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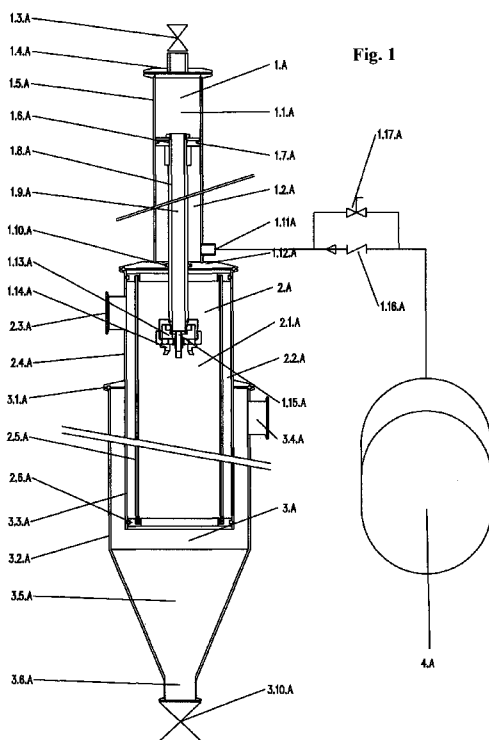
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(54) Title: DEVICE AND METHOD FOR THE SEPARATION OF SUSPENDED SOLIDS FROM LIQUIDS WITH AUTOMATIC WASHING OF FILTER BY THE USE OF HIGH PRESSURE SPRAY NOZZLES MOVED BY A HYDRAULIC PISTON ACTUATED BY THE SAME WASHING LIQUID



(57) Abstract: Equipment and procedure for the separation of solid particles and colloids suspended in liquid with automatic washing system of filtering meshes by means of high pressure water jets generated by a group of mobile spray nozzles, moved vertically by a hydraulic piston controlled by the same washing liquid pressure, operating when the filter is empty of liquid in filtration. The liquid jets are generated by a single nozzles or a group of nozzles, supplied with water through the shaft of the same piston. The nozzles are disposed in such a way to sprinkle the whole surface of the filtering mesh. Feeding the cylinder upper chamber with washing liquid with suitable pressure and flow determines the descending movement of the piston and with it of the nozzle or group of nozzles, mounted at the end of the piston shaft. The velocity of movement of the group of nozzles is regulated, creating in different ways, a resistance to the flow of liquid from the cylinder lower chamber. The upward motion of the plunger to its starting position is obtained by the injection of the liquid, which comes from a pneumatic device or from a dedicated circuit, in the cylinder lower chamber, with the consequent flow of liquid from the superior chamber through the nozzles.



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DESCRIPTION

DEVICE AND METHOD FOR THE SEPARATION OF
SUSPENDED SOLIDS FROM LIQUIDS WITH AUTOMATIC
WASHING OF FILTER BY THE USE OF HIGH PRESSURE SPRAY
5 NOZZLES MOVED BY A HYDRAULIC PISTON ACTUATED BY
THE SAME WASHING LIQUID

TECHINICAL FIELD

The invention refers to an apparatus and a method for the separation of suspended solids and colloids contained in liquids. It
10 aims to improve the overall efficiency of separation systems by simplifying the cleaning and recovery of filter screen, and it is mainly conceived for water recovery and recycling systems and as a pre-filtration system for micro, ultra and nanofiltration as well as reverse osmosis systems.

15 The increasing cost of industrial waste water disposal, induced by more and more restrictive national and European laws in terms of maximum concentration of pollutant in waste waters (both for surface water and sewage) is slowly but constantly directing industries to install water treatment and recycling plants
20 of industrial water.

The technology of modern digesters, correctly applied, allow to meet the required legal pollutant concentration limits, but they do not allow to achieve such levels of purity of recycled water to allow its re-use in the process, even partial; water treatment plants
25 require great volumes and large areas to meet the necessary time of reaction and settling. Filtration techniques such as micro, ultra and nanofiltration as well as reverse osmosis have improved their performances and reliability in the last years and they are now technically and economically competitive; considering the size and

the porosity of the membranes used in such systems, the above mentioned systems impose the adoption of treatment systems and of pre-filtration even more efficient to block the larger impurities and above all to separate the particles which could damage the filtering membranes by blocking the pores or even causing mechanical damage.

BACKGROUND ART

Many types of filtering cartridges with many various types of material to satisfy many different types of use are currently available on the market. Most of these are filtering meshes, which decrease in flow with the increasing of clogging, and are thus prone to blockage. These are therefore not adequate for industrial use, which requires constant flow and long periods of use with low maintenance costs. To resolve this problem of filter blockage many different kinds of self-cleaning filters have been developed, also well present on the market. Those operate according to wide-ranging different principles such as the following: mechanical auto-cleaning filters, auto-cleaning filters with counter current water flow and mixed filters. In heavy duty applications, mechanical filters suffer from frequent breakages (decaying of mesh, breaking of mechanical parts etc) and require a great deal of maintenance and labour. Those washable by water flow usually involve excessive water wastage for their cleaning which doesn't always seem to be efficient. On the market, it is possible also to use centrifugal separation systems (cyclons), in which, however, the sole force of the spin carries out the separation of the suspended material. Usually these do not have filtering meshes and thus the separation of solid-liquid is uncertain. Operative experience in the agro-industrial field has highlighted that some

types of blocking deposits, especially the organic types, seem to be difficult to remove both mechanically (with rigid and flexible scrapers) and with flows of liquid. Such types of deposits are easily removed through direct water jets. From here, the idea is to
5 construct a self-cleaning water jet filter with emptied filtering chambers, which enables an excellent cleaning efficiency in comparison to all self-cleaning filters, with a notable saving of water in comparison to those which are washed by water flow.

DISCLOSURE OF INVENTION

10 The new filter system is conceived for the filtration of liquids containing suspended solids and colloidal suspensions. It can be used as a self standing filtration system with porosity down to 1 micron, or as a prefiltration system for micro, ultra and nanofiltration and reverse osmosis. The main objectives of the
15 invention are:

Allow the removal of deposits from the filter meshes with the minimum water consumption;

Simplify the filter mechanism, especially the parts subject to wear and tear, and reduce the possibility of mechanical
20 breakdown;

Allow the in-line cleaning of filter mesh;

Allow the periodical removal of soil.

In order to better meet the application requirements, the device has been designed in two versions:

25 version "A", provided with centrifugal separator, described in fig. 1.

version "B" simplified version without centrifugal separator, described in fig 2.

For greater clarity the two versions are described separately even

though many descriptions are the same for both of them.

Version "A": Device with centrifugal separator

The device consists of three main sections, each of which is designed for specific functions and is made of several parts

5 Washing system 1.A: this section has the function of periodically remove the deposits that accumulate on the filter mesh during the filtration process.

10 Filtration section 2.A: this section has the function of separating the impurities from the liquid to be filtered. The size of the filter mesh can be adapted to the different applications.

Centrifugal separation section 3.A: whenever the typology of liquid requires, this section has the function to allow the larger particles contained in the liquid to settle before the liquid passes through the filtering mesh to increase the overall efficiency.

15 The washing system 1.A consists of:

- Washing liquid feed valve 1.3.A: it is a manual or automatic 2 way valve that feeds the washing liquid to the cylinder upper chamber 1.1.A, feeding the spray nozzles 1.14.A through the hollow piston shaft 1.9.A, and pushing the piston downwards at
20 the same time 1.6.A.
- Cylinder upper chamber 1.1.A: it consists of the internal volume of the cylinder, 1.5.A delimited by the upper head of the cylinder 1.4.A, the cylinder wall and the upper surface of the piston 1.6.A.
- 25 - Cylinder lower chamber 1.2.A: it consists of the internal volume of the cylinder, 1.5.A, delimited by the lower surface of the piston 1.6.A, the cylinder wall and the connection flange with the filtering section 1.12.A.
- Cylinder head 1.4.A: it consists of a flange connected to the

cylinder, a gasket and a closing counterflange provided with the connection for the high pressure washing liquid feed valve 1.3.A. It ensures the hydraulic seal of the cylinder upper chamber 1.1.A.

- 5 - Cylinder 1.5.A: it consists of a cylinder with rectified and polished inner surface, within which the piston 1.6.A moves thanks to the pressure difference between the liquid contained in the cylinder upper and in the lower chamber. It contains the washing liquid and acts as a guide for the piston. It is closed by
10 the cylinder head 1.4.A at the upper part and by the connection flange 1.12.A at the lower part. The connection flange is also used as a guide for the piston. In the lower part of the cylinder, close to the connection flange, a radial port 1.11.A is placed to allow the flow of the liquid to and from the lower chamber.
- 15 - Piston 1.6.A: it consists of a rigid cylinder placed inside the cylinder, solid with the piston shaft; on its outer surface the seat for the seal 1.7.A is placed. The seal prevents the flow of liquid from the upper to the lower chamber of the cylinder and vice versa. The pressure difference between the piston upper and
20 lower surface makes the piston move: downwards if the pressure is higher in the upper chamber of the cylinder, upwards if the pressure is higher in the lower chamber.
- Piston shaft 1.8.A: it is a hollow shaft with rectified and polished outer surface. One end of the shaft is connected to the
25 piston by a liquid tight connection 1.6.A, the other end is connected to the spray nozzles supporting head 1.13.A; the shaft moves through a hole in the connection flange 1.12.A provided with an water tight seal.
- Connection flange 1.12.A: it is a rigid ring that connects the

piston cylinder to the filtration section cylinder 2.A. It has a coaxial hole for the piston shaft, provided with the seat for the water tight seal 1.10.A.

- 5 - Spray nozzles supporting unit 1.13.A: it consists of a hollow cylinder connected by a water tight connection to the piston hollow shaft 1.8.A; its hollow chamber acts as spray nozzles feeding chamber. Spray nozzles are installed in the lower face of the device.
- 10 - Oriented spray nozzles 1.14.A: for this application flat pattern spray nozzles are used. The jet of water is directed radially to the outside and downward. A variable number of nozzles is arranged in such a way to create a flat and uniform jet of water all around the piston shaft axis (360°). The inclination of the water jet with respect to the axis of the piston is chosen
15 according to the different applications.
- Hollow shaft one way closing valve 1.15.A: it consists of a disc provided with a suitable washer, that allows the flow of washing liquid from the cylinder upper chamber 1.1.A to the spray nozzles supporting unit 1.13.A, while preventing the flow of
20 dirty water in the opposite sense. It is guided by a shaft and closed by a spring. Its opening occurs because of the difference in pressure between the cylinder upper chamber and the filtration section. Its application is not indispensable to the functioning of the filter washing system.
- 25 - Piston return valve 1.16.A: it is a commercial valve that connects the cylinder lower chamber 1.2.A with the piston return device; it allows a unidirectional flow to the cylinder lower chamber without limitation in flow to maximize the piston upwards speed. The piston return can be achieved by pneumatic

devices or other methods.

- Piston speed control valve 1.17.A: it is a commercial valve that connects the cylinder lower chamber 1.2.A with the piston return device 4.A; it has the function of controlling the flow of liquid which is exiting from the lower chamber of the cylinder and consequently the speed of the downwards motion of the piston.

The filtering section 2.A consists of:

- Filtering section cylinder 2.4.A: it is a rigid tubular cylinder that contains the filter 2.5.A; on the upper end it features the connection flange to the cylinder, 1.12.A; on its edge an annular flange 3.1.A is placed, perpendicular to the axis of the cylinder, that connects the filtration section cylinder to the centrifugal separator cylinder 3.2.A; in the upper part of the cylinder, the radial filtered liquid outlet is placed 2.3.A.
- Filter 2.5.A: It is a cylinder 2.5.A made of a porous media. The flow of filtered liquid is form the inside to the outside. Each cylinder end is connected (welded or glued) to a ring 2.6.A coaxial with the filtration section cylinder; between each ring and the cylinder a radial seal is installed; the seat of the seals are placed on the external surface of the rings.
- Filtering section inner chamber 2.1.A: it is the volume contained inside the filter mesh.
- Filtering section outer chamber 2.2.A: it is the volume between the filter mesh 2.5.A and the filtration section cylinder 2.4.A.

The centrifugal separation section 3.A consists of:

- Centrifugal separation cylinder 3.2.A: it is a cylinder coaxial with the filtration section cylinder to which it is connected by annular flanges 3.1.A. It is placed in the lower part of the

filtration section. In the upper part of the centrifugal separation cylinder the feeding inlet is connected tangentially 3.4.A. The lower edge of the cylinder is connected to the widest side of the discharge cone 3.5.A.

- 5 - Discharge cone 3.5.A: it is a cone that connects the cylinder to the discharge valve.
- Discharge valve 3.10.A: it is a commercial valve, manual or automatic, 3.10.A, connecting the discharge cone 3.8.A to the discharge manifold.
- 10 - Discharge manifold 3.6.A: it is the pipe through which the soil settled on the filter mesh during filtration is discharged during the filter mesh cleaning cycle.

Functioning of the device and filtration process

The liquid to be filtered is pumped in the centrifugal separation cylinder 3.3.A; thanks to the centrifugal force generated
15 by the angular velocity of the liquid inside the chamber, solids with higher mass and higher relative density separate from the liquid and are pushed towards the external side of the cylinder 3.2.A and from here to the discharge cone 3.5.A. The liquid, partially purified, moves downwards in the centrifugal separation
20 cylinder 3.3.A, until it reaches the lower edge of the filtration section cylinder 2.4.A; then suddenly reverses its vertical movement direction and flows upward in the filtration section inner chamber 2.1.A, from which it flows through the filter 2.5.A, thanks to the pressure difference generated by the external pump.
25 The filter mesh stops the impurities having a size greater than the filter pore size that are contained in the liquid, which flows in the filtration section outer chamber 2.2.A and from here reaches the filtered liquid outlet 2.3.A.

The constant deposit of impurities on the filter increases exponentially the resistance to the flow of liquid, until the filter clogs. To recover the optimal conditions of the filtering mesh, the filter must be cyclically cleaned. That is the function of the washing system 1.A, that is the most innovative feature of this self cleaning filter. It is common practice that in water treatment applications some kind of deposits (clay, vegetal substances, etc.) are very difficult to remove from filters using counter current flows of liquids or mechanical devices such as scapers or brushes, that might be even counterproductive.

On the other hand it has been observed that a concentrated jet of liquid on the layer of the deposited material in the absence of water removes it with relative ease. From here the idea to realize an orientated jet washing system: the washing piston.

When a mechanical, electrical or electronic device or simply the willing of the user determine the necessity of cleaning the filter mesh, the feed valve 1.3.A is opened (manually or automatically), the washing liquid, provided with suitable pressure and flow, enter the washing cylinder upper chamber 1.1.A and from here it flows through the piston hollow shaft 1.9.A to the spray nozzles supporting unit.

The resistance to the flow of liquid generated by the nozzles transmits to the upper face of the piston, generating a force parallel to its axis that pushes it downwards. The contemporary vertical movement of the piston 1.8.A and the jets of washing liquid through the oriented spray nozzles 1.14.A are then achieved. The spray nozzles, moving downwards, clean the whole filter surface 2.5.A removing the deposits. The cylinder lower chamber 1.2.A is connected to a pneumatic device 4.A: while the piston

moves downwards, the internal pressure of the pneumatic device increases, slowing down the piston. When the piston has made all its own travel, the spray nozzles have washed the whole filter surface. Closing the washing liquid feed valve 1.3.A the pressure
5 inside the cylinder upper chamber 1.1.A drops, because the washing liquid keeps flowing trough the spray nozzles 1.14.A or through a dedicated discharge valve; the pressure in the cylinder lower chamber 1.2.A, accumulated in the pneumatic device is now higher than in the upper chamber, and then the piston 1.6.A moves
10 upwards to the starting position. The upwards motion speed of the piston is controlled by the resistance with which the washing liquid contained in the cylinder upper chamber flows trough the spray nozzles 1.14.A

To prevent the flow of liquid from the filtration section inner
15 chamber to the cylinder upper chamber and the consequent downwards movement of the piston, due to the fact that the pressure in the first chamber is higher than in the second, a non return valve provided with a calibrated closing spring 1.15.A is placed at the end of the piston hollow shaft.

20 Of course the upward movement of the piston can be achieved by feeding water of compressed air in the cylinder lower chamber 1.2.A through a dedicated valve.

It is important to notice that to maximize the cleaning effect of the spray nozzles, before stating the washing cycle it is
25 necessary to drain all the liquid contained in the filtering section inner chamber 2.1.A through the discharge valve 3.10.A, to prevent that the kinetic energy of the water jets is dissipated by mixing with other liquid contained in the chamber.

The efficacy of the washing essentially depends on the

pressure of the water jets and on the speed of the downward motion of the piston.

The water jet pressure control is achieved by controlling the pressure of the cleaning liquid, or changing the spray nozzles resistance, changing the nozzles size; the piston speed control is determined instead by the difference in pressure between the cylinder upper 1.1.A and lower chamber 1.2.A, that can be modified by changing the pre-charge pressure of the pneumatic device 4.A or controlling the speed of the liquid that exits the cylinder lower chamber 1.2.A, through the dedicate port, if the upward movement of the cylinder is made by an independent pressure supply.

Version "B" Fig. 2 : simplified version

The device consists of three main sections, each of which is designed for specific functions and is made of several parts

- Washing system 1.B: this section has the function of periodically remove the deposits that accumulate on the filter mesh during the filtration process.
- The filter feeding chamber 2.B: this section has the of conveying the liquid to be filtered towards the filtering section.
- Filtration section 3.B: this section has the function of separating the impurities from the liquid to be filtered. The size of the filter mesh can be adapted to the different applications.

The washing system consists of:

- Washing liquid feed valve 1.3.B: it is a manual or automatic 2 way valve that feeds the washing liquid to the cylinder upper chamber 1.1.B, feeding the spray nozzles 1.14.B through the hollow piston shaft 1.9.B, and pushing the piston downwards at the same time 1.6.B.

- Cylinder upper chamber 1.1.B: it consists of the internal volume of the cylinder, 1.5.B delimited by the upper head of the cylinder 1.4.B, the cylinder wall and the upper surface of the piston 1.6.B.
- 5 - Cylinder lower chamber 1.2.B: it consists of the internal volume of the cylinder, 1.5.B, delimited by the lower surface of the piston 1.6.B, the cylinder wall and the connection flange with the filtering section 1.12.B.
- Cylinder head 1.4.B: it consists of a flange connected to the
10 cylinder, a gasket and a closing counterflange provided with the connection for the high pressure washing liquid feed valve 1.3.B. It ensures the hydraulic seal of the cylinder upper chamber 1.1.B.
- Cylinder 1.5.B: it consists of a cylinder with rectified and
15 polished inner surface, within which the piston 1.6.B moves thanks to the pressure difference between the liquid contained in the cylinder upper and in the lower chamber. It contains the washing liquid and acts as a guide for the piston. It is closed by the cylinder head 1.4.B at the upper part and by the connection
20 flange 1.12.B at the lower part. The connection flange is also used as a guide for the piston. In the lower part of the cylinder, close to the connection flange, a radial port 1.11.B is placed to allow the flow of the liquid to and from the lower chamber.
- Piston 1.6.B: it consists of a rigid cylinder placed inside the
25 cylinder, solid with the piston shaft; on its outer surface the seat for the seal 1.7.B is placed. The seal prevents the flow of liquid from the upper to the lower chamber of the cylinder and vice versa. The pressure difference between the piston upper and lower surface makes the piston move: downwards if the pressure

is higher in the upper chamber of the cylinder, upwards if the pressure is higher in the lower chamber.

- Piston shaft 1.8.B: it is a hollow shaft with rectified and polished outer surface. One end of the shaft is connected to the piston by a liquid tight connection 1.6.B, the other end is connected to the spray nozzles supporting head 1.13.B; the shaft moves through a hole in the connection flange 1.12.B provided with an water tight seal.
- Connection flange 1.12.B: it is a rigid ring that connects the piston cylinder to the filtration section cylinder 2.B. It has a coaxial hole for the piston shaft, provided with the seat for the water tight seal 1.10.B.
- Spray nozzles supporting unit 1.13.B: it consists of a hollow cylinder connected by a water tight connection to the piston hollow shaft 1.8.B; its hollow chamber acts as spray nozzles feeding chamber. Spray nozzles are installed in the lower face of the device.
- Oriented spray nozzles 1.14.B: for this application flat pattern spray nozzles are used. The jet of water is directed radially to the outside and downward. A variable number of nozzles is arranged in such a way to create a flat and uniform jet of water all around the piston shaft axis (360°). The inclination of the water jet with respect to the axis of the piston is chosen according to the different applications.
- Hollow shaft one way closing valve 1.15.B: it consists of a disc provided with a suitable washer, that allows the flow of washing liquid from the cylinder upper chamber 1.1.B to the spray nozzles supporting unit 1.13.B, while preventing the flow of dirty water in the opposite sense. It is guided by a shaft and

closed by a spring. Its opening occurs because of the difference in pressure between the cylinder upper chamber and the filtration section. Its application is not indispensable to the functioning of the filter washing system.

- 5 - Piston return valve 1.16.B: it is a commercial valve that connects the cylinder lower chamber 1.2.B with the piston return device; it allows a unidirectional flow to the cylinder lower chamber without limitation in flow to maximize the piston upwards speed. The piston return can be achieved by pneumatic
10 devices or other methods.
- Piston speed control valve 1.17.B: it is a commercial valve that connects the cylinder lower chamber 1.2.B with the piston return device 4.B; it has the function of controlling the flow of liquid which is exiting from the lower chamber of the cylinder and
15 consequently the speed of the downwards motion of the piston.

The filter feeding chamber 2.B consists of:

- Feeding chamber cylinder 2.1B: it has the function of conveying the liquid entering the filter to the filtering section. On the upper side it is delimited by the connection flange to the
20 washing system cylinder, 1.12.B, on the lower part it is connected by the connection flange to the filtering section 2.2.B.
- Connection flange 2.2B: it is a flange of other kind of water tight connection (clamp, DIN) that connects the feeding chamber
25 cylinder 2.B with the filtering section cylinder 3.B.
- Feeding chamber inlet 2.3B: it is the connection through which the liquid to be filtered enters the feeding chamber. The size and type of connection can change according to the different applications.

The filtering section 2.B consists of:

- Filtering section cylinder 3.1.B: it is a rigid tubular cylinder that contains the filter 3.3.B; on the upper end it features the connection flange 2.2.B to the filter feeding chamber 2.B. In the upper part of the filtering section cylinder the radial feeding inlet is placed 2.2.B. On its lower edge the filtering section cylinder is connected to the discharge cone 3.5.B.
- Filter 2.5.B: It is a cylinder 2.5.B made of a porous media. The flow of filtered liquid is from the inside to the outside. Each cylinder end is connected (welded or glued) to a ring 2.6.B coaxial with the filtration section cylinder; between each ring and the cylinder a radial seal is installed; the seat of the seals are placed on the external surface of the rings.
- Filtering section inner chamber 2.1.B: it is the volume contained inside the filter mesh.
- Filtering section outer chamber 2.2.B: it is the volume between the filter mesh 2.5.B and the filtration section cylinder 2.4.B.
- Discharge cone 3.5.B: it is a cone that connects the cylinder to the discharge valve.
- Discharge valve 3.10.B: it is a commercial valve, manual or automatic, 3.10.B, connecting the discharge cone 3.8.B to the discharge manifold.
- Discharge manifold 3.6.B: it is the pipe through which the soil settled on the filter mesh during filtration is discharged during the filter mesh cleaning cycle.

Functioning of the device and filtration process

The liquid to be filtered is pumped in the feeding section cylinder, and then flows to the filtering section inner chamber 3.1.B from which it flows through the filter 3.6.B, thanks to the

pressure difference generated by the external pump. The filter mesh stops the impurities having a size greater than the filter pore size that are contained in the liquid, which flows in the filtration section outer chamber 3.2.B and from here reaches the filtered
5 liquid outlet 3.7.B.

The constant deposit of impurities on the filter increases exponentially the resistance to the flow of liquid, until the filter clogs. To recover the optimal conditions of the filtering mesh, the filter must be cyclically cleaned. That is the function of the
10 washing system 1.B, that is the most innovative feature of this self cleaning filter. It is common practice that in water treatment applications some kind of deposits (clay, vegetal substances, etc.) are very difficult to remove from filters using counter current flows of liquids or mechanical devices such as scrapers or brushes,
15 that might be even counterproductive.

On the other hand it has been observed that a concentrated jet of liquid on the layer of the deposited material in the absence of water removes it with relative ease. From here the idea to realize an orientated jet washing system: the washing piston.

20 When a mechanical, electrical or electronic device or simply the willing of the user determine the necessity of cleaning the filter mesh, the feed valve 1.3.B is opened (manually or automatically), the washing liquid, provided with suitable pressure and flow, enter the washing cylinder upper chamber 1.1.B and
25 from here it flows through the piston hollow shaft 1.9.B to the spray nozzles supporting unit.

The resistance to the flow of liquid generated by the nozzles transmits to the upper face of the piston, generating a force parallel to its axis that pushes it downwards. The contemporary

vertical movement of the piston 1.8.B and the jets of washing liquid through the oriented spray nozzles 1.13.B are then achieved. The spray nozzles, moving downwards, clean the whole filter surface 2.5.B removing the deposits. The cylinder lower chamber 5 1.2.B is connected to a pneumatic device 4.B: while the piston moves downwards, the internal pressure of the pneumatic device increases, slowing down the piston. When the piston has made all its own travel, the spray nozzles have washed the whole filter surface. Closing the washing liquid feed valve 1.3.B the pressure 10 inside the cylinder upper chamber 1.1.B drops, because the washing liquid keeps flowing trough the spray nozzles 1.14.B or through a dedicated discharge valve; the pressure in the cylinder lower chamber 1.2.B, accumulated in the pneumatic device is now higher than in the upper chamber, and then the piston 1.6.B moves 15 upwards to the starting position. The upwards motion speed of the piston is controlled by the resistance with which the washing liquid contained in the cylinder upper chamber flows trough the spray nozzles 1.14.B.

To prevent the flow of liquid from the filtration section inner 20 chamber to the cylinder upper chamber and the consequent downwards movement of the piston, due to the fact that the pressure in the first chamber is higher than in the second, a non return valve provided with a calibrated closing spring 1.15.B is placed at the end of the piston hollow shaft.

25 Of course the upward movement of the piston can be achieved by feeding water of compressed air in the cylinder lower chamber 1.2.B through a dedicated valve.

It is important to notice that to maximize the cleaning effect of the spray nozzles, before stating the washing cycle it is

necessary to drain all the liquid contained in the filtering section inner chamber 2.1.B through the discharge valve 3.6.B, to prevent that the kinetic energy of the water jets is dissipated by mixing with other liquid contained in the chamber.

5 The efficacy of the washing essentially depends on the pressure of the water jets and on the speed of the downward motion of the piston.

10 The water jet pressure control is achieved by controlling the pressure of the cleaning liquid, or changing the spray nozzles resistance, changing the nozzles size; the piston speed control is determined instead by the difference in pressure between the cylinder upper 1.1.B and lower chamber 1.2.B, that can be modified by changing the pre-charge pressure of the pneumatic device 4.B or controlling the speed of the liquid that exits the
15 cylinder lower chamber 1.2.B, through the dedicate port, if the upward movement of the cylinder is made by an independent pressure supply.

Brief description of drawings

20 Fig.1 shows the filtering system equipped with a centrifugal separation system called "version A".

25 The Fig.2 shows, instead, the filter without a centrifugal separation system called "version B". The single parts of both pictures are identified with appropriate codes (numbers.letter): the functions and the characteristics of each single component are shown in the description of the invention.

Best mode for carrying out the invention

The filtering part of the equipment in versions "A" with centrifugal separation system and version "B" without centrifugal separation system consists essentially of a lodging cylinder in

which the filter cartridge is installed. The mesh of the thread establish its filtering mesh determining the separation cut off of the suspended solid of the filtering liquid.

The only difference between the version "A" and "B" is represented by the presence of a second cylinder, concentric to the lodging of the filter cartridge, in which the separation of the solid with major mass and density takes place thanks to the centrifugal force. The filtering section, similar to many other commercial filters, is not presenting particular constructive difficulties and therefore it doesn't present any relevant peculiarity.

The qualifying part of this equipment is represented by the cleaning system of the filter mesh, composed by a single hollow cone nozzle, or in alternative by a group of nozzles with oriented water jet, placed at the edge of the piston hollow shaft, which is connected on its opposite edge to the piston that can move inside the cylinder, determining the alternated movement.

From the constructive point of view the piston shaft is preferably made of steel, with polished finishing inside, with an indicative diameter of 70 mm, indicative length of about 1000 mm; the diameter of 70 mm is suitable for equipment for which is foreseen a liquid washing pressure of about 5 bar; for higher pressure (20-100 bar and over) cylinders and pistons of smaller diameter can be used.

One edge of the tube (cylinder) 1.5.A, 1.5.B is soldered, in axial position and perfectly perpendicular to it, on the connection flange 1.12.A, 1.12.B; on the opposite edge of the tube 1.5.A, 1.5.B is instead soldered a junction (type DIN, CLAMP or others) whose net internal diameter results slightly wider than the internal diameter of the cylinder (shiny tube) to allow the insertion of the

piston. An attachment (of the type DIN, CLAMP, GAS or otherwise) is soldered on the head of the piston closure 1.4.A, 1.4.B, linked to the cylinder, through which the washing liquid is fed.

5 The plunger 1.7.A, 1.7.B, connected to the edge of the piston shaft, 1.8.A, 1.8.B, is composed by two rigid rings between which the cylinder holding ring made of a suitable elastomer is placed. Due to the low operating pressure, the plunger could also be of a pre-pressed commercial type. The piston shaft 1.8.A, 1.8.B is
10 obtained from commercial hollow pipe (indicative external diameter 30mm, internal diam. of 20mm) externally rectified, which slides inside the holding ring 1.10.A, 1.10.B positioned in the centre of the connection flanges 1.11.A, 1.11.B.

The piston shaft is linked to one side of the piston plunger with
15 an air-tight connection; on the opposite side a group of spray nozzles is screwed with an adapter on the external edge; a single hollow cone nozzle can be also used. The type of nozzles installed could be adequate to the conditions required and to the pressure of the washing liquid. All the other spare parts of the equipment, for
20 example, the interception valves, pumps or similar, are of a commercial type and are adaptable to the various configurations and the various conditions of use.

Industrial applicability

The described equipment, in its various dimensions, represents
25 a modular element that can be associated in series or in parallel to give origin to self-cleaning filtration systems of great capacity. It can also be included in complex and integrated treatment processes and can be managed automatically by evolved computerised controls. In practice it can also be useful for self-cleaning

filtration processes for liquids with high BOD, in sizes starting from 1 nominal micron. It can also be useful for pre-treatment of liquids with solid suspensions (especially the organic type) destined to deep filtration processes (micro, ultra, nano filtration and inverse osmosis). It is possible to foresee the application of this system in the washing processes of fruit and vegetable, in filtration of fruit juices, in the filtration or prefiltration in industrial flow processing, especially those of the food industry, in the treatment of digestal flows and in the concentration of industrial mud.

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CLAIMS

1. A method and apparatus for the mechanical separation of suspended solids in liquid and for the automatic washing of the filtering mesh, characterised by a mobile group of washing jets of high pressure liquid obtained by moving vertically one or more spray nozzles, that are operated while the filter is empty; the vertical motion is achieved by means of the same pressure of the washing liquid; the system is conceived to maintain high fluxes of filtered liquid even with high levels of suspended solids and other substances, to reduce the water consumption for filter recovery and to allow the use of filtered water for further treatment of deep filtration (micro, nano, ultra-filtration of inverse osmosis)
2. A method which foresees the following sequence of phases for the washing of the filtering meshes with orientated jets of liquid, to recovery periodically the filter flow capacity:
 - momentary interruption of the flow of the liquid in filtration;
 - emptying of the centrifugal separation chamber (3.3.A) and of the filter section inner chamber (2.1.A) of the version "A" system, emptying of the feed chamber (2.1.B) and of the filter section inner chamber (3.1.B) and external (3.2.B) of the version "B" system;
 - introduction of pressurized detergent liquid in the cylinder upper chamber (1.1.A; 1.1.B) with consequent descent of the piston in the empty filter section inner chamber, and contemporary spraying of the internal surface of the filtering mesh (2.1.A; 3.1.B) which removes the deposited dirt;
 - unloading of washing liquid and of the impurities removed from the filtering meshes;

re-filling of the chambers of the filters and restart of normal filter operation.

3. A method, according to claim N° 1 e 2, which foresees the possibility to re-clean the filtering meshes by high pressure liquid jets orientated and concentrated directly on the clogged surface of the filtering mesh;
4. A method, according to claim N° 3, in which the washing of the filtering meshes is effectuated through a group of liquid spray nozzles (1.13.A; 1.13.B), while the filtering section inner chamber is empty (2.1.A; 3.1.B) (2.A; 3.B) (temporary absence of liquid in filtration).
5. A method, according to claim N° 1, in which the process fluid is submitted to spinning (only for version "A"), to achieve the centrifugal separation of the heavier fraction of the suspended solids contained in it, inside a dedicated chamber (3.3.A) separated from the filtering one (3.3.A).
6. A method, according to claim N° 3, in which the washing of the filtering mesh is obtained by a group of liquid spray nozzles (1.13.A; 1.13.B) moving vertically by means of a piston (1.A; 1.B).
7. A method, according to claim N° 6, in which the pressure of the same washing liquid generates the vertical downwards movement of the piston (1.6.A; 1.6.B) (1.A; 1.B).
8. A method, according to claim N° 6, in which the passage of the washing liquid from the cylinder upper chamber (1.1.A; 1.1.B) to the spray nozzles supporting unit (1.13.A; 1.13.B) is made through the internal cavity of the piston shaft (1.9.A; 1.9.B) which in this way acts also as a collector.
9. A method, according to claim N° 8, in which the resistance to

- the passage of the liquid in the nozzles (1.14.A; 1.14.B), installed on the spray nozzles supporting unit (1.13.A; 1.13.B), determines the pressure of the washing liquid which is equivalent to the pressure in the cylinder upper chamber (1.1.A; 1.1.B).
- 5 (1.1.A; 1.1.B).
10. A method, according to claim N° 9, in which the difference in pressure between the cylinder upper (1.1.A; 1.1.B) and lower chamber (1.2.A; 1.2.B) of the cylinder determines the direction and the velocity of descent or ascent of the washing piston
- 10 (1.6.A; 1.6.B);
11. A method, according to claim N° 10, in which the resistance created in the flow of liquid from the cylinder lower chamber (1.2.A; 1.2.B), determines also the speed of the descent of the washing piston (1.6.A; 1.6.B);
- 15 12. A method, according to claim N° 10, in which the re-ascent (return) of the washing piston (1.6.A; 1.6.B) can be determined by the pressure accumulated in a pneumatic device (compressed air tank) (4.A; 4.B) during the phase of descent of the washing piston.
- 20 13. A method, according to claim N° 10, in which the ascent (return) of the washing piston (1.6.A; 1.6.B) can be obtained also with pneumatic systems controlled automatically according to a predetermined sequence.
- 25 14. An apparatus according to claim N° 3 which foresees the installation on a suitable support, (1.13.A; 1.13.B), of oriented spray nozzles (1.14.A; 1.14.B) installed in such a way to ensure a uniform distribution of 360 degrees guaranteeing with this the spraying of the whole internal surface of the filtering mesh (2.5.A; 3.6.B).

15. An apparatus according to claim N° 14 which foresees the application of a piston (1.A; 1.B) for the alternative movement of the spray nozzles (1.13.A; 1.13.B) from the top to the bottom of the filter mesh and vice-versa.
- 5 16. An apparatus according to claim N° 15 in which the piston is equipped (1.A; 1.B), (1.8.A; 1.8.B) with an hollow shaft (1.9.A; 1.9.B) which connects the plunger of the piston (1.6.A; 1.6.B) to the group of nozzles (1.13.A; 1.13.B) allowing the flow of liquid detergent towards the nozzles.
- 10 17. An apparatus according to claim N° 11 in which it is possible to install a uni-directional valve with flow from the elastic expansion tank (4.A; 4.B) to the cylinder lower chamber (1.15.A; 1.15.B), to allow a rapid flow of liquid accumulated in the pneumatic device during the descending phase of the piston, when the washing supply valve is closed (1.3.A; 1.3.B).
- 15 18. An apparatus according to claim N° 17 which foresees the application of a by-pass circuit of the unidirectional valve (1.15.A; 1.15.B) to control at pleasure the flow of liquid from the cylinder lower chamber and with it the speed of decent of the piston, by means of a suitable control valve, when the washing supply valve is opened (1.3.A; 1.3.B).
- 20 19. An apparatus according to claim N° 18 which foresees the application of a pneumatic system (4.A; 4.B) to accumulate energy under the form of increasing pressure in a dedicated closed tank, for the re-ascent of the of the washing piston on the closure of the supply valve (1.3.A; 1.3.B).
- 25 20. An apparatus according to claim N° 19 which foresees the application, in alternative, of other pneumatic and hydraulic systems to supply autonomously, according to a predetermined

sequence, the energy for the re-ascent of the washing piston.

21. An apparatus in which the material used in the construction of its single components vary according to their physical and chemical compatibility with the nature of the fluid to treat and
5 with the kind of duty the system must afford.

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