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(54) **A device and a method for disintegrating liquid waste**

(57) A device for disintegrating liquid waste, comprising a waste processing chamber (100) defined by a housing (101A, 101 B) with a set of discs (103, 104, 105) rotatable with respect to each other and comprising correlated concentric protrusions (103A, 104A) and channels (103B, 104B) defining a shear gap (106) and configured to disintegrate liquid waste by cavitation during rotation, an inlet conduit (111) connected to an inlet port (110) for providing the liquid waste to an inlet chamber (108) at the central portion of the waste processing chamber (100), an outlet conduit (121) connected to an outer

port (120) for collecting the disintegrated liquid waste from a collecting chamber (107) at the periphery of the waste processing chamber (100), wherein the waste processing chamber (100) is liquid-tight and comprises liquid-tight sealing (131-134) and an air vent (141) mounted in the uppermost portion of the waste processing chamber (100), and the inlet conduit (111) comprises switchable inlet valve means (112A, 113A) for providing to the inlet conduit (111) a liquid waste of a first density from a liquid waste input conduit (112) and a liquid of a second density lower than the first density from a supplementary conduit (113).

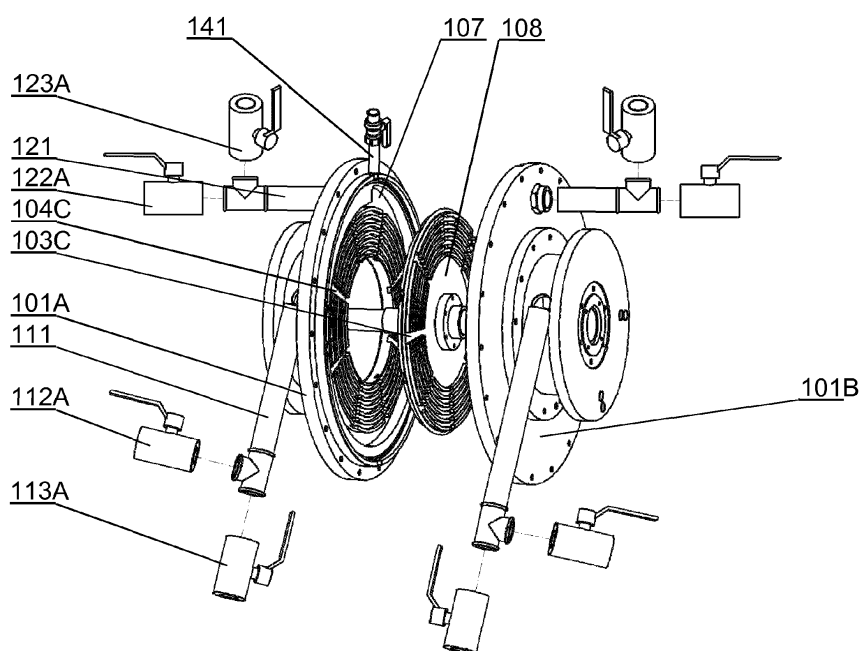


Fig. 1

Description

[0001] The present invention relates to disintegration of liquid waste.

[0002] A typical municipal sewage treatment plant comprises a screening stage in which large objects are separated from the sewage and a plurality of primary and secondary treatment stages, in which liquid waste is processed to remove suspended solids, oils, degrade the biological content etc. The efficiency of the secondary treatment stage of degrading the biological content of the sludge depends on the composition and structural properties of the sludge. It is therefore advantageous to pre-process the sludge entering the secondary treatment stages.

[0003] A PCT application W02005/030659 discloses a device for treatment of a medium containing thread- and flake-forming microorganisms, such as effluent clarifier sludge, by means of a shear field for treating the microorganisms in the medium with mechanical stress, wherein the shear field is defined by a pair of planar elements separated from each other by a shear gap and rotatable around a vertical axis. The medium inlet is or may be connected to a feed pump such that the device does not siphon with at least a reduction, or an avoidance of cavitation in the shear gap.

[0004] A US patent 3996012 discloses an apparatus for continuous treatment of substances in flowable form in conjunction with a catalyst for carrying out chemical reactions, the apparatus including a conical-shaped rotor and stator in opposed relationship defining between opposing working surfaces a reaction area and rotatable around a horizontal axis. The rotating rotor causes a turbulence effect in the reaction mixture which occurs in shearing at impact zones promoted by cavitation-like impact phenomena which intensify the chemical reaction.

[0005] A European patent application EP1985357 discloses an apparatus for processing liquid fluids, such as wastewater, with use of cavitation process, wherein the liquid to be cavitied is input between two planar elements rotatable with respect to each other around a horizontal axis and comprising alternate protrusion and channels.

[0006] The known devices, even if described as applicable for processing wastewater, require a clarified input medium, in order to avoid clogging of the rotatable elements. Such clarification may be typically performed by a filter installed at a pumping arrangement via which the medium to be processed is input to the device.

[0007] The aim of the present invention is to provide a method and a device for disintegrating liquid waste which is convenient to operate and resilient to clogging.

[0008] The object of the invention is a device for disintegrating liquid waste, comprising a waste processing chamber defined by a housing with a set of discs rotatable with respect to each other and comprising correlated concentric protrusions and channels defining a shear gap and configured to disintegrate liquid waste by cavitation during rotation, an inlet conduit connected to an inlet port

for providing the liquid waste to an inlet chamber at the central portion of the waste processing chamber, an outlet conduit connected to an outer port for collecting the disintegrated liquid waste from a collecting chamber at the periphery of the waste processing chamber, wherein the waste processing chamber is liquid-tight and comprises liquid-tight sealing and an air vent mounted in the uppermost portion of the waste processing chamber, and the inlet conduit comprises switchable inlet valve means for providing to the inlet conduit a liquid waste of a first density from a liquid waste input conduit and a liquid of a second density lower than the first density from a supplementary conduit.

[0009] At least one of the discs can be mounted on a rotatable horizontal shaft.

[0010] The shaft can be rotatable by an engine with a speed from 2960 rpm to 3500 rpm.

[0011] The device may further comprise a sensor configured to monitor at least one process parameter of the device and a controller configured to control the inlet valve means depending on the monitored process parameter.

[0012] The sensor can be configured to monitor the temperature of the waste processing chamber.

[0013] The sensor can be configured to monitor the temperature and/or load of an engine driving a rotatable disc.

[0014] The sensor can be configured to monitor the density of the liquid in the outlet conduit.

[0015] The liquid-tight sealing of the waste processing chamber may comprise carbon rings.

[0016] The width of the shear gap can be from 0,4 mm to 0,6 mm.

[0017] The object of the invention is also a liquid waste processing installation, comprising a sedimentation tank, the device for disintegrating liquid waste according to the invention, wherein the liquid waste inlet conduit is configured to collect liquid waste from the bottom portion of the sedimentation tank and wherein the outlet conduit is configured to output the disintegrated liquid waste to the upper portion of the sedimentation tank.

[0018] The installation may further comprise an anaerobic digestion chamber, to which the liquid waste from the sedimentation tank is input, configured to produce biogas to be stored in a biogas tank, a biogas sensor configured to measure the amount of produced biogas, wherein the controller is further configured to control the working cycle of the device depending on the output of the biogas sensor.

[0019] Another object of the invention is a method for disintegrating liquid waste by the device according to the invention, comprising the steps of detecting increase of clogging of the device, switching the inlet valve means to provide to the inlet conduit increased amount of liquid from the supplementary conduit, detecting reduction of clogging of the device, switching the inlet valve means to provide to the inlet conduit increased amount of liquid waste from the liquid waste input conduit.

[0020] The method may comprise the step of, upon detecting increase of clogging of the device, switching the inlet valve means to provide to the inlet conduit only liquid from the supplementary conduit.

[0021] The method may comprise the step of, upon detecting reduction of clogging of the device, switching the inlet valve means to provide to the inlet conduit only liquid waste from the liquid waste input conduit.

[0022] The invention is shown on a drawing, in which:

Fig. 1 presents an exploded view of the device according to the invention.

Fig. 2 presents a cross-sectional view of the device according to the invention.

Fig. 3 presents the functional schematic of a liquid waste processing installation according to the invention.

[0023] The device for disintegrating liquid waste according to the invention is shown in an exploded view on Fig. 1 and in a cross-sectional view of its top portion on Fig. 2. The device comprises a waste processing chamber 100 defined by a housing 101A, 101B with a set of discs 103, 104, 105 rotatable with respect to each other and comprising correlated concentric protrusions 103A, 104A and channels 103B, 104B defining a shear gap 106 and configured to disintegrate liquid waste by cavitation during rotation. The liquid waste is provided to an inlet chamber 108 at the central portion of the waste processing chamber 100 via at least one inlet conduit 111 connected to an inlet port 110 formed in the housing 101A. The liquid waste disintegrated after passing through the shear gap 106 between the discs 103, 104, 105 is collected from a collecting chamber 107 at the periphery of the waste processing chamber 100 by an outlet conduit 121 connected to an outer port 120 formed in the housing 101A.

[0024] The set of discs comprises stationary discs 104, 105, which are fixed to the housing 101A, 101B or are formed within the internal wall of the housing and a rotatable disc 103 mounted on a shaft 102. A collecting chamber 107, shaped as a semi-spiral is formed at the outer periphery of the stationary discs 104, 105 and facilitates collection of the disintegrated liquid waste via the outer port 120. The concentric protrusions 103A, 104A and concentric channels 103B, 104B are formed such that after assembly of the device the concentric protrusions 104A of the stationary discs 104, 105 enter into the concentric channels 103B of the rotary disc 103 and vice versa, defining a shear gap 106. Moreover, radial channels 103C, 104C are formed within the concentric protrusions 103A, 104A to facilitate flow of liquid during disintegration from the inlet chamber 108 within the centre of the housing to the collecting chamber 107 at its periphery.

[0025] In a simple embodiment, one stationary disc 104 and one rotatable disc 103 may be provided. In a more elaborate embodiment, as shown in Figs. 1 and 2,

a pair of stationary discs 104, 105 may be provided, wherein the rotary disc 103 has protrusions and channels formed at its both sides. In such a case, a pair of inlet ports 110 and outlet ports 120 may be provided, one at each housing part 101A, 101B, to facilitate flow of liquid waste.

[0026] The waste processing chamber 100 is liquid-tight and comprises liquid-tight sealing 131-134, comprising liquid-tight seals 131 at the shaft 102 driving the rotatable disc 103, liquid-tight seals 132 at the inlet ports 110, liquid-tight seals 133 at the outlet ports 120 and liquid-tight seal 134 between the housing parts 101A, 101B. Preferably, the liquid-tight seals 131 have a form of carbon rings, which guarantees their resistance to wear and high temperature at a point of contact with the rotatable shaft. Moreover, an air vent 141 is mounted in the uppermost portion of the waste processing chamber 100. The air vent 141 can be opened during the start phase of the operation of the device to outlet all air from the waste processing chamber 100. Such configuration guarantees that during the operation of the device, the whole volume of the waste processing chamber 100 is filled with liquid, which provides most effective cavitation process. The shaft 102 on which the rotatable disc 103 is mounted is preferably horizontal, which facilitates equal distribution of liquid waste within the chamber.

[0027] Furthermore, the inlet conduit 111 comprises switchable inlet valve means 112A, 113A for providing to the inlet conduit 111 a liquid waste of a first density from a liquid waste input conduit 112 and/or a liquid of a second density lower than the first density from a supplementary conduit 113. The switchable inlet valve means 112A, 113A may comprise separate cut-off valves for the liquid waste input conduit 112 and the supplementary conduit 113 or a single three-way valve for connecting both conduits 112, 113 to the inlet conduit 111. The supplementary conduit 113 may provide water or liquid waste of a lower density than the density of the liquid waste provided from conduit 112.

[0028] In use, the liquid waste to be disintegrated enters the inlet chamber 108 via the inlet port 110. As the discs 103, 104, 105 rotate with respect to each other, pressure differences are created within the shear gap. For sufficiently high rotational speed, the low pressure within the gap falls under vapour point of the waste liquid, thus creating cavitation bubbles. The pressure difference also causes self-suction of the liquid and flow of the liquid from the inlet chamber 108 to the collecting chamber 107. The disintegration of the liquid waste is therefore effected in two ways. First, larger particles are broken by entering the narrow shear gap into particles of a size smaller than the shear gap width. Second, the broken particles leaving the shear gap are subject to cavitation, which causes their further disintegration into cavitation bubbles.

[0029] However, when the liquid waste comprises a considerable amount of solid waste including large particles or particles which are hard to disintegrate, the shear gap may become clogged. The clogging may cause in-

creased friction between the discs 103, 104, 105, resulting in increase of power consumption by the engine or reduction of rotational speed of the shaft 102, thereby reducing the operational efficiency of the device. When clogging is detected, the inlet valve means may be switched such that the liquid from the supplementary conduit 113 is input to the processing chamber 100. Since the liquid from the supplementary conduit, preferably water, has a density lower than the density of the liquid waste from the first conduit 112, it causes rinsing of the channels of the discs 103, 104, 105 and reduction of clogging of the shear gap 106. After clogging is removed, the inlet valve means may be switched back to provide the liquid waste from the liquid waste input conduit 112 to the waste processing chamber 100.

[0030] The outlet conduit may comprise switchable outlet valve means 122A, 123A for providing the disintegrated output liquid to a waste output conduit 122 or to a supplementary output conduit 123. The output conduits 122, 123 may be coupled with different tanks. For example, a sedimentation tank 161 may be coupled with a waste input conduit 112 and the waste output conduit 122, while a water supply tank may be coupled with the supplementary input conduit 113 and the supplementary output conduit 123. Instead of a water tank, another sedimentation tank, having waste liquid of a density lower than the sedimentation tank 161, can be used in the installation.

[0031] The clogging may be detected by the operator of the device by simple observation of its operation and the inlet valve means 112A, 113A may be operated manually. Preferably, the clogging can be detected automatically by a sensor 152-154 configured to monitor at least one process parameter of the device and the inlet valve means 112A, 113A may be automatically operated by a controller 151 depending on the monitored process parameter, as shown in Fig. 3. One sensor 153 can be configured to monitor the temperature of the waste processing chamber 100, for example by monitoring the internal temperature or the external temperature of the housing 101A, 101 B, which increase with clogging. Another sensor 152 can be configured to monitor the temperature and/or load of an engine 109 driving the rotatable disc 103, which increase with clogging. Another sensor 154 can be configured to monitor the density of the liquid in the outlet conduit 120, to detect a threshold density above which clogging may occur. The controller 151 may be configured to switch the inlet valve means 112A, 113A such as to provide liquid only from the liquid waste input conduit 112 or only from the supplementary conduit 113, or, alternatively, a mix of liquids from both conduits 112, 113 depending on the monitored process parameter. In other words, when increase of clogging is detected, the inlet valve means 112A, 113A are switched to provide to the inlet conduit 111 increased amount of liquid from the supplementary conduit 113 and when reduction of clogging is detected, the inlet valve means 112A, 113A are switched to provide to the inlet conduit 111 increased

amount of liquid waste from the liquid waste input conduit 112.

[0032] In the liquid waste processing installation of Fig. 3, the device according to the invention operates by processing a part of the liquid waste contained in the sedimentation tank 161, which can be further processed in anaerobic digestion chamber 162, in which biogas is produced and stored in a biogas tank 163. Disintegration of the liquid waste entering the anaerobic digestion chamber 162 promotes the amount of the produced biogas. Therefore, a biogas sensor 164 configured to measure the amount of produced biogas can be connected to the controller 151, and the controller can be configured to control the working cycle, i.e. the amount of time the device operates or the amount of processed liquid waste, depending on the output of the biogas sensor 164, in order to adjust the production of biogas to an optimal amount. The optimal amount can be e.g. the amount of biogas which allows filling the biogas tank 163 up to 90% of its maximum capacity.

[0033] The inlet conduit 112 is configured to collect liquid waste from the bottom portion of the sedimentation tank 161, to avoid air content in the liquid waste to be processed. The outlet conduit 120 is configured to output the disintegrated liquid waste to the upper portion of the sedimentation tank 161, preferably above the surface of the liquid waste, to facilitate dynamic mixing of the processed liquid waste with the liquid waste in the sedimentation tank

[0034] The width of the shear gap is preferably from 0,4 mm to 0,6 mm. The discs 103, 104, 105 are preferably made of corrosion-resistant and cavitation-resistant material, such as stellite. The engine 103 preferably rotates the shaft 102 with a speed from 2960 rpm to 3500 rpm.

Claims

1. A device for disintegrating liquid waste, comprising:

- a waste processing chamber (100) defined by a housing (101 A, 101 B) with a set of discs (103, 104, 105) rotatable with respect to each other and comprising correlated concentric protrusions (103A, 104A) and channels (103B, 104B) defining a shear gap (106) and configured to disintegrate liquid waste by cavitation during rotation,
- an inlet conduit (111) connected to an inlet port (110) for providing the liquid waste to an inlet chamber (108) at the central portion of the waste processing chamber (100),
- an outlet conduit (121) connected to an outer port (120) for collecting the disintegrated liquid waste from a collecting chamber (107) at the periphery of the waste processing chamber (100),

characterized in that

- the waste processing chamber (100) is liquid-tight and comprises liquid-tight sealing (131-134) and an air vent (141) mounted in the uppermost portion of the waste processing chamber (100),
 - and the inlet conduit (111) comprises switchable inlet valve means (112A, 113A) for providing to the inlet conduit (111) a liquid waste of a first density from a liquid waste input conduit (112) and a liquid of a second density lower than the first density from a supplementary conduit (113).
2. The device according to claim 1, wherein at least one of the discs (103) is mounted on a rotatable horizontal shaft (102).
 3. The device according to claim 2, wherein the shaft (102) is rotatable by an engine (109) with a speed from 2960 rpm to 3500 rpm.
 4. The device according to any of previous claims, further comprising a sensor (152-154) configured to monitor at least one process parameter of the device and a controller (151) configured to control the inlet valve means (112A, 113A) depending on the monitored process parameter.
 5. The device according to claim 4, wherein the sensor (153) is configured to monitor the temperature of the waste processing chamber (100).
 6. The device according to claim 4, wherein the sensor (152) is configured to monitor the temperature and/or load of an engine (109) driving a rotatable disc (103).
 7. The device according to claim 4, wherein the sensor (154) is configured to monitor the density of the liquid in the outlet conduit (120).
 8. The device according to any of previous claims, wherein the liquid-tight sealing (131) of the waste processing chamber (100) comprises carbon rings.
 9. The device according to any of previous claims, wherein the width of the shear gap is from 0,4 mm to 0,6 mm.
 10. A liquid waste processing installation, comprising:
 - a sedimentation tank (161),
 - the device for disintegrating liquid waste according to any of claims 1-9, wherein the liquid waste inlet conduit (112) is configured to collect liquid waste from the bottom portion of the sedimentation tank (161) and wherein the outlet conduit (120) is configured to output the disintegrated liquid waste to the upper portion of the

sedimentation tank (161).

11. The liquid waste processing installation according to claim 10, further comprising:
 - an anaerobic digestion chamber (162), to which the liquid waste from the sedimentation tank (161) is input, configured to produce biogas to be stored in a biogas tank (163),
 - a biogas sensor (164) configured to measure the amount of produced biogas,
 - wherein the controller (151) is further configured to control the working cycle of the device depending on the output of the biogas sensor (164).
12. A method for disintegrating liquid waste by the device according to any of claims 1-9, comprising the steps of:
 - detecting increase of clogging of the device,
 - switching the inlet valve means (112A, 113A) to provide to the inlet conduit (111) increased amount of liquid from the supplementary conduit (113),
 - detecting reduction of clogging of the device,
 - switching the inlet valve means (112A, 113A) to provide to the inlet conduit (111) increased amount of liquid waste from the liquid waste input conduit (112).
13. The method according to claim 12, comprising the step of, upon detecting increase of clogging of the device, switching the inlet valve means (112A, 113A) to provide to the inlet conduit (111) only liquid from the supplementary conduit (113).
14. The method according to claim 12 or 13, comprising the step of, upon detecting reduction of clogging of the device, switching the inlet valve means (112A, 113A) to provide to the inlet conduit (111) only liquid waste from the liquid waste input conduit (112).

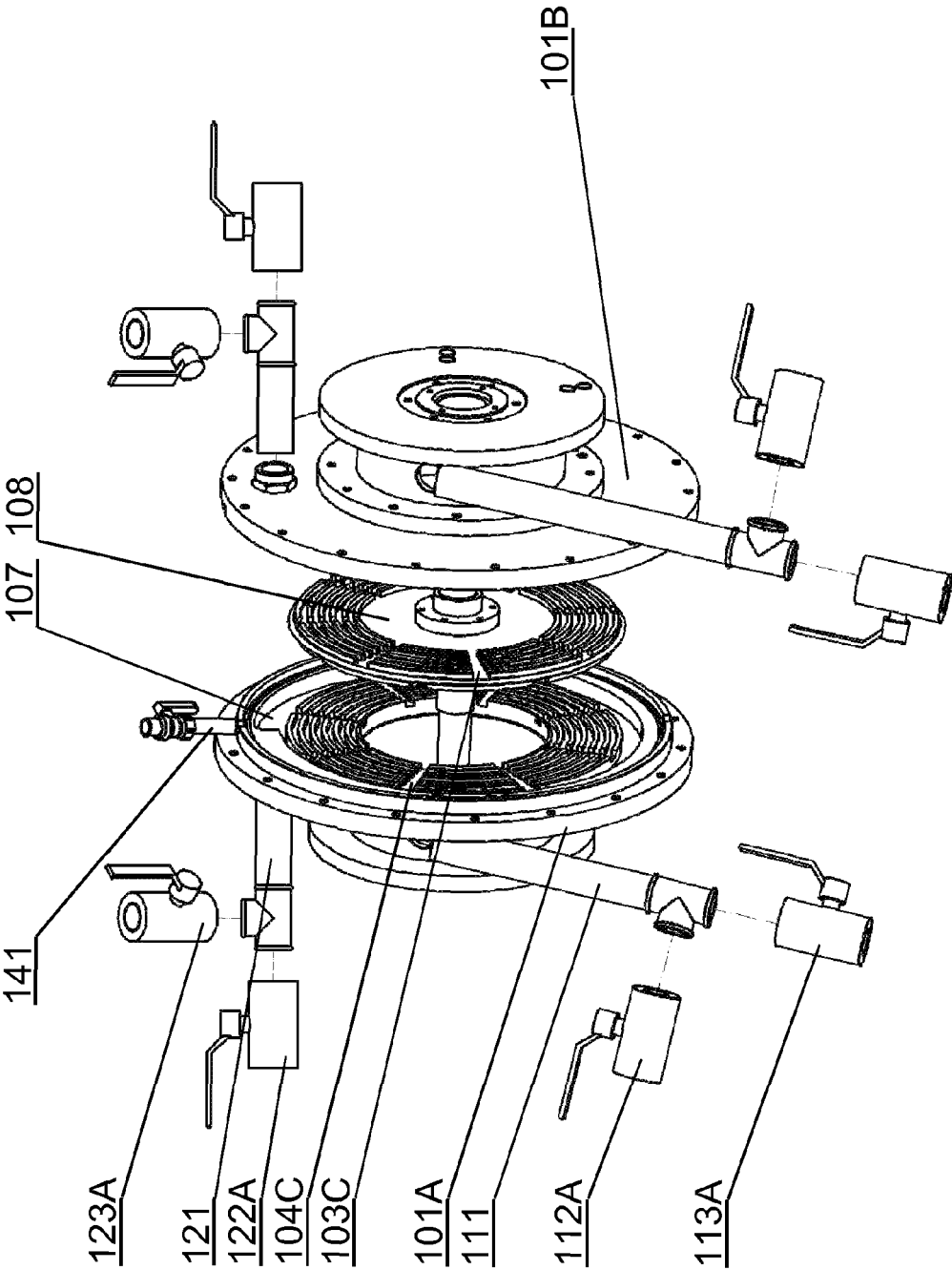


Fig. 1

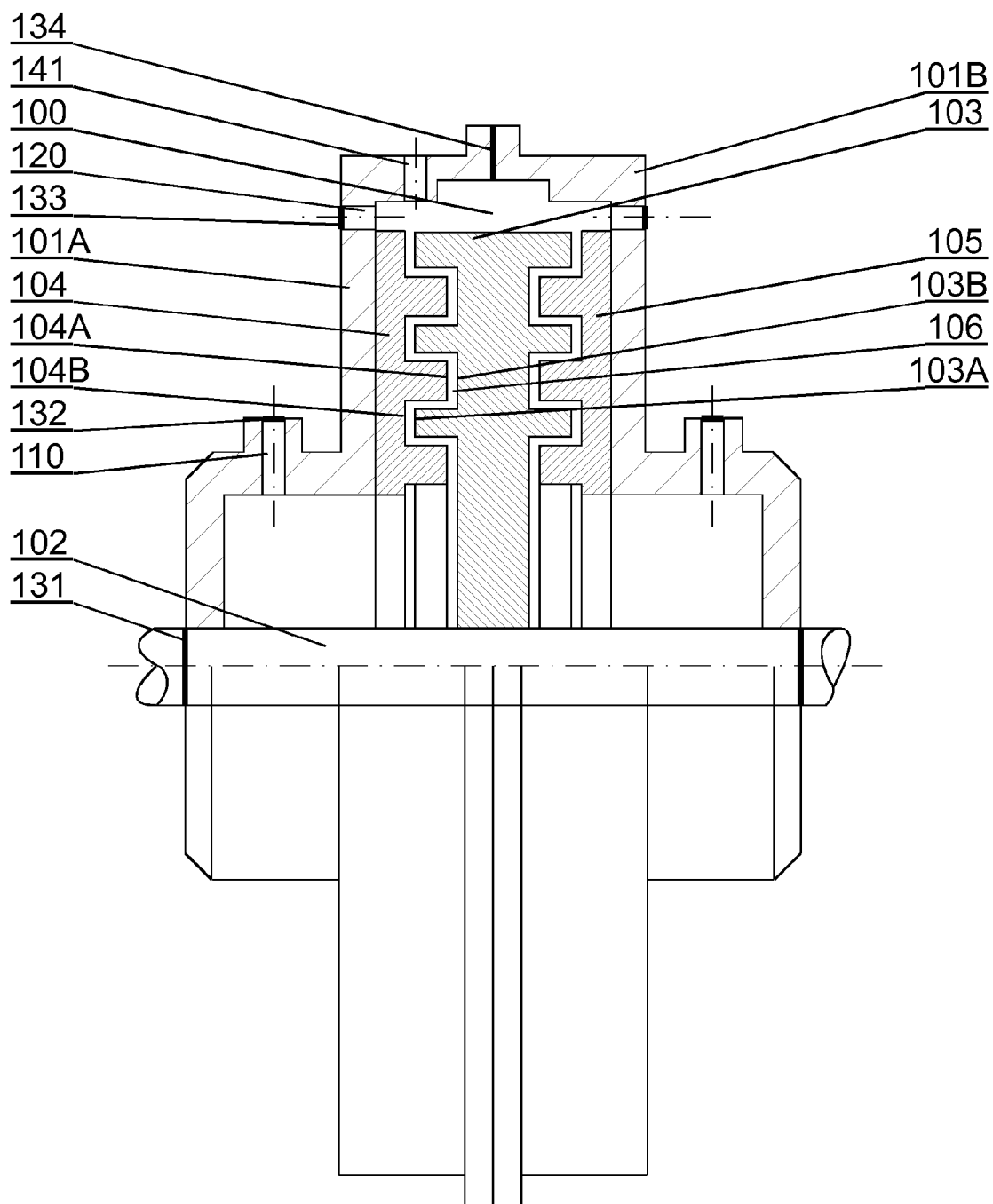


Fig. 2

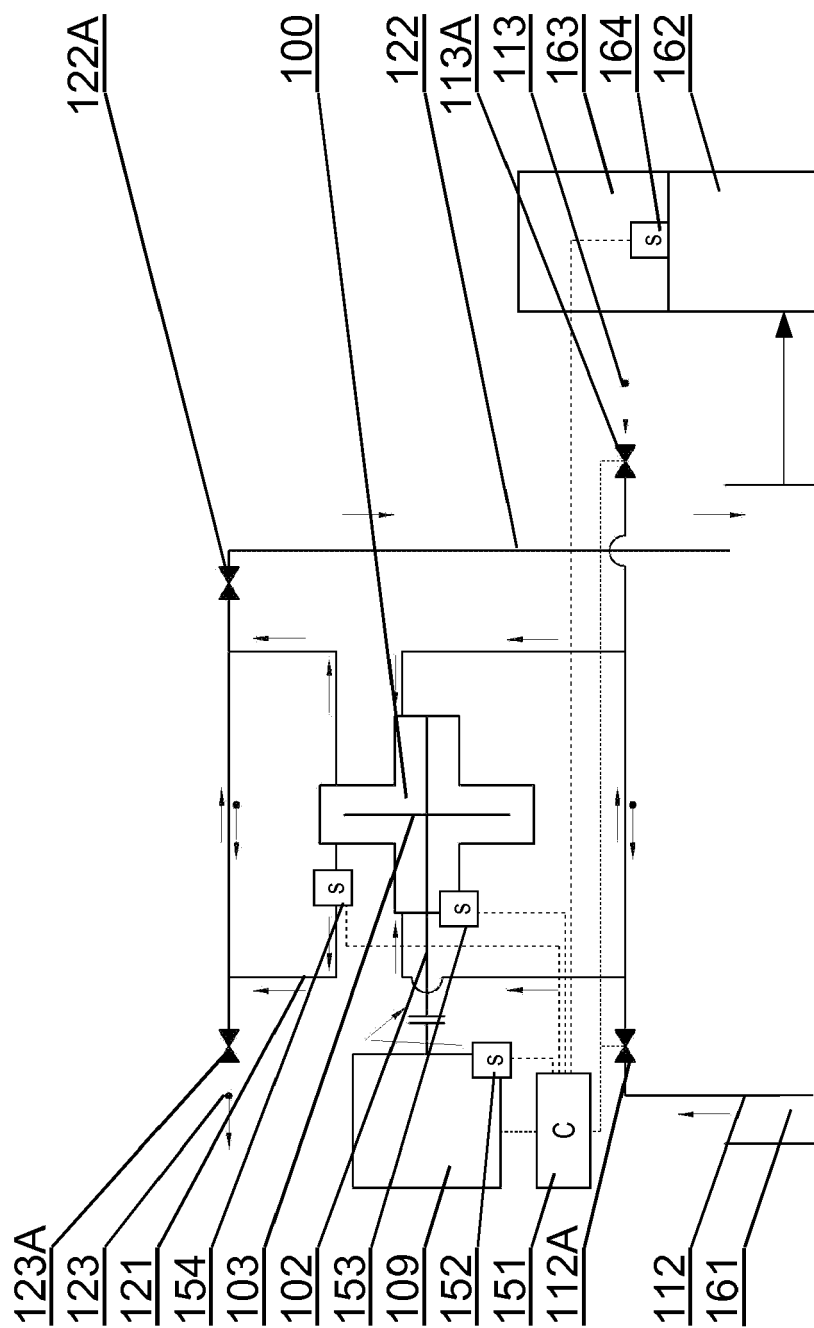


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 10 46 1535

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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