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(54) **DEVICE FOR SEPARATING AND REMOVING SEPARATION MATERIALS FROM A FLOWING LIQUID**

(76) Inventor: **Christian Frommann**, Neumarkt (DE)

Correspondence Address:
Stephen E Bondura
Dorit & Manning
Post Office Box 1449
Greenville, SC 29602-1449 (US)

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(57) **ABSTRACT**

The invention relates to a device, especially a step rake with stationary and movable blades whose movement enables separation materials to be separated and removed from a liquid flowing through said rake. The lower ends of the blades are arranged in the region of the base of the channel or the base of a body of water and are temporarily raised above the base when they move. In order to prevent sediments from being deposited between the movable blades, a pre-mounted cover is provided in the direction of flow. A collector chamber is provided for sediments underneath the cover. A cleaning device is arranged in the collector chamber in order to remove sediments.

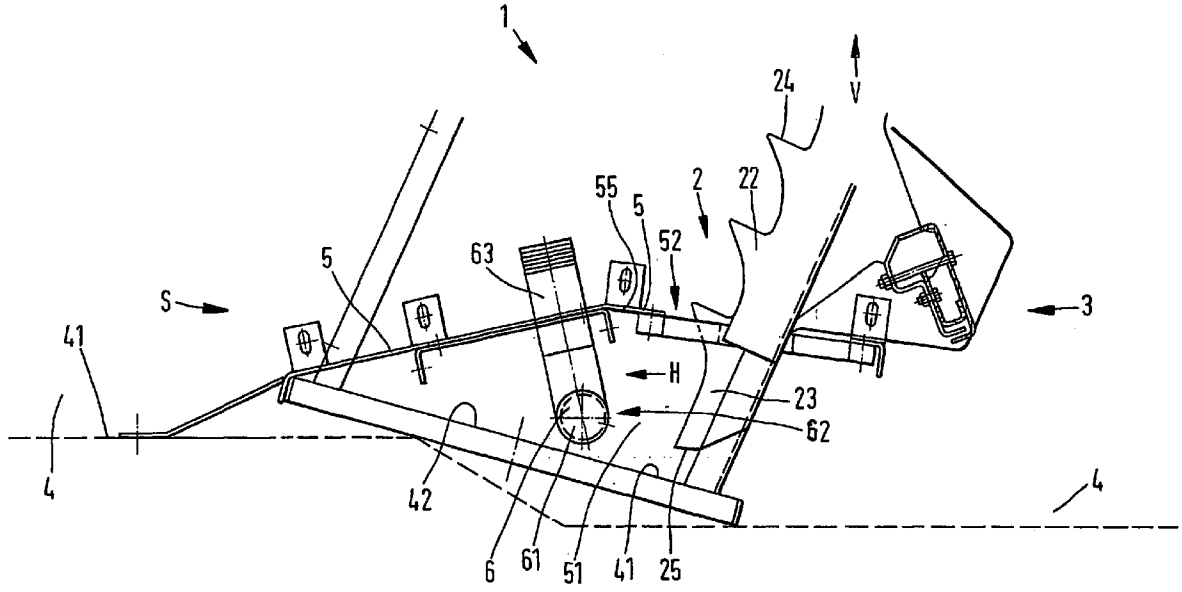
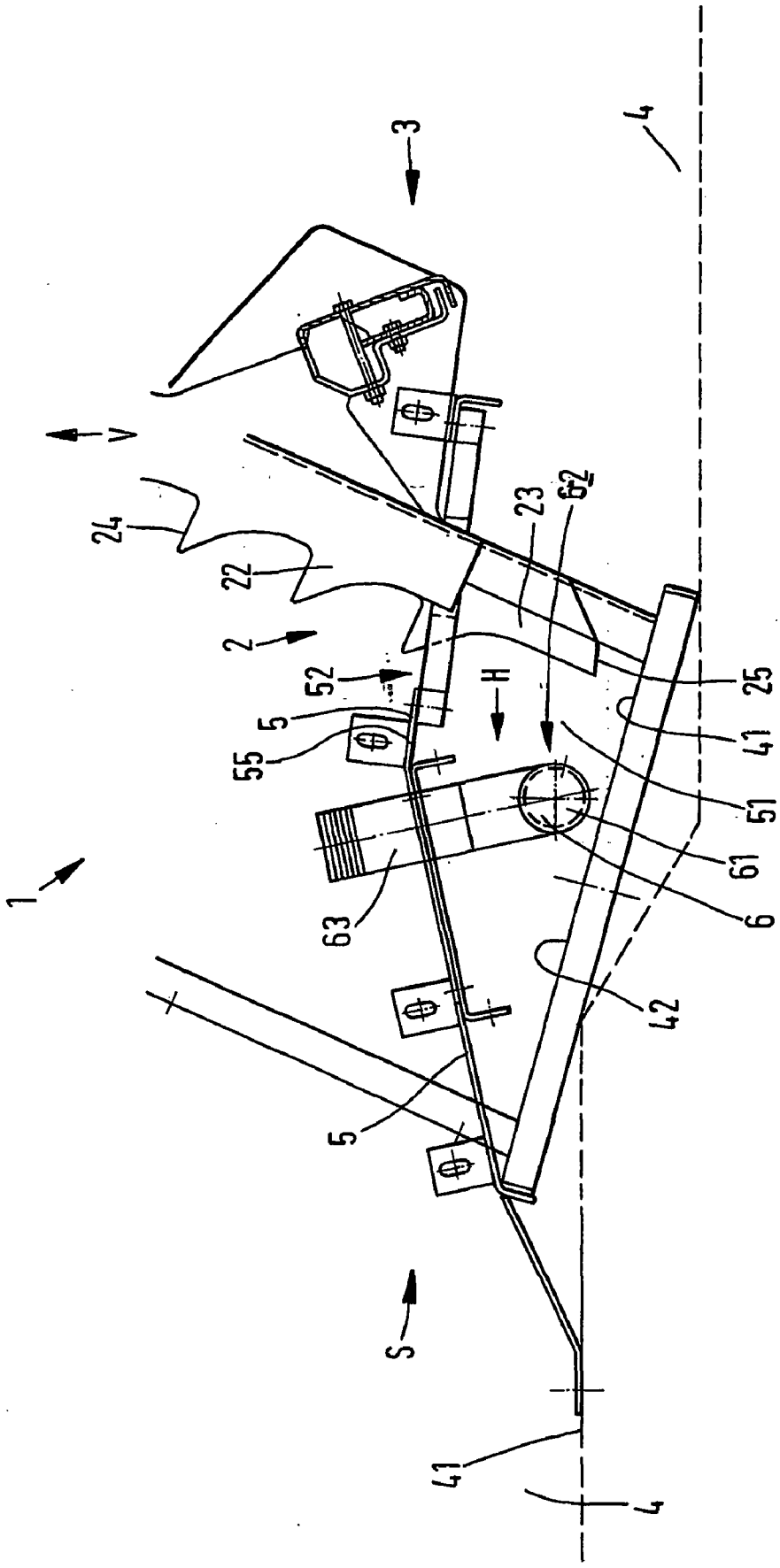


FIG. 1



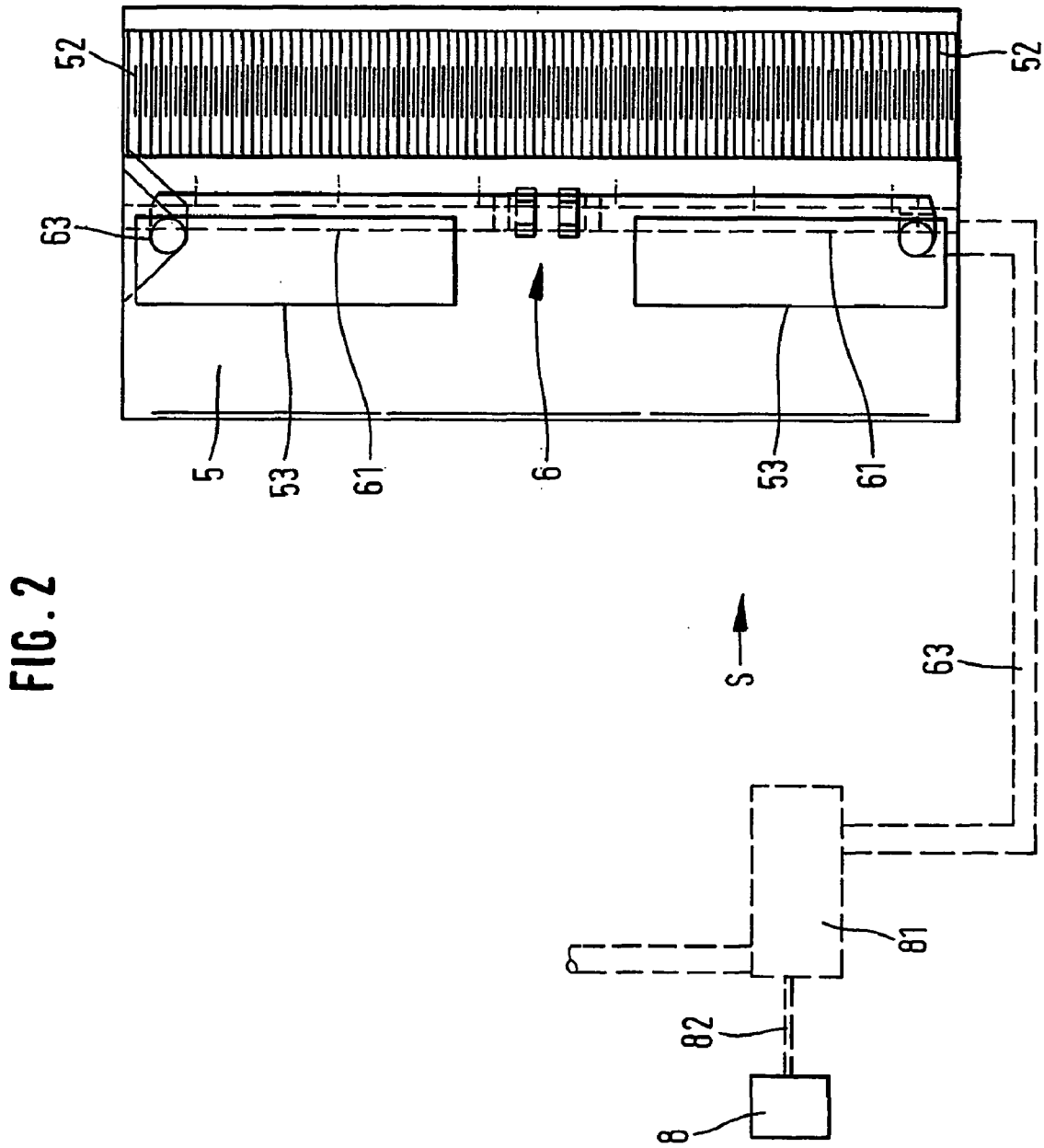
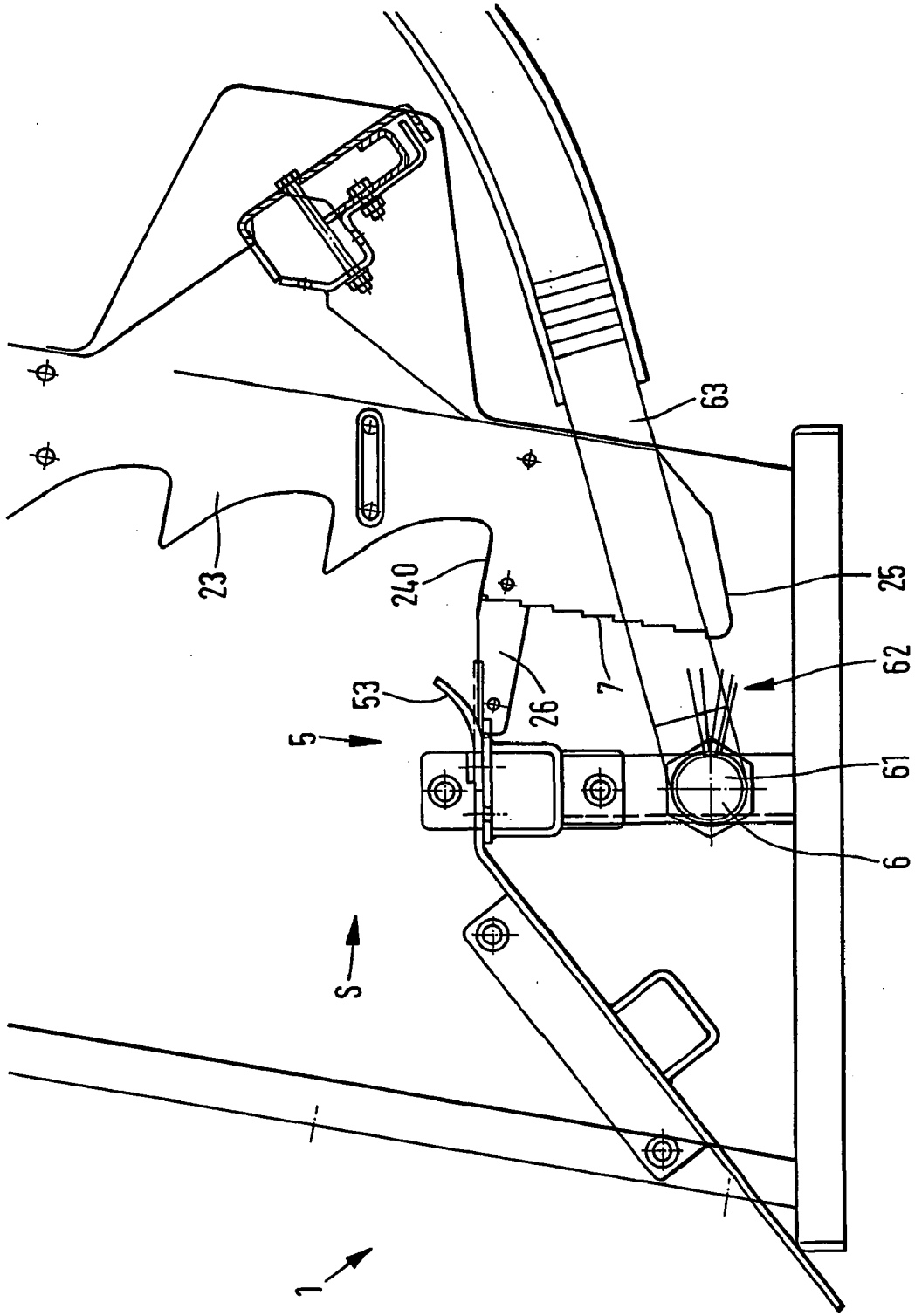


FIG. 2

FIG. 3



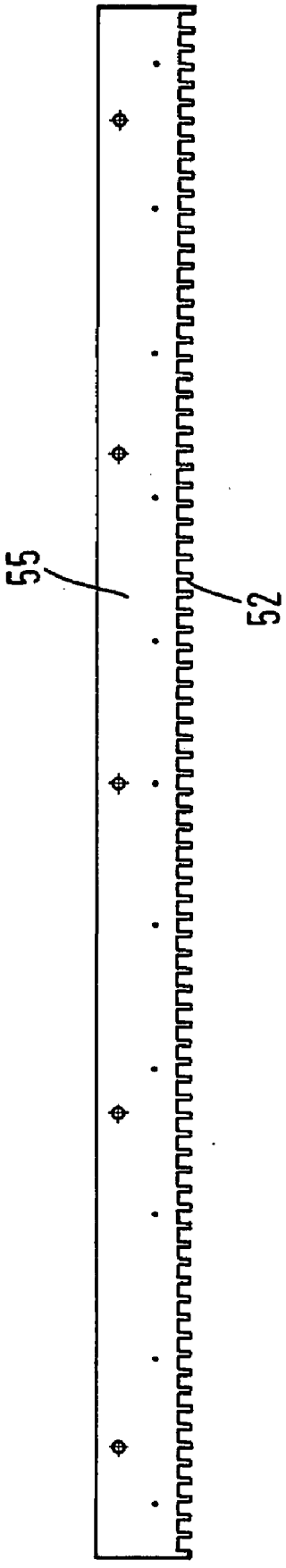
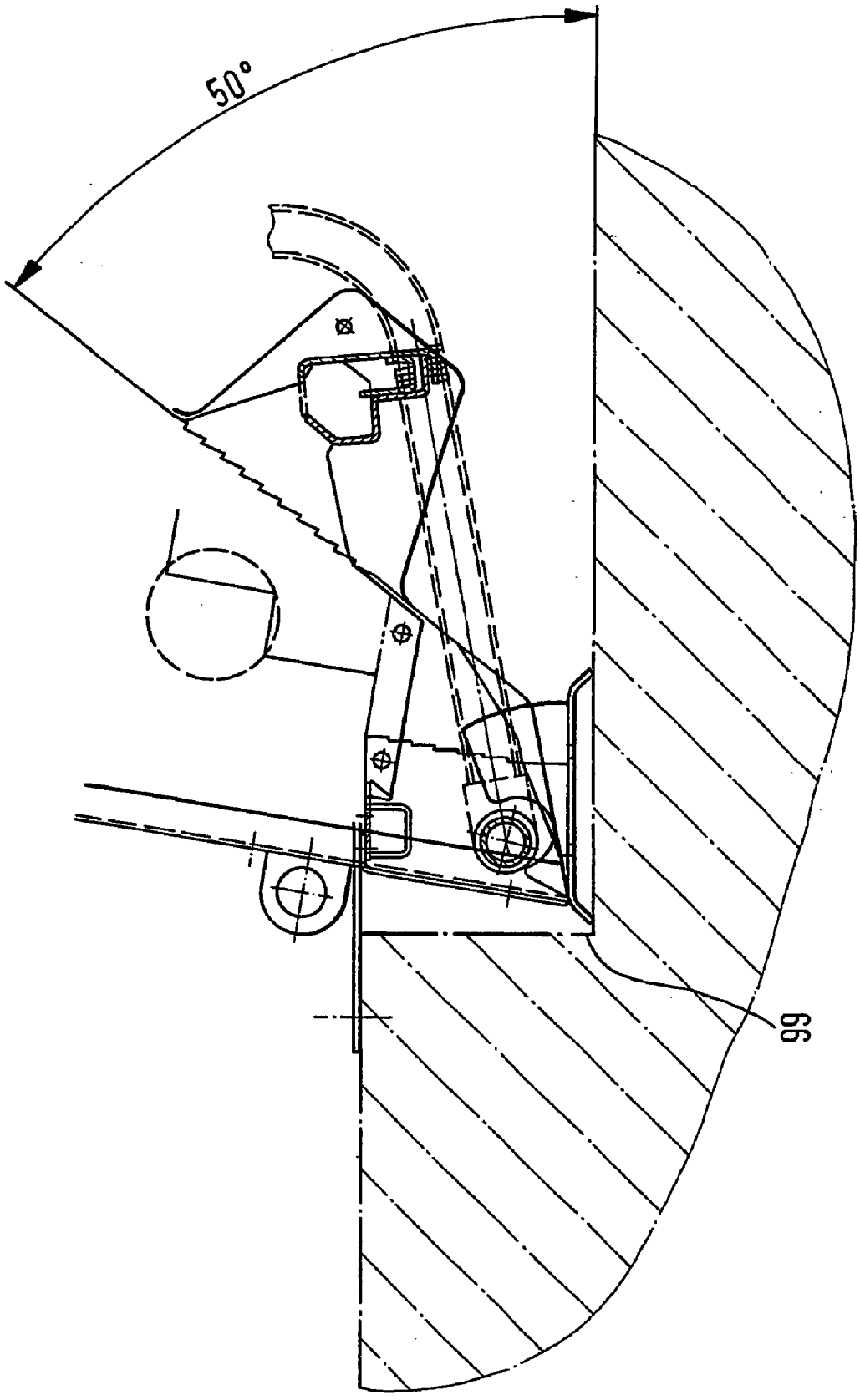


FIG.4

FIG.5



DEVICE FOR SEPARATING AND REMOVING SEPARATION MATERIALS FROM A FLOWING LIQUID

BACKGROUND OF THE INVENTION

[0001] The invention relates to a device for separating and removing separation material from a flowing liquid, e.g., waste water, in the form of a rake having movable and fixed blades plunging into the liquid. The blades are provided with steps on the side for receiving the flow of liquid and a gap exists between the blades for the passage of liquid. The movable blades convey the separation material from step to step of the fixed blades through their movement with at least one movement component in the longitudinal direction of the fixed blades so as to transfer it in the region of the upper ends of the blades to a conveying means for removal. The lower ends of the blades are located in the region of a channel bottom or bottom of a body of water, and have a cover pre-mounted in the direction of flow for the region of the lower ends of the blades.

[0002] A device is known from EP 0346311 A2. In the device shown therein, and in the region of the lower ends, relative to the direction of the flowing liquid of the blades, a cover is provided that is to prevent the passage through the device of substances carried in the liquid. This is because the upward movement of the movable blades causes the clear gap between two adjoining fixed blades to change in the region of the lower ends of the blades to allow the passage of the liquid. The movable blades are moved upward and thus open this region. The fixed and the movable blades of the device are carried in a comb-like part of the cover.

[0003] Although this design of the device makes it possible to prevent the entry of large components into the lower region of the blades and also in particular their passage through the device, considerably smaller particles, such as, e.g., sand or other suspended substances can seriously impair the effectiveness of the device because these are deposited in the region of the blade ends and thus impede the movement of the movable blades. This results in much interference, and even damage to the device. The embodiment of a cover shown in **FIG. 9** of EP 0346311 A2 can also not prevent the accumulation of impurities, in particular sand, in the region of the lower ends of the blades. The particles carried in suspension in the liquid flow in part through the device and are then deposited in critical regions.

[0004] DE 4035174 discloses a device with a movable shutter that is provided with an opening lever. Opening it should cause the current to clean the region behind the valve. The effectiveness of this measure depends, therefore, on the current and it must be carried out manually. Furthermore, much force is required for this in large devices. In the device of EP 0712968 A2, no cover is provided, and the blades are instead provided with an articulation in their lower region, making it possible for the movable blades to always touch the bottom of the channel also in their upward movement. This design of a grate rake causes much wear on the blades and is furthermore disadvantageous with regard to cost.

OBJECTS AND SUMMARY OF THE INVENTION

[0005] It is therefore a principal object of the present invention to create a device that avoids the disadvantages of the state of the art. This object is attained through a device for the separation and removal of separation materials from a flowing liquid, e.g. waste water, in the form of a rake immersed in the liquid having movable and fixed blades with a pre-mounted cover over the region of the lower ends of the blades, which is fixed relative to the device and a collector chamber for the sediments provided below the cover in which a cleaning device is installed for the removal of the sediments in the collection chamber between the cover and the blades. Additional objects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention.

[0006] As a result of designing the device according to the present invention, the sediments collecting under the movable blades can be removed easily and reliably. As a result, faultless operation of the device is ensured thanks to the undisturbed mobility of the movable blades. Designing the device with a cleaning device ensures that cleaning is possibly at any time, independent of the water level and the current speed. Reliable cleaning of sediments from the device is possible at any time independent of the width and other aspects of configuration and installation. In addition, cleaning can be effected at any time and can furthermore be automated, requiring no bodily strength, so that regular cleaning is possible. In combination with a control device, automatic operation can thus be ensured. Providing a cleaning device in form of a pipe conduit with at least one nozzle for the emergence of cleaning fluid under pressure makes for an especially advantageous cleaning device. As a result, the deposits in the region of the movable blades are sure to be removed. A suitable placement and number of nozzles makes it possible to ensure that the locations involved are sure to be kept free of deposits. In addition, the pressure in the pipe conduit can be increased whenever necessary in order to achieve a reliable and also rapid cleaning effect. The cleaning fluid is advantageously water. Depending on the application, it may also be advantageous to let a cleaning gas act on the deposits through the nozzles, whereby air is advantageously used as the cleaning gas. In addition, the nozzle openings can be designed in such manner in an especially advantageous further development of the invention as to produce a cleaning jet radiating at least nearly parallel to the bottom of the collector chamber. As a result, the deposits are reliably lifted from the bottom and can be rinsed away out of the region of the device's blades.

[0007] In an especially advantageous further development of the invention, the cleaning device is connected to a control device that controls the cleaning device. The control device in such case, for example, can advantageously be a valve controlling the access of a medium under pressure to the pipe conduit. Through a correspondingly advantageous design of the control device, more or less pressure medium can be used as needed for the cleaning operation. For this purpose, the cleaning device is advantageously equipped with a connecting pipe connecting the pipe conduit to a container filled with a cleaning fluid or a cleaning gas. The connecting pipe can also advantageously connect the cleaning device to a pump that puts the cleaning medium under pressure. This pump is then provided with an inlet, according to the invention, ensuring the access by the cleaning medium and with a run-off side connected to the pipe conduit. When a pump is used, the control device for the

control of the cleaning device is correspondingly designed as an electric switch that connects the pump to a power source.

[0008] In an especially advantageous further development, the control device is a unit controlling a valve or a pump as a function of measurement indicators, e.g., a timing clock switch or a flow-through measuring device. It is advantageous for the efficiency of the cleaning device to place it before the blades as seen in flow direction because the sediments to be removed are already moving in the direction of the flow of the current going through the device and can thus be carried off more easily by the flow.

[0009] In an especially advantageous further development of the invention, the cover is provided with openings constituting a guide for the movable or fixed blades. In this manner, the fixed and movable blades are advantageously held securely, and, at the same time, the cover surrounds the blades so that as few dirt particles as possible, such as sand, reaches the region below the cover or the region of the movable blades. It is therefore especially advantageous if at least half of the fixed blades, as seen in the flow direction of the current, are covered by the cover. This has an advantageous effect on the reduction of sediments in the region of the lower ends of the movable blades. In an especially advantageous further development, the cover extends until behind the fixed and movable blades, as seen in the direction of flow of the liquid. The openings are most advantageously in the form of slits, so that the region of the blades is covered as much as possible by the cover and the blades are guided securely.

[0010] In an especially advantageous further development of the invention, the fixed blades in the region of the openings of the cover or advantageously also below the cover are advantageously expanded on both sides by doubling. As a result, the fixed blades advantageously provide guidance for the movable blades. The doubling is applied especially advantageously in such manner to a fixed blade of the device that the doubling is located in the opening of the cover. Thereby, the cover also assumes guidance of the blades.

[0011] In an especially advantageous further development of the invention, a preferably elastic sealing lip is provided on the cover before the blades as seen in the direction of flow. Given the path of movement of the movable blades, it enables them to lift the sealing lip. As a result, the sealing lip is able to cover the gap that was uncovered by the movable blades in the region of the opening. Thanks to the flexibility of the sealing lip, the movable blades can touch it without damage. In this way, the greatest possible coverage of the openings of the cover is achieved, so that only few dirt particles enter the region below the cover.

[0012] The invention is explained below through drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] **FIG. 1** shows a side view of a device according to the invention, in a section;

[0014] **FIG. 2** shows a top view of the device of **FIG. 1**, without blades;

[0015] **FIG. 3** shows a side view similar to **FIG. 1**, with a cover of different design;

[0016] **FIG. 4** shows a top view of part of the cover of **FIG. 3**; and

[0017] **FIG. 5** shows the device according to the invention, mounted behind a channel bottom step.

DETAILED DESCRIPTION

[0018] Reference will now be made in detail to the presently preferred embodiments of the invention, one or more examples of which are shown in the figures. Each example is provided to explain the invention, and not as a limitation of the invention. In fact, features illustrated or described as part of one embodiment can be used with another embodiment to yield still a further embodiment. It is intended that the present invention cover such modifications and variations.

[0019] **FIG. 1** shows a section in the region of the lower ends **25** of the blades **2** of the device **1** according to the invention for the separation and removal of separation material from a flowing liquid. A device **1** of this type is generally called a step rake. Here the blades **2** consist of fixed blades **22** and movable blades **23**, whereby a movable blade is installed between every two fixed blades. The movable blades are mounted on a common mounting **3** that connects them to each other. Thus they execute the same movement parallel to each other. As a rule this is in the manner of a circular or elliptical movement in which the movable blades seize and lift up the dirt particles that are on the steps **24** of the fixed blades, deposit them on the step **24** above of the fixed blades. This process is repeated until the dirt particles have reached the upper end (not shown) of the blades, where the dirt particles are removed in a known manner. The device **1** is located in a channel **4**, so that the current S flows essentially at a right angle to the plane in which the blades **2** extending parallel to each other are installed. The movable blades **23** execute a movement in the direction of a horizontal component H in their movement, as well as a movement in the direction of the vertical component V. The movable blades **23** thus reach with their lower ends **25** into the region of the channel bed **41**.

[0020] During the operation of the step rake (device **1**) not only dirt particles, together with the current S, reach the region of the current S where they are held back by the steps **24** of the blades **2** and are eventually removed in a vertical direction, but other dirt components, e.g., small stones and sand, that get between the blades and are deposited under the cover **5** are also carried by the current. They may thereby accumulate to such an extent in the region of the lower ends **25** of the movable blades **23** that the movement of the blades **23** becomes restricted or is prevented. The restricted movement results in increased energy consumption and greater wear of the device **1**, while the prevented movement leads to the destruction of the drive or to the device being shut off, so that the functionality of the device **1** is no longer ensured. The cover **5** is slightly inclined relative to the current S in the shown embodiment of the present invention, thus ensuring that no substantial accumulation of material occurs that could block or fill up the channel bed **41** in the region of the device **1** before the cover **5**, as seen in direction of flow. The slight inclination of the cover **5** causes the materials that are heavier than water to also reach the region of steps **24** of the blades **2**, so that they can be removed from the device **1**. In other embodiments, it may, however, be absolutely possible

to make the side of cover **5** steeper towards the current S. In both embodiments of the cover **5**, however, the suspended particles and small objects carried by the current reach the region between the blades **2** and can accumulate in the region of the channel bed **41** underneath the lower ends **25** of the movable blades **23**.

[**0021**] In the embodiment shown in **FIG. 1**, the region below the cover **5** is designed as the collector chamber **51** in which the materials, e.g., sand or other sediments, can be deposited. According to the invention, the cleaning device **6** is located in the collector chamber **51**. The cleaning device **6** consists essentially of a pipe conduit **61** provided with nozzles **62** in its wall or, in another possible embodiment, connects fixed nozzles **62** to each other. The pipe conduit **61** of **FIG. 1** is provided with nozzles **62** at regular intervals, so that, over the entire width of the device **1**, the region of the lower ends **25** of the movable blades **23** is subjected to a medium under pressure flowing from the nozzles **62** and can thus be removed.

[**0022**] The pipe conduit **61** is connected via a connecting pipe **63** to a pump (not shown in **FIG. 1**) that supplies the cleaning device **6**, e.g., with service water that is under high pressure due to the pump action. The nozzles **62** are adjusted relative to the collector chamber bottom **42** and/or channel bed **41** in such manner that the exiting cleaning medium is able to fluidize or rinse away sand or other deposits located on the channel bottom **41** in the region of the lower ends **25** of the movable blades **23**. The removal is then continued by the current S after the device **1** in the direction of current S. The cleaning action of the nozzles **62** is further assisted by gravity due to the substantially inclined course of the collector chamber bottom **42** in the region below the cover **5**.

[**0023**] The cover **5** is provided with slits **52** (see also **FIG. 2**) in the region of the blades **2**. The fixed blades **22** as well as the movable blades **23** are carried in the slits **52**. The lateral walls of the slits **52** constitute a guide of the movable blades at a right angle to the current S, while the fixed blades **22** are guided and held also in a longitudinal direction, i.e., in the direction of current S and in opposite direction by the slits **52**.

[**0024**] **FIG. 2** shows a top view of the device of **FIG. 1**, but without the blades **2**. The cover **5** has two inspection openings **53** below each of which a pipe conduit **61** can be recognized in a representation by broken lines. The cleaning device **6** in this embodiment is divided into two halves, whereby each is connected via a connecting pipe **63** as described above to a pump **81**. The cover **5** is provided with a number of slits **52** after the cleaning device **6**, as seen in direction of current S into which the blades **2** (see **FIG. 1**) reach and in which they are carried. The slits **52** are of different length, as seen in direction of current S, whereby the shorter ones receive and guide the fixed blades **22** (see **FIG. 1**) and the longer slits **52** the movable blades **23**. Nozzles **62** are distributed over the length of the pipe conduit **61** and, in the drawing of **FIG. 2**, appear to be pointed essentially at the slits **52**. As described in **FIG. 1**, the nozzles **62** are supplied via the pipe conduit **61** with a medium under pressure, here water under pressure, so that a sharp water jet emerges from the nozzles **62** and stirs up and removes the deposits under the slits **52**. The distance between two adjoining nozzles **62** is between approximately 100 mm and 400 mm in the embodiment of **FIG. 1**. The nozzles **62** are inclined in the direction of the channel relative to their connection to the collector chamber bottom **42** extending following the cleaning device, so that the water jet emerging from the nozzles **62** reaches the collector chamber bottom **42** at an angle. The nozzles **62** can be e.g. drilled into the pipe conduit **61**. In the embodiment of **FIG. 1**, the output angle of the nozzles relative to the collector chamber bottom **42** is inclined by approximately 15°. A greater or smaller angle may be indicated depending on the deposited substances or the distance between the cleaning device and the lower end **25** of the blades.

[**0025**] Special steel has proven to be especially advantageous as a material for the device **1**, but various parts of the device **1** can also be made of a synthetic material. Thus in particular, the slits **52** for the fixed blades **22** can be provided with a friction-reducing material, or the cover **5** can be entirely made of a synthetic material in the region of the blades **2**, capable of interacting with especially low friction and little wear with the movable blades.

[**0026**] **FIG. 2** furthermore schematically shows a pump **81** that supplies the pipe conduit **61** of the cleaning device **6** via the connecting pipe **63** with water under pressure. The pump **81** and thereby the cleaning device **6** itself are controlled by the control device **8**. The latter is connected by an electric conduit **82** to the pump **81**. The control device **8** in turn is either caused by an operator to actuate the pump **81** or operates automatically, e.g. by means of a time control system, in order to free the device at regular intervals from deposits of suspended substances. In a different embodiment, it would also be possible for the control device to receive signals from sensors measuring the current of the liquid or from sensors recognizing the quantity of deposits or the influences of the deposits on the drive of the device.

[**0027**] **FIG. 3** shows a device **1** according to the invention that is similar to that of **FIG. 1**, but with a cover **5** of different configuration. In addition, the cover **5** does not assume the guidance of the movable blades **23** directly. Rather, the guidance is assumed by a doubling **26** located in the lower region of the fixed blades that are located respectively on the left side and on the right side on the fixed blades **22** (not shown in **FIG. 3**). The thickness (expansion of the doubling at a right angle to the current S) determines the distance between a fixed blade **22** and a movable blade **23**. The fixed blades **22** are held by the doubling **26** in openings **52** of the cover **5** (see **FIG. 4**). As a result, greater stability of the fixed blades is achieved at a right angle to the current S.

[**0028**] The cover **5** shown in **FIG. 3** has an elastic sealing lip **530** reaching at least in part over the doubling **26** as seen in direction of current S, so that the passage of suspended substances between the blades is at least partially covered even when the movable blades have assumed a position that is furthest from the cleaning device **6**, as seen in the direction of current S. As they move towards the cleaning device **6** and vertically upward, the lip **530** can be pushed away from the steps of the movable blades, so that their passage upward, between the fixed blades is possible and unhindered. The sealing lip **530** is made of a rubber-like material or some other elastic material, preferably neoprene. It is attached to the cover **5** by appropriate means. The cleaning device **6** of **FIG. 3** is configured as shown in **FIGS. 1 and 2** and is also

provided with nozzles **62** that direct a cleaning jet below the lower ends **25** of the movable blades **23** in order to remove suspended substances deposited there. The pipe conduit **61** is also connected to a pump (not shown) by means of a connecting pipe **63**.

[**0029**] The shown movable blade **23** is provided with a toothing **7** similar to a saw on its side towards the cleaning device **6** and below its lowest step **240**, that is able to free the area between two doublings **26** of dirt particles or stones wedged therein.

[**0030**] Such toothing of the movable blades can also be used advantageously with a step rake where the movable blades are carried by a cover as shown in **FIG. 2**. A movable blade **23** such as used e.g., with a cover with slots as in **FIG. 2**, is advantageously also provided with toothing **7** on the downstream side, however, with teeth arranged in the opposite sense, so that the cleaning action takes place during the downward movement.

[**0031**] **FIG. 4** shows a top view of the forward part **55** of the cover **5** of **FIG. 3**. The openings, or slits, **52**, as shown in **FIG. 3**, receive the doublings **26** attached to the fixed blades. The cover **5** thus constitutes at the same time a guide for the stabilization of the fixed blades **22**. These assume a lateral guidance of the movable blades **23** via their doublings **26**.

[**0032**] **FIG. 5** shows a device **1** according to the invention mounted behind the channel bottom step **99** of a channel. Thanks to this positioning of the device **1** in a depression or after a jump into the sluice bottom, the rubble, stones and sand are conveyed directly to the first step, or the current flows towards the rake in such manner that the substances that are larger than the gap width of the rake can be conveyed out of the waste water. This placement of the device according to the invention ensures especially secure and reliable functioning of the device and a removal of the materials to be removed.

[**0033**] It will be appreciated by those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope of the invention. It is intended that the present invention include such modifications and variations as come within the scope of the appended claims and their equivalents.

1. Device for the separation and removal of separation materials from a flowing liquid, e.g. waste water, in form of a rake immersed in the liquid and consisting of movable and fixed blades, whereby the blades are provided with steps on the side receiving the current and a gap is provided between the blades for the passage of liquid, whereby the movable blades convey the separation materials from step to step of the fixed blades through their movement with at least one movement component in the longitudinal direction of the fixed blades in order to transfer them in the region of the upper ends of the blades to a conveying means for removal, and whereby the lower ends of the blades are located in the region of a channel bottom or of the bottom of a body of water, and with a pre-mounted cover over the region of the lower ends of the blades, characterized in that a collector chamber (**51**) for the sediments is provided below the cover (**5**) in which a cleaning device (**6**) is installed for the removal of the sediments.

2. Device as in claim 1, characterized in that the cleaning device (**6**) is provided with a pipe conduit (**61**) with at least one nozzle (**62**) for the output of a cleaning fluid under pressure or a cleaning gas under pressure.

3. Device as in claim 2, characterized in that at least one nozzle (**62**) of the cleaning device (**6**) has a nozzle opening for a cleaning jet that directs the cleaning fluid or the cleaning gas at least nearly parallel to the bottom of the collector chamber (**51**).

4. Device as in one or several of the claims 1 to 3, characterized in that the cleaning device (**6**) is connected to a control device (**8**) for the control of the cleaning device (**6**).

5. Device as in one or several of the claims 1 to 4, characterized in that the cleaning device (**6**) is provided with a connecting pipe (**63**) connecting the nozzles (**62**) with a fluid or gas under pressure.

6. Device as in claim 4 or **5**, characterized in that the control device (**8**) controls a pump (**81**) provided with an inlet for the cleaning fluid and which is connected to the pipe conduit (**61**) on its output side.

7. Device as in one or several of the claims 1 to 6, characterized in that the cleaning device (**6**) precedes the blades as seen in the direction of flow (S).

8. Device as in one or several of the claims 1 to 7, characterized in that the cover (**5**) is provided with slits (**52**) on the side towards the blades (**2**, **22**, **23**) to carry the movable or fixed blades.

9. Device as in claim 1, characterized in that the slits (**52**) of the cover (**5**) receive the fixed blades (**2**, **22**, **23**) at least by one half, as seen in the direction of flow (S) of the liquid.

10. Device as in one or several of the claims 1 to 8, characterized in that the cover (**5**) extends until after the fixed or movable blades (**2**, **22**, **23**) as seen in the direction of flow (S) of the liquid.

11. Device as in one or several of the claims 8 to 10, characterized in that the cover (**5**) is provided with slits (**52**) constituting a guide for the fixed and/or movable blades (**2**, **22**, **23**), in particular at a right angle to the direction of flow of the liquid.

12. Device as in one or several of the claims 1 to 11, characterized in that the width of the fixed blades (**22**) is widened by a doubling in the region of the slits (**52**) of the cover (**5**) or under the cover (**5**).

13. Device as in claim 12, characterized in that the doubling engages the slit (**52**) of the cover (**5**).

14. Device as in one or several of the claims 1 to 13, characterized in that the cover (**5**) is provided with an elastic sealing lip (**53**) on its side towards the blades (**2**, **22**, **23**).

15. Device as in claim 14, characterized in that the elastic sealing lip (**53**) covers the inspection openings (**53**) or the region between two doublings (**26**) at least partially.

16. Device as in one or several of the claims 12 to 15, characterized in that the doubling (**26**) has a vertical length, at a right angle to the direction of flow (S) of the liquid, that is shorter than the distance between two steps (**24**) of the blades (**2**, **22**, **23**).

17. Devcie as in one or several of the claims 12 to 16, characterized in that the doubling (**26**) has a length in the direction of the flowing liquid that is equal to the magnitude of the movement component in that direction of the movable blades (**23**).

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