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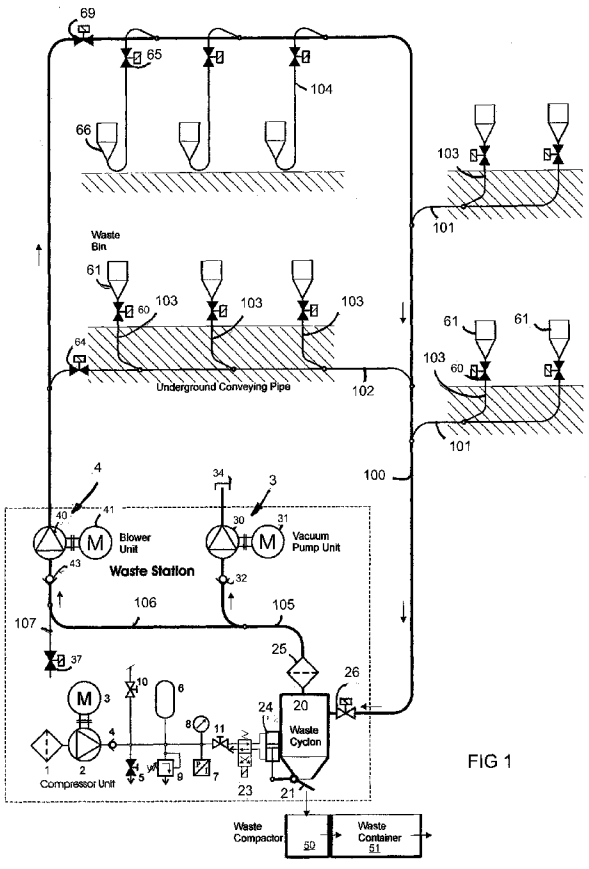

FIG 1

(57) Abstract: A method for feeding and conveying material in a pneumatic material conveying system, such as a waste conveying system, which conveying system comprises at least one feed point (61) of material, particularly of waste material, a material conveying pipe (100) which is connectable to the feed point (61), a separator device (20) in which the material being conveyed is separated from conveying air, and means (3, 4) for providing a pressure difference in the conveying pipe (100) at least during the conveyance of the material. Underpressure is provided in the conveying pipe (100) at least at the point of the feed point (61) intended to be emptied, the feed points are emptied to the conveying pipe (100) using an emptying sequence in which first is emptied a feed point located closer to the separator device (20) in the material conveying direction and next a feed point (61) located substantially farther from the separator device (20) in the material conveying direction.

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METHOD IN PNEUMATIC MATERIAL CONVEYING SYSTEM AND A PNEUMATIC MATERIAL CONVEYING SYSTEM

Background of invention

The invention relates to a method according to the preamble of claim 1.

The invention also relates to a method according to claim 2.

The invention further relates to a pneumatic material conveying system according to claim 17.

The invention relates generally to pneumatic conveying systems, such as vacuum conveying systems, particularly to collecting and conveying waste, such as conveying household waste.

Systems are known in which waste is conveyed in a piping by means of suction. In these, waste is conveyed for long distances in the piping by suction. Apparatuses are utilised, inter alia, for conveying waste in different institutions. Typical for them is that a vacuum apparatus is used for achieving a pressure difference, in which apparatus underpressure in the conveying pipe is provided with vacuum generators, such as vacuum pumps or an ejector apparatus. In the conveying pipe, there is typically at least one valve element by opening and closing of which make-up air coming in the conveying pipe is regulated. The vacuum conveying systems typically contain, inter alia, the following problems: high energy consumption, high air flow in the piping, problems with noise, dust and fine particles in the outlet pipe.

An object of this invention is to achieve a totally novel arrangement into connection with material conveying systems by means of which the disadvantages of known arrangements are avoided. A second object of the invention is to provide an arrangement applicable for vacuum conveying systems by means of which the noise problems of material feed can be decreased.

Brief description of invention

The invention is based on an idea in which the material feed of feed points of a pneumatic material conveying system to the conveying pipe is controlled in a specified sequence so that a passage from the previous feed point to the conveying pipe has not closed before a passage of the next feed point to the conveying pipe opens.

The method according to the invention is mainly characterised by providing underpressure in the conveying pipe at least at the point of the feed point intended to be emptied, by emptying the feed points to the conveying pipe using an emptying sequence in which first is emptied a feed point located closer to the separator device in the material conveying direction and next a feed point located substantially farther from the separator device in the material conveying direction.

In addition, the method according to the invention is characterised by what is stated in claims 2–16.

Furthermore, the material conveying system according to the invention is mainly characterised in that the material conveying system is arranged to use at least one method stated in claims 1–16.

The arrangement according to the invention has numerous significant advantages. By opening and closing the feed points of the system according to the invention, the material is provided with an effective transfer into and conveyance in the conveying pipe when, at the same time, the noise effect caused by the operation of the system can be minimised. By arranging the conveying pipe of the material conveying system to consist of operating areas i.e. partial circuits, it is possible to effectively arrange the conveyance of the material in the conveying piping and emptying the feed points into the conveying pipe. By arranging the piping of the system to comprise a circuit where at least part of conveying air circulates, the volume of outlet air can be decreased. At the same time, the energy consumption of the system is minimised. By maintaining underpressure and simultaneously blowing, it is possible to provide an effective circulation of conveying air in the circuit and conveyance of material in the conveying pipe. With the arrangement according to the invention, it is possible to decrease the volume of outlet air substantially and simultaneously to decrease possible problems with dust and fine particles in the outlet pipe. The arrangement according to the invention also substantially decreases the noise problem caused by prior art. Moisture

accumulated in the piping is minimised and the piping can be dried by circulating air in the piping. As the volume of air being sucked inside decreases, also energy consumption decreases.

Brief description of figures

In the following, the invention will be described in detail by means of an example with reference to the accompanying drawings in which

Fig. 1 schematically shows a system according to an embodiment of the invention,

Fig. 2 schematically shows a system according to a second embodiment of the invention and

Fig. 3 schematically shows a system according to a third embodiment of the invention.

Detailed description of invention

Fig. 1 schematically shows a pneumatic material conveying system, particularly a waste material conveying system. Figs. 1 and 2 shows the underlying basic principles of the material conveying system of the invention and Fig. 3 shows an embodiment of the invention.

In Fig. 1, reference number 61, 66 designates a feed station of materials, particularly of waste material, intended to be conveyed, from which station material, particularly waste material, such as household waste, intended to be conveyed is fed to the conveying system. The system can comprise several feed stations 61, 66 from which the material intended to be conveyed is fed to a conveying piping 100, 101, 102, 103, 104. Typically, the conveying piping comprises a main conveying pipe 100 into which several branch conveying pipes 101, 102 can have been connected and into which again several feed stations 61, 66 can have been connected via feed pipes 103, 104. The fed material is conveyed along the conveying piping 100, 101, 102, 103, 104 to a separator device 20 in which the material being conveyed is separated, e.g. due to dropping rate and centrifugal force, from conveying air. The separated material is removed, e.g. when required, from the separator device 20 to a material container, such as a

waste container 51, or to further treatment. The material container can comprise, as in the embodiment of the figures, a waste compactor 50 from which the material is further conveyed to the waste container 51. In the embodiment of Fig. 1, the separator device 20 is provided with material outlet elements 21, 24. From the separating device 20, a pipe 105 leads to means 3 for generating underpressure in the conveying pipe. In the embodiment of Fig. 1, the means for generating underpressure comprise a vacuum pump unit 3. With the means for generating underpressure, underpressure required for conveying the material is provided in the conveying piping 100, 101, 102, 103, 104. The vacuum pump unit 3 comprises a pump 30 which is operated by an actuator 31.

According to the invention, the system further comprises a blower unit 4 which is connected in the embodiment of the figure from the blowing side to the conveying pipe 100. The conveying pipe 100 is a section of a circuit which in the embodiment of the figure consists of the main conveying pipe 100, the separator element 20 and the pipes 105 and 106. The blower unit 4 comprises a blower 40 and its actuator 41. The blower 40 of the blower unit 4 is arranged from the suction side to the pipe 105, 106 coming from the separating device 20. The conveying pipe 100 is thus connected to the blower 40 on its blowing side. In the main conveying pipe is arranged at least one valve element 69 typically between the blower 40 of the blower unit 4 and the feed pipes 103 and/or branch conveying pipes 101, 102 in the blowing direction of the blower 40. The blower also generates underpressure together with the vacuum generator.

The valve element 64 and 69 being in the closed position, the blower 40 raises pressure to a section between the blower and the valve element 69 in the conveying pipe 100. Equivalently in a section of the circuit on the suction side of the vacuum generator 3 and/or the blower 40, when travelling against the conveying direction and/or the air flow direction, which comprises in the embodiment of the figure the pipes 105, 106, the separator device 20 and a section of the main conveying pipe 100 from the separating device as far as the valves 69, underpressure prevails when the valves 69, 64 and the valves 60, 65 of the feed stations 61, 66 to the conveying pipe are closed.

In the embodiment of Fig. 1, the branch conveying pipe 102 extends from the pressure side of the main conveying pipe 100 to the suction side of the main conveying pipe i.e. forms a section of a smaller circuit. In the branch conveying

pipe 102, at its end on the side of the pressure side of the main conveying pipe, is arranged the valve 64. The valve 64 of the branch conveying pipe being open and the valve 69 of the main conveying pipe being closed, a smaller circuit is formed in the embodiment of the figure in which air circulates from the blower 40 from the pressure side of the main conveying pipe via the branch conveying pipe 102 to the suction side of the main conveying pipe and further via the separator device to the pipe 105 and 106. When the vacuum pump unit runs, part of air circulating in the circuit is led to an outlet 34.

In the embodiment according to Fig. 1, into the main conveying pipe 100 are connected two first branch conveying pipes 101. In the figure, into both first branch conveying pipes 101 are connected two feed stations 61. Into the second branch conveying pipe 102 are connected three feed stations 61 by means of feed pipes 103. However, there can be more of them, e.g. 20. They can be opened and the material conveyed to the conveying pipe stepwise, first the one closest in relation to the separator element, then the next closest etc.

In the upper part of the figure, there are further three feed stations 66 connected directly to the main conveying pipe via feed pipes 104.

The sum of suctions provided by the vacuum unit 3 and the blower unit 4 to the conveying pipe 100, in the figure from the side of the separator element, is advantageously greater than the blowing provided by the blower unit, whereby conveyance takes place in underpressure. With the blower 40, it is typically possible to provide pressure which is e.g. in the range of 0.1-0.5 bar. With the vacuum generators, it is again typically possible to provide underpressure which is e.g. in the range of 0.1-0.5 bar. The blowing stores energy (i.e. overpressure) in the section of the conveying pipe 100 between the blower 40 and the valve 69 (and the valve 64) along with the rise of pressure, when the valves 69, 64 are closed, e.g. +0.5 bar. The suction of the vacuum unit 3 stores on the other side i.e. to the section of the valve 69 and the separator element 20 (and the pipe 105) underpressure which is e.g. -0.5 bar. When at least one of the valves 69, 64 opens, the pressure difference can then be even 1 bar. The suction being greater than blowing, underpressure is provided in the piping, whereby waste can be sucked inside the piping from a funnel of the feed station 61.

The suction being greater than the blowing, which is the target in the system according to the invention, material fed to the conveying pipe, particularly waste material, will not be compressed and compacted, but will be able to travel "freely" in the pipe conveyed by conveying air. Then, the potential of the material being conveyed to form blockages is considerably lower than in a situation in which the blowing is greater than the suction, whereby there is a risk that the material being conveyed will accumulate and block the conveying pipe. Furthermore, underpressure decreases the power required to convey the material, because even partial underpressure in relation to the material portion being conveyed on the side of the conveying direction considerably decreases air drag, among others. In the figure, arrows designate the direction of motion of air in the piping in the operating mode.

In conveying material, such as conveying waste material, when the material of the feed point is first conveyed by suction via the feed pipe 101, 103 or 104 to the conveying pipe, extremely fast acceleration and conveyance are provided for the material.

The conveying power provided by the pressure difference can then be e.g. in a pipe of a diameter of 400 mm about in the range of 12.32 kN (1,256 kp). The pressure side of the conveying pipe 100, i.e. in the example of the figure the section between the blower 40 and the valve 69, 64, can be substantially smaller of its diameter than the suction side of the conveying pipe, i.e. typically at least the section between the valve 69, 64 and the separator element 20. The pressure side can then be formed more advantageous of its diameter and costs.

In the embodiment of the figure, in the pipe 106 on the suction side of the blower is formed a fitting 107 in which there is a valve 37 by opening of which extra air can be brought on the suction side of the blower 4 from outside the circuit. By opening the valve 37, it is possible to raise the pressure of air in the conveying pipe if required and to provide an increased conveying rate for conveying the material.

To the feed pipes 103, 104 is arranged the outlet valve 60, 65 which is opened and closed so that material portions of suitable size are conveyed from the feed point 61, 66 to the branch conveying pipe 101, 102 or directly to the main conveying pipe 100. Material is fed from the feed point 61, 66, such as a waste

container, when after the container is full, the outlet valve 60, 65 is opened either automatically or manually.

The system typically operates as follows: An outlet hatch 21 of the separator device 20 is closed and a valve 26 between the main conveying pipe 100 and the separator device 20 is open. The vacuum pump unit 3 and/or the blower unit 4 maintains underpressure in the main conveying pipe 100. A suction effect provided by the vacuum unit 3 and the blower unit 4 together via the separator device 20 to the conveying pipe 100 is greater than a pressure effect provided by the blower unit 4 to the conveying pipe 100 at its one end i.e. to the blowing side, to the section between the blower 40 and the valve 69 or the valve 64.

All outlet valves 60, 65 in the vicinity of the feed points i.e. waste containers are closed. In the start situation, the area valve 64 of the branch conveying pipe 102 and the line valve 69 of the main conveying pipe 100 are closed.

Let us assume that a waste container of the feed point 61 belonging to the area of the first branch conveying pipe 101 is to be emptied. Based on an emptying signal, the outlet valve 60 is momentarily opened, e.g. for 2–10 seconds, whereby the material being conveyed, such as waste material, conveys from the effect of underpressure to the branch conveying pipe and further to the main conveying pipe 100. The outlet valve 60 is typically closed after a few seconds after the start situation. The vacuum pump unit 3 maintains desired underpressure and the blower unit 4 starts unless not already running. The valve 69 is opened, whereby in the piping is provided blowing i.e. an intensified pressure effect and suction effect which conveys the material portion being conveyed along the piping to the separator device 20.

When the separator device 20 is full, the valve 26 of the conveying pipe 100 closes and a control valve 23 opens, whereby the actuator 24 of the outlet hatch 21 of the separator device opens the outlet hatch 21 and the material accumulated in the separator device is emptied in the compactor device 50 and further in the waste container 51. The outlet hatch 21 of the separator device 20 is closed and the valve 26 opened.

After this, the start situation is reverted and the emptying process can be repeated or the emptying of some other feed point/feed points can be implemented.

The waste container 51, such as a waste freight container, is replaced or emptied when it is full.

In waste conveyance, it is possible to optimise air circulation and blowing so that the blowing is always directed as close as possible to the material portion being conveyed. If a material portion fed directly via the feed point 66 is being conveyed, first is opened the valve 69 in the main conveying pipe 100. After the material portion has passed the connecting point of the branch conveying pipe 102 and the main conveying pipe 100 in the case of the figure, the valve 64 of the branch conveying pipe is opened and the valve 69 of the main conveying pipe is closed, whereby the blowing effect directs at the material portion being conveyed as close as possible and the motion of the material portion can be best maintained in the conveying pipe.

The embodiment according to Fig. 2 schematically shows a more extensive system which comprises several partial circuits A, B, C, D. The system can comprise several circuits the air circulation of which is controllable by means of valve elements A1, B1, C1, D1, AB, CD arranged in pipings 100A, 100B, 100C, 100D, 100AB, 100CD of the partial circuits A, B, C, D. Then, the valves A1, B1, C1, D1 of the blowing side are first closed. The blower raises the pressure in the pipe section between the conveying pipe or a pipe being in connection with it and the valve A1, B1, C1, D1. Equivalently in the section of the circuit on the suction side of the vacuum generator 3 and/or the blower 40, when travelling against the conveying direction and/or the air flow direction, which comprises in the embodiment of the figure the pipes 105, 106, the separator device 20 and the section of the conveying pipes 100AB, 100CD from the separator device 20 to the valves A1, B1 and equivalently as far as C1, D1, underpressure prevails when the valves A1, B1, C1, D1 and the valves 60 of the feed stations 61 to the conveying pipe are closed. Part of the circuits can be out of air circulation and the air circulation is only controlled to those one or more circuits of the system from which the material is conveyed. Typically on the underpressure side in the start situation, the valves AB and CD to the partial circuits are open, but typically the valve of the circuit to be activated is kept open and the valve of the circuit to be non-activated is closed.

The system comprises a pipe network which includes four partial circuits A, B, C and D. Each partial circuit contains the pipelines 100A, 100B, 100C, 100D which are in the circulation direction of conveying air connectable from the inlet side to the pipeline 100 coming from the blower device 4 by opening and closing the valve elements A1, B1, C1, D1. In the embodiment of the figure, the conveying pipes 100A, 100B of the circuits A and B are combined as the conveying pipe 100AB which leads to the separator device 20. Equivalently, the conveying pipes 100C, 100D of the circuits C, D are combined as the conveying pipe 100CD which leads to the separator device 20. In the example of the figure, arrows designate the circulation of conveying air in the circuits in a situation in which the circuits are connected active. Equivalently, the material being conveyed travels in the direction of the arrows to the separator device from one of the material feed points arranged along the circuits.

The invention thus relates to a pneumatic material conveying system, particularly a waste conveying system, which conveying system comprises at least one feed point 61, 66 of material, particularly of waste material, a material conveying pipe 100, 101, 102 which is connectable to the feed point 61, 66, a separator device 20 in which the material being conveyed is separated from conveying air, and means 3, 4 for providing a pressure difference in the conveying pipe 100, 101, 102 at least during the conveyance of the material. At least a part of the conveying pipe 100 and conveying air channels 105, 106 is formed as at least one circuit in which the suction side of at least one vacuum generator 3 is connected. The system further comprises at least one blower 40 the suction side of which is connected to the air channel 105, 106 coming from the separator device 20 of the circuit and the blowing side to the conveying pipe 100 or a section of the circuit being in connection with or being connectable with the conveying pipe so that it is possible to circulate air with the blower 40 in said circuit, and in the circuit is arranged at least one valve element 69 between the blower 40 and at least one material feed point 61, 66. The valve divides the circuit into the pressure side and the suction side on which pressure side is providable overpressure, at least when the valve element 69 of the circuit is closed, and on the suction side underpressure. The valve 69 is arranged to open at least during the conveyance of the material.

The system can comprise several circuits the air circulation of which is controllable by means of the valve elements 69, 64 arranged in the partial circuits. Then, part

of the circuits can be out of air circulation and the air circulation is only controlled to those circuits of the system from which the material is conveyed.

According to an advantageous embodiment, underpressure provided by devices 3, 4 generating underpressure of the circuit activated in the system i.e. suction in the material conveying pipe 100 or its section is greater than the pressure effect i.e. blowing provided by at least one blower 4.

According to a typical embodiment, the vacuum generator 3 is a vacuum pump.

According to another embodiment, the vacuum generator 3 is an ejector pump device. The ejector pump device can be e.g. a hydraulic ejector device, particularly an ejector device operated with liquid mist, whereby it decreases possible emissions of particles, impurities and odours of the system.

According to an advantageous embodiment of the invention, the main part of conveying air is circulated in the circuit. This is an extremely advantageous embodiment, because it considerably decreases the volume of outlet air of the system and, at the same time, emissions of particles and impurities.

According to an embodiment of the invention, only part of conveying air is led out of the circuit.

According to an embodiment of the invention, the vacuum pump unit 3 is arranged to provide basic underpressure in the conveying piping 100.

Typically, the blower device 4 is arranged to circulate conveying air in the circuit.

The vacuum generator 3 and/or the blower device 4 is arranged to intensify at least momentarily the conveying effect of material provided by at least one vacuum generator 3 and/or blower device 4 in the conveying piping 100, 101, 102. Typically, by the rise of pressure provided by the blower 40, it is possible to intensify the start-off of material and to increase the material conveying rate when the valve 69, 64 of the circuit is opened. Alternatively, it is possible to decrease the total power consumption.

According to an advantageous embodiment of the invention, the material conveying system is a waste conveying system.

According to an advantageous embodiment, the material feed points 61, 66 are advantageously waste feed points, such as waste bins or waste chutes.

In the embodiment of Fig. 1, the separator element 20, which is a so-called waste cyclone, the vacuum pump devices 3, the blower unit 4 and the compressor unit 1, which drives the emptying mechanism of the separator element, are located at the delivery end of material of the material conveying system i.e. particularly in a waste conveying system into connection with a waste station.

In a case according to the invention, the conveying pipe 100 is at least a section of a suction/blowing circuit, the output end and inlet end of which are advantageously arranged into connection with the waste station and in which the output end of the suction/blowing circuit is on the blowing side of the blower 40 and the inlet end on the suction side of the blower 40. The blower can then, the valve 69 being open, circulate air in the suction/blowing circuit a section of which is formed by the conveying pipe 100. The feed points 61, 66 can be located decentralised along the system pipings distributedly. In connection with the waste conveying system, the feed points can be e.g. waste bins or waste chutes.

In a case according to the invention, the conveying pipe 100 is at least a section of a suction/blowing circuit, the output end and inlet end of which are advantageously arranged into connection with the waste station and in which the output end of the suction/blowing circuit is on the blowing side of the blower 40 and the inlet end on the suction side of the blower 40. The blower can circulate air in the suction/blowing circuit a section of which is formed by the conveying pipe 100. The feed points 61, 66 can be located decentralised along the system pipings distributedly. In connection with the waste conveying system, the feed points can be e.g. waste bins or waste chutes.

Fig. 3 shows an advantageous embodiment of a system according to the invention. In the figure, the feed stations or feed points 61 and gate elements 60 in connection with them are diagrammatically designated along the conveying piping 100 with one circle. The feed point 61 typically comprises a feed container, such as a funnel, and the valve element 60 by which a connection from the feed point to

the conveying pipe 100 is closed and opened. The system conveying piping 100 and the feed points 61 along with it are dividable by area valves V_A, V_{AB}, V_{BC}, V_{BE}, V_{BE},...etc. arranged in the conveying piping to operating areas A, B, C, D, E, F, G, H, I. In the figure, each part of the conveying piping 100 of the operating area is designated with the letter of the corresponding operating area, whereby at the point of the operating area A the conveying pipe is designated with 100A and at the point of operating area B the conveying pipe is designated with 100B. A corresponding designation is used for the other operating areas. The operation of the system is controlled so that, for emptying the feed points of a desired operating area, at least one valve is open in the material conveying direction in relation to the operating area of the conveying pipe 100 and on the supply side of the conveying air i.e. on the side of suction, whereby the suction is able to affect the conveying pipe of the operating area. Let us assume that, in the arrangement according to the figure, the feed points 61 of the area A are to be emptied. Then, all area valves between the separator element 20 and the operating area A in the conveying pipe 100 (the sections 100B, 100C, 100D of the conveying pipe in the figure) in the conveying direction are open (the valves V_{AB}, V_{BC}, V_{CD}, V_D in the figure). Then, suction provided by at least one vacuum generator 3 prevails in the conveying piping 100A in the operating area A. At least one valve V_A on the blowing side of the conveying pipe 100A is closed, whereby only suction prevails in the operating area A. The feed points 61 of the operating area or at least part of them are emptied so that the connection of the feed point 61 (1) closest to the delivery end in the conveying direction of the conveying pipe, i.e. in the embodiment according to the figure closest to the separator device 20, to the conveying pipe 100A is opened first, whereby the material is able to convey from the first feed point to the conveying pipe, and before the connection of the first feed point (1) to the conveying pipe closes, the connection of the next feed point 61 (2) to the conveying pipe is opened. In the embodiment of the figure, this is, when travelling against the material conveying direction, the next feed point 61 (2) intended to be emptied. After this, the connection of the first feed point 61 (1) is closed to the conveying pipe. Equivalently, the connection of the third feed point 61 (3) intended to be emptied to the conveying pipe is opened before the connection of the second feed point 61 (2) to the conveying pipe is closed. This operation is repeated until all desired feed points have been emptied. In the figure, it has been considered emptying all the feed points 61 of the area A, whereby their emptying sequence to the conveying pipe 100, 100A is designated in the figure by numerals within parentheses: (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), and (11).

When the passage of the last feed point 61 (11) intended to be emptied in the operating area A to the conveying pipe 100 has been opened, the material has conveyed to the conveying pipe 100, 100A and the passage of the feed point to the conveying pipe is closed, a connection is opened in the conveying pipe 100A of the operating area A from the blowing side i.e. the blower 4 by opening at least one valve element V_A which is between the operating area A and the blower device 4 blowing to the conveying pipe 100. Then, an intensified conveying effect (suction and blowing together) is provided for the material being conveyed transferred in the conveying pipe 100, 100A, 100B, 100C, 100D. The conveying air circulates on a route designated with arrows in the figure, whereby material portions conveyed from the feed points to the conveying pipe convey in the conveying piping on the route, in the example of the figure, which passes the areas B, C and D, and further to the separator element 20 in which the material being conveyed is separated from conveying air. In the figure, the area valves V_{BE} and V_{ED} of the conveying pipe 100E of the operating area E are closed, whereby conveying air and material being conveyed are not able to access the conveying pipe 100E of the operating area E but circulate via the conveying pipe 100C of the area C. In connection with the emptying of different operating areas, the material conveying route from the operating area to a delivery station, such as to the separator element 20, can be optimised by keeping the area valves open along the desired conveying route.

Material is conveyed in the conveying pipe to the separator device 20. The separator device 20 is emptied when required, e.g. to the material container 51, in connection with which there can be the compactor device 50. In the system according to the figure, a second separator device 20' is further arranged in the conveying air channel after the separator element for separating smaller particles from conveying air. The particles separated by the second separator element 20' can be conveyed e.g. by a conveyor to the material container 51. The second separator element is followed in the conveying air channel in the air circulation direction by a filter element for removing small particles from conveying air. The air channel is connected on the suction side of the vacuum generator 3 and the conveying air channel branches before the vacuum generator 3 to a second conveying air channel which is connected on the suction side of the blower device 4. The blowing side of the blower device is connected directly or via the air channel to the conveying pipe 1000. The conveying piping 100 comprises at least one circuit in which conveying air can be circulated from the blowing side of the

blower via the separator element 20 on the suction side. It is possible to regulate with the valves which one or ones of the operating areas A, B, C, D, E, F, G, H, I are connected to the active conveying circuit of the conveying pipe 100.

The invention relates to a method for feeding and conveying material in a pneumatic material conveying system, such as a waste conveying system, which conveying system comprises at least one feed point 61 of material, particularly of waste material, a material conveying pipe 100 which is connectable to the feed point 61, a separator device 20 in which the material being conveyed is separated from conveying air, and means 3,4 for providing a pressure difference in the conveying pipe 100 at least during the conveyance of the material. The invention is mainly characterised by providing underpressure in the conveying pipe 100 at least at the point of the feed point 61 intended to be emptied, by emptying the feed points to the conveying pipe 100 using an emptying sequence in which first is emptied a feed point located closer to the separator device 20 in the material conveying direction and next a feed point 61 located substantially farther from the separator device 20 in the material conveying direction.

The invention also relates to a method for feeding and conveying material in a pneumatic material conveying system, such as a waste conveying system, which conveying system comprises at least one feed point 61 of material, particularly of waste material, a material conveying pipe 100 which is connectable to the feed point 61, a separator device 20 in which the material being conveyed is separated from conveying air, and means 3,4 for providing a pressure difference in the conveying pipe 100 at least during the conveyance of the material. In the method, underpressure is provided in the conveying pipe 100 at least at the point of the feed point 61 intended to be emptied, the feed points are emptied in the conveying pipe 100 by using an emptying sequence in which:

- a connection is opened from the feed point 61 to the conveying pipe so that material conveys from the feed point to the conveying pipe,
- the following steps are repeated until all desired feed points 61 have been emptied
    - a connection is opened at least from one next feed point to the conveying pipe,
    - a connection is closed from the previous feed point to the conveying pipe,

- the connection of the last feed point to be emptied to the conveying pipe is closed,
- a blowing effect is provided in the conveying pipe, whereby the blowing effect together with the suction effect convey the material in the conveying pipe to the separator device.

In an embodiment of a method according to the invention, the feed points 61 are emptied in a reverse sequence in relation to the conveying direction of the material in the conveying pipe. According to an embodiment of the invention, first is emptied a feed point located closer to the separator device 20 in the material conveying direction and next a feed point 20 located substantially farther from the separator device 20 in the material conveying direction.

In accordance with an advantageous embodiment according to the invention, in the method, the system is divided in at least two operating areas and the emptying of at least part of the feed points 61 of at least one operating area A, B, C, D, E, F, G, H, I to the material conveying pipe 100, 100A, 100B, 100C, 100D, 100E, 100F, 100G, 100H, 100I is controlled in a sequence in which first is opened a connection of the first feed point 61 (1) intended to be emptied of the operating area to the conveying pipe, and before the connection of the previous feed point to the conveying pipe is closed, a connection of the next feed point 61 (2) to the conveying pipe is opened, the connection of the previous feed point 61 (1) to the conveying pipe is closed, the emptying of the feed points of the operating area is continued as far as the desired feed points (1)...(11) of the operating area have been emptied in the conveying pipe and the connection of the last feed point (11) to the conveying pipe is closed.

In an embodiment of the method according to the invention, one moves to the next operating area to be handled after the feed points of the previous operating area have been emptied, and the emptying sequence of the feed points is repeated in the next operating area.

The feed points of the operating area A, B, C, D, E; F, G, H, I are emptied to the conveying pipe in a reverse sequence (1), (2)...(10), (11) in relation to the conveying direction.

According to an embodiment of the invention, conveying air is circulated in a circuit which is formed by at least a part of the conveying pipe 100, 100A, 100B, 100C, 100D, 100E, 100F, 100G, 100H, 100I and conveying air channels 105, 106 in which the suction side of at least one vacuum generator 3 is connected and in which the suction side of at least one blower device 4 is connected to the air channel 105, 106 coming from the separator device 20 of the circuit and the blowing side to the conveying pipe 100 or a section of the circuit in connection with the conveying pipe so that it is possible to circulate air with the blower device 4 in said circuit.

According to an embodiment of the invention, conveying air circulation and material conveyance in the system is controlled by opening and closing one or more area valves V_A, V_{AB}, V_{BC}, V_{BE}, V_{BE},...V_H arranged in the conveying piping 100, 100A, 100B, 100C, 100D, 100E, 100F, 100G, 100H, 100I.

In accordance with an embodiment of a method according to the invention, at least the main part of the conveying air is circulated in the circuit a section of which is formed by the conveying piping 100, 100A, 100B, 100C, 100D, 100E, 100F, 100G, 100H, 100I.

According to an embodiment of the invention, underpressure provided by the devices 3, 4 generating underpressure of the circuit activated in the system i.e. suction in the material conveying pipe 100, 100A, 100B, 100C, 100D, etc. is arranged greater than the pressure effect i.e. blowing provided by at least one blower 4.

According to an embodiment of the invention, the vacuum pump unit 3 is used for providing basic underpressure in the conveying piping 100.

According to an embodiment of the invention, at least one blower device 4 is used for circulating the conveying air in the circuit. In accordance with an embodiment of a method according to the invention, the vacuum generator 3 and/or the blower device 4 is arranged to intensify at least momentarily the conveying effect of material provided by at least one vacuum generator 3 and/or blower device 4 in the conveying piping 100, 100A, 100B, 100C, 100D, 100E, 100F, 100G, 100H, 100I.

According to an advantageous embodiment of the invention, the method is used in a waste conveying system.

In accordance with an advantageous embodiment of a method according to the invention, the material feed points 61, 66 are waste feed points, such as waste bins or waste chutes.

The invention also relates to a pneumatic material conveying system which is arranged to use at least one method referred to in claims 1–16 and/or the above description.

It is obvious to those skilled in the art that the invention is not limited to the embodiments described above, but it may be varied within the scope of the enclosed claims. When necessary, the features possibly described in this specification together with other features may also be used separately from each other.

Claims

1. A method for feeding and conveying material in a pneumatic material conveying system, such as a waste conveying system, which conveying system comprises at least one feed point (61) of material, particularly of waste material, a material conveying pipe (100) which is connectable to the feed point (61), a separator element (20) in which the material being conveyed is separated from conveying air, and means (3, 4) for providing a pressure difference in the conveying pipe (100) at least during the conveyance of the material, characterised by providing underpressure in the conveying pipe (100) at least at the point of the feed point (61) intended to be emptied, emptying the feed points in the conveying pipe (100) using an emptying sequence in which first is emptied a feed point located closer the separator device (20) in the material conveying direction and next a feed point (61) located substantially farther from the separator device (20) in the material conveying direction.

2. A method for feeding and conveying material in a pneumatic material conveying system, such as a waste conveying system, which conveying system comprises at least one feed point (61) of material, particularly of waste material, a material conveying pipe (100) which is connectable to the feed point (61), a separator device (20) in which the material being conveyed is separated from conveying air, and means (3, 4) for providing a pressure difference in the conveying pipe (100) at least during the conveyance of the material, characterised by providing underpressure in the conveying pipe (100) at least at the point of the feed point (61) intended to be emptied, emptying the feed points in the conveying pipe (100) using an emptying sequence in which:

- opening a connection from the feed point (61) to the conveying pipe so that material conveys from the feed point to the conveying pipe,
- repeating the following steps until all desired feed points (61) have been emptied
    - opening a connection at least from one next feed point to the conveying pipe,
    - closing a connection from the previous feed point to the conveying pipe,
- closing the connection of the last feed point to be emptied to the conveying pipe,

- providing a blowing effect in the conveying pipe, whereby the blowing effect together with the suction effect convey the material in the conveying pipe to the separator device.

3. A method according to claim 2, c h a r a c t e r i s e d by first emptying a feed point located closer to the separator device (20) in the material conveying direction and next a feed point (61) located substantially farther from the separator device (20) in the material conveying direction.

4. A method according to claim 1 or 2, c h a r a c t e r i s e d by emptying the feed points (61) in a reverse sequence in relation to the material conveying direction of the conveying pipe.

5. A method according to any one of claims 1–4, c h a r a c t e r i s e d by, in the method, dividing the system in at least two operating areas and controlling the emptying of at least part of the feed points (61) of at least one operating area (A, B, C, D, E, F, G, H, I) to the material conveying pipe (100, 100A, 100B, 100C, 100D, 100E, 100F, 100G, 100H, 100I) in a sequence in which first is opened a connection of the first feed point (61) (1) intended to be emptied of the operating area to the conveying pipe and before the connection of the previous feed point to the conveying pipe is closed, a connection of the next feed point (61) (2) to the conveying pipe is opened, the connection of the previous feed point 61 (1) to the conveying pipe is closed, the emptying of the feed points of the operating area is continued until the desired feed points of the operating area have been emptied in the conveying pipe and the connection of the last feed point to the conveying pipe is closed.

6. A method according to claim 5, c h a r a c t e r i s e d by moving to the next operating area to be handled after having emptied the feed points of the previous operating area, and repeating the emptying sequence of the feed points in the next operating area.

7. A method according to claim 5 or 6, c h a r a c t e r i s e d by emptying the feed points of the operating area in the conveying pipe in a reverse sequence in relation to the conveying direction.

8. A method according to any one of claims 1–7, characterised by circulating conveying air in a circuit which is formed by at least a part of the conveying pipe (100, 100A, 100B, 100C, 100D, 100E, 100F, 100G, 100H, 100I) and conveying air channels (105, 106) in which the suction side of at least one vacuum generator (3) is connected and in which the suction side of at least one blower device (4) is connected to the air channel (105, 106) coming from the separator device (20) of the circuit and the blowing side to the conveying pipe (100) or a section of the circuit in connection with the conveying pipe so that it is possible to circulate air with the blower device (4) in said circuit.

9. A method according to any one of claims 1–8, characterised by controlling the conveying air circulation and the material conveyance in the system by opening and closing one or more area valves (V_A, V_{AB}, V_{BC}, V_{BE}, V_{BE},...etc.) arranged in the conveying piping (100, 100A, 100B, 100C, 100D, 100E, 100F, 100G, 100H, 100I).

10. A method according to any one of claims 1–9, characterised by circulating at least the main part of conveying air in the circuit a section of which is formed by the conveying piping (100, 100A, 100B, 100C, 100D, 100E, 100F, 100G, 100H, 100I).

11. A method according to any one of claims 1–10, characterised by arranging underpressure provided by the devices (3, 4) generating underpressure of the circuit activated in the system i.e. suction in the material conveying pipe (100, 100A, 100B, 100C, 100D, 100E, 100F, 100G, 100H, 100I) greater than the pressure effect i.e. blowing provided by at least one blower (4).

12. A method according to any one of claims 1–11, characterised by using the vacuum pump unit (3) to provide basic underpressure in the conveying piping (100).

13. A method according to any one of claims 1–12, characterised by using at least one blower device (4) to circulate conveying air in the circuit.

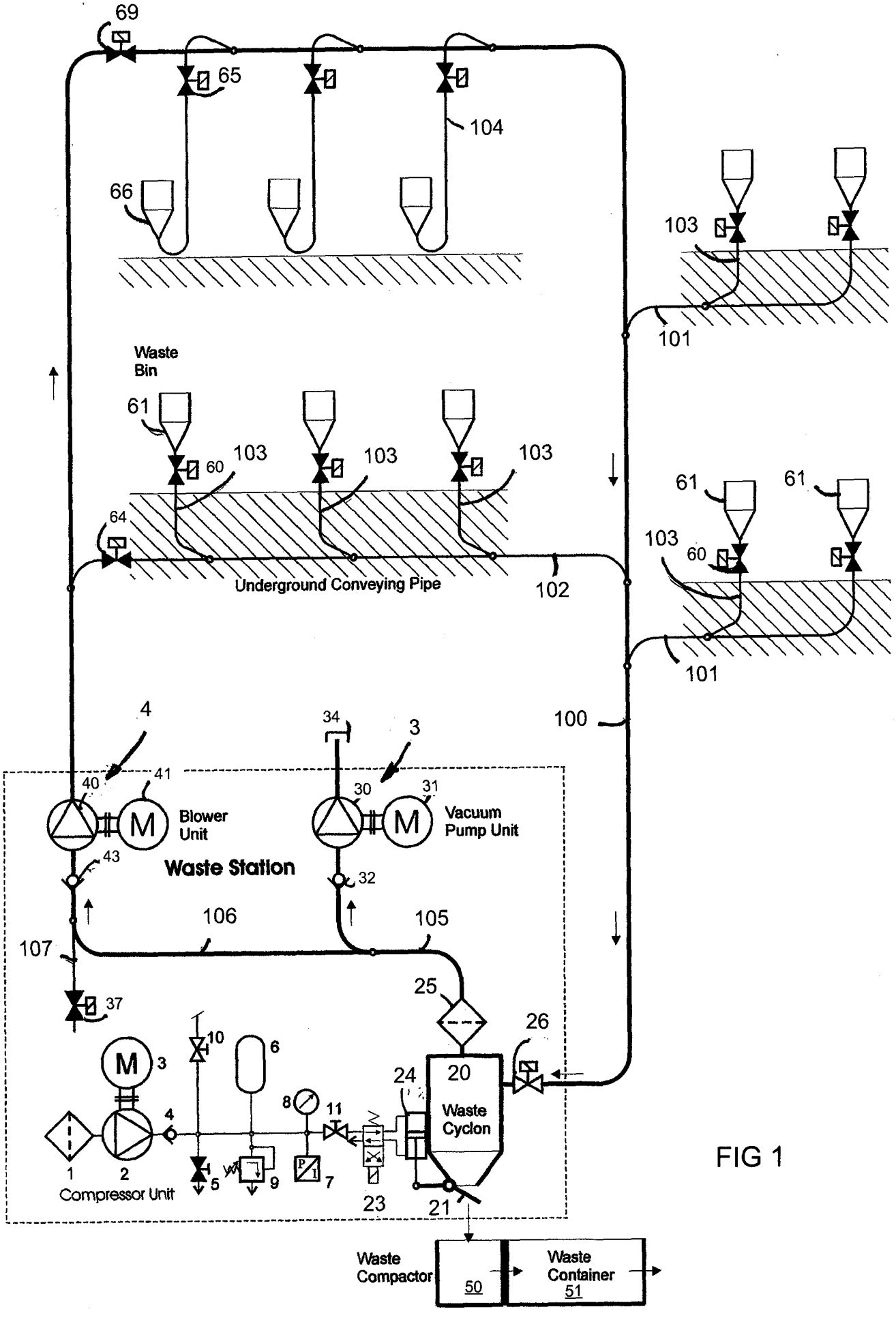
14. A method according to any one of claims 1–13, characterised by arranging the vacuum generator (3) and/or the blower device (4) to intensify at least momentarily the conveying effect of material provided by at least one

vacuum generator (3) and/or blower device (4) in the conveying piping (100, 100A, 100B, 100C, 100D,...100I).

15. A method according to any one of claims 1–14, c h a r a c t e r i s e d by using the method in a waste conveying system.

16. A method according to any one of claims 1–15, c h a r a c t e r i s e d in that the material feed points (61, 66) are waste feed points, such as waste bins or waste chutes.

17. A pneumatic material conveying system, which is arranged to use a method according to at least one of claims 1–16.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104
66
103
101
Waste
Bin
61
60
103
103
103
64
Underground Conveying Pipe
102
61
61
103
60
101
100
4
34
3
40
41
30
31
Blower
Unit
Vacuum
Pump Unit
Waste Station
43
32
106
105
107
37
25
26
M
3
10
6
24
20
Waste
Cyclon
8
11
4
1
2
5
9
7
23
21
Compressor Unit
Waste
Compactor
50
Waste
Container
51

FIG 1

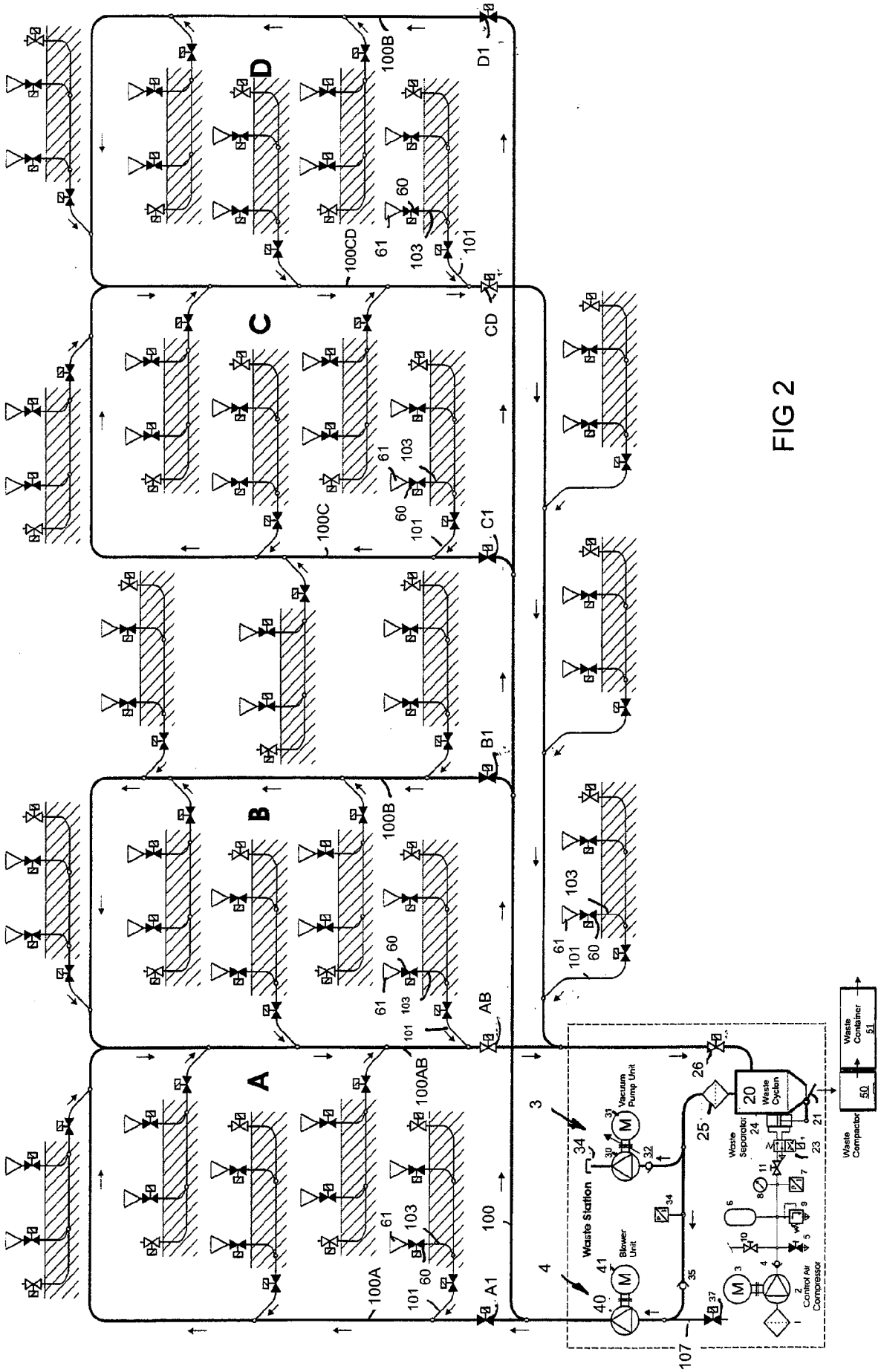
A
B
C
D
100A
100B
100C
100CD
100AB
A1
B1
C1
D1
AB
CD
100
101
103
60
61
107
Waste Station
Blower Unit
Vacuum Pump Unit
Control Air Compressor
Waste Cyclon
Waste Separator
Waste Container
Waste Compactor

FIG 2

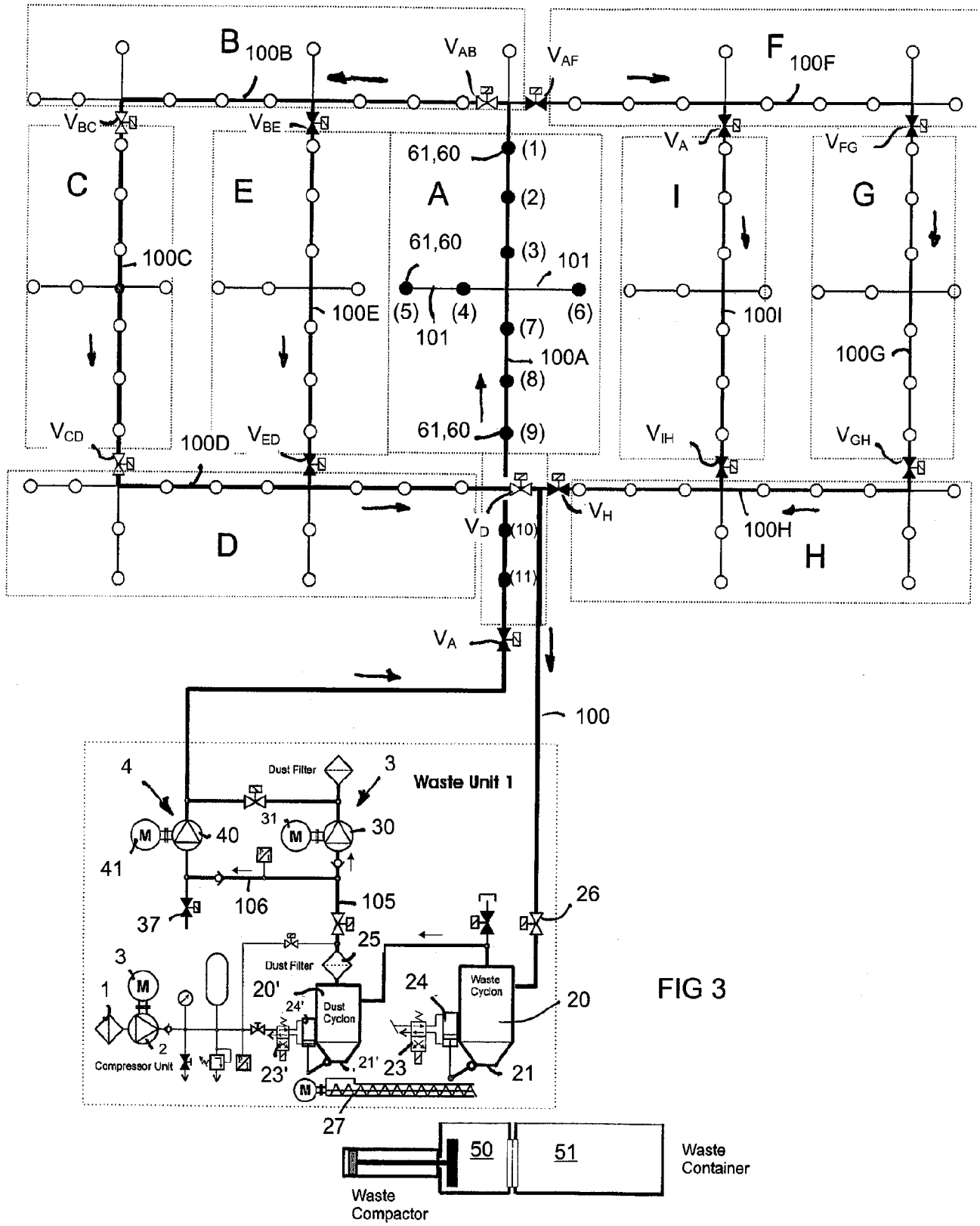
B
100B
V_{AB}
V_{AF}
F
100F
V_{BC}
V_{BE}
V_A
V_{FG}
C
E
A
I
G
61,60
(1)
(2)
(3)
101
100C
100E
100I
100G
(5)
(4)
(6)
(7)
100A
(8)
V_{CD}
100D
V_{ED}
61,60
(9)
V_{IH}
V_{GH}
D
V_D
(10)
V_H
100H
H
(11)
V_A
100
Waste Unit 1
Dust Filter
Dust Filter
Dust Cyclon
Waste Cyclon
Compressor Unit
Waste Container
Waste Compactor
50
51

FIG 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2008/050756

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B65G

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

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI, COMPDX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	US 4318643 A (LARSSON BERTIL S W et al.) 09 March 1982 (09.03.1982)	
X	abstract; column 3, lines 52-66; figure 3	2
Y		1, 3-7, 12, 15-17
	WO 2005085104 A1 (MARICAP OY et al.) 15 September 2005 (15.09.2005)	
X	figure 1; page 5, line 28 – page 6, line 18; page 11, line 32 – page 12, line 7	2
Y		1, 3-7, 12, 15-17
	US 3809438 A (HUBBARD E) 07 May 1974 (07.05.1974)	
X	abstract; figure 1; column 4, lines 30-41	2
Y		1, 3-17
Y	GB 1435611 A (CENTRALSUG AB) 12 May 1976 (12.05.1976), figure 1; page 1, lines 58-81; page 3, lines 5-18 and lines 81-107; claim 3	1, 3-17

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 March 2009 (19.03.2009)	28 April 2009 (28.04.2009)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2008/050756

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
US 4318643 A	09/03/1982	None	
WO 2005085104 A1	15/09/2005	JP 2007526191T T	13/09/2007
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		AU 5919673 A	20/02/1975
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2008/050756

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.
B65G 53/34 (2006.01)
B65G 53/52 (2006.01)