

SCREEN WITH HIGH PRESSURE NOZZLES

5 The invention lies in the technical field of raking devices for separating solids from liquids, for sewage-treatment plants, for example, with cleaning elements circulating in a rake frame, basically extending over the width of the frame, which are connected to at least one lateral endless chain that is driven by a motor.

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Such types of raking devices are used in the intakes of sewage-treatment plants, but also in industrial operations, in order to clean liquids containing solids and solid particles of those solids. Usually, these raking devices have rods arranged like a grid in a frame, which basically fill in the cross section of the intake and are laid out at a steep incline, see for example CH 382 670 A, 15 US 2 106 851 A or US 5 730 862 A. In these known raking devices, comb-like cleaning elements are attached to lateral endless chains some distance apart in order to push solids left hanging on the rods onto the rake head, near the rake head, there is a discharge for the raked materials where the solids 20 collected are discharged and run off to the side, for example.

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In these known raking devices, the functions of separating out the solids, on one hand, and carrying off the separated solids, on the other, are carried out by various components; this leads to the constant problem of keeping free the area between the rods that perform the separating or screening function. In particular, the comb-like cleaning elements can get stuck at clogging points, which can put an excess load on the drive motor for the endless chain. In this connection, therefore mechanical and electronic safety devices have already been proposed to free these types of clogs on the raking rods with multiple 30 comb-like cleaning elements that move back and forth. Apart from the

structural expense necessary for them, the known raking devices still operate with only limited reliability.

Now it is the goal of the invention to create a raking device of the type mentioned at the beginning that has a simple structure that reliably prevents clogging or dislocation and makes efficient cleaning possible during operation. The invention is therefore based on the idea that when the above-mentioned separating and carrying off functions are carried out by one and the same component, a new type of cleaning can be provided, which reliably prevents the raking device from becoming clogged and guarantees that it remains permeable. The latter is essential, since otherwise a clog in the liquid in front of the raking device could lead to an overflow of the liquid in the intake area.

The raking device in the invention, which is the type mentioned at the beginning, is therefore characterized by the fact that screening elements are provided that are perforated and arranged like steps on an escalator and by the fact that on the top of the rake frame, there is a screening element/cleaning device with nozzles to clean the perforated screen elements as they go by.

In this raking device (which is no longer a “rake” in the literal sense, with rake prongs, but for which the name “raking device” will be used because this name has been introduced in general for a wide variety of types of raking devices, especially in sewage-treatment plants), the perforated screening elements perform both the function of separating out the solids and carrying off these solids to the raking head. The solids are separated on the basis of perforations in the screen element, where the size of the holes is such that the liquid can pass through the screen elements, but the solids are held back from a certain size on. Solids separated out in this way are transported upward with the help of the steps in the screen element on the upstream side of the raking device, and at the top reverse point of the raking device, at the head of the rake, where the screen element changes its position 180°, these solids are

carried off and then run down the sides. After that, the step-like screen elements in the raking device in the invention are cleaned by the nozzles, so that the holes in the screen element, if any solids have become attached there, are freed again; in this way, after passing the reverse point on the bottom, the perforated screen elements can in turn separate the solids from the liquid in the upstream segment during upward movement and transport them up, with no fear of clogging the screen element and thus the raking device as a whole. The nozzles can thereby be connected to a pump via pipe lines and hose lines that pump in the cleaning liquid, especially water, so that the nozzles can clean the perforated screen elements with the water jets provided.

The nozzles themselves can be placed outside the actual raking device, i.e., outside the escalator-like screen element that moves up and down, in order to spray the perforated screen elements from the outside. But this leads to the fact that solids collect in the space inside between the circulating screen elements, which must be taken out of the inside space at least periodically, which can be structurally expensive. It has therefore proven worthwhile, when the nozzles are placed in the space inside the raking device defined between the upstream and downstream screen elements and are pointed generally to the downstream back of the raking device in order to clean the perforated screen elements from the inside or the back. In this way, the solids are rinsed off by the screen elements on the outside toward the downstream side, so that the space inside the raking device is not loaded with solids.

Solids can be rinsed directly in the liquid behind the raking device, which can then be reliable when there are still other cleaning and precipitating steps in the liquid flow afterward. However, this design with the nozzle-cleaning device on the rake head and the design of the raking device with step-like screen elements does have the advantage of offering the possibility of collecting solids rinsed off by the screen elements along with the cleaning liquid containing them efficiently so they do not get into the liquid behind the

raking device. One preferred form of embodiment of the raking device is the invention is characterized by the fact that the outside of the downstream segment of the screen element has a collecting wall or cup to catch cleaning liquid sprayed by the nozzles on the rake frame. In this design, the solids
5 rinsed off the step-like screen elements with the cleaning liquid are collected and carried off, and they can also be fed back to the front of the raking device so that there, with the help of the screen element, they can be separated off finally and then can be discharged at the rake head. In this connection, a simple structural design has proven worthwhile, in which a feedback line
10 leading to the upstream side of the raking device is connected to the collecting wall or cup. The feedback line can have an incline from the back of the raking device to the front, so that the cleaning liquid with the rinsed off solids flows by itself to the front of the raking device.

15 The nozzles could be arranged in a single line across the direction of movement of the screen element to make the cleaning very effective; however, the nozzles can also be connected one after another in the direction of movement of the screen element and, for this it is good if the nozzles are placed on two or more nozzle beams.

20 The nozzles can be arranged close together, when seen crosswise, and/or they can also be designed as flat nozzles producing separate jets; but in order to be able to clean the screen elements reliably with a relatively low throughput of cleaning liquid, it has proven very worthwhile to provide relatively few
25 nozzles, but to place them so they can move to spray the screen elements reliably with relatively thin, strong beams directed over one area of the screen element. For this one advantageous form of embodiment of this raking device is characterized by the fact that the nozzle beams are arranged so they can swivel back and forth, for example in a direction transverse to the direction in
30 which the screen elements circulate. This also provides an efficient way of

driving them, in that the nozzle beams are connected to one another on a jointed rod and to a motor via a crank drive.

As already mentioned, one special goal is to clean the screen element with few jets, and in this connection, it has proven advantageous when the nozzles are designed as high-pressure nozzles, for example designed for a pressure from 15 to 20 bars. In this way, the cleaning time per surface unit of the screen element can be kept extremely short, and reliable cleaning of the screen elements and their holes can be guaranteed nonetheless.

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To help carry off the solids in the area near the rake head and do a kind of pre-cleaning of the screen elements before they are sprayed with the nozzles, it has also proven worthwhile if the screen element/cleaning device in the solid discharge area next to the point where the top screen element reverses has a cleaning brush for the screen element. That way, the cleaning brush can be designed as a stationary brush extending over the width of the raking device against which the screen element brushes as it does by. But for reliable pre-cleaning in the area of the corresponding angle of the screen element as well, it is a special advantage if the cleaning brush is a motor-driven rotating brush.

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This design of the raking device with step-like screen element and nozzle-cleaning device also advantageously offers the possibility of being able to react to a fluctuating load of liquid with solids quickly and automatically, and this takes only very simple measures. It is also good if a control circuit connected to liquid-level sensors arranged upstream and downstream of the raking device is assigned to the motor driving the screen element over the endless chain, so the motor can be adjusted to a higher rpm if the level difference increases. If in this raking device, it happens that the level of liquid in front of it rises because of the high load of solids compared to the level of liquid behind the raking device, this is detected by the sensors, and the motor for the endless chains is made to run at higher rpm by the control circuit.

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Then the step-like screen elements accordingly circulate faster, so that there is faster separation of solids from the liquid, and more liquid can in turn flow through the raking device, so that in turn an adjustment in the level takes place upstream and downstream from the raking device. The control circuit can be designed so that at the same level upstream and downstream of the raking device, the rpm of the motor are set back far enough until a slight level difference is detected again. The rake device can be made and used in industry, in particular at sewage treatment plants, and is therefore capable of industrial application.

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The invention will be described below using the drawings and especially preferred examples of embodiment, but it is not limited to them. Figure 1 shows a front view of a raking device, shown schematically in an intake or gutter; Figure 2 shows an accompanying side view of this raking device, where one side wall of the intake and adjacent side part of the raking frame are left out; Figure 3 shows a schematic side view of the rake head on an enlarged scale compared to Figure 2, without the different individual parts like the screen elements and rotating brush; Figure 4 shows a front view of a cleaning and screening element for this raking device; Figure 5 shows an accompanying side view of this cleaning and screening element, along arrow V in Figure 4; Figure 6 shows a view of part of an endless chain in this raking device, to display the bolts used to attach the screen element in Figure 4 and 5 to the chain sections; Figure 7 shows schematically a partial section of a nozzle unit to be placed in the area near the rake head; Figure 8 shows a cross section through this nozzle unit, along line VIII-VIII in Figure 7, but on an enlarged scale compared to Figure 7; and Figure 9 shows a block diagram of a control circuit for the electric motor driving the endless chain of the raking device, along with a schematic drawing of the raking device.

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Figures 1 and 2 show a raking device, marked 1 in general, also called a filter step rake below, which is used in an intake or gutter 2 for example for a liquid

containing solids to be cleaned by the latter in a generally uprights position; however, as can be seen from Figure 2, the raking device 1 is arranged in the flow direction, see arrow 3 in Figure 2, rising under 60° to the horizontal. For example, intake 2 can be an intake to a sewage-treatment plant or to equipment for cleaning liquids in industrial plants.

The raking device 1 has a frame 4, which consists of two side parts 5, 6, which are connected to one another on the front and back by several cross struts 7. These cross struts 7 are distributed over the height of the raking unit 1 some distance away from one another, see especially Figure 2. On the inside of the frame/side parts 5, 6, there are chain rails, not shown in greater detail, for running a lateral endless chain 8, which is only shown schematically in Figure 2, and from which a cut-out in top view is shown in Figure 6. These endless chains 8 run, in a way that is known, over a top chain wheel 9 and a bottom chain wheel 10, and these chain wheels 9, 10 are mounted so they can rotate in the frame 4. The top chain wheel 9 is driven in the conventional way by a motor 11, especially an electric motor, and, of course, there can also be a corresponding gear box, not shown, in the usual way.

Attached to the endless chains 8 as rake-cleaning elements are perforated screen elements 12, also "hook elements", and these screen elements 12 are set at an angle like steps arranged like an escalator on the endless chains 8, as can be seen especially in Figure 2. These screen elements 12 thus together form, on the flow side - i.e., the upstream front side of the raking unit 1 (in Figure 2 the left side) – a practically uniform screen surface, as can be seen also in Figure 1; the screen elements 12 are therefore designed with regular holes both on the upright surface and also on the horizontal step surface.

As can be seen more clearly in Figures 4 and 5, the individual screen elements 12 are formed by triple angles screen sheet metal 13, whose rows of holes are staggered to one another by a half-hole division, so that an arrangement of

holes 14 is made that corresponds to equilateral triangles, as can be seen in Figure 5. The holes 14 can have a diameter, for example, on the magnitude of several millimetres, for example 4 millimetres. The screen metal sheets 13 are firmly attached to side plates 15 on both front sides, for example by welding.

5 These side plates 15 have boreholes 16, 17, with which they are attached to bolts 18, 19 on the individual chain elements 20 of the respective endless chains 8, see also Figure 6. The screen elements 12 extend over the whole width of the raking device 1, i.e., over practically the width of the intake 2; this width or the length of the screen elements 12 can be 1 to 1.5m, 1.2m for

10 example.

In operation, the liquid from which the solids are to be separated flows in the direction of arrow 3 in Figure 2 against the raking device 1, whereby the solids from a certain particle size predetermined by the size of the whole, are

15 separated with the help of the perforated screen elements 12, whereupon the liquid can flow through the raking device 1. The separated solids collect on the horizontal step surfaces of the escalator-like screen elements 12 and are transported by the continually circulating screen elements 12 up to the rake head 21. There, the upper chain wheels 9 define a point of reversal for the

20 endless chains 8, and accordingly for the screen elements 12 and the solids are discharged at 22 (raking-material discharge) by the screen elements 12 on the basis of their 180° turn. After that, the solids are removed laterally, which is conventional and is not shown on the drawing in greater detail.

25 Figure 3 shows the rake frame 4 in the area near the rake head 21, where one endless chain 8 and one upper chain wheel 9 are also shown in dots and dashes. The rake-material discharge 22 is also shown, and one of two symmetrically arranged rear, lateral mounting plates 23 can be seen, which are used to mount a rotating brush 25 (see Figure 2) driven by a motor 24 and

30 arranged on the back of the rake head 21. For this purpose, the mounting plates 23 have a mounting hole 26. The mounting plates 23 are also connected

to a polygon-type angles, back hood cover 27, which along with the mounting plates 23, as a unit, is hinged by a hinged joint 28 on the top cover 29 of the rake head 21. In this way, the unit with the mounting plates 23 and the hood cover 27 can be folded back or away after a tension closure 30 is opened, if
5 this is necessary for maintenance or repair work.

Finally, Figure 3 shows the top part of a collection cup or wall 31, see also Figure 2, whose purpose is to collect the cleaning liquid, especially water, given off by a nozzle unit 32 (see Figure 2 and Figures 7 and 9) rinsed off the
10 back of the raking device 1. To this collection cup or wall 31, a feedback on the side, which feeds the cleaning liquid and the rinsed off solids back to the front of the raking unit 1.

The rotating brush 25 and the nozzle unit 32 thus together form a screen
15 element/cleaning device, which is shown in general by 34 in Figure 2, and which is arranged near the raking head 21, in order to effectively clean the cleaning elements provided with this filter-step rake 1, namely the screen elements 12, which perform both a screening function and also a transport function, at a site above the level of the liquid. As can be seen in Figure 2, the
20 nozzle unit 32 is preferably in the space 35 inside between the front working segment of the endless chains 8 and screen elements 12, shown at 36 in Figure 2, and the back feedback segment 37.

Finally, Figure 2 shows an inspection hole 38, through which the nozzle unit
25 32 and the collection cup 31 (and of course other component like the endless chains 8 and that screen element 12) can be inspected.

In Figure 7 and 8, a cross piece 29 extending over the width of the rake is attached to the side parts of the frame 5, 6, for example by means of bolts 40, to which cross piece 39 three nozzle beams 42 are attached so they can swivel
30 by means of mounting bolts 41. Each of these nozzle beams 42 has two

nozzles 43, one on each end, and these nozzles are connected to distributor pipes 44 via hose lines not shown in greater detail, which are attached to the cross piece 39, preferably via pipe fittings 45, as can be seen especially in Figure 8.

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The three nozzle beams 42 are connected to one another via a rod 47 connected to them with bolts 46 and jointed, and on one of the nozzle beams 42, the right one 42 in Figure 7, a crank gear shown schematically at 48 engages, which is driven by a motor 49, in order to swivel the nozzle beams 42 together around their respective jointed points (mounting bolts 41), see also double arrow 50 in Figure 7.

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Figures 7 and 8 also show bushings welded into the nozzle beams 42; of course, these bushings can be used to hold separate nozzle elements having very small nozzle holes, which is not shown in greater detail in the drawing.

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In operation, the motor 49 drives the crank gear 47 with the drive rod 51, and the first nozzle beam 42, which thus is swivelled on its mounting bolts 41, thereby via rod 48 drives the other two nozzle beams 41 swivelling back and forth. In this way, the nozzles 43 are moved back and forth in a circle, as shown by arrow 49 in Figure 7, so that they reach the whole area of the filter step rake 1 between the side frame parts 5, 6 on two levels and so can clean approximately one-third of the rake width i.e., a third of the length of the screen element 12.

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The nozzles 43 are high-pressure nozzles, whose water is fed at a pressure of 15 to 20 bar (especially 18 bar), for example, in order to spray the screen elements 12 and their holes 14 to free them of any solids. First, the screen elements 12 and hence their holes 14 as well are cleaned with the rotating brush 25 shown in Figure 2, and the solids brushed off the screen elements 12 with the rotating brush 25 are fed to the rake-material discharge 22 for final

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removal. On the other hand, the solids rinsed out of the holes 14 in the screen element 12 with the spray jets are collected in the collection cup 31 – along with the water – and fed back to the front of the rake.

5 Although now shown in greater detail in the drawing in Figure 2, in the area of the bottom point of reversal of the filter step rake 1, i.e.. radially outside the bottom chain wheel 10, there are stationary brush elements to brush off and clean both lateral endless chains 8, on one hand, and the screen elements 12, on the other.

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Figure 2 also shows schematically two liquid-level sensors 52, 53, where the one, 52, is arranged upstream from the filter step rake 1, and the other, 53, downstream from it. These liquid-level sensors 52, 53 detect the respective level of the liquid upstream and downstream from the raking device 1, and they are connected to a control circuit for the chain drive motor 11, so if there is a difference in the level that occurs when the liquid flowing in has a high load of solids, and the liquid in front of the filter-step rake 1 clogs, it makes the motor 11 run at a higher rpm. The corresponding control circuit 54 is described in greater detail below using Figure 9.

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As can be seen from Figure 9, the control circuit 54 is connected to the upstream level sensor 52, on one hand, and to the downstream level sensor 53, on the other (see also arrow 3 indicating the direction in which the liquid flows), so the output signals of the two sensors or measuring elements 52, 53 are fed to a measuring transducer 55. For example, sensors 52, 53 can be pressure sensors, which detect the hydrostatic pressure based on the liquid above them, and in the measuring transducer 55, the signals given off by the sensors 52, 53 transformed in the conventional way, are amplified in digital form for this purpose. The difference between the measured values produced is found, which can be done either in the measuring transducer 55 or for this purpose in a processor 56 connected after the measuring transducer 55, which

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in the latter case contains both measured signals fed back from the two sensors 52, 53 in the form processed. The processor 56 contains in a storage area, not shown in greater detail, predetermined set values for the rake speed, i.e., the rpm of the motor 11, and depending on the difference found in the measured values, it gives a control signal to control the motor speed, which is fed to a frequency transformer 57 in this example. According to this control signal, the frequency transformer 57 applies a voltage with a changing frequency to the drive motor 11. The drive motor 11 can be a conventional three-phase motor, for example, which is set for a nominal frequency control. So, the rpms can be controlled by the frequency transformer 57 in steps between two frequency limits, a minimum frequency of 30Hz, for example, and a maximum frequency of 60Hz, for example, but it is also conceivable to switch the frequency in stages or to have a type of two-point control with only two possible rpms, one corresponding to the minimum frequency (10Hz, for example) and the other the maximum frequency (60Hz, for example).

Besides supplying voltage with adjustable frequency, the frequency transformer 57 can also be used for overload control, since depending on the load on the drive motor 11, current is drawn from it, which can be detected in the frequency transformer 57. For example, current values in the range from 2A to 7A are conceivable, and when, presumably, the drive motor 11 has a nominal current of 3A, if that frequency is exceeded by 10%, for example, an alarm signal can be given and/or an emergency shut-off can take place. The alarm signal can also be given when the maximum rpm are reached (for example, when the rpm control corresponds to a maximum frequency of 60Hz).

CLAIMS

1. A raking device for separating solids from liquids, for example for
5 sewage-treatment plants, with cleaning screen elements (12) with holes
(14) arranged in steps like an escalator circulating in a rake space
extending basically over the width of a frame (4), the screen elements
being connected to at least one lateral endless chain (8), which is driven
by a motor (11), the chain extending over an upper chain wheel (9) and
10 a lower chain wheel (10), defining an upstream section of screen
elements and a downstream section of screen elements as the chain
rotates around the chain wheels, and nozzles (43) located between the
upstream and downstream sections of screen elements and facing
downstream to clean the downstream section of screen elements as they
15 go by, characterized by a collection housing (31) located on a
downstream side of the downstream section of screen elements for
collecting water discharged from the nozzles and debris dislodged from
the screen elements by the nozzles, and a feedback conduit (33)
connected to the collection housing and leading to the upstream side of
20 the upstream section of the screen elements for returning water and
debris from the collection housing to the upstream section of the screen
elements.
2. The raking device in claim 1, characterized by the fact that the nozzles
25 (43) are designed as high-pressure nozzles, for example designed for a
pressure from 15 to 20 bar.
3. The raking device in claim 1, characterized by the collection housing
(31) being mounted to the frame (4).