, because the latter is sized according to the capacity of the reservoir.

[0006] The operators of such surface treating machines, in case they have to cover wide surfaces, like the case for example of overnight cleaning of places like airports, hospitals, schools, offices, etc., have often the problem of not knowing, unless in very rough approximation, the amount of residual liquid in the reservoir, and then the range of the machine in terms of amount of surface that can be treated before making again a replenishment of liquid.

[0007] A precise knowledge of the range of the machine is desirable, because it would allow planning an optimal treatment route up, to the nearest replenishment point before the treatment liquid finishes.

[0008] In WO2010/099968A2 a machine for cleaning surfaces is described that provides a system for automatically calculating the range of the machine. It carries out a measurement of physical and kinematical quantities, in particular the translation speed of the machine, from which the ratio is calculated between the cleaned surface and time necessary to clean it, responsive to many parameters indicated by the operator, like the size of the brush or the size of the nozzle for soaking the brush. The operator, by knowing the residual range of the machine, has a useful information for completing the route up to the next replenishment.

[0009] In the surface treating machines with liquid treatment it can occur that the delivery of liquid to the surface treatment element is not fixed, and this does not allow to calculate the range of the machine precisely with an easy knowledge of physical and kinematical quantities, as space, time, speed.

[0010] For example, in case of feeding the liquid by gravity, as the reservoir is progressively emptied the flow-rate of liquid to the treatment element changes. Even in case of feeding the liquid by means of a pump not of positive displacement type, which however would be heavier and expensive, the flow-rate of liquid to the surface treatment element can change, owing to leakages and to sensitivity of the pump to the supply pressure. The operator, then, in order ensure an effective treatment, i.e. with a sufficient amount of liquid versus treated surface, adjusts the opening value of the feeding duct section in such a way to ensure always an amount of liquid vis-a-vis treated surface that is enough for treatment also in the most unfavorable situations. This determines, however, owing to unsteadiness of the flow-rate, a reduction of the range of the machine.

[0011] Furthermore, changing the translation speed of the surface treating machines with respect to the surface to treat, there is a subsequent change of the amount of supplied liquid versus treated surface, and also this requires an adjustment of the feeding duct section, in order to ensure an amount of liquid that is sufficient also in case of maximum translation speed of the machine, with the consequence of reducing the range of the machine.

[0012] In US8551262 the chemical detergent is dosed with respect to water, taking into account the level in the water reservoir. A level sensor provides a signal of level that influences a controller of a positive displacement pump which feeds the chemical detergent. This way, the dilution in water of the chemical detergent is kept fixed regardless of the level of water reservoir.

[0013] US2007192973 describes a surface treatment machine which uses a cleaning liquid that is supplied by a system containing at least two reservoirs, one for a dilution fluid and another for a concentrated chemical detergent. A system provides controlled metering of liquid in proportion to the concentrated chemical detergent to obtain a cleaning solution with desired concentration.

[0014] In US2004/221415 a surface treatment machine is disclosed. In particular, the machine comprises a base assembly that moves along the surface to be cleaned. The machine also comprises a speed sensor and a controller that receives by the speed sensor a signal based on the speed of the base assembly moving across the surface. More in detail, the controller outputs a pulse width modulated control signal to a pump, which controls the amount of a cleaning solution to be distributed on the surface based on the detected speed signal.

Summary of the invention

[0015] It is a feature of the present invention to provide a surface treatment machine that ensures an effective treatment vis-a-vis the amount of liquid versus treated surface and in the meantime maximizes the range of the machine.

[0016] It is another feature of the invention to provide such a machine which permits controlling the delivery of liquid to the surface treatment element versus the level of liquid present in the reservoir for improving the range of the machine.

[0017] It is another feature of the invention to provide such a machine for having the same treatment efficiency, concerning liquid versus treated surface, and versus the translation speed of the machine.

[0018] It is also a feature of the present invention to provide such a machine that enables an operator to determine in real time the residual range of the machine.

[0019] These and other objects are achieved by a surface treating machine, comprising:

- a frame configured to translate with respect to a surface to treat,
- a surface treatment element connected to the frame and configured to treat with liquid a surface with respect to which the frame advances,
- a reservoir connected to the frame and arranged to provide liquid to the surface treatment element through a delivery mouth;
- an adjustment element arranged to adjustably pulse-feed the liquid supplied from the reservoir to the delivery mouth;
- a sensor configured to measure an operating parameter P of the machine, selected from the group consisting of: level P_1 of residual liquid in the reservoir, actual flow-rate P_2 of the liquid from the reservoir towards the delivery mouth simultaneously to the pulse,
- a control unit configured to receive from the sensor a signal proportional to the operating parameter P and configured to set the adjustment element responsive to operating parameter P, in order to pulse-feed the liquid with a duty cycle t%, expressed as a ratio between the duration of a pulse of the pulse-feed step and the time between two consecutive pulses, determined according to a predetermined function t% - f(P) of optimization of the flow-rate, wherein said function f(P) is selected from the group consisting of:

$$t\% = f(P_1) = K1 * P_1^{-1/2} \quad (1)$$

$$t\% = f(P_2) = K_2 * P_2^{-1} \quad (2)$$

[0020] This way, once calculated function f (P), the control unit adjusts automatically the adjustment element so that it provides an amount of liquid versus time responsive to changes of operating parameter P.

[0021] In the case, for example, where operating parameter P is the level P_1 of residual liquid present in the reservoir, since the level influences the amount of liquid supplied by the different head of residual liquid in the reservoir at an outlet section thereof, the lower the level of residual liquid and the lower the amount of liquid dispensed, in a non-linear way, but determinable according to the geometry of the duct, and to the features of the adjustment element. Therefore, function f (P_1) is configured to keep as far as possible fixed the amount of liquid supplied so that the undesirable effect of delivery affected by the level of liquid in the reservoir is eliminated and the flow-rate is optimized, achieving the goal of maximizing the range of the machine responsive to the remaining space to be treated up to reaching a programmed replenishment point. In other words, function f(P) is inputted with the distance to be covered or surface to be covered up to the point of replenishment and is configured to adjust the flow-rate so that the machine carries out the treatment up to such point avoiding shortage of liquid.

[0022] In the case, instead, where operating parameter P is the flow-rate P_2 of the liquid at the outlet of the reservoir, then function f(P) is configured to keep as far as possible the flow-rate constant, i.e. a control in closed loop flow-rate feedback, so that it meets a predetermined range chosen by the operator, so that the flow-rate is independent from external factors that can influence it.

[0023] In the case, always for example, where operating parameter P is the translation speed of the machine, then function f(P) is determined so that the amount of supplied liquid versus treated surface is constant, whichever is the speed. Therefore, at a lower speed the control unit would set the adjustment element so that the ratio between amount of liquid actually supplied and treated surface versus time meets a predetermined value.

[0024] Advantageously, if operating parameter P is a measurement of the level of liquid present in the reservoir, the parameter P is proportional to the amount of liquid present in the reservoir, and for example is a pressure value P_1, and the sensor is a sensor of pressure that is communicating with the reservoir for determining the level of liquid present in the reservoir.

[0025] This solution allows a very precise control of the level in the liquid in the reservoir. In fact, a pressure sensor located at the base of the reservoir, after filtering fluctuations due to the movement of the machine that are eliminable as noise, gives a precise value of the level, which can influence the flow-rate, i.e. the hydrostatic pressure, owing to the head liquid in the reservoir, in order to optimize the flow-rate.

[0026] Alternatively, the level of liquid present in the reservoir can be determined with a force sensor, in particular a load cell, which can be arranged to hold the weight of support elements of said reservoir.

[0027] Alternatively, the level of liquid present in the reservoir can be determined with a level sensor, in particular an optical sensor or ultrasonic pulse sensor or floating sensor, which is located in said reservoir, and configured to measure the distance of the liquid surface of the liquid from the bottom or from a top wall of the reservoir.

[0028] In a possible exemplary embodiment, where the

parameter P is a value P_1 proportional to an amount or level of liquid present in the reservoir, the adjustment element is selected from the group consisting of:

- a piloted valve, where the control unit is configured to pulse-feed the liquid, with a predetermined duty cycle t%, by adjusting the opening time of the adjustment valve in an increasing way responsive to decrease of the level according to function $f(P_1)$;
- a pump, where the control unit is configured to pulse-feed the liquid, with a predetermined duty cycle t%, by adjusting a pulse-feed rate of the pump in an increasing way responsive to decrease of the level according to function $f(P_1)$.

[0029] This way, it is eliminated the undesirable effect that causes the variation of the flow-rate of liquid supplied to the surface treatment element versus the level of liquid present in the reservoir, and the flow-rate is optimized, according to function f(P). This way the amount of supplied liquid is adjusted, in order to have an ideal treatment efficiency without excessive or insufficient liquid supply, in order to maximize the range of the machine.

[0030] In a possible exemplary embodiment, if operating parameter P is a measurement of the flow-rate of liquid that is supplied to the delivery mouth, and the sensor is a flow-rate sensor, such as a flow meter or liter-counter, which is arranged in a portion of duct between the reservoir and the delivery mouth and provides a signal P_2 proportional to the flow-rate, the adjustment element is selected from the group consisting of:

- a piloted valve, where the control unit is configured to pulse-feed the liquid, with a predetermined duty cycle t%, by adjusting the opening time of the adjustment valve in closed loop feedback according to function $f(P_2)$;
- a pump, where the control unit is configured to cause the pump to pulse-feed the liquid, with a predetermined duty cycle t%, by adjusting a pulse-feed rate of the pump in closed loop feedback according to function $f(P_2)$.

[0031] In this case, the control unit influences the adjustment element, i.e. the valve or the pump, so that there is a continuous feedback adjustment of the flow-rate, eliminating also here the causes that determine an undesired variation of the flow-rate with respect to ideal operation parameters, and optimizing the flow-rate, in order to achieve a maximum range of the machine.

[0032] In an embodiment, which is not part of this invention, if i-f- operating parameter P is a measurement of the speed P3 of the frame of the machine with respect to the surface to treat, the sensor is a speed sensor configured to provide a value P_3 proportional to a speed of the machine, and the adjustment element is selected from the group consisting of:

- a piloted valve, where the control unit is configured to cause a pulse-feed of the liquid, with a predetermined duty cycle t%, by adjusting the opening time of the adjustment valve in an increasing way responsive to an increase of the translational speed according to function $f(P_3)$;
- a pump, where the control unit is configured to cause the pump to pulse-feed the liquid, with a predetermined duty cycle t%, by adjusting a pulse-feed rate in an increasing way responsive to an increase of the translational speed according to function $f(P_3)$.

[0033] This way, the delivery is ensured of an amount of liquid versus treated surface for achieving an optimal treatment of the surface, and keeping the flow-rate within the minimum necessary, such that a maximum range of the machine is obtained.

[0034] Advantageously, the frame is configured to translate with respect to the surface to treat by means of wheels, and the sensor configured to provide a value P_3 proportional to a translation speed of the machine is an encoder arranged to measure the speed of one of the wheels.

[0035] In another embodiment, which is not part of this invention, the frame is configured to translate with respect to the surface to treat operated by a motor, and the sensor configured to provide a value P_3 proportional to a translation speed of the machine is a sensor configured to measure the pulse-width modulation (PWM) of the motor.

[0036] Responsive to the parameter P_2 function $f(P_1, P_2)$ is configured to keep constant the amount of liquid versus treated surface, with a control in closed loop feedback of the flow-rate.

[0037] Advantageously, the control unit is associated with a display unit of the operating parameters and of a value of range of the machine calculated on the basis of instant values of function f(P).

[0038] This way, the operator is enabled to see on the display unit the values of residual range of the machine, versus time, or the residual surface to treat, in order to determine the optimal route that allows to reach a replenishment point without loss of time or covering useless routes.

[0039] In an embodiment the adjustment element is a piloted valve, and the reservoir is arranged with respect to the delivery mouth for delivering liquid to the surface treatment element by gravity through the valve.

[0040] This solution makes it possible to minimize the costs for making the machine, since it does not need a pump for delivering the liquid to the treatment element, but exploits simply the gravity, achieving the goal of avoiding to have an not controllable amount of supplied liquid responsive to the treated surface.

[0041] Also the operator is enabled to see on the display unit the values of residual range of the machine, versus time, or the residual surface to treat, and to set in turn the treatment route that allows maximizing the range

of the machine and eventually making a replenishment without loss of time or covering useless routes. In particular, the operator can set the range of the machine so that up to the replenishment point the flow-rate of liquid is constant and all the liquid present in the reservoir is used.

[0042] According to another aspect of the invention a method of treatment of surfaces is provided according to attached claim 7.

Brief description of the drawings

[0043] The invention will be now shown with the following description of an exemplary embodiment thereof, exemplifying but not limitative, with reference to the attached drawings in which:

- Fig. 1 shows a block diagram of a generic surface treatment machine according to the prior art;
- Fig. 2 shows a block diagram of a generic surface treatment machine according to the invention;
- Fig. 3 shows a block diagram of a first exemplary embodiment of the invention;
- Fig. 4 shows a block diagram of a second exemplary embodiment of the invention;
- Fig. 5 shows a block diagram of an embodiment, which is not part of this invention;
- Fig. 6 shows a block diagram of an embodiment, which is not part of this invention.

Detailed description of some exemplary embodiments

[0044] As shown in Fig. 1, a surface treating machine, whose diagrammatical general view is known and indicated as 1, comprises a frame 11 configured to translate with respect to a surface 12 to treat.

[0045] The translation, in a in the direction of arrow 2, can be carried out by pushing, through a handlebar or through separate handles (not shown), or in a motorized way, through wheels or tracks (not shown), and the machine can be of ride-on type and of walk-behind type. Surface 12 to treat can be a floor but can also be vertical, as windows or vertical walls, moved on vertical guides or through lifting platforms (not shown).

[0046] Machine 1 comprises a surface treatment element 13 connected to the frame 11 and configured to treat with liquid surface 12 with respect to which the frame 11 advances.

[0047] The surface treatment element, indicated generally as block 13, can be a rotating brush or other brush element, as well as can be a vibrating pad or other treatment element, for example a spray liquid distributor. A motor can be provided or other actuating element 13a for actuating a connecting element 13b linked to the surface treatment element 13, for example a rotating shaft.

[0048] Furthermore, machine 1 comprises a reservoir 14 connected to the frame 11 and arranged to provide liquid to surface treatment element 13 through a delivery mouth 15. It is then provided an adjustment element 16 arranged to feed adjustably the liquid supplied from reservoir 14 to delivery mouth 15, and located between two branches 15a and 15b arranged for feeding the liquid from reservoir 14 to delivery mouth 15.

[0049] The treatment liquid in reservoir 14 can be water, water with detergent, pure detergent, or other treatment liquid, for example protecting film, coating film, etc. A further reservoir of chemical detergent can also be provided to mix with the water before the delivery (not shown).

[0050] The adjustment element indicated generally with block 16 can be a valve or a pump. It can be simply an On/Off device or an adjustable device, for example an adjustable tap valve. The adjustment element is of pulse-feed type, with a predetermined duty cycle t%.

[0051] In Fig. 1 a collection element 17 is also shown, for example a wiper or so-called "squegee" associated with a suction device, which drains, as machine 1 progressively moves in the direction of arrow 2, the surplus treatment liquid 18 that soaks surface 12. Collection element 17 is connected hydraulically to a container 19 arranged for collecting residual liquid and possible dirt.

[0052] Collection element 17 can also be missing in certain models of machine.

[0053] As shown in Fig. 2, according to the present invention, a surface treatment machine 10, starting from surface treatment machine 1 of Fig. 1, is modified in order to comprise an adjustment element 26 arranged to feed adjustably the liquid supplied by reservoir 14 to the delivery mouth. The adjustment element 26 can be, for example, an adjustment valve electrically, or an electric pump with adjustable speed, of liquid pulse-feed type according to a predetermined duty cycle t%, which is the average ratio between the duration of a pulse of the pulse-feed step and the time between two consecutive pulses.

[0054] Furthermore, it comprises a sensor 20 configured to measure an operating parameter P of the machine, selected from the group consisting of: level of residual liquid in reservoir 14, liquid flow-rate from reservoir 14 towards delivery mouth 15, translation speed of the machine relatively to surface 12. Furthermore, it comprises a control unit 30 arranged to receive from sensor 20 a signal proportional to operating parameter P and configured to set the adjustment element 26 responsive to operating parameter P, in order to pulse-feed the liquid with a duty cycle t% according to a predetermined function f(P) of optimization of the flow-rate for maximizing the range of the machine.

[0055] With reference to Fig. 3, operating parameter P can be a measurement of the level of liquid present in reservoir 14. In this case, the sensor is, for example, a sensor 21 of a value P_1 which is relative to the amount of liquid present in reservoir 14. In this case, the duty cycle t% would be

$$t\% = f(P_1) = K_1 * P_1^{-1/2} \quad (1)$$

i.e. proportional to the reciprocal of the square root of the level.

[0056] For example, value P_1 which is relative to the amount of liquid present in reservoir 14 is a pressure value, and sensor 21 is a pressure sensor arranged to provide a signal of pressure P_1 that is communicating with a lower portion of reservoir 14. Such pressure sensor 21 is a sensor of the hydrostatic pressure directly related to the level of liquid surface 14a.

[0057] In this case, the adjustment element 26 is selected from the group consisting of:

- a piloted valve, where control unit 30 is configured to adjust an opening section in a pulse-feed way of said valve with a duty cycle t% in an increasing way responsive to decrease of pressure P_1 according to function $f(P_1)$;
- a pump, where control unit 30 is configured to adjust the flow-rate of the pulse-feed pump in an increasing way responsive to decrease of pressure P_1 according to function $f(P_1)$.

[0058] Such function can be, as shown above, an analytical function, which allows to calculate an adjustment parameter for each value of operating parameter P_1. Or it can be a table of values that associates to each pressure P_1, progressively decreasing, an adjustment parameter, for example an opening parameter, progressively increasing, of the piloted valve, or a number of turns, progressively increasing, of the pump.

[0059] Measuring the level P_1 is directly related to the volume of residual liquid, responsive to the geometry of the reservoir. This allows also to calculate the volume of residual liquid and then the range of the machine, versus volume. Such volume value can be advantageously, displayed on the machine, as useful information for operator. Owing to function f(P) the operator can then manage the residual range of the machine.

[0060] Alternatively, sensor 21 is a force sensor, for example a load cell, for example located under reservoir 14, or arranged to hold the weight of support elements of reservoir 14, capable of measuring instantly the weight of the reservoir, which changes from a value of weight equal to reservoir 14 full to a value of weight equal to reservoir 14 empty. The weight of the residual liquid is easily related both to the amount of residual liquid, useful as value of range of the machine, and to the level, for determining the adjustment parameter. Then, once determined the initial level from the measured weight, it is possible to calculate the formula (1) above indicated.

[0061] As further alternative embodiment, sensor 20 can be, in a way not shown, a level sensor, for example optical sensor, ultrasonic pulse sensor, electromagnetic, mechanical floating sensor located above or in the reservoir, and that is configured to measure the distance of the liquid surface 14a of the liquid from the upper wall of reservoir 14.

[0062] Also in the latter two cases, responsive to a decrease of the weight of the reservoir or the level in the liquid surface 14a, function $f(P_1)$, in analytical form (1) or implemented as table, it provides increasing values of the adjustment parameter, i.e. of the duty cycle of the pulse-feed step, for each flow-rate value of liquid. Such flow-rate value can also be referred to a specific flow-rate, i.e. volume of liquid supplied for each surface unit covered by the machine.

[0063] In the exemplary embodiment of Fig. 4, operating parameter P is a direct measurement of the flow-rate of liquid that is supplied to delivery mouth 15, and the sensor is a flow-rate sensor 22, for example a flow meter, which is arranged in a portion of duct between reservoir 14 to delivery mouth 15, and provides a signal P_2 proportional to the flow-rate, and the adjustment element 26 is selected from the group consisting of:

- a piloted valve, where control unit 30 is configured to adjust an opening section of the valve in closed loop feedback of liquid pulse-feed type, with a predetermined duty cycle t%, according to a function $f(P_2)$;
- a pump, where control unit 30 is configured to adjust the speed of the pump 26 of liquid pulse-feed type, with a predetermined duty cycle t%, in closed loop feedback according to function $f(P_2)$.

[0064] Function $f(P_2)$ can be expressed as:

$$t\% = f(P_2) = K_2 * P_2^{-1} \quad (2)$$

where the flow-rate P_2 is the flow-rate during feeding pulses.

[0065] In other words a pulse-feed rate is carried out as a succession of instants in which there is a measurable flow-rate and instants where the flow-rate is still, i.e. it is substantially the same as zero, and value P_2 is the flow-rate determined from the flow-rate sensor 22 when there is delivery, and the longer the duration of the pulse of delivery, with respect to the time between two pulses, the lower is the instantaneous flow-rate during feeding pulses.

[0066] This way, if for example the level in the reservoir decreases, owing to the hydrostatic pressure also the instantaneous flow-rate decreases, and then the duty cycle of the valve or the pump of pulse-feed type increases.

[0067] Then, control unit 30 has in memory a flow-rate threshold value, receives the actual flow-rate signal from the flow-rate sensor 22, then compares it with the flow-rate threshold value, and if the actual flow-rate signal is lower, it provides an adjustment parameter, such as an increased duty cycle of the piloted valve, or of the pulse-feed pump.

[0068] As shown in Fig. 5, an embodiment which is not

part of this invention, operating parameter P can be, alternatively, a value P_3 proportional to a translation speed of the frame 11 with respect to surface 12 to treat. In this case, the sensor is a speed sensor 23 configured to provide a value P_3 proportional to the speed, the adjustment element 26 can be selected from the group consisting of:

- a piloted valve, where control unit 30 is configured to adjust an opening section of the liquid pulse-feed type valve, with a predetermined duty cycle t%, in an increasing way responsive to an increase of the speed according to a function $f(P_3)$;
- a pulse-feed pump with a predetermined duty cycle t%, where control unit 30 is configured to adjust the duty cycle of the pulse-feed pump in an increasing way responsive to an increase of the speed according to function $f(P_3)$,

wherein function $f(P_3)$ can be expressed as:

$$t\% = f(P_3) = K_3 * P_3 \quad (3)$$

[0069] The frame 11 is configured to translate with respect to surface 12 to treat by means of wheels 40, and sensor 23 configured to provide a value P_3 proportional to a translation speed of the machine can be an encoder arranged to measure the speed of one of wheels 40.

[0070] For example, the higher the speed, function $f(P_3)$, in the form of table or analytical function, provides increasing values of the adjustment parameter, in order to keep constant the amount of supplied liquid versus treated surface.

[0071] The translation can be carried out by pushing or in a motorized way. Such solution with encoder 23 on one of wheels 40 adjusts precisely the delivery of the treatment liquid even with translation by pushing, which can be particularly irregular, since that, with respect to a driven translation, the operator in a difficult way can keep a constant value of the speed.

[0072] In case of driven translation, as diagrammatically shown in Fig. 6, the frame 11 is configured to translate with respect to surface 12 to treat operated by a motor 50. Alternatively to the encoder described of Fig. 5, the sensor, in the case of Fig. 6, can be an amperometric sensor 24 arranged to measure, as parameter P_3 proportional to the speed, the pulse-width modulation (PWM) of the motor 50. Even in this case, the higher the driving current, function $f(P_3)$, in the form of table or analytical function, provides increasing values of the adjustment parameter, in order to keep constant the amount of supplied liquid versus treated surface.

[0073] According to a further exemplary embodiment not shown in the figures, control unit 30 can be associated with a display unit of the operating parameters and of a value of range of the machine calculated on the basis of instant values of function f(P).

[0074] The adjustment element 26 of Fig. 2 can be a valve, for example a piloted valve, and reservoir 14 arranged with respect to delivery mouth 15 for delivering liquid to surface treatment element 13 by gravity through the adjustment valve 26. In this case, the control of level or flow-rate is essential to ensure an amount of liquid supplied that is constant, since the feeding by gravity is extremely affected by variation of level in the water reservoir.

[0075] In particular, the operator can set a value of range of the machine so that up to the next replenishment the flow-rate of liquid is constant and all the liquid present in the reservoir is used.

Claims

1. A surface treatment machine (10), comprising:

- a frame (11) configured to translate with respect to a surface (12) to treat,
- a surface treatment element (13) connected to said frame (11) and configured to treat with liquid a surface (12) with respect to which said frame (11) advances,
- a reservoir (14) connected to said frame (11) and arranged to provide liquid to said surface treatment element (13) through a delivery mouth (15);
- an adjustment element (26) arranged to adjustably pulse-feed the liquid provided from said reservoir (14) to said delivery mouth (15);

characterized in that it comprises furthermore:

- a sensor (20) configured to measure an operating parameter P of said machine, selected from the group consisting of: level P_1 of residual liquid in the reservoir (14), actual flow-rate P_2 of the liquid from said reservoir (14) towards said delivery mouth (15) simultaneously to the pulses;
- a control unit (30) configured to receive from said sensor (20) a signal proportional to said operating parameter P, and configured to adjust said adjustment element (26) responsive to said operating parameter P, in order to pulse-feed said liquid with a duty cycle t%, expressed as a ratio between the duration of a pulse of the pulse-feed step and the time between two consecutive pulses, determined according to a predetermined function t% - f(P) of optimization of the flow-rate, wherein said function f(P) is selected from the group consisting of:

$$t\% = f(P_1) = K_1 * P_1^{-1/2} \quad (1)$$

$$t\ \% = f(P_2) = K_2 * P_2^{-1} \quad (2).$$

2. Surface treatment machine according to claim 1, wherein said operating parameter P is a measurement of the level of liquid present in said reservoir (14), and said sensor (20) is a sensor of a value P_1 proportional to said level of liquid present in said reservoir (14) and said function f(P) is a function f(P1) of optimization of the flow-rate calculated on said value PI, said sensor selected from the group consisting of:

- a pressure sensor (21) communicating with said reservoir (14) and arranged to provide a signal of pressure owing to a liquid head starting from the liquid surface of said reservoir (14);

- a force sensor (21), in particular a load cell, which can be arranged to hold the weight of support elements of said reservoir (14);
- a level sensor, in particular an optical sensor or ultrasonic pulse sensor or floating sensor, which is located in said reservoir, and configured to measure the distance of the liquid surface (14a) of the liquid from a bottom wall or from a top wall of said reservoir (14).

3. Surface treatment machine according to claim 2, wherein said adjustment element (26) is selected from the group consisting of:

- a piloted valve, wherein said control unit (30) is configured to adjust an opening section in a pulse-feed way of said valve, with a predetermined duty cycle t%, by adjusting the time for opening said valve in an increasing way responsive to decrease of the level of liquid P1 according to said function f(P1);
- an adjustable pump, wherein said control unit (30) is configured to cause the pump to pulse-feed the liquid, with a predetermined duty cycle t%, by adjusting a pulse-feed rate of said pump in an increasing way responsive to decrease of the level of liquid P1 according to said function f(P1).

4. Surface treatment machine according to claim 1, wherein said operating parameter P is a measurement of the flow-rate P2 of liquid that comes to said delivery mouth (15), and said sensor (20) is a flow-rate sensor (22), in particular a flow meter or liter-counter, which are located between said reservoir (14) to said delivery mouth (15) configured to provide a signal P_2 proportional to said flow-rate, said function f(P) being a function $f(P_2)$ of optimization of the flow-rate calculated on said value P_2, and said adjustment element (26) is selected from the group consisting of:

- a piloted valve, configured to pulse-feed the liquid, with a predetermined duty cycle t%, wherein said control unit (30) is configured to adjust said duty cycle t% according to said function $f(P_2)$;
- an adjustable pump, configured to pulse-feed the liquid, with a predetermined duty cycle t%, wherein said control unit (30) is configured to adjust a pulse-feed rate of said pump according to said function $f(P_2)$.

5. Surface treatment machine according to claim 2, or 4, wherein said operating parameter P is a combination of a measurement P_3 of the translation speed of said frame (11) and of a measurement P_1 of the level of liquid present in said reservoir (14) or of a measurement P_2 of the flow-rate of liquid that comes to said delivery mouth (15), said function f(P) configured to maximize the range of the machine of said machine starting from settings of said machine given by the nature of said surface and/or by environmental conditions, said range of the machine being calculated as residual time or residual surface that can be treated by said machine before replenishment of liquid in said reservoir.

6. Surface treatment machine according to claim 1, wherein said control unit (30) is associated with a display unit (60) of said operating parameter and of a value of range of the machine calculated on the basis of instant values of said function f(P), said range of the machine being calculated as residual time or residual surface that can be treated by said machine before replenishment of liquid in said reservoir.

7. A method (10) of treatment of surfaces, comprising the step of:

- translating a surface treatment machine with respect to a surface (12) to treat, said machine having a surface treatment element (13) connected to a frame (11);
- feeding, at said surface treatment element (13), a treatment liquid, so that said surface treatment element (13) treats with said liquid said surface (12) during said translating;
- said treatment liquid being drawn from a reservoir (14) connected to said frame (11), in order to provide said liquid to said surface treatment element (13) through a delivery mouth (15);
- adjusting (26) said delivery of liquid provided from said reservoir (14) to said delivery mouth (15);

characterized in that it comprises furthermore:

- measuring by a sensor (20) an operating parameter P of said machine, selected from the group consisting of: level P_1 of residual liquid in the reservoir (14), actual flow-rate P_2 of the liquid from said reservoir (14) towards said delivery mouth (15),
- wherein said adjusting (30) is carried out on the basis of a signal proportional to said operating parameter P and of said adjustment element (26) responsive to said operating parameter P, in order to pulse-feed said liquid with a duty cycle t%, expressed as a ratio between the duration of a pulse of the pulse-feed step and the time between two consecutive pulses, determined according to a predetermined function t% = f(P) of optimization of the flow-rate, wherein said function f(P) is selected from the group consisting of:

$$t\% = f(P_1) = K_1 * P_1^{-1/2} \quad (1)$$

$$t\% = f(P_2) = K_2 * P_2^{-1} \quad (2).$$

Patentansprüche

1. Oberflächenbehandlungsmaschine (10), umfassend:

- einen Rahmen (11), der eingerichtet ist, um sich in Bezug auf eine zu behandelnde Oberfläche (12) zu verschieben, ein Oberflächenbehandlungselement (13), das mit dem Rahmen (11) verbunden und eingerichtet ist, um eine Oberfläche (12), gegenüber der der Rahmen (11) vorrückt, mit Flüssigkeit zu behandeln,
- einen Behälter (14), der mit dem Rahmen (11) verbunden und angeordnet ist, um dem Oberflächenbehandlungselement (13) durch eine Abgabeöffnung (15) Flüssigkeit zuzuführen;
- ein Einstellelement (26), das angeordnet ist, um die aus dem Behälter (14) vorgesehene Flüssigkeit einstellbar impulsweise der Abgabeöffnung (15) zuzuführen;
- **dadurch gekennzeichnet, dass** es ferner aufweist:

- einen Sensor (20), der eingerichtet ist, um einen Betriebsparameter P der Maschine gleichzeitig mit den Impulsen zu messen, der aus der Gruppe ausgewählt wird, bestehend aus: Füllstand P_1 der Restflüssigkeit im Behälter (14), tatsächliche Durchflussrate P_2 der Flüssigkeit vom Behälter (14) zur Abgabeöffnung (15);
- eine Steuereinheit (30), die eingerichtet ist, um vom Sensor (20) ein Signal zu empfangen, das proportional zum Betriebsparameter P ist, und eingerichtet ist, um das Einstellelement (26) als Reaktion auf den Betriebsparameter P einzustellen, um die Flüssigkeit mit einem Arbeitszyklus t% impulsweise zuzuführen, ausgedrückt als Verhältnis zwischen der Zeitdauer eines Impulses des Impulszuführschritts und der Zeit zwischen zwei aufeinanderfolgende Impulsen, bestimmt nach einer neu bestimmten Funktion t% - f(P) einer Optimierung der Durchflussrate, wobei die Funktion f(P) ausgewählt wird aus der Gruppe, bestehend aus:

$$t\% = f(P_1) = K_1 * P_1^{-1/2} \quad (1)$$

$$t\% = f(P_2) = K_2 * P_2^{-1} \quad (2).$$

2. Oberflächenbehandlungsmaschine nach Anspruch 1, wobei der Betriebsparameter P ein Messwert des Flüssigkeitsstands im Behälter (14) ist und der Sensor (20) ein Sensor eines Werts P_1 ist, der proportional zum Flüssigkeitsstand im Behälter (14) ist, und wobei die Funktion f(P) eine Funktion $f(P_1)$ zur Optimierung der Durchflussrate ist, die anhand des Werts P_1 berechnet wird, wobei der Sensor aus der Gruppe ausgewählt wird, bestehend aus:

- einem Drucksensor (21), der mit dem Behälter (14) in Verbindung steht, und angeordnet ist, um ein Drucksignal aufgrund eines von der Flüssigkeitsoberfläche des Behälters (14) ausgehenden Flüssigkeitskopfes vorzusehen;
- einem Kraftsensor (21), insbesondere einer Kraftmessdose, die angeordnet werden kann, um das Gewicht der Stützelemente des Behälters (14) zu halten;
- einem Füllstandsensor, insbesondere einem optischen Sensor oder Ultraschall-Impulssensor oder Schwimmsensor, der im Behälter angeordnet ist, und eingerichtet ist, um den Abstand der Flüssigkeitsoberfläche (14a) der Flüssigkeit von einer Bodenwand oder von einer oberen Wand des Behälters (14) zu messen.

3. Oberflächenbearbeitungsmaschine nach Anspruch 2, wobei das Einstellelement (26) ausgewählt wird aus der Gruppe, bestehend aus:

- einem vorgesteuerten Ventil, wobei die Steuereinheit (30) eingerichtet ist, um einen Öffnungsabschnitt in einem Impulszuführweg des

Ventils mit einem vorbestimmten Arbeitszyklus t% durch Einstellen der Zeit zum Öffnen des Ventils in zunehmender Weise als Reaktion auf ein Verringern des Flüssigkeitsstands P_1 gemäß der Funktion $f(P_1)$ einzustellen;
- einer einstellbaren Pumpe, wobei die Steuereinheit (30) eingerichtet ist, um zu bewirken, dass die Pumpe die Flüssigkeit mit einem vorgegebenen Arbeitszyklus t% durch Einstellen einer Impulszuführrate der Pumpe in zunehmender Weise als Reaktion auf ein Verringern des Flüssigkeitsstands P_1 gemäß der Funktion $f(P_1)$ impulsweise zuführt.

4. Oberflächenbehandlungsmaschine nach Anspruch 1, wobei der Betriebsparameter P ein Messwert der Durchflussrate P2 der Flüssigkeit ist, die zur Abgabeöffnung (15) gelangt, und der Sensor (20) ein Durchflussratensensor (22) ist, insbesondere ein Durchflussmesser oder Literzähler, die zwischen dem Behälter (14) und der Abgabeöffnung (15) angeordnet sind, der eingerichtet ist, um ein Signal P_2 vorzusehen, das proportional zur Durchflussrate ist, wobei die Funktion f(P) eine Funktion $f(P_2)$ zur Optimierung der Durchflussrate ist, die anhand des Werts P_2 berechnet wird, und das Einstellelement (26) aus der Gruppe ausgewählt wird, bestehend aus:

- einem vorgesteuerten Ventil, das eingerichtet ist, um die Flüssigkeit impulsweise mit einem vorgegebenen Arbeitszyklus t% zuzuführen, wobei die Steuereinheit (30) eingerichtet ist, um das Arbeitsverhältnis t% gemäß der Funktion $f(P_2)$ einzustellen;
- einer einstellbaren Pumpe, die eingerichtet ist, um die Flüssigkeit impulsweise mit einem vorgegebenen Arbeitszyklus t% zuzuführen, wobei die Steuereinheit (30) eingerichtet ist, um eine Impulszuführrate der Pumpe gemäß der Funktion $f(P_2)$ einzustellen.

5. Oberflächenbehandlungsmaschine nach Anspruch 2 oder 4, wobei der Betriebsparameter P eine Kombination aus einem Messwert P_3 der Verschiebungsgeschwindigkeit des Rahmens (11) und einem Messwert P_1 des im Behälter (14) vorhandenen Flüssigkeitstands oder einem Messwert P_2 der Flüssigkeitsdurchflussrate ist, der zur Abgabeöffnung (15) gelangt, wobei die Funktion f(P) eingerichtet ist, um den Arbeitsbereich der Maschine ausgehend von den durch die Beschaffenheit der Oberfläche und/oder durch die Umgebungsbedingungen vorgegebenen Einstellungen der Maschine zu maximieren, wobei der Arbeitsbereich der Maschine als Restzeit oder Restoberfläche berechnet wird, die von der Maschine behandelt werden kann, bevor Flüssigkeit in den Behälter nachgefüllt wird.

6. Oberflächenbehandlungsmaschine nach Anspruch 1, wobei die Steuereinheit (30) mit einer Anzeigeeinheit (60) des Betriebsparameters und eines Arbeitsbereichswerts der Maschine verbunden ist, der auf der Grundlage von Momentanwerten der Funktion f(P) berechnet wird, wobei der Zeitbereich der Maschine als Restzeit oder Restoberfläche berechnet wird, die von der Maschine behandelt werden kann, bevor Flüssigkeit in den Behälter nachgefüllt wird.

7. Verfahren (10) zur Behandlung von Oberflächen, das die Schritte aufweist:

- Verschieben einer Oberflächenbehandlungsmaschine in Bezug auf eine zu behandelnde Oberfläche (12), wobei die Maschine ein Oberflächenbehandlungselement (13) aufweist, das mit einem Rahmen (11) verbunden ist;
- Zuführen einer Behandlungsflüssigkeit an das Oberflächenbehandlungselement (13), so dass das Oberflächenbehandlungselement (13) die Oberfläche (12) während der Verschiebung mit der Flüssigkeit behandelt;
- wobei die Behandlungsflüssigkeit aus einem mit dem Rahmen (11) verbundenen Behälter (14) entnommen wird, um die Flüssigkeit über eine Abgabeöffnung (15) dem Oberflächenbehandlungselement (13) zuzuführen;
- Einstellen (26) der Abgabe von der im Behälter (14) vorgesehenen Flüssigkeit an die Abgabeöffnung (15);
- **dadurch gekennzeichnet, dass** es ferner aufweist:

  - Messen eines Betriebsparameters P der Maschine durch einen Sensor (20), der aus der Gruppe ausgewählt wird, bestehend aus: Füllstand P_1 der Restflüssigkeit im Behälter (14), tatsächliche Durchflussrate P_2 der Flüssigkeit vom Behälter (14) zur Abgabeöffnung (15),
  - wobei die Einstellung (30) auf der Grundlage eines Signals durchgeführt wird, das proportional zum Betriebsparameter P und dem Einstellelement (26) ist, das auf den Betriebsparameter P reagiert, um die Flüssigkeit mit einem Arbeitszyklus t% impulsweise zuzuführen, ausgedrückt als Verhältnis zwischen der Zeitdauer eines Impulses des Impulszuführschritts und der Zeit zwischen zwei aufeinanderfolgende Impulsen, bestimmt nach einer neu bestimmten Funktion t% = f(P) einer Optimierung der Durchflussrate, wobei die Funktion f(P) ausgewählt wird aus der Gruppe, bestehend aus:

$$t\% = f(P_1) = K_1 * P_1^{-1/2} \quad (1)$$

$$t\% = f(P_2) = K_2 * P_2^{-1} \quad (2).$$

Revendications

1. Machine de traitement de surface (10), comprenant :

- un cadre (11) configuré pour effectuer une translation par rapport à une surface (12) à traiter,
- un élément de traitement de surface (13) relié audit cadre (11) et configuré pour traiter avec du liquide une surface (12) par rapport à laquelle ledit cadre (11) avance,
- un réservoir (14) relié audit cadre (11) et agencé pour fournir du liquide audit élément de traitement de surface (13) à travers une bouche de distribution (15) ;
- un élément de réglage (26) agencé pour administrer par impulsions de manière réglable le liquide fourni depuis ledit réservoir (14) à ladite bouche de distribution (15) ;

Caractérisée en ce qu'elle comprend en outre :

- un capteur (20) configuré pour mesurer un paramètre de fonctionnement P de ladite machine, sélectionné dans le groupe consistant en : niveau P_1 de liquide résiduel dans le réservoir (14), débit réel P_2 du liquide depuis ledit réservoir (14) vers ladite bouche de distribution (15) simultanément aux impulsions ;
- une unité de commande (30) configurée pour recevoir depuis ledit capteur (20) un signal proportionnel audit paramètre de fonctionnement P, et configurée pour régler ledit élément de réglage (26) en réponse audit paramètre de fonctionnement P, afin d'administrer par impulsions ledit liquide avec un cycle de service t %, exprimé en tant qu'un rapport entre la durée d'une impulsion de l'étape d'administration par impulsions et le temps entre deux impulsions consécutives, déterminé selon une fonction t % - f(P) prédéterminée d'optimisation du débit, dans laquelle ladite fonction f(P) est sélectionnée dans le groupe consistant en :

$$t\% = f(P_1) = K_1 * P_1^{-1/2} \quad (1)$$

$$t\% = f(P_2) = K_2 * P_2^{-1} \quad (2).$$

2. Machine de traitement de surface selon la revendication 1, dans laquelle ledit paramètre de fonctionnement P est une mesure du niveau de liquide présent dans ledit réservoir (14), et ledit capteur (20) est un capteur d'une valeur P_1 proportionnelle audit niveau de liquide présent dans ledit réservoir (14) et ladite fonction f(P) est une fonction $f(P_1)$ d'optimisation du débit calculée sur ladite valeur P_1, ledit capteur étant sélectionné dans le groupe consistant en :

- un capteur de pression (21) communiquant avec ledit réservoir (14) et conçu pour fournir un signal de pression dû à un niveau de liquide partant de la surface de liquide dudit réservoir (14) ;
- un capteur d'effort (21), en particulier une cellule piézoélectrique, qui peut être agencé pour tenir le poids d'éléments de support dudit réservoir (14) ;
- un capteur de niveau, en particulier un capteur optique ou capteur à impulsions ultrasonores ou capteur flottant, qui est situé dans ledit réservoir, et configuré pour mesurer la distance de la surface de liquide (14a) du liquide depuis une paroi inférieure ou une paroi supérieure dudit réservoir (14).

3. Machine de traitement de surface selon la revendication 2, dans laquelle ledit élément de réglage (26) est sélectionné dans le groupe consistant en :

- une vanne pilotée, dans laquelle ladite unité de commande (30) est configurée pour régler une section d'ouverture dans une voie d'administration par impulsions de ladite vanne, avec un cycle de service t % prédéterminé, en réglant le temps d'ouverture de ladite vanne de manière croissante en réponse à une diminution du niveau de liquide P_1 selon ladite fonction $f(P_1)$;
- une pompe réglable, dans laquelle ladite unité de commande (30) est configurée pour amener la pompe à administrer par impulsions le liquide, avec un temps de service t% prédéterminé, en réglant un débit d'administration par impulsions de ladite pompe d'une manière croissante en réponse à la diminution du niveau de liquide P_1 selon ladite fonction f(P1).

4. Machine de traitement de surface selon la revendication 1, dans laquelle ledit paramètre de fonctionnement P est une mesure du débit P_2 de liquide qui arrive à ladite bouche de distribution (15), et ledit capteur (20) est un capteur de débit (22), en particulier un débitmètre ou compte litres, qui sont situés entre ledit réservoir (14) vers ladite bouche de distribution (15) configuré pour fournir un signal P_2 proportionnel audit débit, ladite fonction f(P) étant une fonction $f(P_2)$ d'optimisation du débit calculée sur ladite valeur P_2, et ledit élément de réglage (26) est sélectionné dans le groupe consistant en :

- une vanne pilotée, configurée pour administrer par impulsions le liquide, avec un cycle de service t % prédéterminé, dans laquelle ladite unité de commande (30) est configurée pour régler ledit cycle de service t % selon ladite fonction $f(P_2)$;
- une pompe réglable, configurée pour administrer le liquide par impulsions, avec un cycle de service t % prédéterminé, dans laquelle ladite unité de commande (30) est configurée pour régler un débit d'administration par impulsions de ladite pompe selon ladite fonction $f(P_2)$.

5. Machine de traitement de surface selon la revendication 2, ou 4, dans laquelle ledit paramètre de fonctionnement P est une combinaison d'une mesure P_3 de la vitesse de translation dudit cadre (11) et d'une mesure P_1 du niveau de liquide présent dans ledit réservoir (14) ou d'une mesure P_2 du débit de liquide qui arrive à ladite bouche de distribution (15), ladite fonction f(P) configurée pour maximiser la plage de la machine de ladite machine en partant des réglages de ladite machine donnés par la nature de ladite surface et/ou les conditions environnementales, ladite plage de la machine étant calculée en tant que temps résiduel ou surface résiduelle qui peut être traitée par ladite machine avant remplissage de liquide dans ledit réservoir.

6. Machine de traitement de surface selon la revendication 1, dans laquelle ladite unité de commande (30) est associée à une unité d'affichage (60) dudit paramètre de fonctionnement et d'une valeur de plage de la machine calculée sur la base de valeurs instantanées de ladite fonction f(P), ladite plage de la machine étant calculée en tant que temps résiduel ou surface résiduelle qui peut être traitée par ladite machine avant remplissage de liquide dans ledit réservoir.

7. Procédé (10) de traitement de surfaces, comprenant les étapes de :

- translation d'une machine de traitement de surface par rapport à une surface (12) à traiter, ladite machine ayant un élément de traitement de surface (13) relié à un cadre (11) ;
- administration, au niveau dudit élément de traitement de surface (13), d'un liquide de traitement, de telle sorte que ledit élément de traitement de surface (13) traite avec ledit liquide ladite surface (12) pendant ladite translation ;
- ledit liquide de traitement étant prélevé d'un réservoir (14) relié audit cadre (11), afin de fournir ledit liquide audit élément de traitement de surface (13) à travers une bouche de distribution (15) ;
- réglage (26) de ladite distribution du liquide fourni depuis ledit réservoir (14) à ladite bouche de distribution (15) ;

caractérisé en ce qu'il comprend en outre :

- la mesure par un capteur (20) d'un paramètre de fonctionnement P de ladite machine, sélectionné dans le groupe consistant en : niveau P_1 de liquide résiduel dans le réservoir (14), débit réel P_2 du liquide depuis ledit réservoir (14) vers ladite bouche de distribution (15),
- dans lequel ledit réglage (30) est réalisé sur la base d'un signal proportionnel audit paramètre de fonctionnement P et dudit élément de réglage (26) en réponse audit paramètre de fonctionnement P, afin d'administrer par impulsions ledit liquide avec un cycle de service t %, exprimé en tant que rapport entre la durée d'une impulsion de l'étape d'administration par impulsions et le temps entre deux impulsions consécutives, déterminé selon une fonction t % = f(P) prédéterminée d'optimisation du débit, dans lequel ladite fonction f(P) est sélectionnée dans le groupe consistant en :

$$t\,\% = f(P_1) = K_1 * P_1^{-1/2} \qquad (1)$$

$$t\,\% = f(P_2) = K_2 * P_2^{-1} \qquad (2).$$

Fig. 1

(prior art)

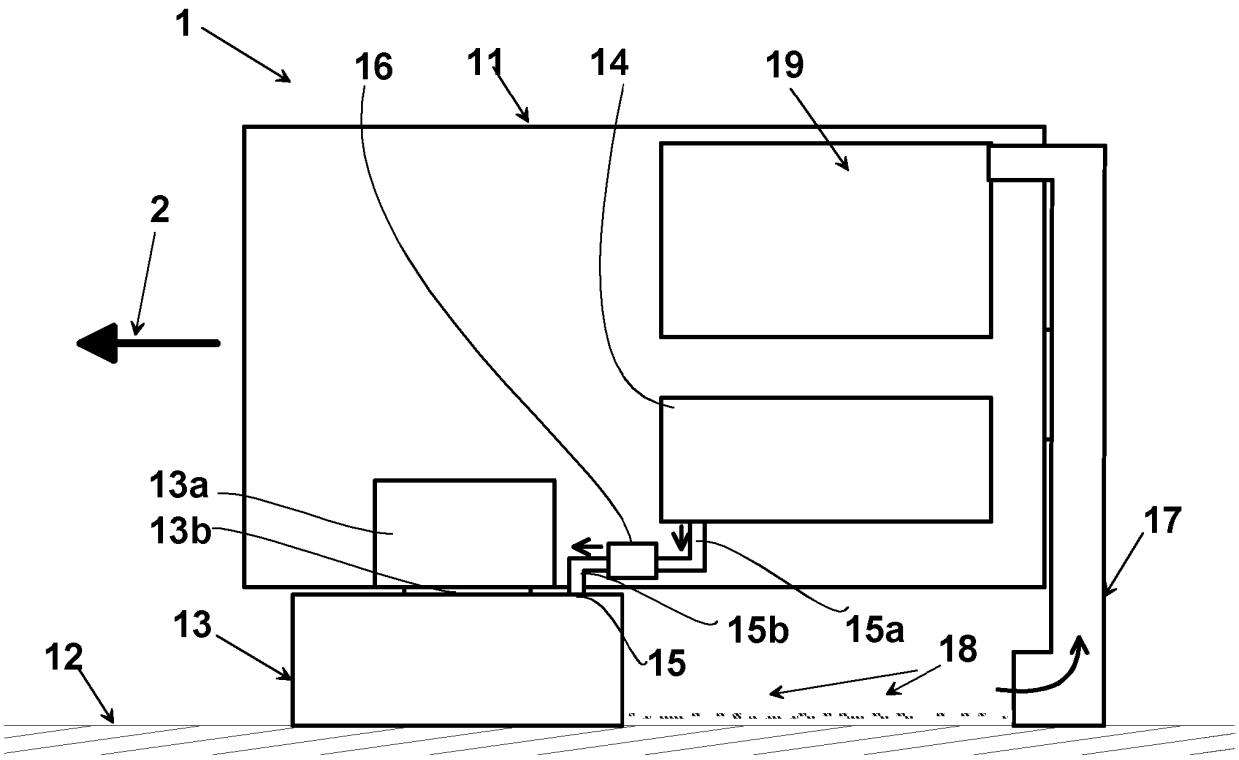


Fig. 2

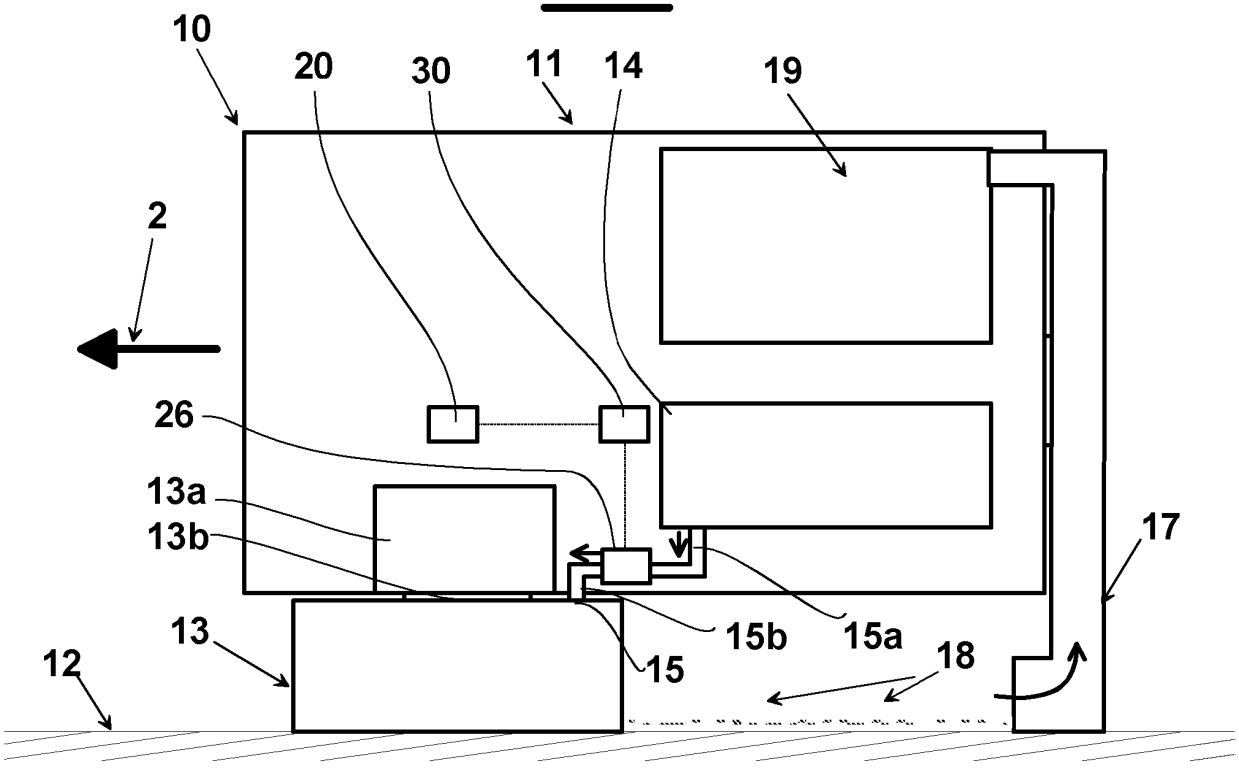


Fig. 3

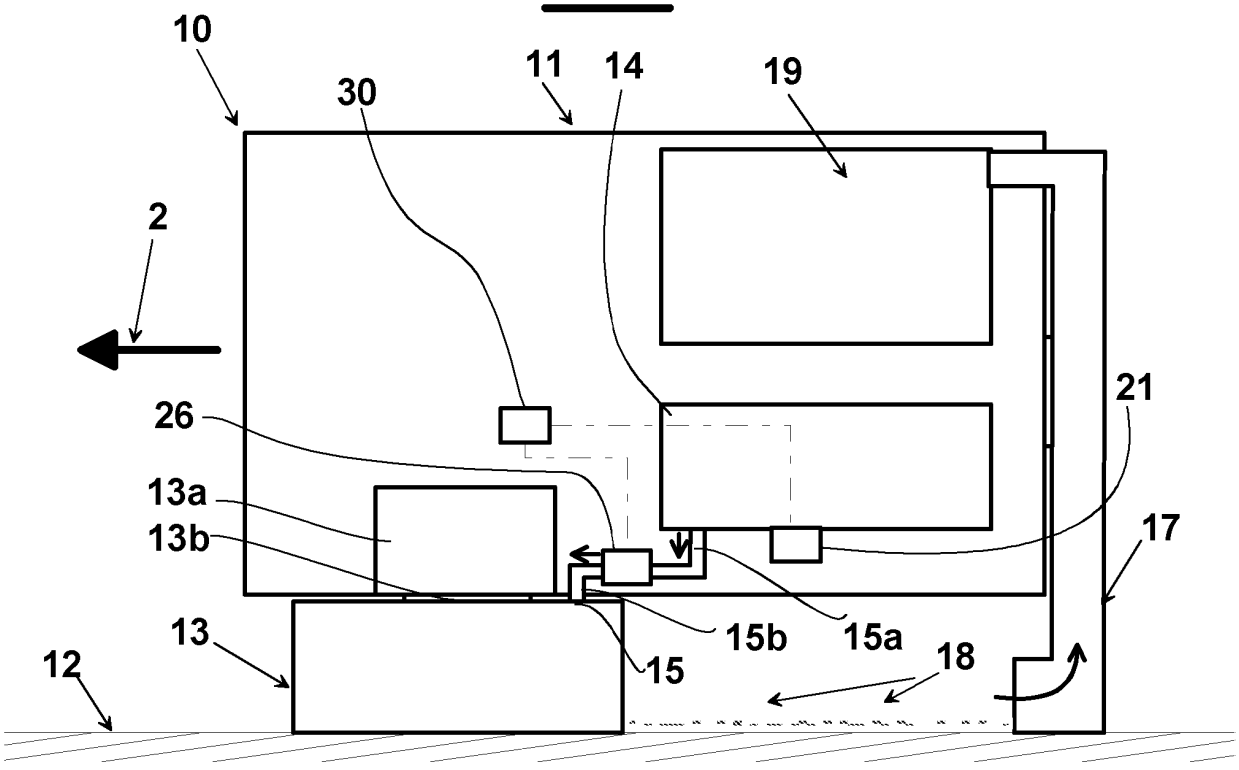


Fig. 4

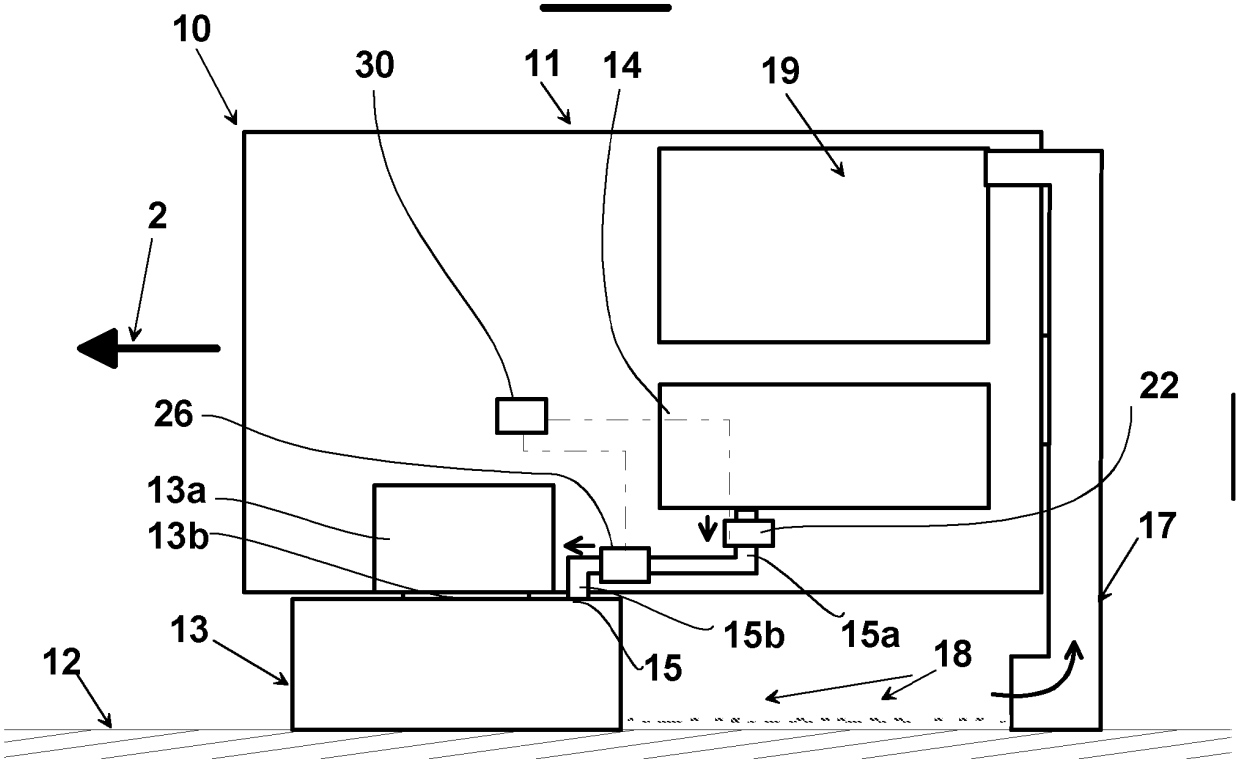


Fig. 5

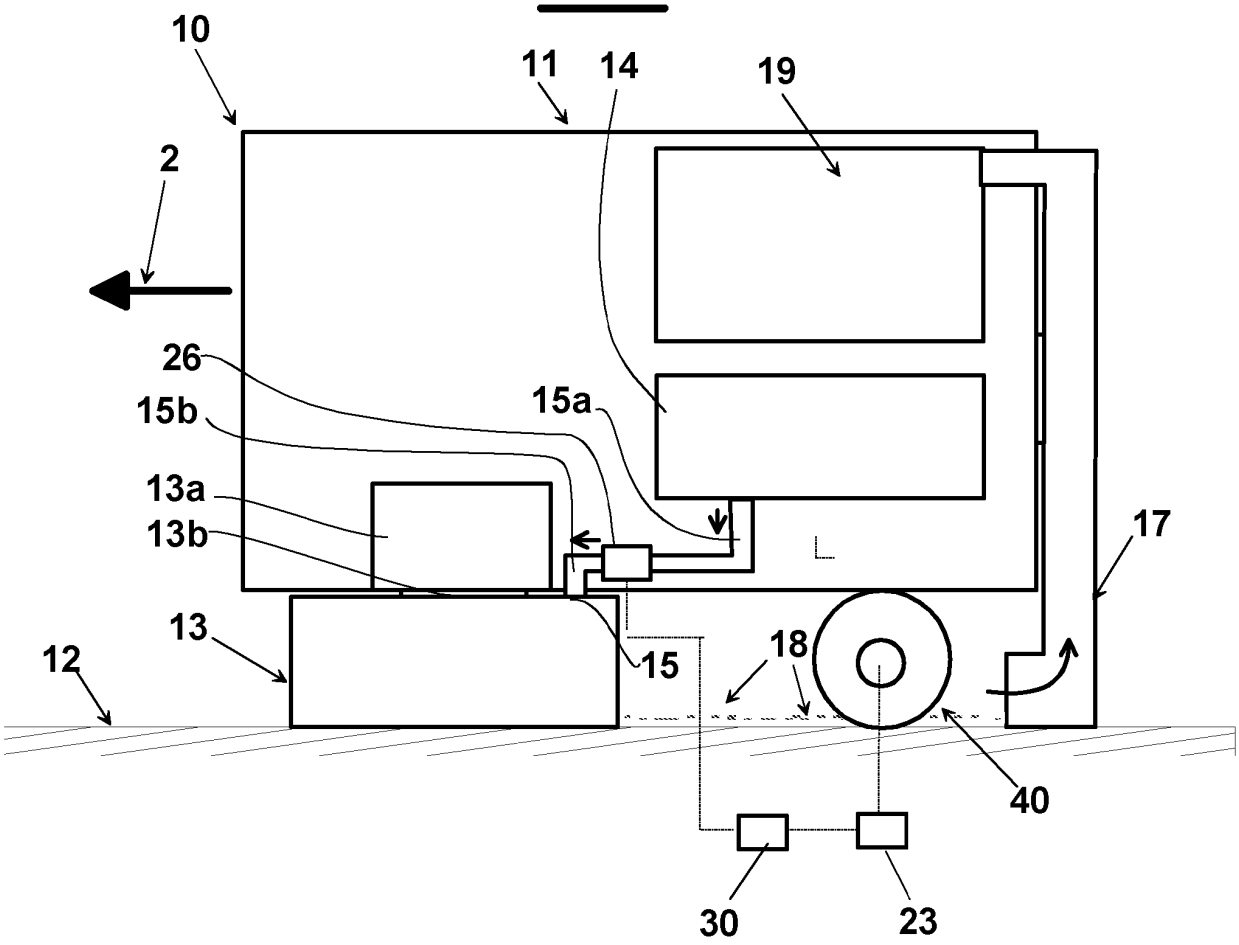
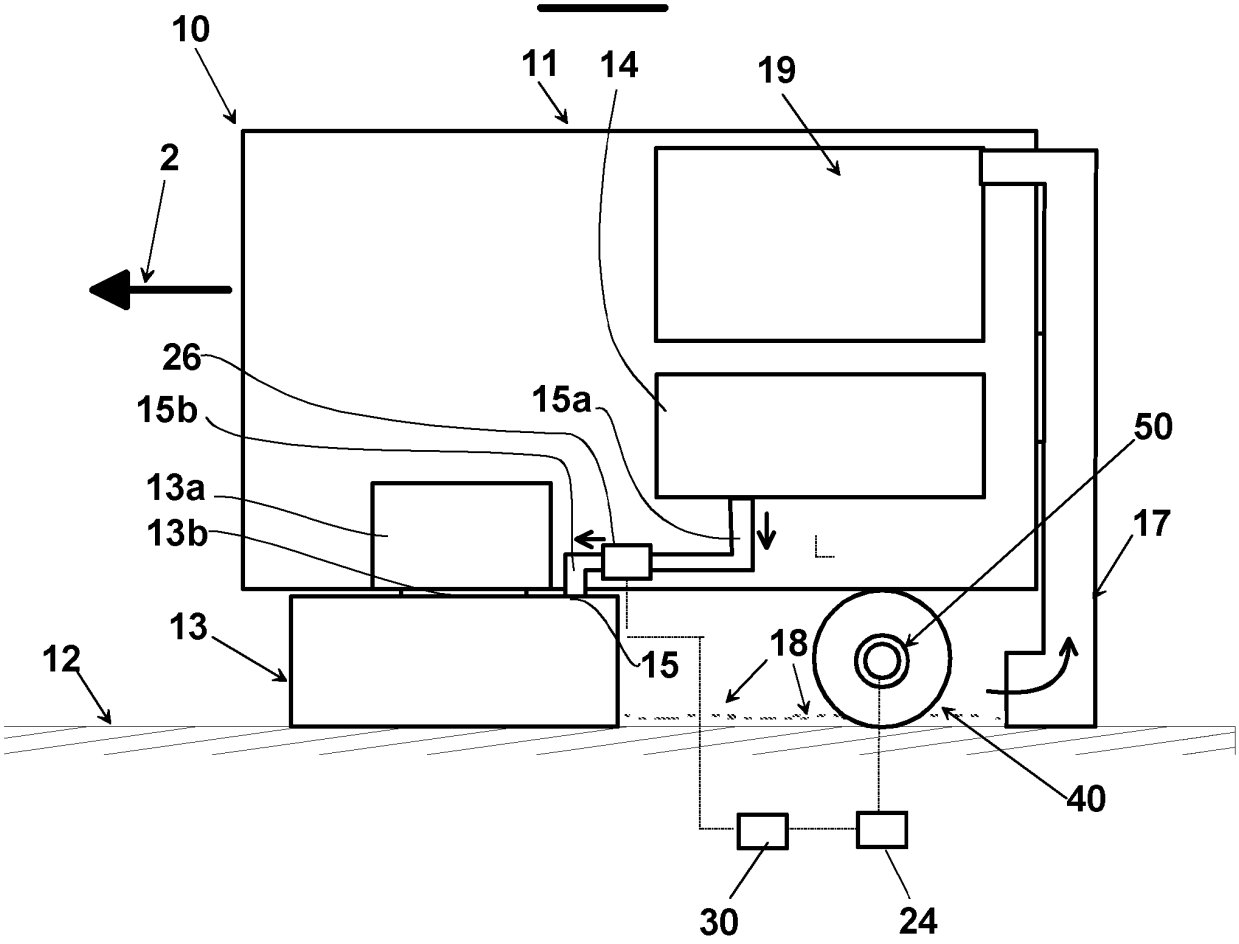


Fig. 6



REFERENCES CITED IN THE DESCRIPTION

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