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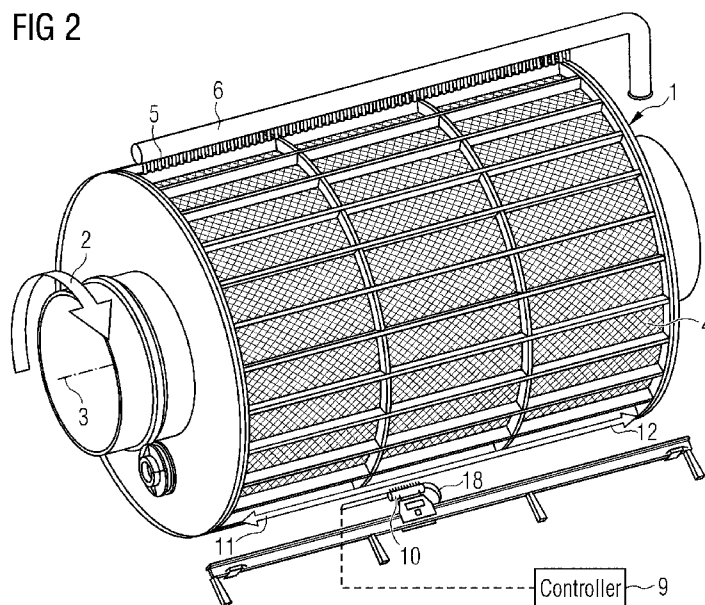
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(54) Title: DRUM CLEANER

FIG 2



(57) Abstract: A slag slurry drum filter is mounted for rotation about an axis of rotation (3) and comprises a mesh filter (4) comprising an inner and an outer surface. A slag slurry drum filter cleaner for mounting on the outer surface of the slag slurry drum filter comprises a fluid supply (35); a controller (9); an array (8a, 8b) of spray nozzles (7) to receive fluid from the fluid supply and supply some of the fluid through the outer surface of the filter to the inner surface of the filter; and valves (35, 36) associated with each spray nozzle. Each valve is operable to control fluid from the fluid supply under the control of the controller. For at least one valve (36), the same valve is associated with more than one nozzle (7).

DRUM CLEANER

This invention relates to a slag slurry dewatering drum cleaner and a method of cleaning a dewatering drum.

5 In wet slag granulation, water is added to molten slag to cool and granulate the slag. A typical apparatus for carrying out this process is described in US4204855. Water is removed from the slag granule and water mix by carrying the mixture up a rotating drum by means of vanes within the drum, so that the slag granules collect on the inner surface of the wire mesh of the drum and the water can pass through the
10 mesh. As the drum rotates, the slag is carried out of the water towards the top of the drum where it then falls under gravity onto a conveyor for transport to a stockpile. A line of compressed air jets on the outside and towards the top of the rotating drum are provided to assist with removal of the accumulated slag granules.

However, there are problems with this system in that the filter mesh becomes
15 clogged up and needs to be cleaned, otherwise the water filtration rate is unacceptably reduced and slurry and water pour out of the ends of the drum. For this purpose, conventionally, an additional array of medium pressure (typically 6 bar to 12 bar) water spray nozzles have been provided along the full length of the drum for cleaning and the compressed air jets for dislodging the accumulated slag have included high flows of
20 compressed air, including cold blast. However, these multiple sprays along the full length of the drum are an energy and resource intensive way of cleaning the mesh. As a result, operators may resort to regular manual cleaning with jet washers, which can be labour intensive, expensive and gives rise to health and safety issues.

An alternative solution that has been proposed is described in WO2011/067400
25 in which a slurry overflow and secondary dewatering unit are provided to process excess slurry and prevent it from reaching the water outlet. However, this requires changes to the layout and equipment which may not be convenient for existing installations.

Another solution is described in WO2009010556A1 which uses a flexible inner
30 mesh, inside a rigid support mesh, to aid cleaning of the rigid mesh. When high pressure water comes into contact with the rigid mesh this causes the inner mesh to flex inwards help remove slag or slurry on the flexible mesh.

In accordance with a first aspect of the present invention, a slag slurry drum filter cleaner for mounting on an outer surface of a slag slurry drum filter, wherein the filter is mounted for rotation about an axis of rotation and comprising a mesh filter comprising an inner surface and an outer surface, comprises a fluid supply; a controller; an array of spray nozzles to receive fluid from the fluid supply and supply some of the fluid through the outer surface of the filter to the inner surface of the filter; and valves associated with each spray nozzle, each valve being operable to control fluid from the fluid supply under the control of the controller; wherein for at least one valve, the same valve is associated with more than one nozzle.

The controller controls operation of each valve to control supply of fluid to each nozzle in the array associated with the or each valve, such that output of fluid from a nozzle or group of nozzles associated with a valve can be controlled independent of output from another nozzle or group of nozzles associated with another valve. The array may extend along all, or only part of the length of the drum mesh filter, but when extending along the full length of the drum, the valves are controlled to allow fluid flow through a limited number of valves, rather than requiring a large, high power, pump to be able to have high pressure fluid flow out of all nozzles at once.

Preferably, each valve is associated with a group of nozzles.

Preferably, one group of nozzles further comprises individual valves for each nozzle.

Preferably, at least two valves are provided, each associated with a different nozzle or group of nozzles.

In accordance with a second aspect of the present invention, a method of controlling operation of a slag slurry drum filter cleaner comprises causing fluid flow to one or more nozzles at a first position relative to a drum filter; detecting completion of at least one revolution of the drum filter; terminating fluid flow at the first position and causing fluid to flow to one or more nozzles at a second position relative to the drum filter.

The cleaner is typically mounted on an outer surface of a slag slurry drum filter and at least some of the fluid passes through the filter to clean contaminants off an inner surface of the drum filter.

In one embodiment, the one or more nozzles are mounted on a nozzle mounting and the nozzle mounting is moved to the second position before fluid flow to the nozzles at the second position begins.

Alternatively, the one or more nozzles are fixed in position relative to the drum
5 filter and wherein fluid flow to nozzles at each position is controlled by opening or closing a valve associated with the one or more nozzles.

Preferably, the method further comprises in series terminating fluid flow at one position and causing fluid to flow to one or more nozzles at another position relative to the drum filter.

10 Preferably, the method comprising sensing drum speed and controlling traversing speed in accordance with the sensed drum speed

Preferably, the method further comprises rotating the nozzle mounting about the axis of rotation in accordance with the sensed drum speed to clean a predefined sector of the drum.

15 In accordance with a third aspect of the present invention, a slag slurry drum filter cleaner for mounting on an outer surface of a slag slurry drum filter, the filter being mounted for rotation about an axis of rotation and comprising a mesh filter comprising an inner surface and an outer surface, comprises at least one spray nozzle, a nozzle mounting; a fluid supply, and a controller; wherein the at least one spray nozzle
20 is adapted for movement on the nozzle mounting along of the length of the drum on the outer surface; and wherein the controller controls supply of fluid to the nozzle or each nozzle and the nozzles supply some of the fluid through the outer surface of the filter to the inner surface of the filter.

The cleaner enables more effective cleaning with low flow and a reduced
25 number of nozzles, either a single nozzle, or an array of nozzles, by moving the reduced number of nozzles across the drum to achieve the desired coverage, rather than supplying fluid to large numbers of nozzles at one time. Active control also allows the position of the nozzle to be controlled, directing cleaning effort where it is required.

The spray nozzle could be moved back and forth along the length of the drum
30 at an angle to a plane through the axis of rotation, but movement across the curved or helical path is more complicated, so preferably the spray nozzle is adapted for movement along an axis parallel to the axis of rotation of the drum.

In one embodiment, preferably, the nozzles extend along no more than 50% of the length of the drum.

The back and forth movement of the traversing spray nozzle allows the full mesh to be cleaned with only a limited coverage in a single rotation of the drum.

5 Preferably, the cleaner further comprises a sensor to sense speed of rotation of the drum and a controller to control speed of movement of the nozzle mounting along of the length of the drum according to the sensed speed of rotation.

Preferably, the cleaner further comprises a crescent or horse shoe shaped array of spray nozzles concentric with the axis of rotation.

10 The size of the nozzle array and traversing speed of the nozzle mount are calculated to maximize coverage and minimize overlapping. Opening and closing valves controls the flow of fluid to each nozzle along the array to give the desired cleaned path.

Preferably, the fluid comprises at least one of a gas or a liquid.

15 Preferably, the gas is air and the liquid is water.

The cleaner may be adapted for installation on an inclined dewatering drum.

An example of a drum cleaner in accordance with the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 illustrates a dewatering drum with an array of spray nozzles;

20 Figure 2 illustrates a first example of a drum cleaner according to the present invention, using a traversing spray;

Figure 3 and Figure 4 illustrate parts of the cleaner of Fig.2 in more detail;

Figure 5 illustrates in more detail, a second example of a drum cleaner according to the present invention, using an array of fixed nozzles controlled in sequence by valves; and,

25 Figures 6a to 6e illustrate alternative arrangements of sprays for use in the embodiment of Fig.5.

The present invention provides a more effective cleaning mechanism than has been possible before by allowing all or a portion of the flow available from the high pressure mesh cleaning pump to be directed over a smaller portion of the mesh and hence increasing the cleaning effectiveness in that area. This is achieved by either combining a spray nozzle or batch of nozzles with relative lateral movement across the length of the drum or by sequencing cleaning water flow through fixed nozzles by

controlling a series of valves in order to achieve the same effect. Both methods of cleaning accumulated slag off the filter mesh have the advantage of being relatively easily to retrofit and can offer improved filter mesh cleaning without upgrading to a larger pump, whilst avoiding the need for manual cleaning. The nozzles may be easily
5 mounted to the outer surface of the drum to clean off contaminants that have accumulated on the inner surface of the mesh. The amount of water usage can be kept to a minimum, so that the dewatering process is not unduly affected by the cleaning. Adding large amounts of water for cleaning during a dewatering process is not desirable in terms of the efficiency of the overall slag granulation process.

10 The present invention addresses the problem of cleaning the filter screen of a slag slurry drum filter for wet slag granulation, such as an INBA type filter, but is applicable for other types of filtration drums, such as those described in our co-pending GB patent application no. 1206563.7. Such drum filters are large, e.g. 5m to 12 m in length, most typically 6m long and from 3m to 5m in diameter, so a row of sprays
15 along the full length of a 6m long drum may require as many as 100 nozzles, no more than 60mm apart to have any effect. The actual arrangement depends upon nozzle size, pressure and flow. The energy resources required for this method of cleaning can be significant, typically in the region of 40kW to 50kW. The environment in which the rotary drum filter is operating is harsh due to the nature of the materials being
20 processed and the temperature, so any solution must be robust enough to cope with these.

In the example of Fig.1, a drum 1 is mounted for rotation in a direction indicated by arrow 2 about an axis of rotation 3. The drum comprises a mesh filter 4 and conventional gas spray nozzles 5 to dislodge granulated slag from the inside
25 surface of the drum are provided in an array 6 along the full length of the drum, typically spaced apart by about 50mm to 300mm, depending on pressure and flow. The large number of nozzles gives rise to a high gas flow requirement. In addition, low pressure water spray nozzles 7 for cleaning the mesh filter 4 are provided in an array 8 along the full length of drum.

30 All of this energy and resource usage can be significantly cut back using the present invention and the invention also allows for operation with a reduced rate of flow of fluid compared with conventional equipment. The present invention overcomes the need for a high water flow requirement, as well as achieving more effective

cleaning of the filter mesh 4 by means of an arrangement as illustrated in Figs. 2, 3 and 4. As before, the filter mesh 4 of the drum is provided with gas nozzles 5 in an array 6 for dislodging the granulated slag from the inner surface of the drum. However, rather than just another array of nozzles requiring high flow, but providing only low pressure water spray, the present invention provides as a replacement for the array, or in addition to the array, a single high pressure programmable traversing water spray nozzle, or a small number of nozzles 10 on a carriage 13 which is movable on a rail along the length of the drum between points 11 to 12, so that a high pressure spray can be achieved with low flow requirements. The number of nozzles used depends upon the type and requirements, but is preferably constrained to extend over less than 10% of the length of the drum. The options include a small number of wide angled nozzles or a larger number of small nozzles in the same length, giving the same pressure and flow input and hence the similar cleaning effect.

In the embodiment illustrated in Figs. 2 to 4, a single nozzle, or a small number of nozzles, typically extending over no more than 10% of the length of the drum are mounted for transverse movement along the full length of the drum, parallel to the axis of rotation of the drum. The fluid sprays may be gas or water sprays, or a mixture of gas and water sprays where a group of nozzles are used. Typically, the gas is compressed air which is readily available and non hazardous. The nozzle or nozzles traverse across the full length of the drum on or close to the outer surface. The reduced number of nozzles relative to conventional arrangements gives scope for the pressure and flow to these nozzles to be increased while using a smaller and cheaper pump. The smaller pump provides a lower overall flowrate with the benefit of saving capital cost and electrical power. Typically in a slag granulation system, it is not feasible to filter all particles from the process water and it is common for some fines to be recirculated in the process. In order to maintain a clean mesh and functioning cleaning spray nozzles, it is desirable to use clean uncontaminated water for filter mesh cleaning, so reducing the required flow of uncontaminated water is a further benefit of the present invention, particularly in hot climates. A typical flow rate of fluid is of the order of $8\text{m}^3/\text{hr}$ which is able to supply gas or liquid at a pressure in the order of 90 bar, whereas conventionally the high flow gas and water sprays are require a flow rate of $80\text{m}^3/\text{hr}$ to operate at around 12bar. The invention therefore results in more effective cleaning, whilst using less compressed air/water and energy.

Reducing the number of spray nozzles enables those which are used to be operated at higher pressures and be more effective across the full length of the drum. Using less water to get effective cleaning of the filter mesh reduces the need for a large amount of clean water, uncontaminated by fines, to be provided and stored on site, which can have the benefit of reduced site footprint. There is a reduced chance of the mesh clogging, as the cleaning has increased effectiveness. By automating the cleaning process in a more effective way, using a lower flow and higher pressure spray which moves along the drum, manual cleaning with jet washes can be eliminated.

As effective mesh cleaning is a function of pressure multiplied by flow multiplied by number of nozzles, all factors being relative to power consumption, then achieving more effective mesh cleaning requires more pressure or flow, both of which require more electrical power and more clean uncontaminated water. The present invention offers the possibility of increased pressure and/or flow to a smaller proportion of the nozzles by reducing the number of nozzles or effective nozzles.

The traversing mechanism is shown in more detail in Figs. 3 and 4. Movement and operation of the spray nozzles is controlled by a controller 9. Fig.4 illustrates an example showing how the spray nozzle is moved back and forth along the length of the drum. The traversing spray controller 9 detects drum rotation via a sensor and for simple control, the carriage 13 only traverses along the length of the drum after each complete revolution of the drum. After a minimum of one revolution, the controller sends a signal to rotate a motor drive 14 until the carriage 13 has moved parallel to the axis of the drum the same distance as the effective spray length 15, so that the spray nozzles are now cleaning a new section of filter mesh. The carriage position along the length of the drum may be controlled by an encoder on the traversing drive 14. Limit switches 16 and mechanical stops may be provided at carriage travel limits. The carriage 13 is supported on rollers 17 which support the spray nozzles 10, drive motor 14, couplings and one end of a drag chain 18. The drag chain supports and keeps tidy high pressure flexible hoses for cleaning water 19 and/or for air 20 as well as control and power cables, or pipes 21, 22 for the drive motor 14

In this embodiment back and forth movement in a direction substantially parallel to the axis of rotation of the drum is illustrated. This simplifies construction, although mounting the spray nozzle to move across the surface of the mesh screen at an angle to a plane through the axis of rotation, rather than simply in the longitudinal

direction is also possible. This might be useful where the drum was in a constricted position and there was not sufficient space to add the traversing nozzle where the array of fixed nozzles had previously been mounted.

In some applications it may be beneficial to clean a full length sector of the drum rather than a full circumferential band. As the drum rotates during the traverse of the spray nozzle mounting, then it may be necessary to modify the shape of the array of nozzles to compensate, so that the resulting cleaned section is linear, or the direction of traverse may be adapted to give a linear cleaned section, with the nozzle mounting moving in a helical manner at a speed chosen to match the speed of rotation of the drum appropriately to result in a linear cleaned section. The cleaner may traverse along a helical path, or along a path with components parallel to the axis of rotation and in a circular path concentric with the axis of rotation. A series of nozzles may be arrayed in a crescent or horse shoe shape concentric with the axis of rotation and traverse along the length of the drum in a path parallel to the axis of rotation and in order to clean a sector that is parallel to the axis of rotation, flow to nozzles along the circular array may be independently controlled by valves. Alternatively, a spray head may traverse along a path parallel to the axis of rotation and the entire cleaner device be rotated concentrically clockwise and anticlockwise around the axis of rotation in order to achieve the same effect. For cleaning a helical path, a crescent or horse shoe shaped array of spray nozzles may traverse in a path parallel to the axis of rotation at a speed chosen according to the speed of the drum and the size of the array to enable a helical path to be cleaned along the full length of the drum. The design of the array and control of the array are chosen to maximise the pitch of the cleaned helix, and minimise overlapping while ensuring that no parts of the mesh are missed.

In a second embodiment of the present invention, illustrated in Figs. 5 and 6a to 6d, various arrangements of nozzles that can be controlled by sequencing valves along an array are shown. The desired result may be achieved by separating the existing array of water nozzles 7 into two arrays 8a, 8b and controlling operation of each in series by means of valves 35, 36, so that only one or a group comprising a small number of valves are open resulting in, for this example, less than 50% of the total number of nozzles being operational at any one time. This can be seen in Fig. 6a. Alternative arrangements are illustrated in Figs. 6b to 6d. These, when applied to the array of Fig. 1, have the benefit of providing total mesh cleaning coverage at a medium

pressure and / or flow as well as the flexibility of increased flow and pressure to smaller portions of the mesh for more intense cleaning. For example, a mesh cleaning solution as illustrated in Fig 6b with inlet 34 may provide total cleaning coverage during normal operation, but during breaks in operation, valves 37, 38, 39, 40 & 41 are controlled in sequence to direct more or all flow to a group of nozzles 50, 51, 52, 53, 54 covering a smaller portion of length of the drum and hence of the mesh. Opening one valve, whilst keeping the other four closed in the example of Fig.6b limits cleaning to only that group, so in this example, only 20% of the nozzles at any one time. This allows the mesh to be given a deep clean in-between dewatering batches of slag, removing the fine particles trapped within the mesh without the energy and large pump requirement of convention high pressure cleaning. In an alternative example, shown in Fig.6c, valves 42 & 43 control operation of the nozzles in two parallel arrays 45, 46, so that half are spraying and the other half do not, then the controller switches the valves to operate the other half. This has the advantage over the arrangement illustrated in Fig. 6a that more effective cleaning across the full mesh may be achieved. Another option, not shown would be to subdivide each of the parallel arrays in the way indicated in Figs.6a , 6b or 6e to get further fine control. It would be possible to control each nozzle individually, as illustrated in figure 6d, but the added complexity and cost does not make this a desirable example. For such a requirement, the traversing spray embodiment would be preferable, either alone, or used in addition to a fixed array.

There may be situations where particular areas are prone to blockage, but not all across the mesh, in which case one sub-group of nozzles may have individual valves 44 for each nozzle, but the other sub-groups would have only one valve 36, 37, 39, 40 per sub-group, as shown in Fig.6e. Each valve is opened and closed in sequence, but the effect is not the same throughout.

Although the examples illustrated in Figs 6a to 6e show the valves in close proximity with the nozzles which they control, alternatively, valves including multi-position valves may be located in a valve stand away from the filter drum in order to achieve the same effects as those illustrated in figures 6a to 6e, with connecting supply pipes between the valves and the nozzle or groups of nozzles which they control.

It may be desirable to provide total mesh coverage during dewatering, therefore a traversing spray alone may not be adequate for medium mesh cleaning during operation due to slow drum speeds (typically 0.5rpm to 9rpm). A sequence spray as

illustrated in Figs. 6a to 6e can be installed as a direct replacement for a conventional cleaning spray bar 6, 8, or a traversing spray may be used in conjunction with either a conventional gas and/or fluid spray cleaning system, a sequenced air and/or fluid system as illustrated in Figs. 6a to 6e or independently, replacing a conventional air and/or fluid spray system. The examples of the sequenced spray have been described with respect to use with water, but in combination with a traversing spray, a sequenced fluid spray may use either air or water, or other suitable fluid.

In all cases, the methods and apparatus described are particularly suited to the batch process nature of the slag granulation process. As continuous availability of the dewatering drum is not required, cleaning may be carried out during natural pauses in the slag granulation process. Thus, a smaller, lower energy pump with lower capital cost than conventional cleaning pumps can be used with less water, without any significant impact on the overall slag granulation process.

CLAIMS

1. A slag slurry drum filter cleaner for mounting on an outer surface of a slag
slurry drum filter, wherein the filter is mounted for rotation about an axis of rotation
5 and comprises a mesh filter comprising an inner and an outer surface; the cleaner
comprising a fluid supply; a controller; an array of spray nozzles to receive fluid from
the fluid supply and supply some of the fluid through the outer surface of the filter to
the inner surface of the filter; and valves associated with each spray nozzle, each valve
being operable to control fluid from the fluid supply under the control of the controller;
10 wherein for at least one valve, the same valve is associated with more than one nozzle.
2. A slag slurry drum filter cleaner according to claim 1, wherein each valve is
associated with a group of nozzles.
- 15 3. A slag slurry drum filter cleaner according to claim 1 or claim 2, wherein one
group of nozzles further comprises individual valves for each nozzle.
4. A slag slurry drum filter cleaner according to claim 1 wherein at least two
valves are provided, each associated with a different nozzle or group of nozzles.
20
5. A method of controlling operation of a slag slurry drum filter cleaner, the
method comprising causing fluid flow to one or more nozzles at a first position relative
to a drum filter; detecting completion of at least one revolution of the drum filter;
terminating fluid flow at the first position and causing fluid to flow to one or more
25 nozzles at a second position relative to the drum filter.
6. A method according to claim 5, wherein the one or more nozzles are mounted
on a nozzle mounting and the nozzle mounting is moved to the second position before
fluid flow to the nozzles at the second position begins.
30
7. A method according to claim 5, wherein the one or more nozzles are fixed in
position relative to the drum filter and wherein fluid flow to nozzles at each position is
controlled by opening or closing a valve associated with the one or more nozzles.

8. A method according to any of claims 5 to 7, further comprising in series terminating fluid flow at one position and causing fluid to flow to one or more nozzles at another position relative to the drum filter.

5

9. A method according to any of claims 5 to 8, the method comprising sensing drum speed and controlling traversing speed in accordance with the sensed drum speed

10. A method according to claim 9, further comprising rotating the nozzle mounting about the axis of rotation in accordance with the sensed drum speed to clean a predefined sector of the drum.

11. A slag slurry drum filter cleaner for mounting on an outer surface of a slag slurry drum filter, the filter being mounted for rotation about an axis of rotation and comprising a mesh filter comprising an inner surface and an outer surface; the cleaner comprising at least one spray nozzle, a nozzle mounting; a fluid supply, and a controller; wherein the at least one spray nozzle is adapted for movement on the nozzle mounting along of the length of the drum on the outer surface; and wherein the controller controls supply of fluid to the nozzle or each nozzle and the nozzles supply some of the fluid through the outer surface of the filter to the inner surface of the filter.

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12. A slag slurry drum filter cleaner according to claim 11, wherein the spray nozzle is adapted for movement along an axis parallel to the axis of rotation of the drum.

25

13. A slag slurry drum filter cleaner according to claim 11 or claim 12, wherein the nozzles extend along no more than 50% of the length of the drum.

14. A slag slurry drum filter cleaner according to any of claims 11 to 13, further comprising a sensor to sense speed of rotation of the drum and a controller to control speed of movement of the nozzle mounting along of the length of the drum according to the sensed speed of rotation.

30

15. A slag slurry drum filter cleaner according to any of claims 11 to 14, further comprising a crescent or horse shoe shaped array of spray nozzles concentric with the axis of rotation

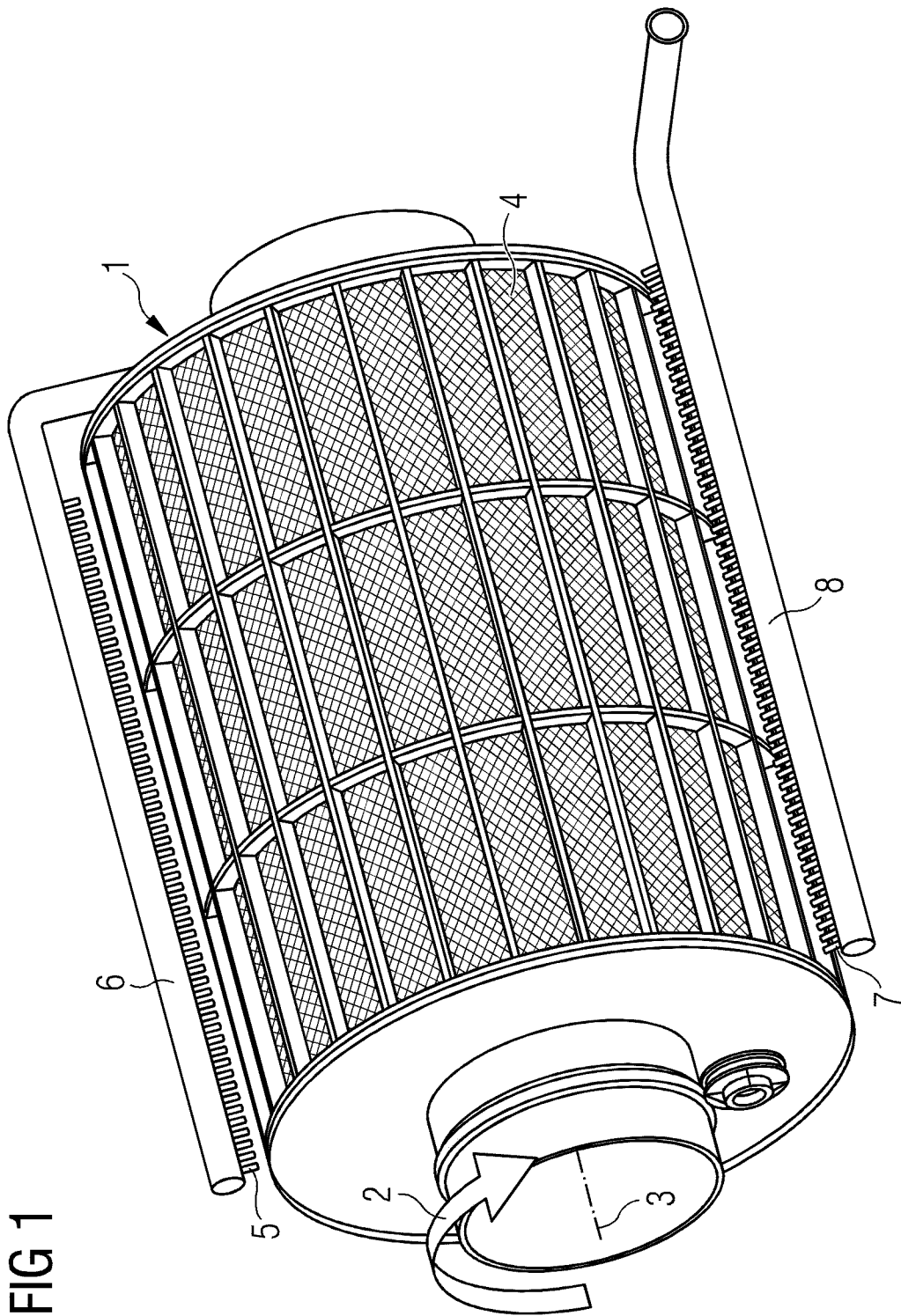
5 16. A slag slurry drum filter cleaner according to any of claims 1 to 4, or 11 to 15, wherein the fluid comprises at least one of a gas or a liquid.

17. A slag slurry drum filter cleaner according to any of claims 1 to 4, or 11 to 16, wherein the gas is air and the liquid is water.

10

18. A slag slurry drum filter cleaner according to any of claims 1 to 4, or 11 to 17 adapted for installation on an inclined dewatering drum.

15



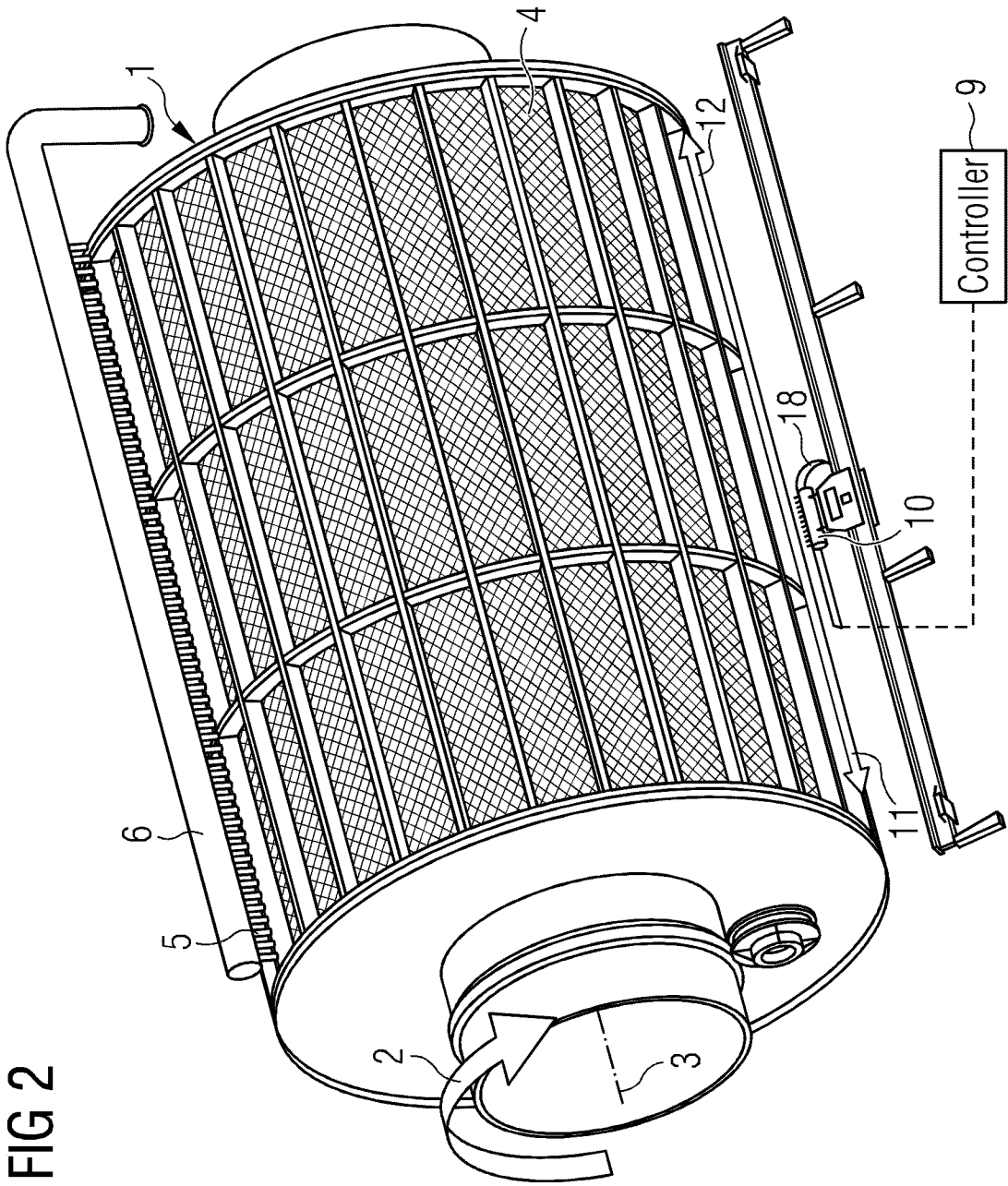


FIG 3

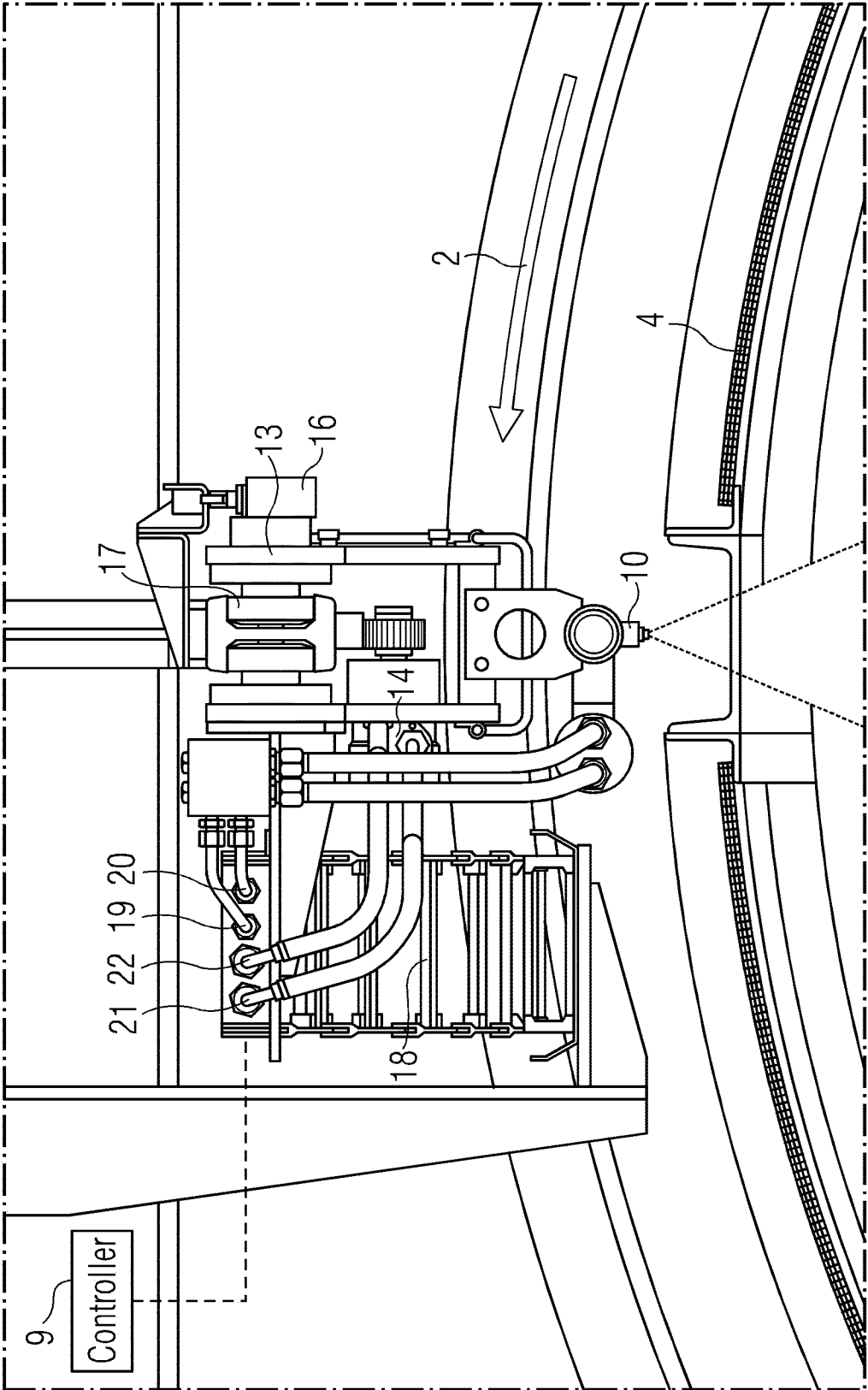
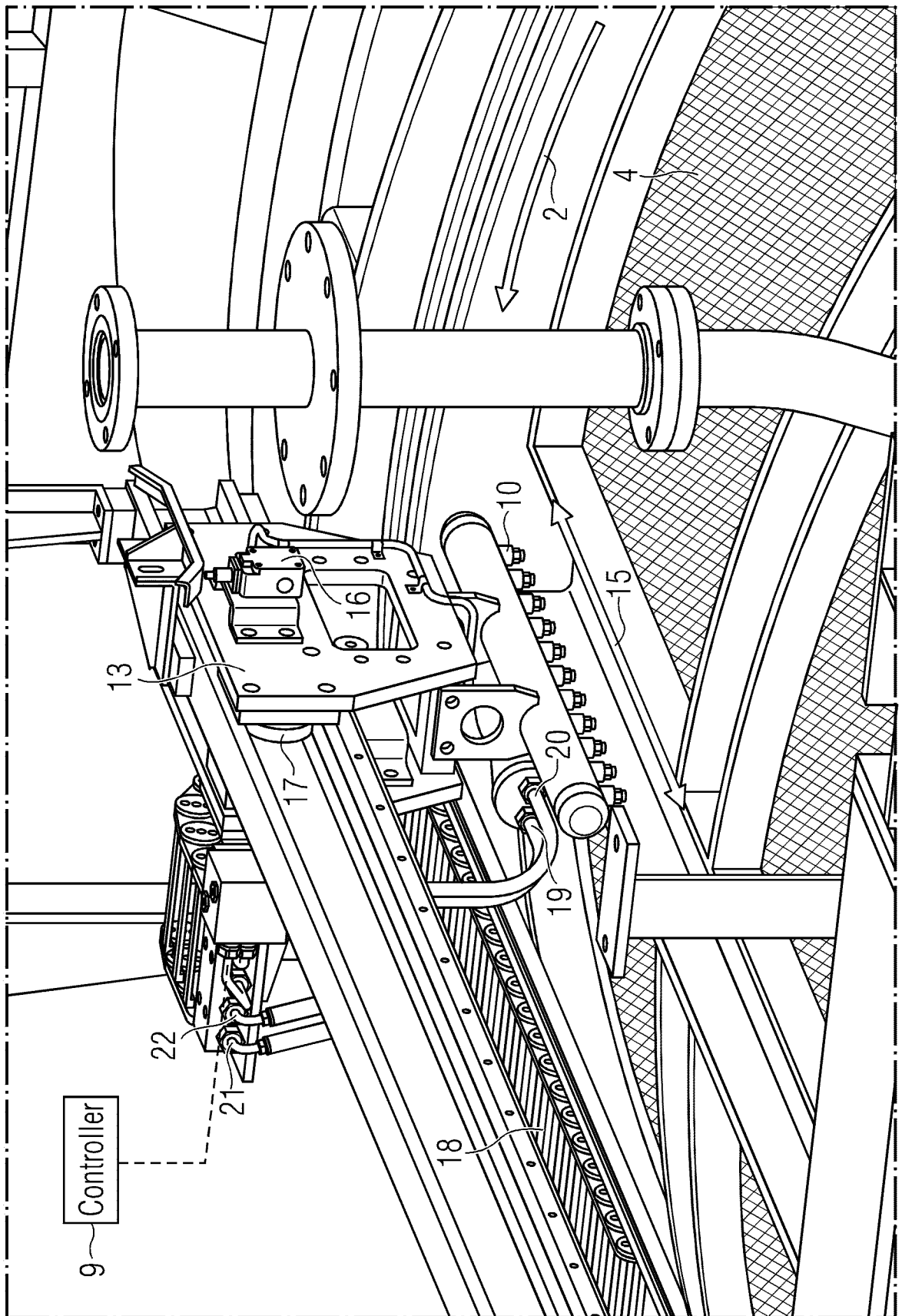


FIG 4



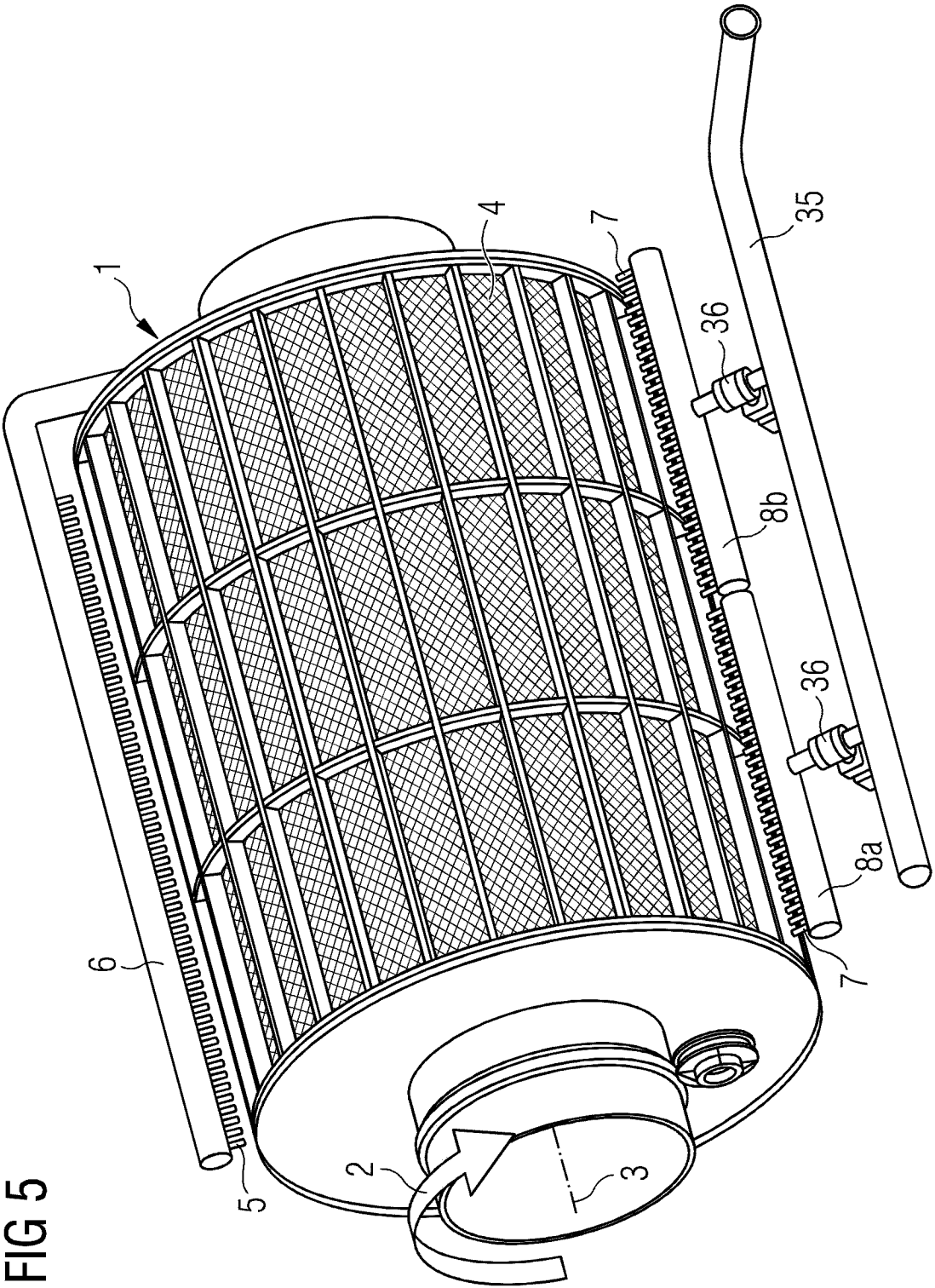
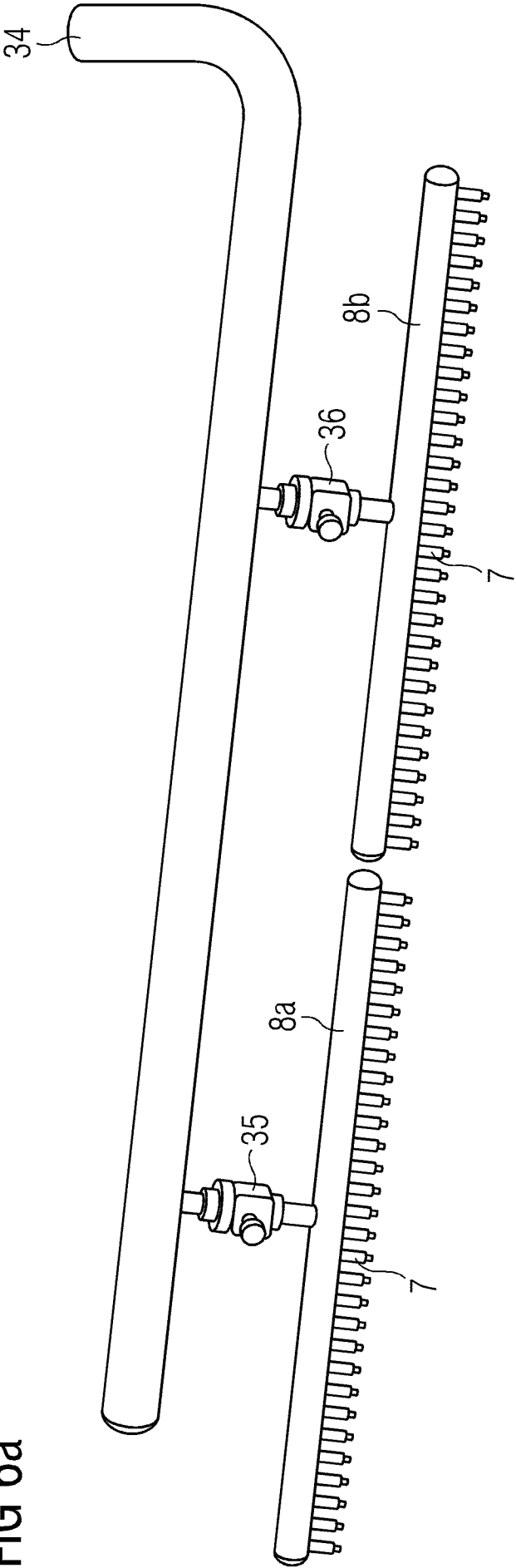


FIG 6a



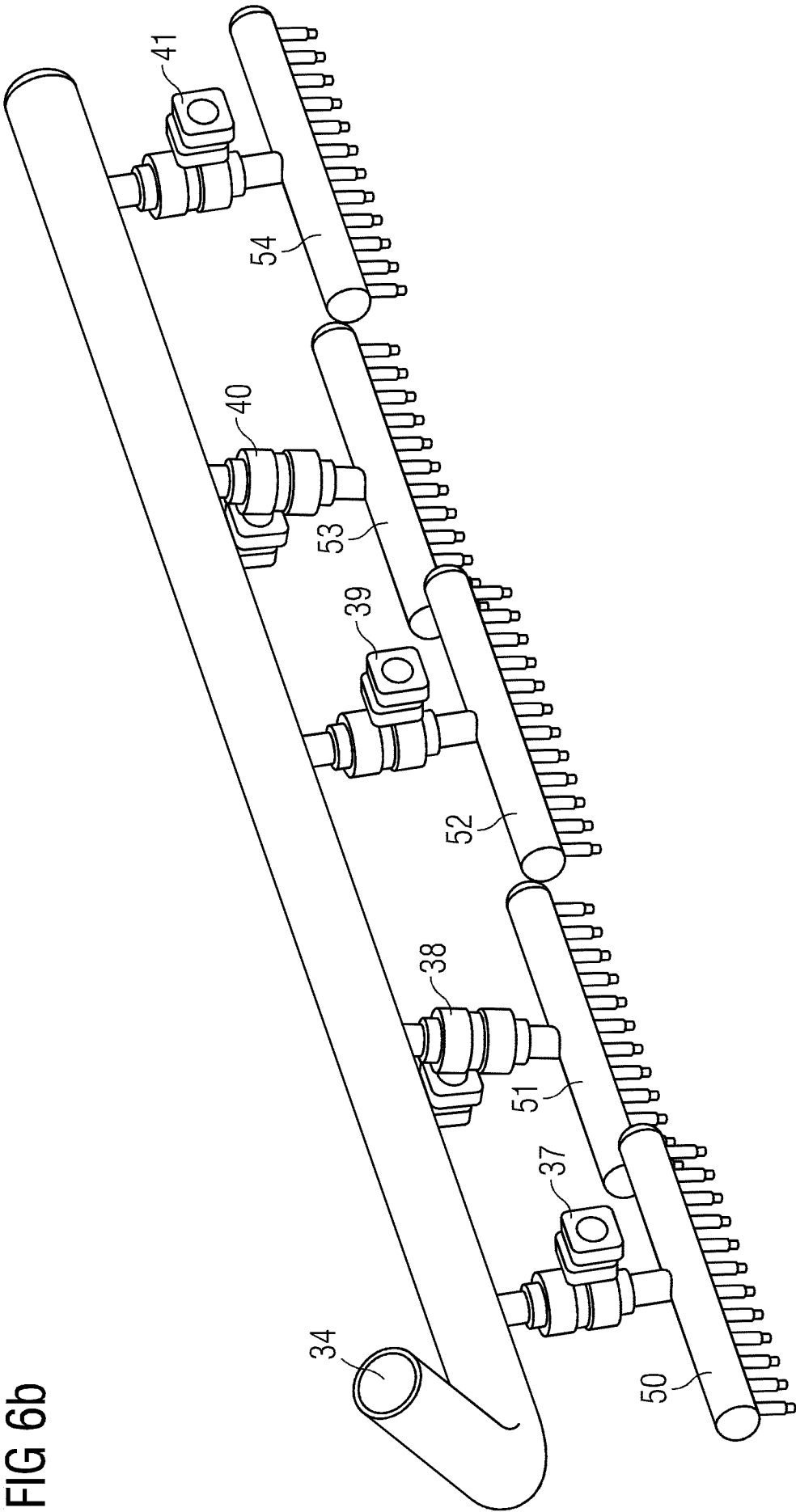
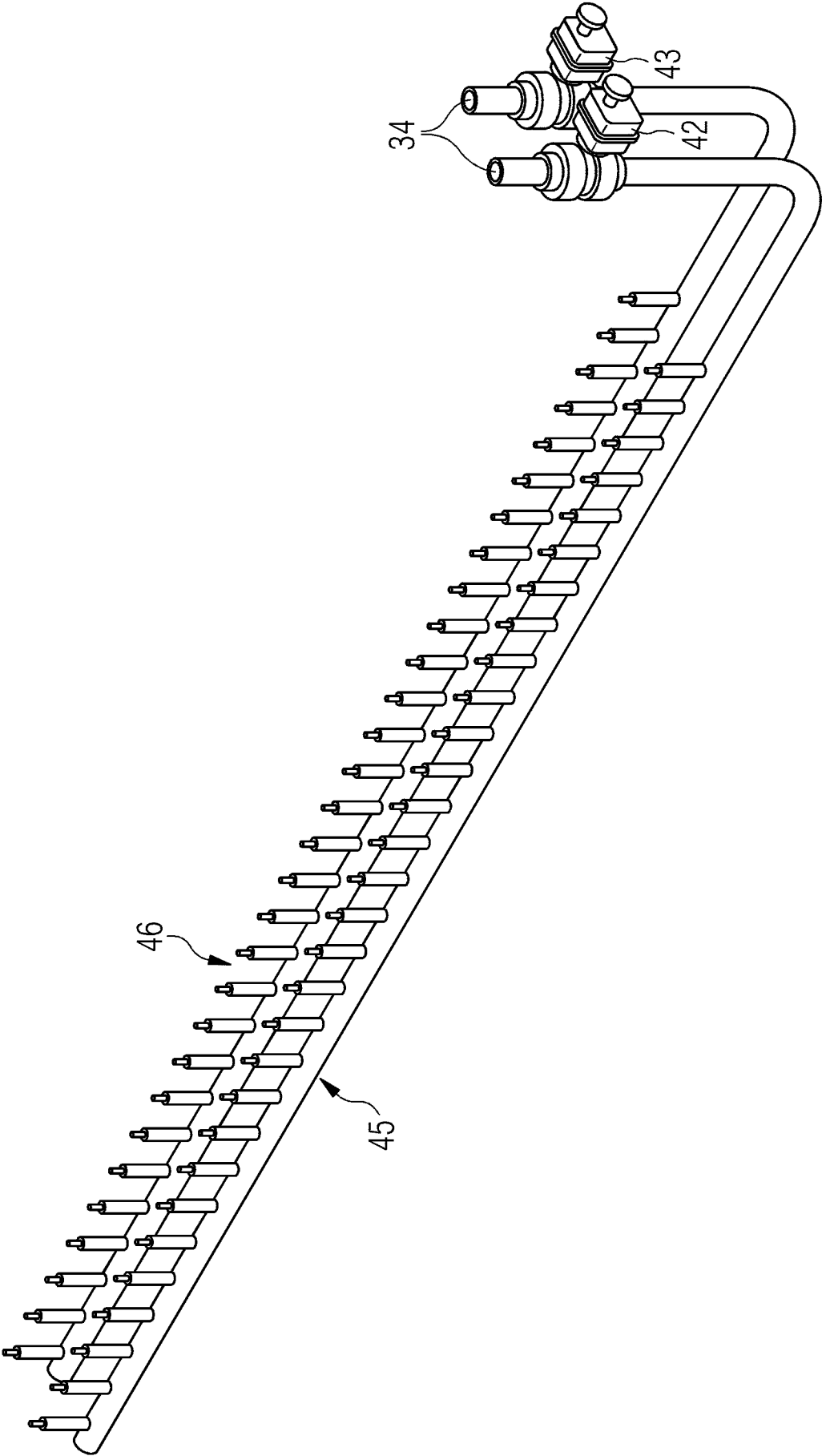


FIG 6b

FIG 6C



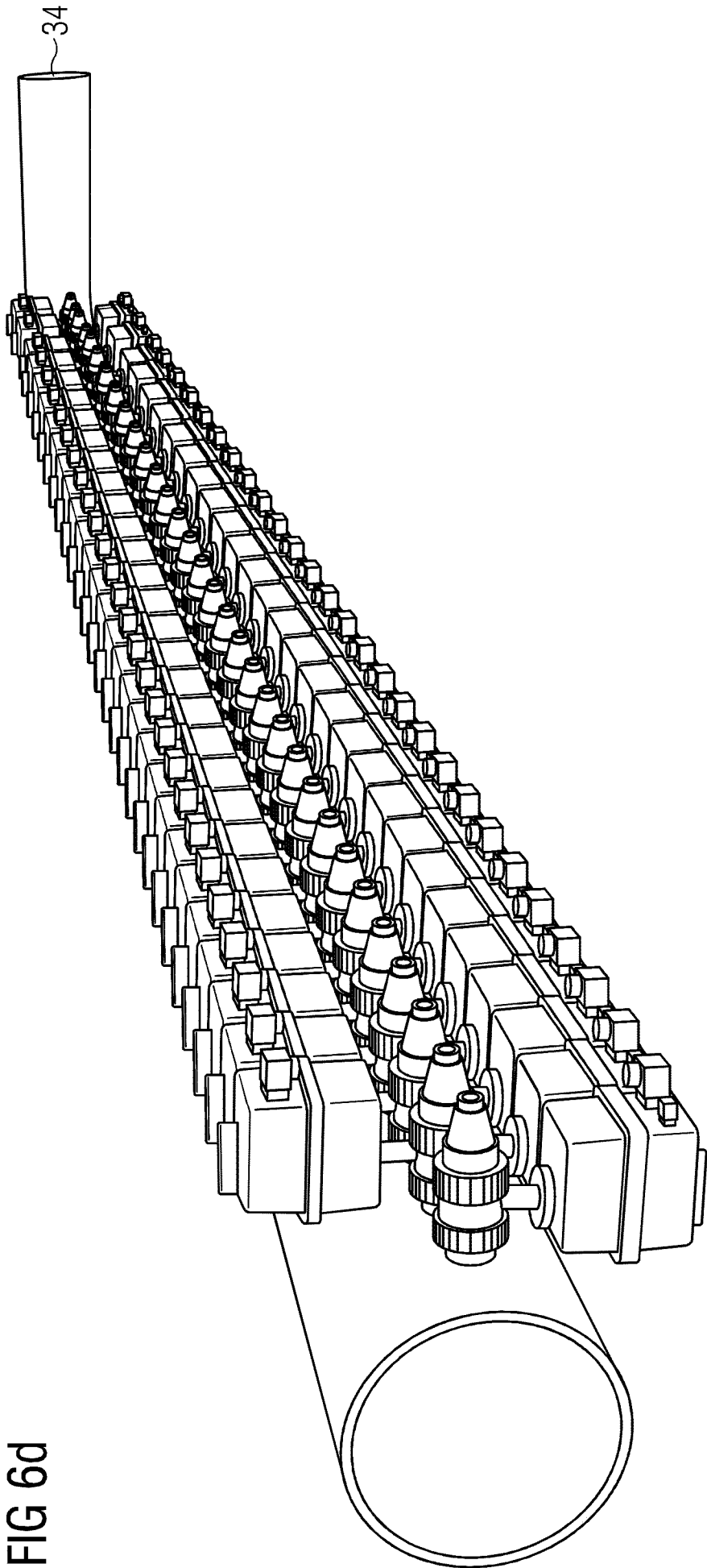


FIG 6d

