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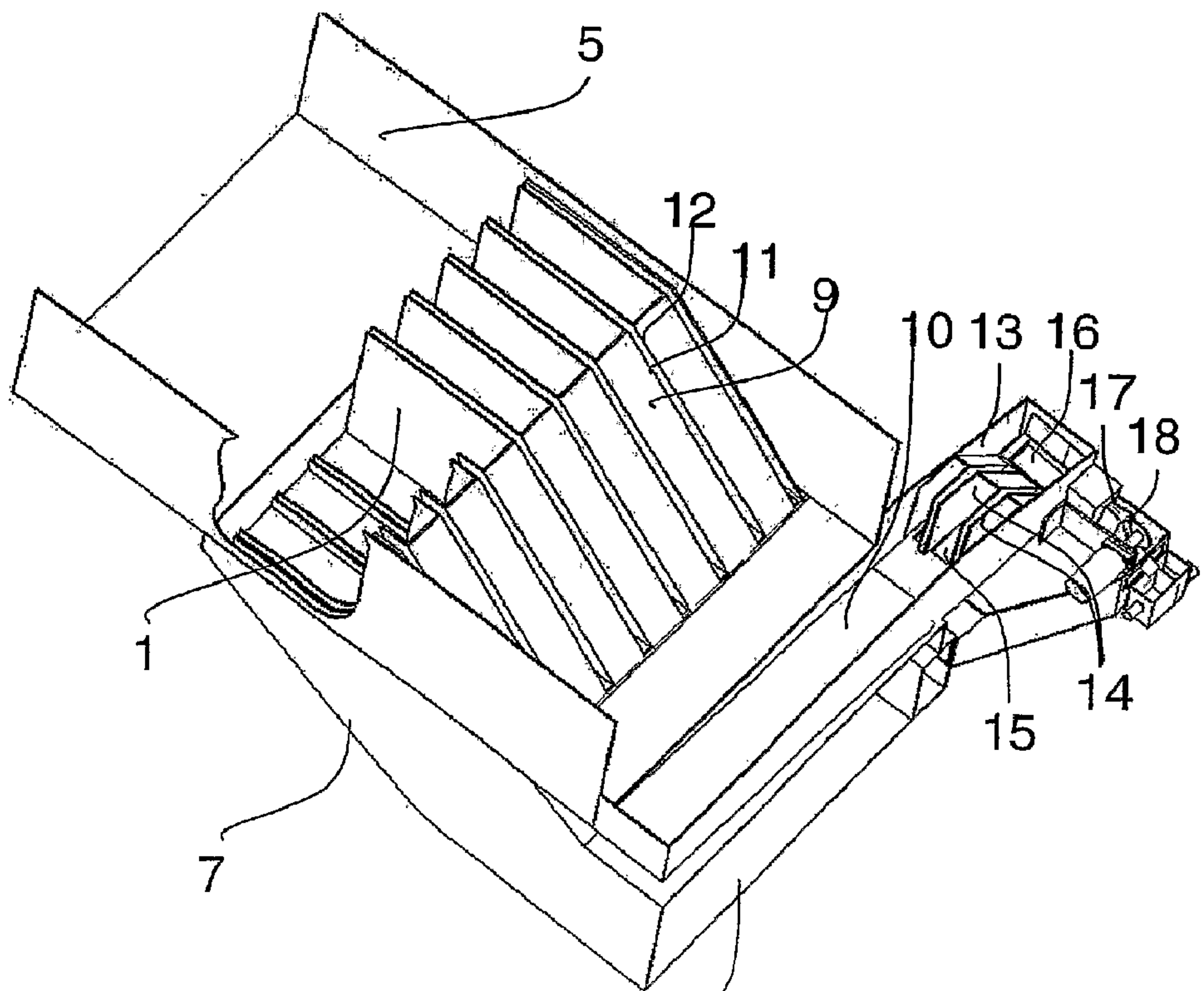
(54) **Titre : PROCEDE ET APPAREIL PERMETTANT DE PRELEVER DES ECHANTILLONS DE SUSPENSION EPAISSE**
(54) **Title: METHOD AND APPARATUS FOR TAKING SLURRY SAMPLES**



(57) **Abrégé/Abstract:**
The invention relates to a method and apparatus for taking slurry samples containing solids from a large, essentially horizontally flowing process flow, in which process flow there is at least partly immersed a sampler, and where the sampling is carried out in at

(57) **Abrégé(suite)/Abstract(continued):**
least two steps. According to the invention, in the first sampling step, the solids-bearing process flow (3) is conducted into a sampler (2) comprising at least three sampling units (1) that are arranged in the process flow channel in such a position that in the process flow direction (4), at the same spot where part of the process flow enters the sampling units (1), the slurry flow left outside the sampling units (1) is directed onto a lower level (6). In addition, the slurry flows obtained from the sampling units (1) are combined and subjected to mixing before the slurry flows are returned to new sampling that alternatively includes either the first sampling step (13) or the extracting of a sample for a analysis.

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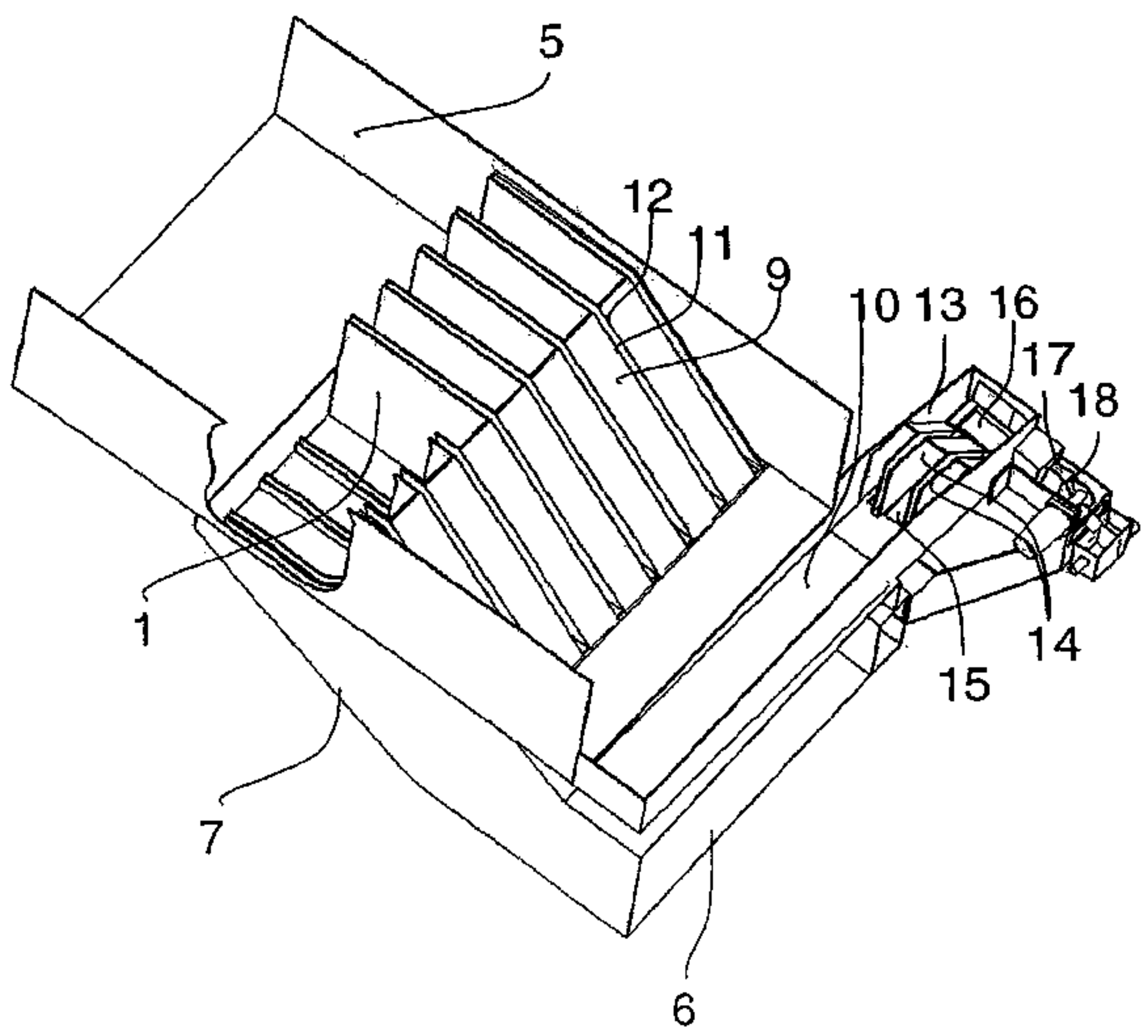
(54) Title: METHOD AND APPARATUS FOR TAKING SLURRY SAMPLES



(57) Abstract: The invention relates to a method and apparatus for taking slurry samples containing solids from a large, essentially horizontally flowing process flow, in which process flow there is at least partly immersed a sampler, and where the sampling is carried out in at least two steps. According to the invention, in the first sampling step, the solids-bearing process flow (3) is conducted into a sampler (2) comprising at least three sampling units (1) that are arranged in the process flow channel in such a position that in the process flow direction (4), at the same spot where part of the process flow enters the sampling units (1), the slurry flow left outside the sampling units (1) is directed onto a lower level (6). In addition, the slurry flows obtained from the sampling units (1) are combined and subjected to mixing before the slurry flows are returned to new sampling that alternatively includes either the first sampling step (13) or the extracting of a sample for a analysis.

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METHOD AND APPARATUS FOR TAKING SLURRY SAMPLES

The present invention relates to a method and apparatus for taking slurry samples containing solids from a large process flow, into which process flow a sampling device is at least partly immersed.

From a slurry flowing as a large process flow, there are generally extracted samples for analysis, because the whole amount of the slurry cannot be measured owing to its large volume. Among the employed analyzers, let us point out for instance X-ray analyzers for analyzing the contents of the slurry, and particle size analyzers for analyzing the size and distribution of the solid particles contained in the slurry. Samples are also needed for laboratory measurements. In order to ensure that the sample advantageously describes the whole process flow, one of the important quality features of the sample is its representability. Among the factors affecting the representability of the sample, let us point out for example the sample size that can vary within the range 10 l/min – 1,000 l/min. From this kind of sample, there is further extracted, either in one step or in two different steps, a combined sample often composed of several small single samples for further laboratory measurements. Typically a combined sample represents the operation carried out in the plant in question within one shift or within 24 hours. Moreover, the representability of the sample is affected by the fact that the sampler is prevented from being blocked by impurities possibly contained in the process flow or in the slurry.

Various different types of samplers are developed for sampling. For freely flowing slurries in atmospheric pressure, there are generally used vertical sample cutters that cut a small slice of the process flow. The moving samplers move back and forth transversally against the flowing direction and extract a representative sample even if the process flow is not homogeneous. Fixed cutter samplers extract a representative sample, if the process flow is homogeneous in the horizontal direction. Fixed cutter samplers also allow a certain degree of non-homogeneousness in the vertical direction of the flow.

The input flow orifice of a cutter used for sampling must be sufficiently large in order to prevent occasional large particles or impurities from blocking the orifice too easily. Advantageously the minimum width of the orifice is 8 mm, but often there is needed an orifice with a width that is larger than 20 mm.

A sample obtained from large process flows that is extracted by letting the slurry flow freely into the sample cutter is too large for analysis. The constriction of the sample flow lowers the flow speed at the input orifice of the cutter, which leads to separation, and the obtained sample is therefore not representative. In that case the right solution is to extract the sample from the process flow in two steps, as is described for example in the FI patent application 20002348. First there is extracted a primary sample, and from said primary sample there is further extracted a secondary sample, the volume whereof is suitable to be conducted to the analyzer. However, one of the problems here is that the process flow and the sample flow are at least partly nested, in which case the samplers must be specially designed in order to create speed differences therebetween.

The object of the present invention is to eliminate some of the drawbacks of the prior art and to realize an improved and simple method and apparatus for taking a representative slurry sample containing solids at least in two steps from a large, proceeding process flow in atmospheric pressure. The essential novel features of the invention are enlisted in the appended claims.

According to the invention, the first-step sampler advantageously comprises at least three sampling units that are arranged adjacently and at least partly immersed in a solids-bearing slurry flow proceeding in the horizontal direction, in such a position that in the slurry flow direction, at the same spot where part of the slurry flow enters the sample units, the slurry flow left outside the sample units is conducted to a lower level. In order to conduct the solids-bearing slurry flow to a lower level, those elements of the slurry flow channel that are located on different sides of the sampling spot are installed at different heights with respect to the horizontal level. In the sampler unit, however, the sample flow is advantageously conducted through the input orifice to a space that is provided in the sampler after the sampler unit. In said space provided after the sampling units, the sample flows are combined and mixed together before the second-step sampling is carried out by methods known as such. In case the combined sample flow obtained from the first-step sampling units is still too large to be fed directly into the analyzer, the combined sample flow is according to the invention subjected to another sampling of the first step by at least two new sampling units, and the obtained new sample flows are combined and mixed prior to the sampling of the third step.

In the first-step sampling, in between the sampling units and the space provided after the sampling units, there can, according to the invention, be installed a moving sampling device that cuts part of the flow obtained from the sampling units and conducts the cut section to the space provided after the sampling units. That part of the flow obtained from the sampling units that is left outside the cutter is returned to the main process flow proceeding in the flow channel.

According to the invention, there is then carried out the extracting of the slurry to be analyzed from the slurry flow containing solids by first creating by at least a one-step sampling system a sample flow, from which sample flow there is obtained the sample flow to be fed to the analyzer or to the combination sampler.

When applying the method and apparatus according to the invention for creating the first-step sample flow, the slurry flow containing solids and the sample flow obtained from said slurry flow are advantageously separated by conducting the slurry flow that is left outside the sample flow to a lower level. In that case for instance pumping or separation based on pressure difference is not needed for conducting the slurry flow and the sample flow in different directions. In order to conduct the slurry flow to a lower level, the elements constituting the flow channel that contains the slurry flow bearing solids are mutually installed so that that element of the flow channel that is located in the flowing direction after the point of orientation is placed lower with respect to the horizontal level than the element of the flow channel that is located in the flowing direction before the point of orientation. With respect to the point of orientation, the element of the flow channel that is located before and the element that is located after are mutually aligned, so that the elements are interconnected by means of a connecting element placed in an essentially inclined position, said connecting element being advantageously similar in cross-section as the flow channel. Said connecting element can also be arranged in an essentially vertical position.

In order to create a sample flow from the solids-containing slurry flow proceeding in the flow channel, at the end of that element of the flow channel that is located horizontally higher, at the end located at the point of orientation or in the immediate vicinity of said end, there is installed a sampler comprising at least three adjacent sampling units, said sampler being at least partly immersed in the slurry flow. Prior to the first sampling units, it is possible, when desired, to employ a mixing step that transforms the sample proceeding in the flow channel to a chute flow. The sampling units are designed so that the slurry flow entering the sampling units continues to proceed into the space provided in the sampler after the sampling units. The slurry flow that is left outside the sampler is conducted, via a conduit piece arranged between the flow channel elements, to a horizontally lower level, but continues flowing, advantageously in the same direction as the flow channel element that was located prior to the sampler.

The walls of the sampling units are mutually installed so that the walls are drawn apart in the direction of the slurry flow, when proceeding away from the input orifices of the slurry flow contained in the sampler unit. Thus the space available for the slurry flow entering the sampling unit is increased, the flowing speed of the slurry flow is reduced and the surface of the slurry flow with respect to the wall of the sampling unit is lowered, so that the suction created by the lowering of the surface compensates some of the friction caused by the sampler unit.

The slurry flows entering through the sampling units and a possible moving sampling device are combined, and the slurry flows are subjected to mixing in the space provided after the sampling units prior to further treatment in the sampling step that alternatively comprises either a repetition of the first sampling step or the extraction of a sample to be analyzed. The mixing can be carried out by example by installing an agitator in the slurry flow. However, according to a preferred embodiment of the invention, the mixing can also be carried out so that the direction of the combined slurry flow on the horizontal level is altered, so that the slurry flow forms an angle of at least 60 degrees, advantageously at least 90 degrees, with the original flowing direction. In addition to the agitation effect, the change in the flowing direction also reduces the space needed for the sampling equipment.

According to the invention, the slurry flow that forms an angle with respect to the original flowing direction can be conducted, depending on the size of the slurry flow, directly to the second-step sampling, where from the slurry flow there is extracted a sample that advantageously has a suitable size and is representative, to be further conducted to the analyzer in order to be analyzed or for extracting a combined sample. However, in case the size of the slurry flow forming an angle with the original flowing direction is such that it is not realistic to obtain a representative sample directly for the analyzer, the slurry flow that forms an angle in the original flowing direction is again conducted to a sampler comprising at least two sampling units but being located separately with respect to the sampler that was placed prior to the change of the flowing direction.

The sampler that is arranged separately with respect to the sampler that was placed prior to the change of the flowing direction is installed in a similar position with respect to the slurry flow as the sampler that was placed prior to the change of the flowing direction, in which case the slurry flow entering the sampling units proceeds flowing into the space provided after the sampling units. In the space provided after the sampling units, the slurry flows are combined, and they are subjected to mixing, advantageously by changing the flowing direction on the horizontal level. Thus the combined and mixed slurry flow generally has, after two steps of sampling, an advantageous size for extracting a combined sample or for creating a representative sample flow that can be analyzed in an analyzer. As for the slurry flow that is left outside the sampling units, it is again conducted, via a conduit piece of the elements of the slurry flow channel that are horizontally arranged at different levels, to flow onto a horizontally lower level than the slurry flow that proceeded in the flow channel prior to the sampling units.

According to the invention, when the solids-bearing slurry flow is conducted into the sampling units in order to reduce the slurry flow, for extracting a combined sample or for creating a representative sample flow that can be analyzed by an analyzer, the slurry flow left outside the sampling units is at the sampling spot directed downwardly. On the other hand, the direction of the slurry flow that has proceeded through the sampling units is on the horizontal level altered in the space provided after the sampling units.

Depending on the size of the original slurry flow, the slurry flow is subjected to one or several first-step samplings according to the invention by directing the slurry flow left outside the sampling units downwardly at the sampling spot. When so desired, in connection with such sampling units, there can also be installed at least one moving sampler, which as such has an advantageous effect when defining required first-step samplings according to the invention.

The invention is described in more detail below with reference the appended drawings, where

figure1 is a schematical illustration of a preferred embodiment of the invention, seen from the side,
figure2 is a more detailed illustration of the sampler according to figure 1,
figure 3 is a schematical illustration of another preferred embodiment of the invention, seen from the side, and
figure 4 is a schematical illustration of the first-step sampling of the embodiment of figure 3, seen from the top.

According to figures 1 and 2, the sampler 2 comprising several sampling units 1 is installed in an element 5 of a solids-containing slurry flow 3, the direction of said flow being indicated by means of the arrows 4, said element 5 being arranged on a level that is horizontally higher than the element 6 of the flowing channel. Said elements 5 and 6 of the flowing channel are mutually connected by means of a conduit piece 7 that is arranged in an essentially inclined position. The sampler 2 is installed in the element 5 of the flowing channel so that the sampler 2 is in mechanical contact with the flowing channel element 5 only at the first end thereof, when seen in the flowing direction 4. The sampler 2 can also be installed so that there is no mechanical contact with the flowing channel element 5, but the sampler 2 is completely supported from outside the element 5. However, the sampler 2 is installed essentially near to the angle created by the flowing channel element 5 and the conduit piece 7, so that in the flowing direction 4, the slurry flow coming from the flowing channel element 5 is partly conducted into the sampler 2 and partly to the flowing channel element 6 via the conduit piece 7 and the orientation elements 9 connected to the sampler 2.

The slurry flows entering the sampler 2 via the sampling units 1 are conducted into a space 10 arranged in succession to the sampling units 1. The walls 11 and 12 of the sampling units are mutually installed so that said walls 11 and 12 are drawn apart with respect to the flowing direction 4 of the slurry flow. In the space 10 provided after the sampling units, the slurry flows obtained from separate sampling units 1 are combined, and the direction of the created combined slurry flow is changed, essentially on the same horizontal level as the space 10, so that the angle of change of the flowing direction is 90 degrees. By means of this change of the flowing direction, the slurry flows obtained from separate sampling units 1 are advantageously mixed together. After the change in the flowing direction, the combined slurry flow is returned to sampling in a new sampler 13, provided with several adjacent sampling units 14. The slurry flow left outside the sampling units 14 is conducted, via an aperture 15 provided between the sampling units 14, to a lower level.

In structure, the sampler 13 essentially corresponds to the sampler 2, but there is one difference: the number of the sampling units 14 is at least two; thus the slurry flow that has entered the sampling units 14 is further conducted to a space 16 arranged after the sampling units 14, where the slurry flows obtained from separate sampling units 14 are combined. The combined slurry flow leaving the space 16 provided after the sampling units 14 is subjected, in order to achieve a good mixing, to a change of the flowing direction, so that the angle of change is 90 degrees, essentially on the same horizontal level as the space 16. The slurry flow that proceeds into analysis is discharged from the sampling arrangement through an outlet orifice 17.

The slurry flow discharged through the outlet orifice 17 can, depending on the size of the flow, be conducted either to be directly analyzed, or the slurry flow can be subjected to one more sampling 18, for instance by means of a regular sample cutting.

According to figures 3 and 4, the slurry flow 3 that proceeds to the sampling units 1 from the flowing channel 5, the flowing direction of said slurry flow 3 being indicated by means of the arrow 4, is after the sampling units 1 subjected to another sampling step by a moving sampling device 21. The moving sampling device 21 moves in an essentially horizontal direction and cuts a slice of the flow of the sampling conduits 19, after which said slice is conducted into a space 20 provided after the sampling units, where the entering sample flow is subjected to mixing in a way described above. That part of the slurry flow that is not directed into the sampling units 1 and via the moving sampling conduits 19 to the space 20 is conducted, via the conduit 7, to the part 6 of the flowing channel and further to the next process step.

CLAIMS

1. A method for taking slurry samples containing solids from a large, substantially horizontally flowing process flow, in which process flow there is at least partly immersed a sampler, and where the sampling is carried out in at least two steps, wherein in the first sampling step, the solids-bearing process flow (3) is conducted into a sampler (2) comprising at least three sampling units (1) disposed as a substantially horizontal extension of a substantially horizontal process flow channel section (5) on the downstream side thereof, the sampling units being arranged in such a position that in the process flow direction (4), at the same spot where part of the process flow enters the sampling units (1), the slurry flow left outside the sampling units (1) is directed onto a lower level (6), and that the slurry flows obtained from the sampling units (1) are combined and subjected to mixing before the slurry flows are returned to new sampling that includes one of: the first sampling step (13) ; and the extracting of a sample for a analysis.

2. A method according to claim 1, wherein the mixing of the slurry flows obtained from the sampling units (1) takes place in a space (10) arranged after the sampling units.

3. A method according to claim 1, wherein the mixing of the slurry flows obtained from the sampling units (1) is carried out by changing the flowing direction of the slurry flows substantially on the same horizontal level as a space (10) arranged after the sampling units.

4. A method according to claim 2, wherein the mixing of the slurry flows obtained from the sampling units (1) is carried out by changing the flowing direction of the slurry flows substantially on the same horizontal level as the space (10) arranged after the sampling units.

5. A method according to any one of claims 3 to 4, wherein the flowing direction is changed at least 60 degrees.

6. A method according to any one of claims 3 to 4, wherein the flowing direction is changed at least 90 degrees.

7. A method according to claim 1, wherein the mixing of the slurry flows obtained from the sampling units (1) is carried out in a space (10) provided after the sampling units by means of an agitator.

8. A method according to claim 2, wherein the mixing of the slurry flows obtained from the sampling units (1) is carried out in the space (10) provided after the sampling units by means of an agitator.

9. A method according to any of claims 2 to 8, wherein a moving sampling device (21) arranged between the sampling units (1) and the space (10) provided after the sampling units cuts a slice of the flow obtained from the sampling units.

10. An apparatus for taking slurry samples containing solids from a large, substantially horizontally flowing process flow, in which process flow there is at least partly immersed a sampler, and where the sampling is carried out in at least two steps, wherein in the first sampling step, the sampler (2) comprises at least three sampling units (1) disposed as a substantially horizontal extension of a substantially horizontal process flow channel section (5) on the downstream side thereof in a position where the process flow channel sections (5, 6) that are located on different sides of the sampling spot are horizontally arranged on different heights in order to direct the slurry flow that is left outside the sampling units (1) onto a lower level (6), and that in order to combine the slurry flows obtained from the sampling units (1), in succession to the sampling units there is arranged a space (10) where the slurry flows can be subjected to mixing prior to returning them to a new sampling step (13).

11. An apparatus according to claim 10, wherein the sections (5, 6) of the flowing channel, located on different sides of the sampling spot in the flowing direction of the slurry flow, are mutually combined by a substantially vertically positioned conduit piece (7).

12. An apparatus according to any one of claims 10 to 11, wherein a plurality of walls (11, 12) of the sampling units are in the flowing direction (4) of the process flow arranged to be drawn apart, starting from an input orifice of the sampling units (1).

13. An apparatus according to any one of claims 10 to 12, wherein the space (10) provided after the sampling units is designed so that a discharge orifice of said space forms an angle of at least 60 degrees with the original flowing direction, substantially on the same horizontal level.

14. An apparatus according to claim 13, wherein the space (10) provided after the sampling units is designed so that the discharge orifice of the space forms an angle of at least 90 degrees with the original flowing direction, substantially on the same horizontal level.

15. An apparatus according to any one of claims 10 to 14 wherein between the sampling units (1) and the space (10) provided after the sampling units, there is installed a moving sampling device (21).

16. An apparatus according to claim 1, wherein the sampling units (1) are disposed equidistantly across the width of the substantially horizontal process flow channel section (5) and have a height that substantially matches the height of said substantially horizontal process flow channel section (5).

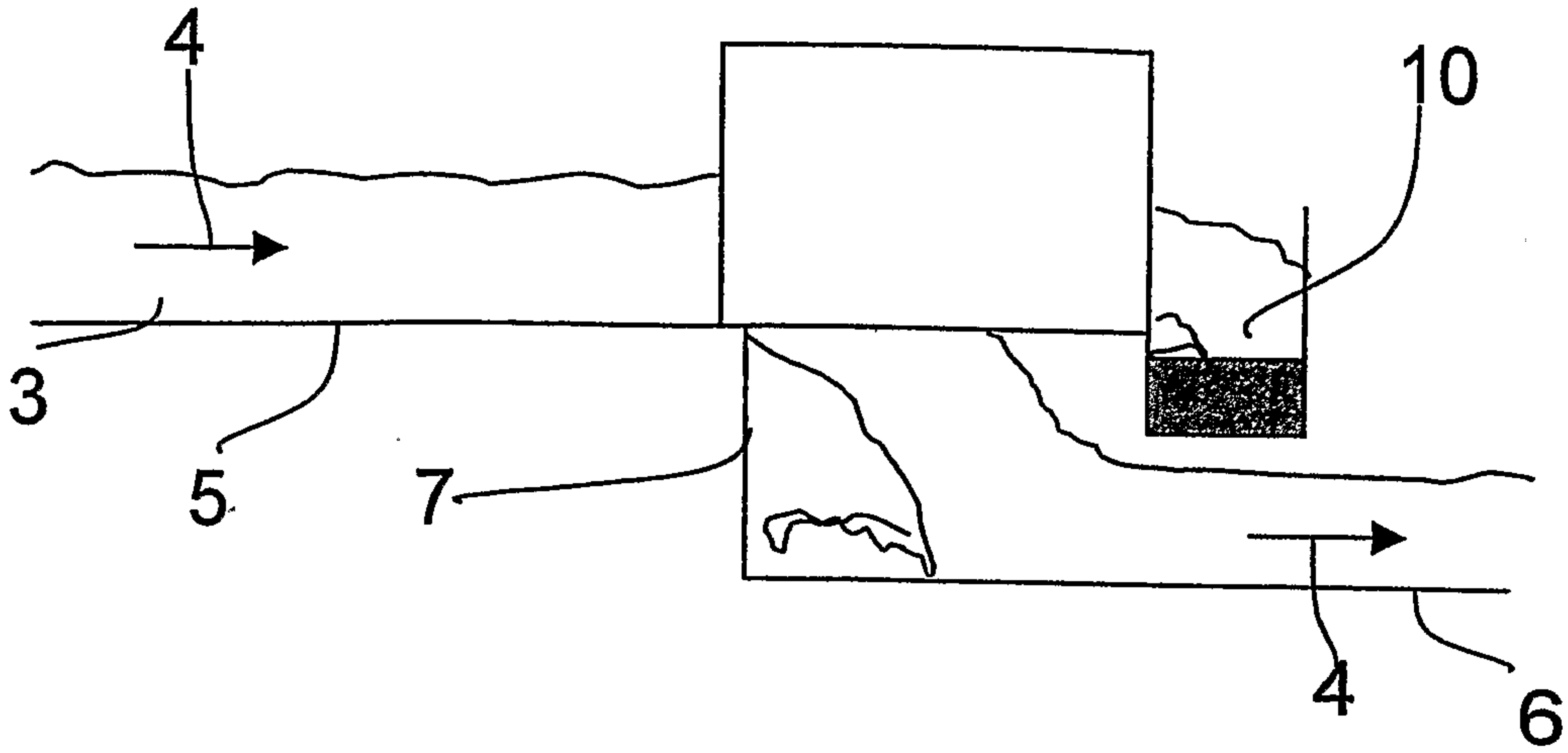


Fig. 1

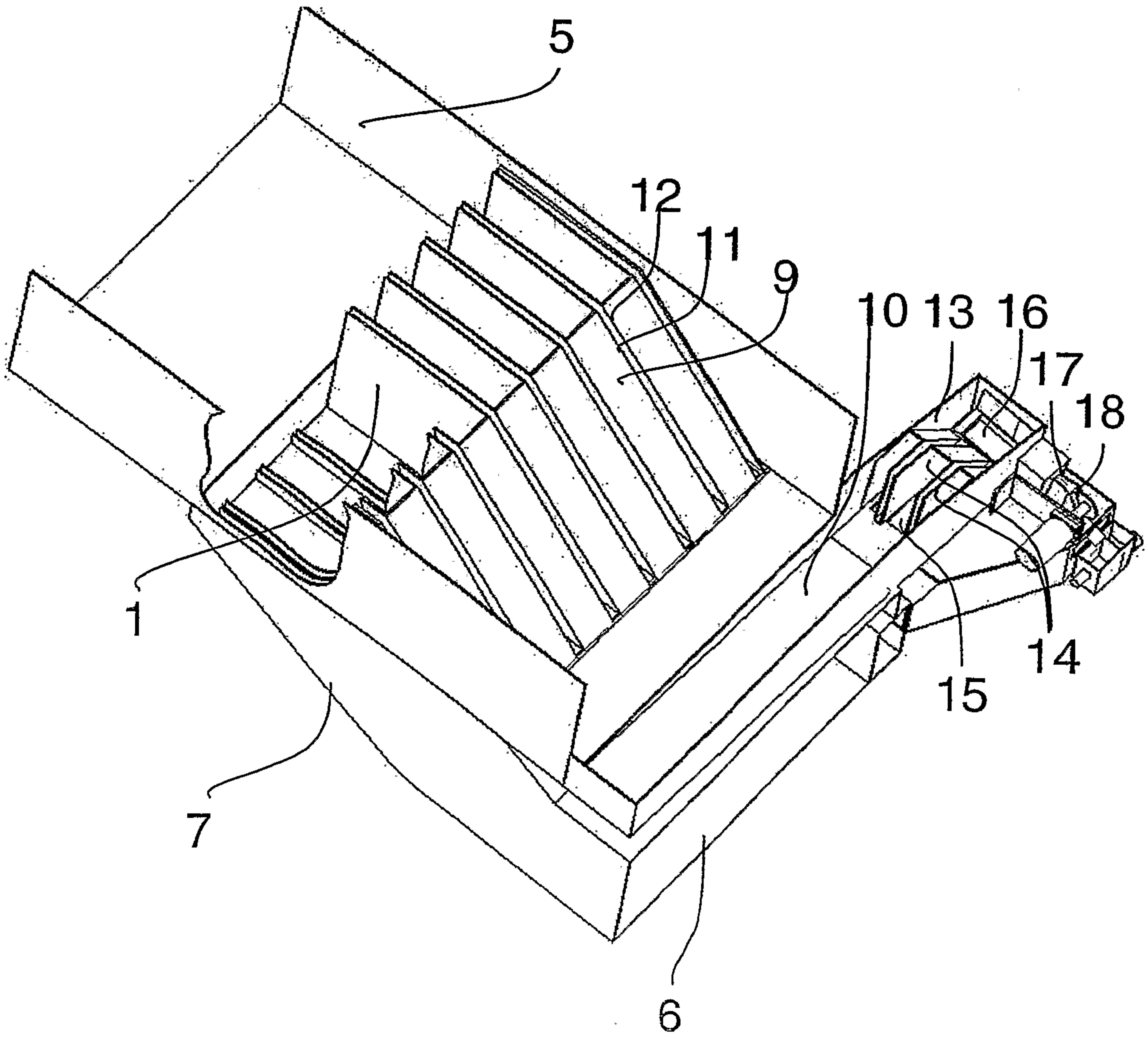


Fig. 2

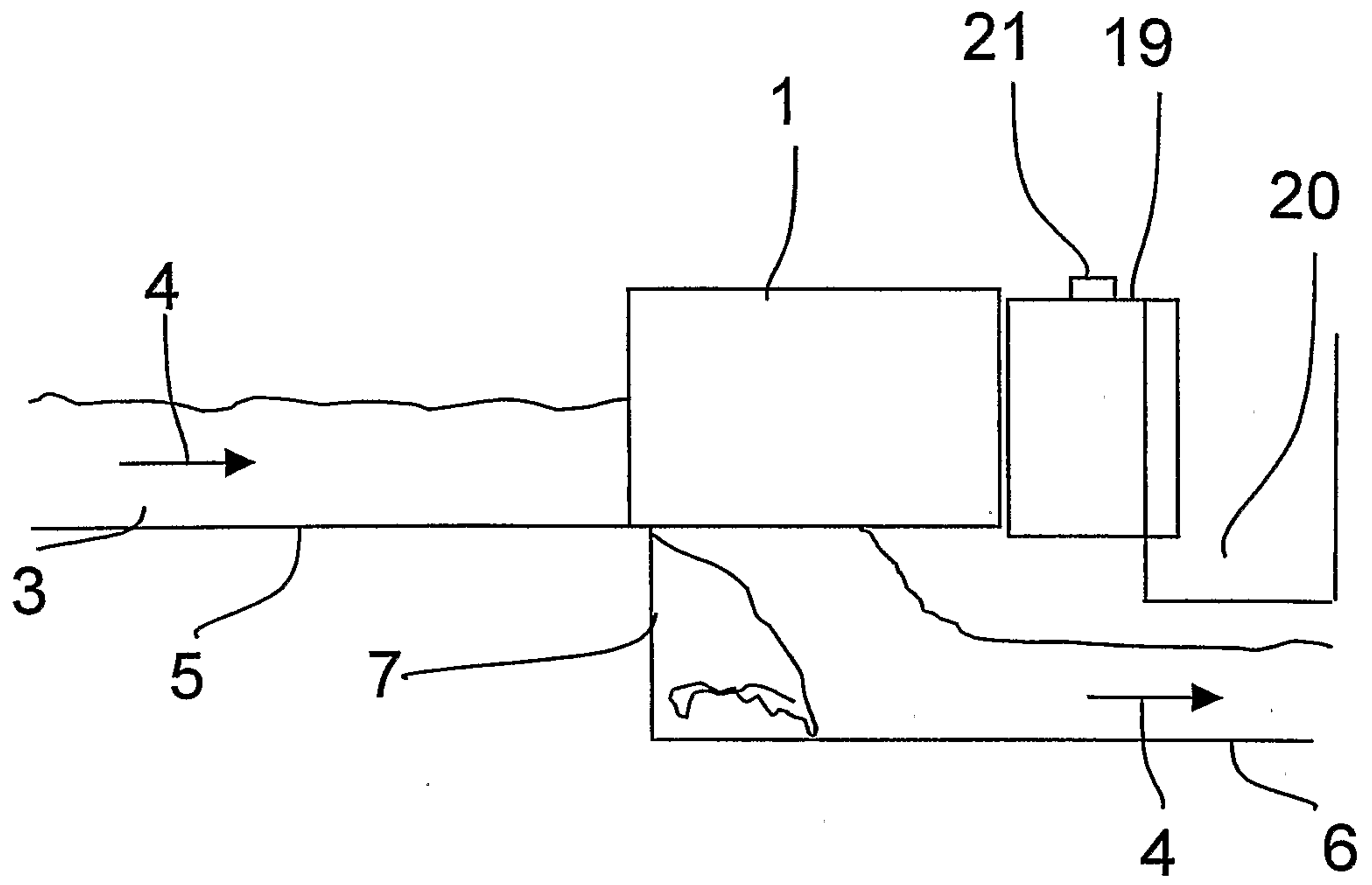


Fig. 3

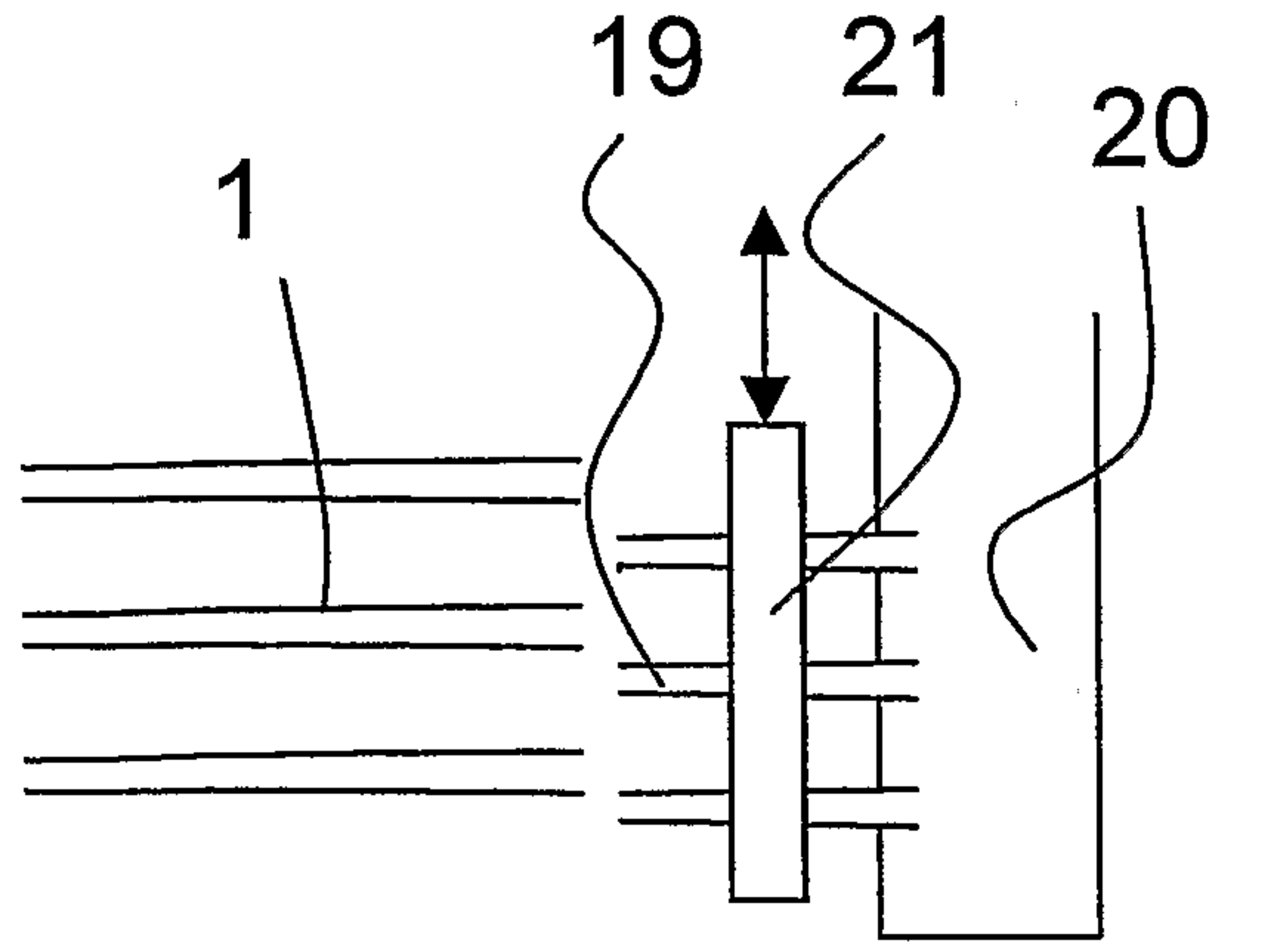
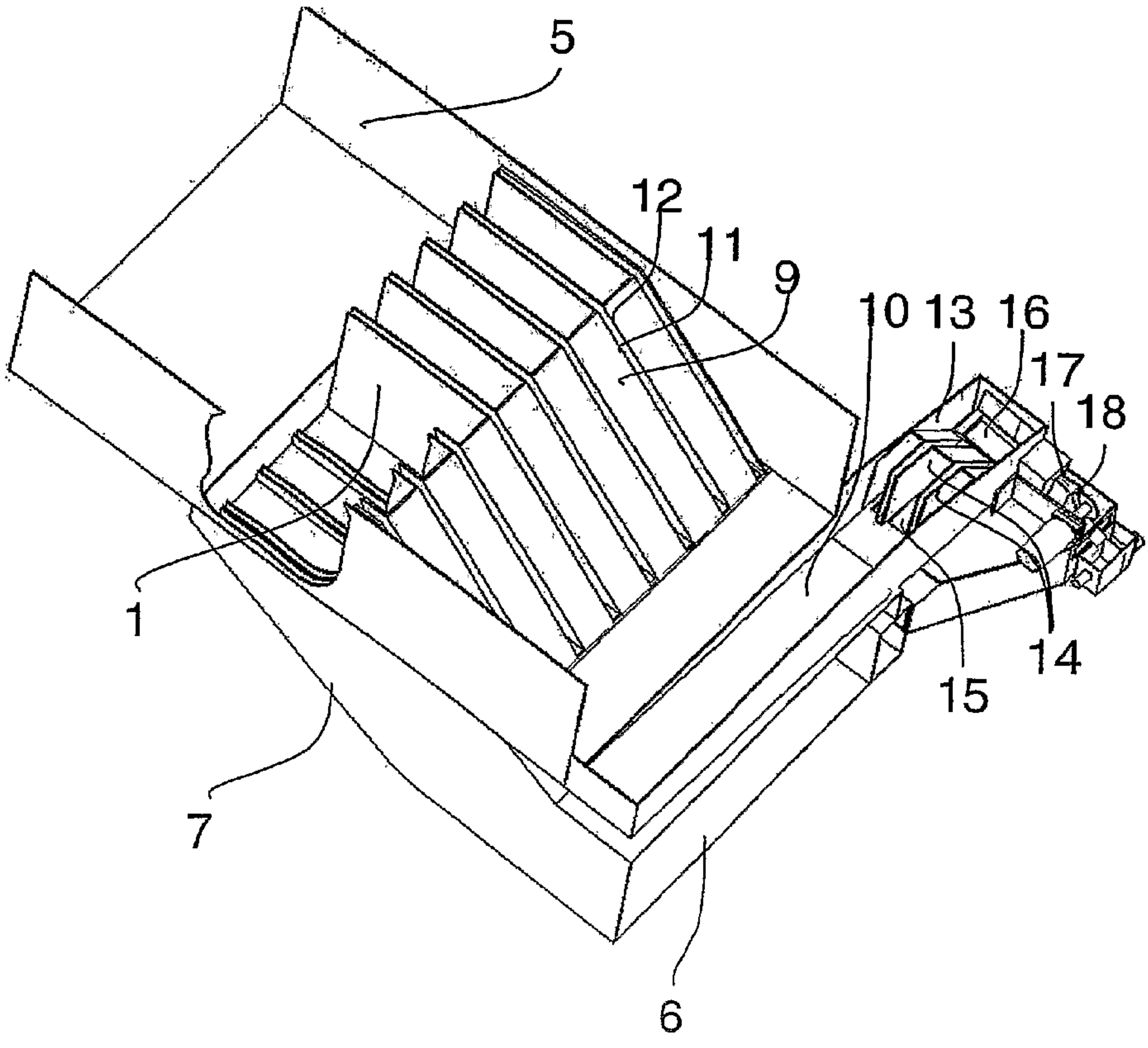


Fig. 4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