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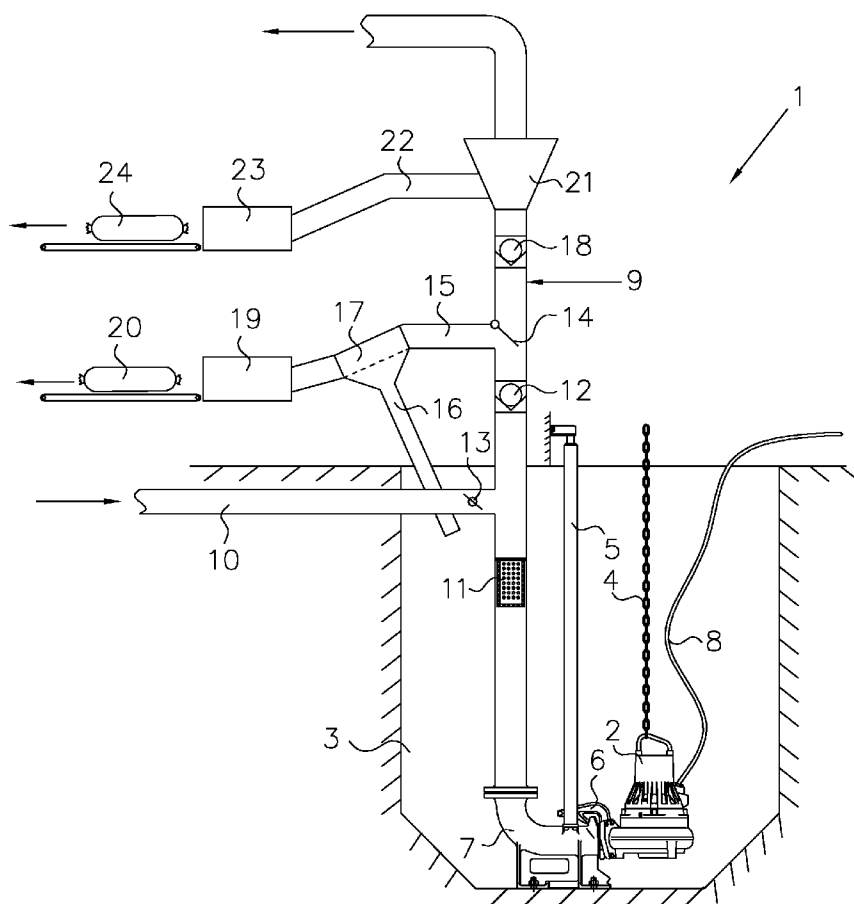
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(54) Title: A PUMP SYSTEM AND A METHOD FOR SEPARATING SOLIDS FROM A LIQUID



(57) Abstract: In a first aspect the present invention relates to a pump system for separating solids from a liquid, comprising an inlet pipe (10) connected to a first side of a screen (11), the screen (11) being arranged to accumulate solids at said first side, an outlet pipe (9) connected to the first side of said screen (11), and a pump (2) connected to an opposite second side of said screen (11) and arranged to intermittent create outgoing liquid flows through said screen (11) and into said outlet pipe (9). Furthermore, the pump system comprises a diverter (14) is connected to the outlet pipe (9), the diverter (14) having a first state in which an initial portion of the outgoing liquid flow containing the accumulated solids is diverted from the outlet pipe (9), and a second state in which the following portion of the outgoing liquid flow is passed through said outlet pipe (9). In a second aspect the invention relates to a method for separating solids from a liquid.



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A PUMP SYSTEM AND A METHOD FOR SEPARATING SOLIDS FROM A LIQUID

Technical field of the invention

The present invention relates generally to a pump
5 system for separating solids from a liquid, and more specifically to a pump system for separating screenings from waste water. The pump system comprises an inlet pipe connected to a first side of a screen, the screen being arranged to accumulate solids at said first side, an outlet pipe connected to the first side of said screen, and a pump connected to an opposite second side of said screen and arranged to intermittently create outgoing liquid flows through said screen and into said outlet pipe. The invention also relates to a method for separating solids from a liquid.

Background of the invention

Sewage water or waste water, which is pumped/transported from domestic and/or industrial establishments to and through a sewage treatment plant, may contain a lot of different pollutants and solids, which are to be removed at any location during the transportation or in any process step at the sewage treatment plant. The amount and structure of the solids depends on the season and type of area from which the water emanates, and may for instance be plastic material,
20 hygiene articles, textiles, paper, rags, grass, leaves, grit, stones, sand, etc., all of which need to be separated from the sewage water during the treatment.

Usually, the sewage water is pumped unscreened to the sewage treatment plant and undergoes different process steps in order to be purified at said sewage treatment plant. In a first step the sewage water undergoes a mechanical treatment where heavy and/or large solids are trapped in a screen and small particles, such as sand and grit, are let to settle in a settling tank in a subsequent second step.

In said first step the incoming liquid flow is led through a relatively fine meshed screen, sieve, drum filter, or the like, which is positioned across the usually open head channel for the incoming liquid flow, in order to trap
5 solids, e.g. of the type described above. The screenings, or solids, that are trapped are accumulated and makes an aggregation which is collected by a scraper, or the like, and transported by a chain feeder, or the like, to an open container awaiting that a large enough amount of screenings is
10 accumulated, such that the container may be removed in order to be emptied. An unpleasant problem is that the screenings is cumbersome to handle and emits a nasty smelling odour, at the same time as the handling of the screenings is unhygienic. In said second step the sewage water is filled into big
15 basins, in which sand, grit and other small particles are let to settle and accumulate at the bottom of the basins. The settling step is a slow and space requiring process step.

Other known ways of separating screenings from the
20 sewage water may include letting the unscreened sewage water into a cavity surrounded by perforated walls, which walls allows the liquid to pass to a second outer cavity and from there to a second treatment step as mentioned above. The screenings is accumulated in the first cavity and transported
25 therefrom by means of a feed screw, which feeds the screenings to a container as mentioned in the first step above. A disadvantage is that the system is dependent on a separate power source for the feed screw, at the same time as it cannot be guaranteed that all the screenings is re-
30 moved from said first cavity, which screenings may cause problems with future liquid flows, by blocking the perforations.

During transportation of sewage water between two pumping stations or between a pumping station and a sewage
35 treatment plant or within a sewage treatment plant, it is known from e.g. GB 1,235,005 and US 2,265,650 to use a pump

system, in which the incoming water passes a trap/screen and into a sump. Thereby, the screenings are temporarily separated by being caught in the trap and will not reach the pump. When the pump is activated it will pump the screened liquid
5 through the trap in a second direction, such that the caught screenings will follow the outgoing liquid flow. The aim of this known arrangement is to prevent solids to enter the sump since the pump is not constructed to pump unscreened sewage water.

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Summary of the invention

The present invention aims at obviating the aforementioned disadvantages of previously known pump systems, and at providing an improved pump system. A primary object of
15 the present invention is to provide an improved pump system of the initially defined type, which treats the waste water during transportation thereof. It is another object of the present invention to provide a pump system that requires relatively little space. It is yet another object of the
20 present invention to provide a pump system, which treats the waste water in a hygienic way.

According to the invention at least the primary object is attained by means of the initially defined pump system and method having the features defined in the independent
25 claims. Preferred embodiments of the present invention are further defined in the dependent claims.

According to a first aspect of the present invention, there is provided a pump system of the initially defined type, which is characterized in that a diverter is connected
30 to the outlet pipe, the diverter having a first state in which an initial portion of the outgoing liquid flow containing the accumulated solids is diverted from the outlet pipe, and a second state in which the following undiverted portion of the outgoing liquid flow is passed through said
35 outlet pipe.

According to a second aspect of the present invention, there is provided a method, which comprises the steps of: directing a finite set of an incoming liquid flow through a screen from a first side, thereby accumulating solids at
5 this first side of said screen; operating a pump to create an outgoing liquid flow from an opposite second side of the screen through said screen and into an outlet pipe; diverting from the outgoing liquid flow an initial portion containing the accumulated solids, from the outlet pipe; and
10 passing the following undiverted portion of the outgoing liquid flow through said outlet pipe.

Thus, the present invention is based on the insight of a pump driven automatic separation of solids from a liquid during the transportation thereof from a first location to a
15 second location, which facilitates the treatment of the liquid and makes the treatment more hygienic, at the same time as the treatment is fast and requires a relatively small space.

In a preferred embodiment of the present invention, the
20 diverter is arranged to shift from said first state to the second state when a predetermined condition is fulfilled. This predetermined condition should be set to ensure that the accumulated solids are separated/diverted at the diverter.

Brief description of the drawings

A more complete understanding of the above mentioned and other features and advantages of the present invention will be apparent from the following detailed description of
30 preferred embodiments in conjunction with the appended drawing, wherein:

Fig. 1 is a schematic view of a pump system according to the invention.

Detailed description of preferred embodiments of the invention

The invention is based on the wish to separate large and small solids, such as particles, sand, grit, etc., from waste water in a simple and hygienic way, by means of a system that is fast and that require a relatively small space.

In fig 1 is shown a pump system, generally designated 1, for separating solids from a liquid during transportation of the liquid from a first location to a second location.

10 The pump system 1 may be located at a pump station for transporting and at the same time treating waste water or at a sewage treatment plant as a first treatment step.

The pump system 1 comprises a dry installed or submersible pump 2, preferably a submersible centrifugal pump, which is lowered into a sump 3, basin, well, or the like. During set up and maintenance, the pump 2 is lowered and raised by means of a chain 4, a wire, or the like, between the bottom of the sump 3 and the ground level. A guide rail 5 controls the pump 2 during movement thereof by being in movable engagement with a claw 6 connected to the pump 2. In the shown lower position an outlet opening of the pump 2 is in water tight engagement with an inlet opening of a discharge connection 7, which in a conventional way may be bolted to the bottom of the sump 3. Said guide rail 5 is fixedly connected to the discharge connection 7 and the claw 6 rests upon the discharge connection 7 when the pump 2 is in the shown lower position, such that the pump 2 turns in a clockwise direction around the engagement point between the claw 6 and the discharge connection 7. The water tightness between the pump 2 and the discharge connection 7 is achieved by forcing the outlet opening of the pump 2 against the inlet opening of the discharge connection 7, by means of the dead weight of the pump 2, and/or by means of auxiliary bolts. Further, the pump 2 is powered and controlled by means of an electric cable 8 extending from the pump 2 to a

power source and/or a control unit located at ground level, in order to be intermittently activated and operated. Moreover, the pump system 1 comprises an outlet or discharge pipe 9, which is connected to and extends from said discharge connection 7 and onwards to a subsequent process step, a second basin, etc., to which the liquid is pumped.

An inlet or feed pipe 10 is in the shown embodiment connected to said outlet pipe 9, such that the incoming liquid is led through the inlet pipe 10, to and "backwards" through the outlet pipe 9, through the discharge connection 7, through the pump 2, and into the sump 3. In the outlet pipe 9, at a position between the connection of the inlet pipe 10 and the pump 2, is a screen 11 located. Said screen 11 may be constituted by a trap, a filter, a net, a sieve, a strainer, or the like, which allows the liquid to flow through at the same time as the solids, which are dispersed in the liquid, are accumulated and concentrated by means of the screen 11, such that a screen plug is created above the screen 11.

It is essential that said inlet pipe 10 is connected to a first side of the screen 11, directly or indirectly by means of a section of the outlet pipe 9. Further, the outlet pipe 9 shall as well be connected to the first side of the screen 11. The pump 2 is connected to a second side of said screen 11, which second side is opposite said first side, directly or indirectly by means of a section of the outlet pipe 9 and/or the discharge connection 7. Said first side of the screen is the upstream side when liquid flows from the inlet pipe 10 to the sump 3, and the downstream side when liquid is pumped by the pump 2 from the sump 3. Further, said second side is the upstream side of the screen 11 when liquid is pumped by the pump 2 from the sump 3. Thus, the pump system 1 is alternately subject to, an incoming liquid flow to fill the sump 3 and at the same time trap the solids at the screen 11, and an outgoing liquid flow to empty the sump 3 and at the same time treat the liquid by discharging

the created screen plug. The pump 2 is arranged to intermittent create outgoing liquid flows, e.g. each time the liquid level in the sump 3 reaches a predetermined level or when a predetermined amount of solids are accumulated above the screen 11. The latter may be determined by checking the pressure upstreams of the screen 11 during the sump 3 filling process step.

During the sump 3 filling process step the outlet pipe 9 may in a basic/fundamental embodiment be closed by means of a valve (not shown) at a location above the connection of the inlet pipe 10, in order to prevent incoming liquid and solids to flow in this direction. However, in the shown embodiment the outlet pipe 9 comprises a check valve 12, which allows a liquid flow in the downstream direction, as a safety arrangement if the screen 11 is totally clogged. When the sump 3 is filled to a predetermined level, or when a certain amount of solids is accumulated above the screen 11, the inlet pipe 10 is closed such that further liquid is obstructed to flow through the screen 11 and into the sump 3. The inlet pipe 10 may then be closed by means of a valve 13. When the inlet pipe 10 is closed, the incoming liquid flow may be buffered in the inlet pipe 10, which in such a case is sized and constructed to allow said buffering. In alternative embodiments the incoming liquid flow is ceased or the incoming liquid flow is directed past the pump 2 to the sump 3 via an overflow pipe and an overflow screen (not shown).

Moreover, the pump system 1 comprises a diverter 14, which is located in the outlet pipe 9 at a position downstream of/above the screen 11 and preferably above the connection of the inlet pipe 10. Said diverter 14 is preferably constituted by a controllable valve, gate, or the like, having a first state in which the outlet pipe 9 is closed and a first discharge pipe 15 is opened, and a second state in which the outlet pipe 9 is opened and the first discharge pipe 15 is closed. The diverter 14 may as well

possess the function of a check valve, which prevents liquid to flow in the upstreams direction in the outlet pipe 9. Alternatively, a separate check valve 16 may be located above the diverter 14 in the outlet pipe 9. Preferably, said first state is a default state. In the sump 3 emptying process step the inlet pipe 10 is closed and the pump 2 is activated. Thereby the pump 2 starts to pump liquid from the sump 3 and ejects it through the screen 11 and through the outlet pipe 9 towards said diverter 14. The screen plug of accumulated solids, located above the screen 11, is conveyed by the outgoing liquid flow towards the diverter 14. At the diverter 14, which is in said first state, the initial portion of the outgoing liquid flow, containing the screen plug, is diverted to said first discharge pipe 15 until a predetermined condition is fulfilled. Thereafter, the diverter 14 is shifted to the second state in which the following portion of the outgoing liquid flow is passed through the outlet pipe 9. Said predetermined condition may be mechanically conditioned, e.g. the diverter 14 may shift from the first state to the second state when a preset amount of liquid is diverted or a preset liquid pressure is reached in the area of the diverter 14, since the liquid pressure at the diverter 14 is low as long as a screen plug is present between the screen 11 and the diverter 14. Alternatively, said predetermined condition may be a preset time period, which may be based on the flow velocity and the distance between the pump 2 and the diverter 14. Another alternative includes an operator who monitors the process and shifts the diverter 14 from said first state to said second state. Whichever predetermined condition used, it should be set to ensure that all the accumulated solids are diverted to the first discharge pipe 15. Thus, either a big enough amount of liquid, or a long enough time period, or a high enough liquid pressure, or the like, must be used as a condition.

The initial portion of the outgoing liquid flow containing the screen plug may pass a dewatering unit 17, which constitute a part of the first discharge pipe 15. In the dewatering unit 17 the screen plug is dewatered in a suitable way and the dewatered liquid is, in the shown embodiment, returned to the sump 3 via a return pipe 18. The liquid may for instance be squeezed out from the screen plug. The dewatered screen plug may thereafter be packaged in a hygienic way in a packaging unit 19, preferably in packages 20 enclosed in plastic, which are easy to handle and dispose. A packaging process step similar to hygienic food packaging may be used, in order to get a storable sausage like package. In this type of handling the solids are in the closed pump system 1 the entire time, until they are packaged, such that the nasty smelling odour is kept from spreading.

A cyclone 21, or the like, may be connected to the outlet pipe 9 above/downstreams of the diverter 14, the cyclone 21 being arranged to separate solids, that has passed the screen 11 in the sump 3 filling process step and/or passed the diverter 14 in the sump 3 emptying process step. The liquid is put in rotational motion in the cyclone 21 and in a conventional way the solids and small particles, such as sand and grit, are thereby separated from the liquid. The liquid continues along the outlet pipe 9 to a subsequent process step, or the like, and the separated particles are led through a second discharge pipe 22 from the cyclone 21, and may thereafter be packaged in a hygienic way in a packaging unit 23, preferably in packages 24 enclosed in plastic, which are easy to handle and dispose. Furthermore, a dewatering unit and a return pipe may be located between the cyclone 21 and the packaging unit 23, similar to the one described above in connection with the diverter 14. A cyclone 21 yields faster separation and utilizes less space than a settling basin.

Feasible modifications of the present Invention

The invention is not limited only to the embodiments described above and shown in the drawing. Thus, the pump system may be modified in all kinds of ways within the scope
5 of the appended claims.

It shall be pointed out that the pump system according to the invention may be used for separating solids from a liquid in general, and not only solids from waste water. In industries such as food processing, etc., when the liquid is
10 used as a transportation means, e.g. for fruits, nuts, roots, vegetables, pills, etc., are some products suitable to be separated in a diverter and some products are suitable to be separated in a cyclone. In industries such as mineral processing, mining, waste water treatment, fish industry,
15 and other industries dealing with slurries, the solids may as well be separated by a diverter and/or a cyclone.

It should also be pointed out that the incoming liquid, in the sump filling process step, not necessarily has to be led "backwards" through the pump. Instead the incoming
20 liquid may be led directly to the sump after passing the screen, as long as the outgoing liquid flow passes through the screen in the opposite direction when the pump is activated.

It should also be pointed out that all information
25 about/concerning terms as above, etc., should be interpreted/read having the pump system in the orientation as displayed in fig 1, having the drawing oriented in such a way that the reference signs could be properly read. Thus, such terms only indicate a mutual relationship in the shown
30 embodiment, which are to be changed if the inventive pump system is provided with another design.

In an alternative embodiment the inventive pump system may comprise two parallel sets of pumps, screens and piping arranged in the same sump, which are arranged to be operated
35 alternately and which may use the same outlet pipe, in order

to get a continuous incoming and outgoing liquid flow. In the case when a common outlet pipe is used for two sets of pumps and/or screens, check valves must be located between said screens and the common outlet pipe portion, in order to prevent backflow to the pump that is switched off.

Claims

1. A pump system for separating solids from a liquid, comprising an inlet pipe (10) connected to a first side of a screen (11), the screen (11) being arranged to accumulate solids at said first side, an outlet pipe (9) connected to the first side of said screen (11), and a pump (2) connected to an opposite second side of said screen (11) and arranged to intermittently create an outgoing liquid flow through said screen (11) and into said outlet pipe (9), **characterized** in that a diverter (14) is connected to the outlet pipe (9), the diverter (14) having a first state in which an initial portion of the outgoing liquid flow containing the accumulated solids is diverted from the outlet pipe (9), and a second state in which the following portion of the outgoing liquid flow is passed through said outlet pipe (9).
2. The pump system according to claim 1, wherein the diverter (14) is arranged to shift from said first state to the second state when a predetermined condition is fulfilled.
3. The pump system according to claim 2, wherein said predetermined condition is mechanically conditioned.
4. The pump system according to claim 2 or 3, wherein said predetermined condition is a preset amount of diverted liquid.
5. The pump system according to claim 2 or 3, wherein said predetermined condition is a preset liquid pressure in the area of the diverter (14).
6. The pump system according to claim 2, wherein said predetermined condition is a preset time period.

7. The pump system according to any preceding claim, wherein said pump system comprises a dewatering unit (17), which is arranged to dewater said diverted portion of the outgoing liquid flow.

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8. The pump system according to any preceding claim, wherein said pump system comprises a packaging unit (19), which is arranged to package the accumulated solids contained in said diverted portion of the outgoing liquid flow.

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9. The pump system according to any preceding claim, wherein a cyclone (21) is connected to the outlet pipe (9) downstream of said diverter (14), the cyclone being arranged to separate small solids from the liquid.

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10. A method for separating solids from a liquid, comprising the steps of:

- directing a finite set of an incoming liquid flow through a screen (11) from a first side, thereby accumulating solids at this first side of said screen (11), and thereafter
- operating a pump (2) to create an outgoing liquid flow from an opposite second side of the screen (11) through said screen (11) and into an outlet pipe (9),

20

characterized by the steps of:

25

- diverting from the outgoing liquid flow an initial portion containing the accumulated solids, from the outlet pipe (9), and

- passing the following portion of the outgoing liquid flow through said outlet pipe (9).

30

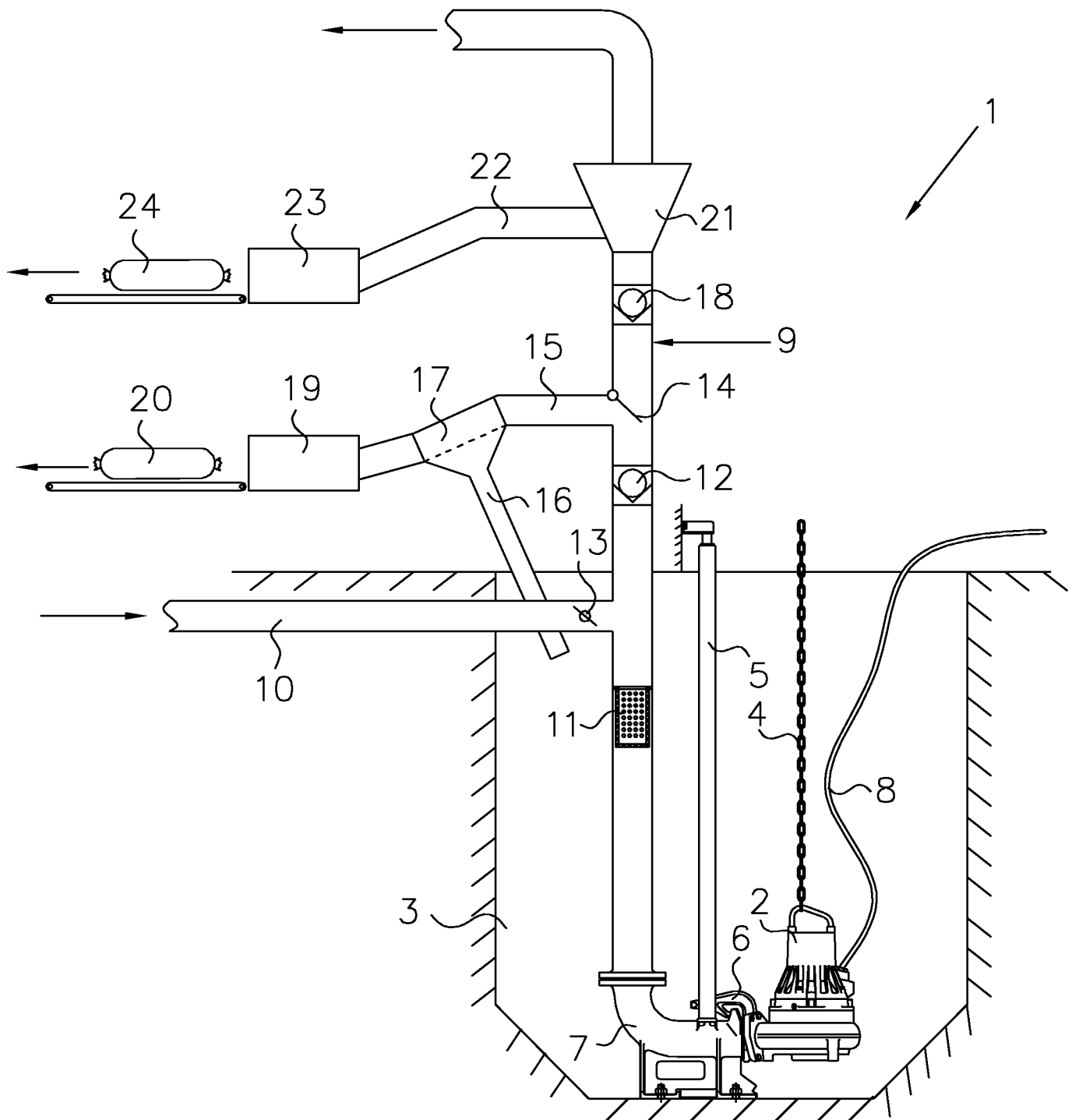


Fig 1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2007/050331

A. CLASSIFICATION OF SUBJECT MATTER

IPC: 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: E03F, F04D

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 1774234 A (HARRY E. LA BOUR), 26 August 1930 (26.08.1930), page 3, line 11 - line 98 --	1-10
A	GB 1235005 A (TASHKENTSKY INSTITUT INZHENEROV ZHELEZNODOROZHNOGO TRANSPORTA), 9 June 1971 (09.06.1971), page 2, line 17 - line 80 --	1-10
A	US 2265650 A (WILLIAM H. LANNERT), 9 December 1941 (09.12.1941), page 2, column 2, line 4 - line 50 --	1-10
A	US 2563862 A (LEONARD M. NECHINE), 14 August 1951 (14.08.1951), column 4, line 55 - column 5, line 14 --	1-10

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

* Special categories of cited documents:

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"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

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2007/050331

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2401254 A (WILLIAM H. LANNERT), 28 May 1946 (28.05.1946), page 2, column 2, line 37 - page 3, column 1, line 19 --	1-10
A	US 2238597 A (ALFRED CHARLES PAGE), 15 April 1941 (15.04.1941), page 4, column 1, line 62 - column 2, line 12 --	1-10
A	US 1785480 A (AUGUSTUS C. DURDIN), 16 December 1930 (16.12.1930), page 3, line 73 - page 4, line 2 -- -----	1-10

International patent classification (IPC)**E03F 5/22** (2006.01)**Download your patent documents at www.prv.se**

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Use the application number as username.

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Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/06/2007

International application No.

PCT/SE2007/050331

US	1774234	A	26/08/1930	NONE
GB	1235005	A	09/06/1971	NONE
US	2265650	A	09/12/1941	NONE
US	2563862	A	14/08/1951	NONE
US	2401254	A	28/05/1946	NONE
US	2238597	A	15/04/1941	NONE
US	1785480	A	16/12/1930	NONE