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(54) **Title:** WATER TREATMENT APPARATUS AND METHOD

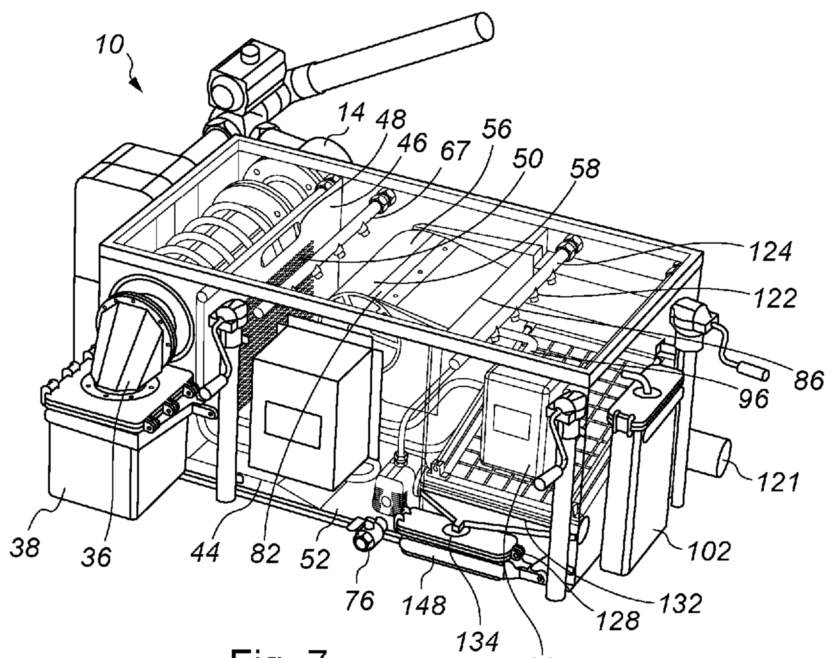

Fig. 7

(57) **Abstract:** The present disclosure relates to water purifiers, remediators and waste collection apparatus, especially those used in a food waste environment, such as water run-off from food preparation areas and facilities. The present disclosure Water treatment apparatus comprising a fluid inlet, a compressor provided within a compressor chamber, a skim chamber provided adjacent the compressor chamber, a skimmer provided within the skim chamber, one or more fluid conduits to enable fluid to pass from the compressor chamber to the skim chamber, and a micro-solids capture assembly. The compressor is an auger-type compressor.

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WATER TREATMENT APPARATUS & METHOD

Description

Field of the Invention

The present invention relates to water purifiers, remediators and waste collection apparatus, especially those used in a food waste environment, such as water run-off from food preparation areas and facilities.

Background to the Invention

Wastewater from food preparation will usually contain a mixture of primary or large solids, micro-solids and “FOGs” (Fats, Oils and Greases). If simply flushed into the sewage system, these elements may coagulate, or even solidify in pipes and cause blockages. Such blockages may cause tremendous damage and be expensive and time-consuming to clear.

Every year there are around 200,000 sewerage blockages in the UK alone, the vast majority (>75%) are caused by fats, oils and greases (FOGs) that enter the sewerage network largely from commercial kitchen effluent. These blockages are responsible for around 55% of all sewer flooding events.
Even if blockages to not occur in the local sewer network they will often cause major issues downstream at pumping stations and inlets to sewerage treatment works.

Where additional contaminants are also present in the effluent in the form of the primary solids (TSS), starch, flour and other binding micro-solids (for example) these problems are exacerbated.

Solidification of FOGs in the formation of blockages is dependent on a number of factors including:

- The presence and quantity of FOG's;
- The presence and quantity of primary and micro-solids;
- The temperature of effluent at discharge point;
- The quantity of detergent used (which only has a temporary effect);
- The outside temperature.

Blockage forming contaminants, FOG’s and micro-solids in particular, originate from numerous sources, however these can be generally categorised as domestic, commercial and industrial sources.

FOG blockage problems are intensified in areas where commercial food service premises dominate, however domestic sources do still contribute significantly, particularly during certain times of year when food forms a major part of festival celebrations.

Numerous studies have indicated that commercial properties are a major contributor to FOG and micro-solid deposits in sewers with an emphasis on pubs, hotels, restaurants, fast food establishments and stores. For example, estimates of annual FOG production of various types of businesses in Dublin are 624, 906 & 2353 for pubs, fast food outlets and hospitals, respectively.

Industrial FOG sources including abattoirs, rendering plants and industrial food manufacturing establishments do contribute to FOG release.

Commercial kitchen effluent in its raw state, contains all the necessary contaminants to pose significant risk of blockage formation. These include:

Primary solid contaminants such as:

- Meat and bone fragments – These solids exacerbate the formation of FOG / micro-solid deposits by physically clinging / wrapping around existing deposits inside the sewer network;
- Rice, pasta, and noodles – These starch rich solids swell when in contact with water which makes them almost impossible to break down no matter how much a sewer or piping system is flushed;
- Fruit and vegetable peeling – These solids are stringy and slimy and tend to wrap around exiting deposits;

FOG’s:

- Solidification of FOG’s is the primary cause of blockage formation;

Micro-solids:

- Such as starch and sugar, which become glue-like and greatly exacerbate the problem of FOG deposit formation. Micro-solids are also a primary cause of foul odours, drain fly and contribute heavily to Biological Oxygen Demand (BOD) and suspended solids loading (TSS);

The contaminants found in commercial kitchen waste, although pose numerous hazards when not adequately controlled, can also provide valuable resource. Almost any organic contaminant if effectively isolated and captured can be re-used. Some examples include:

- Land application for nutrient recovery – applies to primary solids, FOG’s and micro-solids and is possibly the cheapest disposal / re-use method. However, land spreading is closely regulated, and consideration must be given to possible nitrogen leaching. There is also evidence that spreading of FOG’s may coat soil particles impeding nutrient and water – root uptake;
- Composting – produces a valuable co-product and reduces potential for methane release that occurs with landfill. However, limited work has been done with respect to this application with FOG’s;
- Anaerobic digestion (AD) and biogas production – use captured contaminants as feedstock for biogas production, a renewable energy source. This application is particularly suited

to primary solids and micro-solids. FOG's can be successfully digested too, however care must be taken as high FOG loading can be inhibitory to methane production. An added benefit of AD is that the solid by-product (digestate) is highly nutrient rich and can itself be utilised as a fertilising agent to enhance crop growth with some post processing;

- Biodiesel production – biodiesel is produced from several sources including vegetable / plant oils produced from non-edible crops and animal fats. However, there has been growing concern recently regarding the sustainability of using arable crops for this purpose, largely centred around its effects on natural habitat, increasing competition with food crops and carbon footprint linked to the energy required for plant growth (ploughing, harvesting etc). Accordingly, alternatives have been sought. Biodiesel production from waste oils and fat has been found to be economically feasible (largely due to low cost acquisition), environmentally sound and carbon negative by numerous studies. It also provides savings in wastewater treatment and disposal costs.

One potential solution in the prevention or at least mitigation of FOG-related blockages is the installation of grease-traps.

Most grease traps are permanent in-floor and/or subsurface installations integrated with a buildings drainage system. Such types of construction are typically costly, difficult to service and require regular specialized collection services since each grease trap may only hold a finite amount.

Grease traps ideally require upstream strainer installation to prevent carry-over of primary solids in the effluent (i.e. bone fragments, peelings etc). These strainers require manual servicing / emptying on a regular basis which is messy and time consuming. Failure to do so will result in system blockage and potential flooding.

Moreover, grease traps suffer from numerous additional drawbacks:

- Inadequate upstream filtration will allow carry over of primary solids which can cause numerous problems including but not limited to downstream blockages and worsening foul odours;
- Grease traps, even with upstream strainers installed, do not remove micro-solids from the effluent. Strainers can easily get blocked with solidified FOG's;
- Grease-traps require routine manual emptying / servicing once FOG capture module is full. This is typically every 90 days;
- Because of the relatively long service interval and because micro-solids are not removed, grease traps often cause very unpleasant odours / olfactory problems in the region of installation;
- Emptying of grease traps is typically completed using specialised vacuum trucks. This specialised equipment adds significantly to FOG disposal costs and carbon footprint;
- Grease traps are far from 100% effective. Significant FOG

carry-through can occur during normal operation and 100% FOG carry through will occur if the grease trap FOG module is full;

Grease recovered from a grease trap will often contain significant amounts of water and biological detergents / sanitisers / surfactants / smell reduction agents.

These entrained water and chemicals can either:

- Limit re-use/ recycling options, or;
- Increase the cost of recycling/disposal;
- Grease traps are inherently manual in operation and do not target, isolate and effectively contain specific kitchen effluent contaminants that hold value as co-products in an optimal manner.

Summary of the Invention

According to a first aspect of the present invention there is provided water treatment apparatus comprising a fluid inlet, a compressor provided within a compressor chamber, a skim chamber provided adjacent the compressor chamber, a skimmer provided within the skim chamber, one or more fluid conduits to enable fluid to pass from the compressor chamber to the skim chamber, and a micro-solids capture assembly.

The apparatus may therefore comprise three discrete sections or modules: a primary solids removal section; a FOG removal section; and a micro-solids removal section.

Water passes into the apparatus and firstly into the primary solids removal section i.e. the compressor chamber.

Water passes into the apparatus via the fluid inlet where it is initially received and compressed by the compressor.

The compressor may be an auger-type compressor.

The compressor may have an auger screw, comprising a central shank surrounded by an auger flight.

The auger screw may be rotatable.

The auger screw may be driven by an electric motor.

The compressor chamber may comprise a static cylindrical filter screen.

The cylindrical filter screen may be a perforated filter screen.

The cylindrical filter screen may be a wire screen.

The cylindrical filter screen may be a wedge wire screen.

The auger shank may have a cross-sectional diameter and this cross-sectional diameter may be non-uniform along the length of the shank.

The diameter of the auger shank may be tapered and increase in diameter from a first diameter adjacent the fluid inlet to a second diameter at a distal end of the shank.

The auger flight may have a discontinuous section.

The discontinuous section may include one or more slots extending from adjacent the shank to the flight tip.

The discontinuous section may be provided adjacent the fluid inlet.

The discontinuous section may be provided around at least one auger scroll.

The discontinuous section may comprise up to four auger scrolls or around 25-30% of the auger flight.

The cylindrical filter screen may include a primary solids outlet at the opposite end to the fluid inlet.

There may be provided a primary solids collection bin adjacent to the primary solids outlet.

There may be provided a compression baffle and primary solids collection manifold between the primary solids outlet and the bin.

The primary solids bin may be provided with a collection bag.

The collection bag may be bio-degradable and / or digestible.

The collection bag may have a self-sealing valve.

A compressor heater may surround the compressor.

The compressor heater may comprise a piped radiator assembly.

The compressor heater may be fed by an exterior air source heat pump.

The compressor heater may be fed by other means. i.e. thermal fluid boiler.

The compressor heater may mitigate coagulation or solidification of entrained FOGs.

The discontinuous section may comprise three and a half auger scrolls.

Water may then pass from the primary solids removal section i.e. the compressor chamber to the skim chamber i.e. the FOG removal section.

A grating may be provided between the compressor chamber and the skim chamber.

The water may pass through the grating.

The grating may act as a filter.

The grating may act as a flow straightener.

The skim chamber may be provided with a lower sump portion.

The skim chamber may be provided with a skim chamber heater.

The skim chamber heater may be a piped radiator assembly.

The skim chamber heater may be fed by an exterior air source heat pump.

The air source heat pump may feed both the compressor housing heater and the skim chamber heater.

The compressor heater and the skim chamber heater may be fed by other means. i.e. thermal fluid boiler.

The skim chamber heater may share the exterior heat pump of the compressor heater.

The compressor heater may mitigate coagulation or solidification of entrained FOGs.

A skimmer mechanism may be provided within the skim chamber.

The skimmer mechanism may include a rotating drum.

The skimmer mechanism may include a drum scraper.

The rotating drum may be a sealed drum such that it has buoyancy when liquids are present in the skim chamber.

The drum / skimmer assembly may be mounted such that it can move vertically in response to changes in liquid level in the skim chamber, due to the resulting buoyancy force.
The skimmer mechanism may include a FOGs reservoir.

The skimmer mechanism may include a FOGs conduit.

The FOGs conduit may allow FOGs to be transported from the drum/drum scraper to the FOGs reservoir.

There may be provided a FOGs bin.

The FOGs bin may be connected to the FOGs reservoir by a second FOGS conduit.

The FOGs bin may be provided with a collection bag.

The collection bag may be biodegradable.

The collection bag may be digestible.

The collection bag may have a self-sealing valve.

The FOGs may be lifted from the upper surface of water/effluent pooling in the skim chamber and transported to the micro-solids capture assembly.

The micro-solids capture assembly may comprise a chamber or tank with one or more spray nozzles, and one or more screen filters traversing at least part of the chamber or tank, wherein water is projected from the one or more spray nozzles towards the one or more screen filters.

The screen filter may divide the chamber or tank into an upper header portion and a lower sump or fluid collection portion.

The screen filters may have a filter size suitable to remove the desired size of micro-solids.

The screen filter may be attached at an angle to the horizontal.

This angle may be between 15° and 30°.

The screen filter may have an upper or first edge and a lower or second edge.

The upper edge may be located adjacent the one or more nozzles.

A micro-solids capture bin may be located adjacent the lower edge.

The tank may be provided with an exit slot between the lower edge and the micro-solids capture bin.

A micro-solids collection chamber may be located between the slot and the screen(s).

There may be provided a plurality of micro-solids collection chambers.

The micro-solids collection chamber(s) may comprise a cylindrical or semi-cylindrical housing, a central axle, and one or more paddle bodies extending from the axle towards the cylindrical housing.

The paddle bodies may be perforated, and mesh covered to allow excess water to drain into the sump.

The paddle bodies may be constructed from wire mesh to allow excess water to drain into the sump.

The paddle bodies may be constructed from wedge wire to allow excess water to drain into the sump.

The central axle may be rotatable.

A stepper motor may provide rotation of the central axle.

There may be provided a micro-solids collection manifold between the exit slot and the bin.

The micro-solids bin may be provided with a collection bag.

The collection bag may be bio-degradable and / or digestible.

The collection bag may have a self-sealing valve.

According to a second aspect of the present invention there is provided a method of water treatment comprising the steps of:

- compressing the water to remove primary solids;
- skimming the water to remove entrained FOGs; and
- filtering the water to remove entrained micro-solids.

Optional features of the first aspect may apply to the second aspect *mutatis mutandis.*

Brief Description of the Drawings

Embodiments of the present invention will now be described, by way of example only, with reference to the following drawings, in which:

Fig. 1 is a schematic view of a first embodiment apparatus and method according to the present invention;

Fig. 2 is a perspective view of a first embodiment apparatus according to the present invention;

Fig. 3 is a partially transparent end elevation of the apparatus of Fig. 2;

Fig. 4 is a partially transparent side elevation of the apparatus of Fig. 2;

Fig. 5 is a partially transparent end elevation of the apparatus of Fig. 2;

Fig. 6 is a partially transparent plan view of the apparatus of Fig. 2;

Fig. 7 is a partially transparent perspective view of the apparatus of Fig. 2;

Fig. 8 is a further partially transparent perspective view of the apparatus of Fig. 2;

Fig. 9 is a partially transparent perspective detail view of the bagging assembly of the apparatus of Fig. 2;

Fig. 10 is a part-sectional plan detail view of an auger compressor of the apparatus of Fig. 2;

Fig. 11 is a further part-sectional plan detail view of the auger compressor of the apparatus of Fig. 2;

Fig. 12 is a partially transparent perspective detail view of a second and third module of the apparatus of Fig. 2;

Fig. 13 is a partially transparent plan detail view of a third module of the apparatus of Fig. 2;

Fig. 14 is a partially transparent end detail elevation of a third module of the apparatus of Fig. 2;

Fig. 15 is a partially transparent perspective detail view of a micro-solids removal module of the apparatus of Fig. 2;

Fig. 16 is a partially transparent side elevation of the apparatus of Fig. 2;

Fig. 17 is a partially transparent side elevation of a second embodiment apparatus according to the present invention; and

Fig. 18 is a further partially transparent side elevation of the second embodiment apparatus of Fig 17.

Referring to the drawings and initially to Fig. 1, a method of water purification and apparatus for same is depicted. The method commences with the step of receiving a quantity of water which may contain one or more contaminants which may include mixture of primary or large solids, micro-solids and “FOGs” (Fats, Oils and Greases). The primary or large solids may be, for example, vegetable peelings and so forth.

The apparatus, generally referred to as 10 in the drawings, includes a fluid inlet 12 which leads to a fluid compressor 14. The fluid compressor 14 comprises an auger screw 16 which is rotatable within a compressor body 18. The embodiment depicted is approximately 1000mm in length, 550mm in width and 700mm in height.

The fluid inlet 12 is fed by an inlet pipe 11. A flow control valve 13 is provided upstream of the inlet pipe 11, the flow control valve 13 being fed from a wastewater supply pipe 15. This wastewater supply pipe 15 may collect effluent from several sinks or other sources within a kitchen environment and direct it towards the apparatus 10. The flow control valve 13 is an electronically activated one, allowing to switch between directing effluent flow towards the apparatus, or through a bypass pipe 17. The bypass pipe 17 allows flow to be directed straight towards a drain or other bypass location should, for example, maintenance or cleaning of the apparatus be necessary. The inlet pipe 11, wastewater supply pipe 15 and bypass pipe 17 are all standard domestic grade pipe, which may either be plastic or metallic.

The compressor body 18 is formed from a wire screen material, in this particular embodiment, a TEFLON® coated cylindrical wound wedge wire screen 20 is used to form the compressor body 18. The wedge wire screen 20 has a slot width of around 250 to 500 microns in the present embodiment, but may be varied as required.

An auger drive unit 19 is provided on the exterior of the apparatus adjacent the fluid inlet 12. The auger drive unit 19 comprises an electric motor 19a attached to the auger screw 16. A back-pressure sensor 19b is also provided which actuates the motor 19a upon sensing a set level of back-pressure at the fluid inlet 12. The drive unit 19 is intended to provide a relatively slow, stepwise rotation of the auger screw 16 as effluent enters the apparatus 10. Of course, the actual speed will vary depending on the amount of the effluent entering the system and the back pressure at the fluid inlet 12 being monitored. The drive unit 19 provides a constant torque and drive with a typical speed of between 1 and 5 RPM.

A compressor chamber 22 is provided within the body 24 of the apparatus 10 to house the compressor 14. A heating coil 26 is provided within the compressor chamber 22 and which surrounds the compressor 14. The heating coil 26 maintains the compressor 14 at a temperature which lowers the viscosity of the effluent being treated and mitigates the FOGs from congealing/solidifying.

A heat pump unit 27 is provided which is attached to the exterior of the apparatus 10 which powers the heating coil 26. The heating coil 26 contains a suitable working fluid and maintains the temperature around the compressor 14 in the 40-50°C range, warm enough to enable the FOGs to remain substantially liquid and/or have a lower viscosity.

The auger screw 16 comprises a central stem 28 and an auger flight 30 surrounding the central stem 28. The central stem 28 has a taper, increasing in diameter along the length of the auger screw 16 (measured from the fluid inlet 12). This tapering increases the degree of compression of the fluid/effluent entrained within the compressor 14.

One or more slots 32 are provided on the auger flight 30. The slots 32 are placed at the initial section of auger flight 30 adjacent the fluid inlet 12. The slots 32 mitigate back pressure and improve initial transport across the auger flight 30 of bulk solids at the initial portion of the auger screw 16.

A primary solids outlet 34 and a compression baffle 36 are located at the distal end of the compressor 14 from the fluid inlet 12. A primary solids container 38 is provided adjacent and below the primary solids outlet 34 and compression baffle 36. A primary solids conduit 40 connects the baffle 36 to the container 38.

The primary solids conduit 40 channels the primary solids to the container 38. The container 38 and conduit 40 are formed from metal sheeting. One or more bags 42 are provided within the container 38 into which the primary solids are collected. The collection bags 42 have a bifurcated entry valve which self-seals once a sufficient quantity of primary solids have collected. The bags 42 are formed from a digestible, compostable and/or biodegradable material, such that they may be more easily or usefully disposed of (the primary solids representing a significant energy potential for biofuel, compost etc). This may be a suitable bioplastic, cellulose-based or algae-based material. The bags 42 are replaced once full and may be collected for disposal and being formed from a compostable / biodegradable and / or digestible material provide a convenient way of collection and replacement.

A bag change mechanism (not shown) is provided. The bag change mechanism monitors the level of FOGs within a bag 42 being fed from the outlet conduit 40. This may be by weight of the bag 42, opacity or some other known form of assessing the fill level. Once a set level has been reached the bag change mechanism may move the filled bag 42 away from the conduit 40 and move another bag 42 into place. The micro-solids bin 38 may provide a storage magazine of such bags 42 for periodic collection.

A spray bar assembly 37 is provided within the compressor chamber 22. This comprises a spar pipe 39 extending parallel to the auger 16. Water jets 41 are provided on the spar pipe 39. The spar pipe 39 is pressurised by a supply of water. This may be fresh mains water or purified water from the apparatus 10 output.

This process may be automated, such that once a bag 42 is filled, it may be replaced with an empty bag for further solids collection.

As effluent moves along the compressor 14, water, FOGs and a portion of the micro-solids are forced through the wire wedge screen 20 and collect in a lower portion of the compressor chamber 22.

A central tank 44 is located adjacent the compressor chamber 22 and occupies the central portion of the apparatus 10. A compressor sidewall 46 forms the boundary between the central tank 44 and the compressor chamber 22. The lower portion of the compressor chamber 22 is higher than the lower portion of the central tank 44.

The compressor sidewall 46 includes an overflow slot 48 adjacent its uppermost edge. A perforated flow straightener section 50 occupies the central and lower portions of the compressor sidewall 46. The perforated flow straightener section 50 accounts for around 50-70% of the total area of the compressor sidewall 46 and comprises a plurality of horizontal slots or perforations of approximately 10mm width / diameter

Effluent pooling in the compressor chamber 22 passes through the perforated flow straightener section 50 with any entrained solids larger than the perforation size being filtered and retained within the compressor chamber 22. A compressor chamber drain 22a is provided for these to be removed once a certain level has been reached.

A pressed sump section 52 is provided on the floor of the central tank 44 accounting for around 25% of the floor area and being located distally from the perforated section 54. The pressed sump section 52 has two sloped sections and a central flat portion and is located adjacent a distal corner 44a of the central tank 44.

The pressed sump section 52 comprises a sloped transition section 53 adjoining to the remainder of the central tank floor plate 55 and a lower most sump section 57. This may encourage settlement of micro-solids within the lower most sump section 57.

The perforated flow straightener section 50 reduces the turbulence in the effluent flow and assists the FOGs in floating to the surface of the effluent pooling within the central tank 44, whilst the micro-solids sink to the base of the central tank 44 and towards the pressed sump section 52.

An effluent heating coil 54 is provided within the central tank 44. The effluent heating coil 54 is in the same heating circuit as the heating coil 26 and is powered by the heat pump unit 27. The effluent heating coil 54 also maintains the temperature within the central tank 44 in the 40-50°C range, warm enough to enable the FOGs to remain substantially liquid, and thereby tend to collect upon the upper volume of the entrained effluent.

A skimmer mechanism 56 is provided within the central tank 44. A drum type skimmer mechanism 56 is provided in the presently described embodiment. This comprises a cylindrical drum 58 mounted upon a rotating axle 60. The outer surface 62 of the cylindrical drum 58 is rotatable and generally clockwise from the perspective of Fig. 16. This is generally the outer surface 62 rotating such that the upstream portion is surfacing to drag FOGs from the upper layer of the pooling effluent.

A skimmer mechanism drive mechanism 64 is provided to urge the skimmer mechanism 56 to draw FOGs from the effluent surface by rotating. A FOGs level sensor 66 may be provided to measure the surface of the effluent and sense where an optimum skimmable level of FOGs is present and provide a control signal to activate the skimmer mechanism 56.

The outer surface 62 of the skimmer mechanism 56 may be provided with an adherent surface to improve the adhesion of the FOGs to the skimmer mechanism 56. This may be a coating, a roughening or knurling of the surface, or a combination of such features.

The central tank 44 functions as a skim chamber, within which the effluent filtered of its primary solids and certain larger micro-solids retained within the compression chamber 22 is skimmed by the skimmer mechanism to remove floating FOGs.

A spray bar assembly 67 is provided within the central tank 44. This comprises a spar pipe 68 extending parallel to the central rotating axle 60 of the skimmer mechanism 56. Water jets 70 are provided on the spar pipe 68. The spar pipe 68 is pressurised by a supply of water. This may be fresh mains water or purified water from the apparatus 10 output.

There are filter jets 72 and drum jets 74. The filter jets 72 are orientated such that their nozzles 72a are directed towards the flow straightener/filter grating 50. The drum jets 74 are orientated such that their nozzles 74a are orientated towards the skimmer mechanism 56. The filter jets 72 and drum jets 74 are spade jets in the present embodiment, although it will be understood by the skilled addressee that alternative jets are usable in alternative embodiments.

The water jets 70 act as cleaning jets 70 and may be activated in a cleaning cycle or during operation to wash the surfaces of the grating and/or skimmer to enable more optimal performance or to clean the apparatus 10.

A central tank drain 76 is provided adjacent the pressed sump section 52. The central tank drain 76 is a simple valved pipe outlet with a threaded section to enable connections of a hose or similar to assist in the draining process.

A drum scraper 78 is located adjacent the drum 58. The drum scraper 78 is located distally from the point on the drum 58 where it emerges from the effluent, being approximately 120 to 180° from that point (depending on effluent level). The drum scraper 78 comprises a mounting plate 80 which is joined to and projects from the sidewall of the central tank 44 (the sidewall located distally from the compressor chamber 22) and a resilient blade 82. The resilient blade 82 is formed from a rubber material. The drum scraper 78 projects towards the drum 58 at an angle to the horizontal of approximately 5 to 10°. A blade bracket 84 allows attachment of the blade 82 to the mounting plate 80.

The mounting plate 80 has a raised border 86 around the three sides not having the blade 82. The raised border 86 progressively increases in height from the blade bracket 84 along the sides perpendicular to the blade 82, with the border 86 being uniform along the distal sidewall.
FOGs are scraped from the surface of the drum 58 by the blade 82 and then flow down the mounting plate 80 with the raised border 86 entraining the FOGs and preventing them falling back into the effluent pool.

A FOGs aperture 88 is provided on the raised border 86, on the section of raised border 86 on the distal sidewall. A FOGs collection pipe 90 attaches to the FOG aperture 88 and collects FOGs as they collect at the base of the mounting plate 80. The FOGs collection pipe 90, aperture 88 and the mounting plate 80 may act as a FOGs conduit, allowing transport of the FOGs away from the drum 58

A FOGs reservoir 92 is provided at the exit of the FOGs collection pipe 90. The FOGs reservoir 92 is a casing 94 with an internal chamber 96 provided on the interior of the apparatus (although it may also be mounted outside the apparatus casing).

A FOGs reservoir inlet aperture 98 is provided to allow the FOGs collection pipe 90 to flow into the internal chamber 96. This is provided on the upper portion of the FOGs reservoir.

The internal chamber 96 is sealed such that the odour of the FOGs is largely retained within the chamber 96.

FOGs skimmed from the effluent pool within the FOGs reservoir 92. A FOGs outlet conduit 100 is provided adjacent the base of the FOGs reservoir 92 which allows FOGs to be removed from the reservoir 92. Being at the base of the reservoir and unheated, the FOGs may have congealed or solidified into a more viscous state.

A FOGs bin 102 is provided on the exterior of the apparatus 10 adjacent the distal corner from the fluid inlet 12. The FOGs bin may be a simple reservoir for FOGs which may be periodically removed and emptied.

One or more FOGs collection bags 104 are provided within the FOGs bin 102 in the present embodiment. The FOGs collection bags 104 have a bifurcated entry valve which self-seals once a sufficient quantity of FOGs have collected. The bags 104 are formed from a digestible, compostable and/or biodegradable material, such that they may be more easily or usefully disposed of (the FOGs representing a significant energy potential for biofuel, animal feed etc). This may be a suitable bioplastic, cellulose-based or algae-based material.

A bag change mechanism (not shown) is provided. The bag change mechanism monitors the level of FOGs within a bag 104 being fed from the outlet conduit 100. This may be by weight of the bag 104, opacity or some other known form of assessing the fill level. Once a set level has been reached the bag change mechanism may move the filled bag 104 away from the conduit 100 and move an bag 104 into place. The FOGs bin 102 may provide a storage magazine of such bags 104 for periodic collection.

A foot collection valve 106 and skim chamber outlet conduit 108 are provided within the base of the skim chamber 44. The foot collection valve 106 is located on the opposite distal corner from the sump 52, thereby being located away from both the sump 52 itself and the grating 50. This helps mitigate unintentional collection of larger micro-solids collecting in the sump 52 and FOGs. A skim effluent pump 110 pumps the effluent from the skim chamber 44 along the conduit 108.

A micro-solids capture assembly 112 is fed by the skim chamber outlet conduit 108. A capture assembly housing 114 is provided adjacent the skim chamber 48. The FOGs reservoir 96 is located within the capture assembly housing 114. The FOGs bin 102 is mounted on the exterior of the capture assembly housing 114.

The micro-solids capture assembly 112 comprises a capture water inlet 116 fed from the skim chamber outlet conduit 108. An elongate spray bar nozzle 118 is fed from the water inlet 116 which spreads out the water/effluent into a broad spray of water. The elongate spray bar nozzle 118 comprises a lip of pressed steel with suitable apertures formed in the lowermost portion.

The elongate spray bar nozzle 118 is located towards the upper portion or header of the capture assembly housing 114.

A screen filter 120 is located within the capture assembly housing 114. The screen filter 120 is affixed across the centre of the capture assembly housing 114. The screen filter 120 is a planar screen of filter media and is affixed at an angle within the capture assembly housing 114. The screen filter 120 is affixed with its centre approximately coincident with a centre point of the capture assembly housing 114. The screen filter 120 is attached with a first edge 120a being adjoined adjacent but underneath the elongate spray bar nozzle 118. Water from the spray bar nozzle 118 is directed towards the screen filter 120. A second edge 120b is located at a lower point on the distal inner side of the capture assembly housing 114 from the spray bar nozzle 118 side. The second edge 120b is joined at a lower point, adjacent the base of the capture assembly housing 114. Thus, the screen filter 120 is sloped from its uppermost point adjacent the spray bar nozzle 118 / the fluid inlet 116, to its lower most point distally from the spray bar nozzle 118. The angle of the slope is between 15 and 30° to the horizontal.

The screen filter 120 is a 500 micron screen size in the present embodiment, although this size may be varied. Micro-solids within the water will collect on the upper surface 120c of the screen filter 120.

Spray jets 122 are mounted around the interior of the capture assembly housing 114, located above the screen filter 120. These may be fed by fresh water from the water mains or may be fed by water which is outputted from the apparatus 10 itself. The spray jets 122 are spade jets 122 and direct towards the upper surface 120c of the screen filter 120 and may be used to wash micro-solids towards the second edge 120b. A jet feed pipe or pipes 124 are provided to feed the spray jets 122 with fluid. The spray jets 122 may be fed continuously whilst the apparatus is functioning or may be activated upon detection of a suitable control signal from a suitable sensor.

Water is allowed to pass through the filter screen 120 and pools within the lower portion of the capture assembly housing 114 which acts as a collection tank 114 for this treated water. This water is sufficiently free from FOGs, primary solids and micro-solids to be safely disposed of in the main sewage system or may be recycled for local usage.

A discharge pipe 121 is attached to a lower corner of the capture assembly housing/tank 114 which allows the collected and treated water to exit the apparatus 10. The bypass pipe 17 is connected to the assembly housing/tank 114. A bypass non-return valve 123 is connected between the bypass pipe 17 and the assembly housing/tank 114. In the event of an emergency bypass, effluent may flow directly into the assembly housing/tank 114 and through the discharge pipe 121. The discharge pipe 121 may be connected to the drain or recycled locally.

A micro-solids exit slot 126 is in the sidewall of the capture assembly housing 114. A micro-solids collection manifold 128 is provided on the exterior of the capture assembly housing 114, adjacent and beneath the micro-solids exit slot 126.

The micro-solids collection manifold 128 is provided with a tapered body 130 with the longest edge 132 joined to the capture assembly housing 114. An outlet nozzle 134 is located distally from the tapered body 130.

A micro-solids paddle collector 136 is located between the lower most edge 120b of the screen filter 120 and the micro-solids exit slot 126. The micro-solids paddle collector 136 comprises four paddle bodies 138 projecting from a central axle 140 and located within a tight-fitting cylindrical housing 142. The four paddle bodies 138 and/or the cylindrical housing 142 may be perforated or grated such that water may pass through their surface, whereas micro-solids cannot. Four separate micro-solids collection chambers 144 are therefore defined by the four paddle bodies 138 and the cylindrical housing 142.

Micro-solids collect within the first micro-solids collection chamber 144a presented adjacent the lower most edge 120b of the screen filter 120 as they are washed down the screen filter 120. A stepper motor 146 rotates the central axle 140, moving a second micro-solids collection chamber 144b into engagement with the lower most edge 120b of the screen filter 120 once the first collection chamber 144a is filled. This may be measured by weight or by the torque being applied to the stepper motor 146 by the presence of the micro-solids within the first chamber 144a. The first chamber 144a moves beneath the plane of the filter screen 120 and is strained of water against the housing 142.

A third micro-solids collection chamber 144c is rotated into engagement with the lower most edge 120b of the screen filter 120 once the second collection chamber 144b is filled by the stepper motor 146. The second chamber 144b moves beneath the plane of the filter screen 120 and is strained of water against the housing 142. The third chamber 144b moves towards the exit slot 126 and remains beneath the plane of the filter screen 120 and is strained of water against the housing 142. Water strained is allowed to flow into the base of the housing tank 114.

Lastly, as a fourth chamber 144d moves into position, the first chamber 144a is brought above the plane of the filter screen 120 and into engagement with the exit slot 126 allowing micro-solids to exit into the manifold 128.

A micro-solids collection bin 148 is fed from the micro-solids collection manifold 128. A compostable/biodegradable/digestible bag 150 is provided within the bin 148 into which the micro-solids are collected. The bags 150 are replaced once full and may be collected for disposal and being formed from a compostable/biodegradable/digestible material provide a convenient way of collection and replacement. The collection bags 150 have a bifurcated entry valve which self-seals once a sufficient quantity of micro-solids have collected. The bags 150 are formed from a digestible, compostable and/or biodegradable material, such that they may be more easily or usefully disposed of (the micro-solids representing a significant energy potential for biogas etc). This may be a suitable bioplastic, cellulose-based or algae-based material.

This process may be automated, such that once a bag 150 is filled, it may be replaced with an empty bag for further solids collection.

As an alternative, the rotating drum may be a sealed drum such that it has buoyancy when liquids are present in the skim chamber. The drum / drum scraper / mounting plate assembly may be mounted to the side wall, such that it can move vertically in response to changes in liquid level in the central tank, due to the resulting buoyancy force (not shown). The vertical movement of the drum / skimmer assembly facilitates maximum FOG skimming cycle times by maintaining liquid – drum contact during changes of liquid level.

Figs 17 and 18 depict a second embodiment apparatus generally referred to as 210. Common or analogous features are identified with a similar numbering scheme as to the first embodiment except with a prefixing “2” for integer numbers less than 100 (such as the compressor chamber 222 and central tank 244) and with a prefixing “3” for integer numbers greater than 100 (such as the capture assembly housing 314 and the screen filter 320).

In the second embodiment 210, a buoyant sealed drum 258 is used in the drum type skimmer mechanism 256. The skimmer mechanism 256 is mounted upon a slidable bracket assembly 283. This allows the assembly to move vertically within the central tank 244 depending on the level of effluent within the central tank 244. The slidable bracket assembly 283 comprises two drum mounting brackets 285 which mount the buoyant sealed drum 258 by its central axle 260. L-shaped wall mounting brackets 287 are provided on the sidewall of the central tank 244 which constrain the lateral movement of the drum mounting brackets 285 but permit limited vertical movement. A lower abutment 289 constrains the lowermost travel of the drum mounting brackets 285.

The drum scraper 278 comprising the mounting plate 280 and resilient blade 282 are pivotally mounted onto the sidewall of the central tank 244 via a pivot mounting 291. This allows the mounting plate 280 and resilient blade 282 to pivot in response to the movement of the skimmer mechanism 256 without requiring significant modification to the FOGs capture mechanism comprising the FOGs collection pipe 290 etc.

Fig. 17 shows the skimmer mechanism 256 located at a lower level within the central tank 244, and this may be as the central tank 244 is beginning to fill with effluent.

Fig. 18 shows the skimmer mechanism 256 located at a higher level within the central tank 244, and broadly analogous to the height of the fixed skimmer mechanism 56 in the central tank 44 of the first embodiment.

By providing the slidable bracket assembly 283 and the sealed buoyant drum 258, the skimmer mechanism 256 is able to function and skim FOGs with less effluent in the central tank 244. Modifications and improvements may be made to the described embodiments without departing from the scope of the present invention.

For example, multiple screen filters may be arranged within the tank 114 and may be layered to provide progressive filtering of micro-solids. The screen or screens may have a non-uniform grating size measured from first edge to second edge.

Claims

1. Water treatment apparatus comprising a fluid inlet, a compressor provided within a compressor chamber, a skim chamber provided adjacent the compressor chamber, a skimmer provided within the skim chamber, one or more fluid conduits to enable fluid to pass from the compressor chamber to the skim chamber, and a micro-solids capture assembly.

2. Water treatment apparatus according to claim 1 wherein the compressor is an auger-type compressor.

3. Water treatment apparatus according to any preceding claim wherein the compressor has an auger screw, comprising a central shank surrounded by an auger flight.

4. Water treatment apparatus according to any preceding claim wherein the compressor chamber comprises a static cylindrical filter screen.

5. Water treatment apparatus according to claim 4 wherein the cylindrical filter screen is a perforated filter screen.

6. Water treatment apparatus according to claim 4 wherein cylindrical filter screen is a wire screen.

7. Water treatment apparatus according to claim 4 or 6 wherein the cylindrical filter screen is a wedge wire screen.

8. Water treatment apparatus according to claim 3 or any of claims 4 to 7 when dependent on claim 3 wherein the auger shank has a cross-sectional diameter and this cross-sectional diameter is non-uniform along the length of the shank.

9. Water treatment apparatus according to claim 3 or any of claims 4 to 8 when dependent on claim 3 wherein the diameter of the auger shank is tapered and increases in diameter from a first diameter adjacent the fluid inlet to a second diameter at a distal end of the shank.

10. Water treatment apparatus according to claim 3 or any of claims 4 to 9 when dependent on claim 3 wherein the auger flight has a discontinuous section.

11. Water treatment apparatus according to claim 10 wherein the discontinuous section includes one or more slots extending from adjacent the shank to a flight tip of the auger flight.

12. Water treatment apparatus according to claim 10 or 11 wherein the discontinuous section is provided adjacent the fluid inlet.

13. Water treatment apparatus according to claims 10, 11 or 12 wherein the discontinuous section is provided around at least one auger scroll.

14. Water treatment apparatus according to any of claims 10 to 13

wherein the discontinuous section comprises up to four auger scrolls.

15. Water treatment apparatus according to any of claims 10 to 14 wherein the discontinuous section comprises around 25-30% of the auger flight.

16. Water treatment apparatus according to claim 4 or any of claims 5 to 15 when dependent on claim 4 wherein the cylindrical filter screen includes a primary solids outlet at the opposite end to the fluid inlet.

17. Water treatment apparatus according to claim 16 further including a primary solids collection bin adjacent to the primary solids outlet.

18. Water treatment apparatus according to claim 17 further including a compression baffle and primary solids collection manifold between the primary solids outlet and the primary solids collection bin.

19. Water treatment apparatus according to claim 18 wherein the primary solids collection bin is provided with a collection bag.

20. Water treatment apparatus according to claim 19 wherein the collection bag is bio-degradable and / or digestible.

21. Water treatment apparatus according to claims 19 or 20

wherein the collection bag has a self-sealing valve.

22. Water treatment apparatus according to any preceding claim further including compressor heater surrounding the compressor.

23. Water treatment apparatus according to claim 22 wherein the compressor heater comprises a piped radiator assembly.

24. Water treatment apparatus according to claims 22 or 23 wherein the compressor heater is fed by an exterior air source heat pump.

25. Water treatment apparatus according to any preceding claim further including a grating provided between the compressor chamber and the skim chamber.

26. Water treatment apparatus according to any preceding claim wherein the skim chamber is provided with a lower sump portion.

27. Water treatment apparatus according to any preceding claim wherein the skim chamber is provided with a skim chamber heater.

28. Water treatment apparatus according to claim 27 wherein the skim chamber heater is a piped radiator assembly.

29. Water treatment apparatus according to claims 27 or 28 wherein the skim chamber heater is fed by an exterior air source heat pump.

30. Water treatment apparatus according to any of claims 27 to 29 when dependent on claim 22 wherein the air source heat pump feeds both the compressor housing heater and the skim chamber heater.

31. Water treatment apparatus according to any preceding claim wherein a skimmer mechanism is provided within the skim chamber.

32. Water treatment apparatus according to claim 31 wherein the skimmer mechanism includes a rotating drum.

33. Water treatment apparatus according to claim 31 or 32 wherein the skimmer mechanism includes a drum scraper.

34. Water treatment apparatus according to claim 32 or 33 when dependent on claim 32 wherein the rotating drum is a sealed drum such that it has buoyancy when liquids are present in the skim chamber.

35. Water treatment apparatus according to claim 31 or any preceding claim dependent on claim 31 wherein the skimmer assembly is mounted such that it can move vertically in response to changes in liquid level in the skim chamber, due to the resulting buoyancy force.

36. Water treatment apparatus according to claim 31 or any preceding claim dependent on claim 31 wherein the skimmer

mechanism includes a FOGs reservoir.

37. Water treatment apparatus according to claim 31 or any preceding claim dependent on claim 31 wherein the skimmer mechanism includes a FOGs conduit.

38. Water treatment apparatus according to any preceding claim further including a FOGs bin.

39. Water treatment apparatus according to claim 36 or any preceding claim dependent on claim 36 wherein the FOGs bin may be connected to the FOGs reservoir by a second FOGS conduit.

40. Water treatment apparatus according to claim 38 or any preceding claim dependent on claim 38 wherein the FOGs bin is provided with a collection bag.

41. Water treatment apparatus according to claim 40 wherein the collection bag is biodegradable.

42. Water treatment apparatus according to claim 40 or 41 wherein the collection bag is digestible.

43. Water treatment apparatus according to claim 40, 41 or 42 wherein the collection bag has a self-sealing valve.

44. Water treatment apparatus according to any preceding claim wherein the micro-solids capture assembly comprises a tank with

one or more spray nozzles, and one or more screen filters traversing at least part of the tank, wherein water is projected from the one or more spray nozzles towards the one or more screen filters.

45. Water treatment apparatus according to claim 44 wherein the screen filter divides the chamber or tank into an upper header portion and a lower sump or fluid collection portion.

46. Water treatment apparatus according to claims 44 or 45 wherein the one or more screen filters have a filter size suitable to remove the desired size of micro-solids.

47. Water treatment apparatus according to any of claims 44 to 46 wherein the one or more screen filters is/are attached at an angle to the horizontal.

48. Water treatment apparatus according to claim 47 wherein the angle is between 15° and 30°.

49. Water treatment apparatus according to any of claims 44 to 48 wherein the one or more screen filters have an upper or first edge and a lower or second edge.

50. Water treatment apparatus according to claim 49 wherein the upper edge is located adjacent the one or more nozzles.

51. Water treatment apparatus according to claims 49 or 50 wherein a micro-solids capture bin is located adjacent the lower

edge.

52. Water treatment apparatus according to claim 51 wherein the tank is provided with an exit slot between the lower edge and the micro-solids capture bin.

53. Water treatment apparatus according to claim 52 wherein a micro-solids collection chamber is located between the slot and the screen(s).

54. Water treatment apparatus according to claim 53 wherein there are provided a plurality of micro-solids collection chambers.

55. Water treatment apparatus according to claims 53 or 54 wherein the micro-solids collection chamber(s) comprise a cylindrical or semi-cylindrical housing, a central axle, and one or more paddle bodies extending from the axle towards the cylindrical housing.

56. Water treatment apparatus according to claim 55 wherein the one or more paddle bodies are perforated.

57. Water treatment apparatus according to claims 55 or 56 wherein the one or more paddle bodies are constructed from wire mesh.

58. Water treatment apparatus according to any of claims 55 to 57 wherein the paddle bodies are constructed from wedge wire.

59. Water treatment apparatus according to any of claims 55 to 58 wherein the central axle is rotatable.

60. Water treatment apparatus according to any of claims 55 to 59 wherein a stepper motor is provided for rotation of the central axle.

61. Water treatment apparatus according to any of claims 52 to 60 wherein a micro-solids collection manifold is provided between the exit slot and the bin.

62. Water treatment apparatus according to any of claims 51 to 61 wherein micro-solids bin may be provided with a collection bag.

63. Water treatment apparatus according to claim 62 wherein the collection is bio-degradable and / or digestible.

64. Water treatment apparatus according to claim 62 or 63 wherein the collection bag has a self-sealing valve.

65. A method of water treatment comprising the steps of:

- compressing the water to remove primary solids;
- skimming the water to remove entrained FOGs; and
- filtering the water to remove entrained micro-solids.

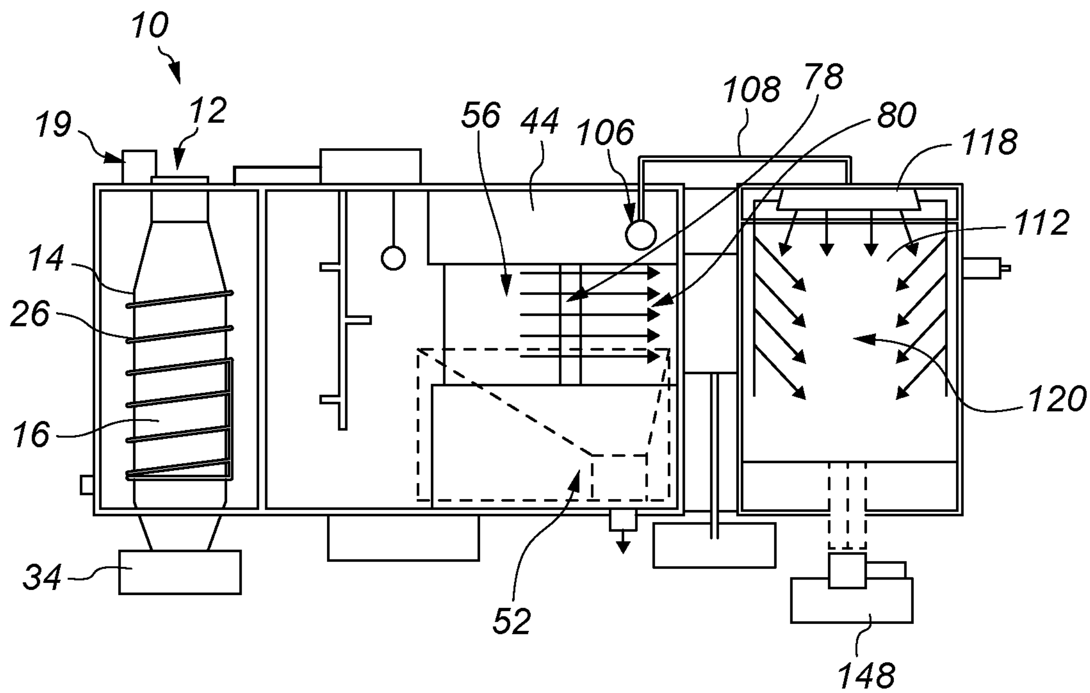
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Fig. 1

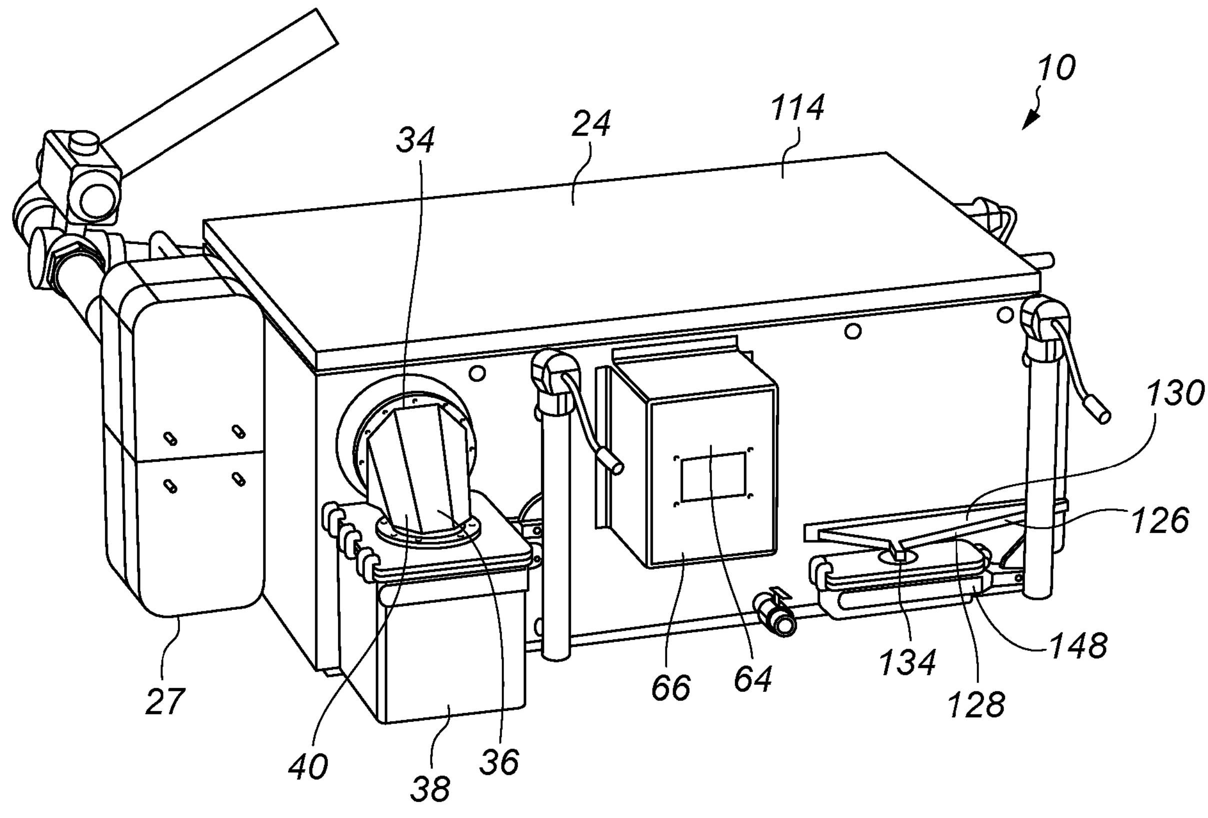
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Fig. 2

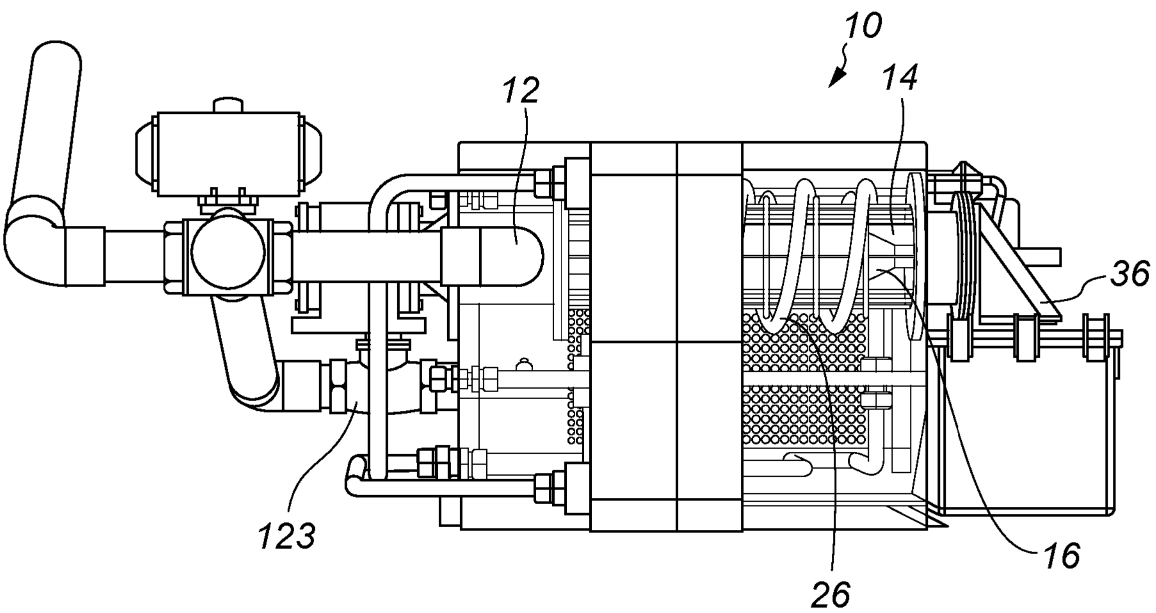
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Fig. 3

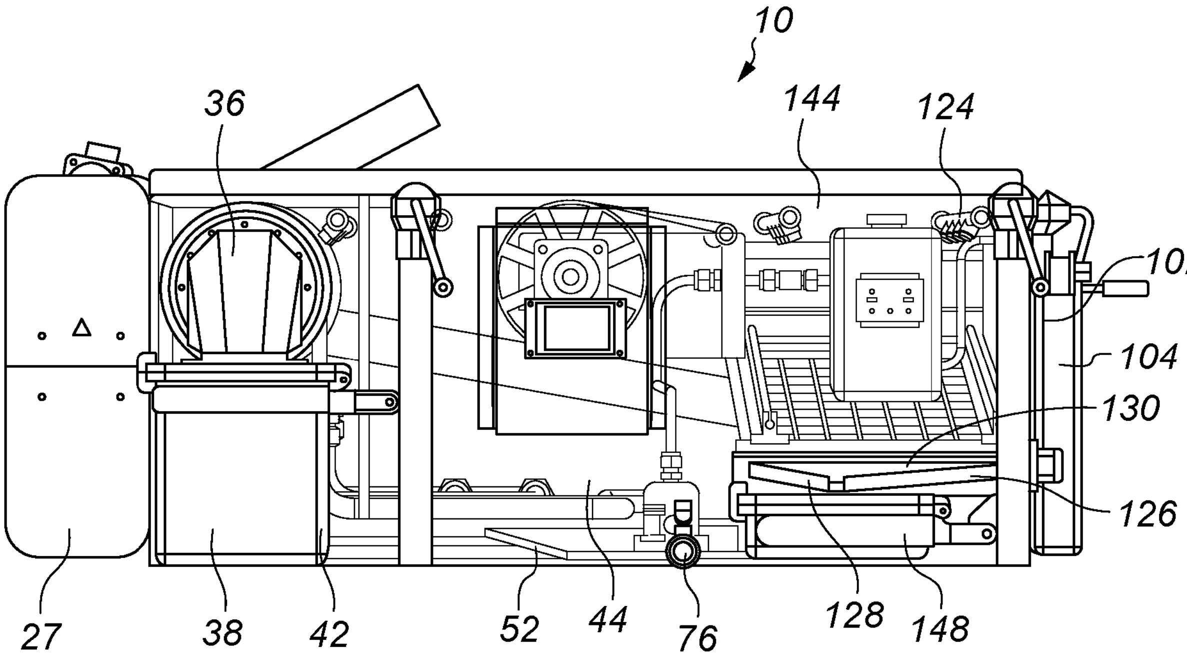
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Fig. 4

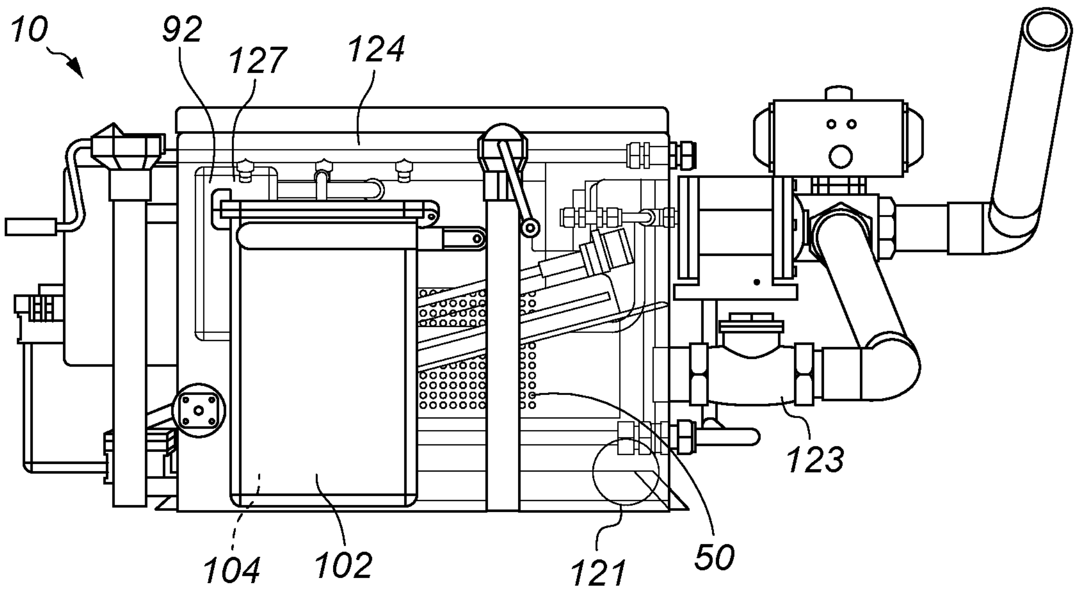
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Fig. 5

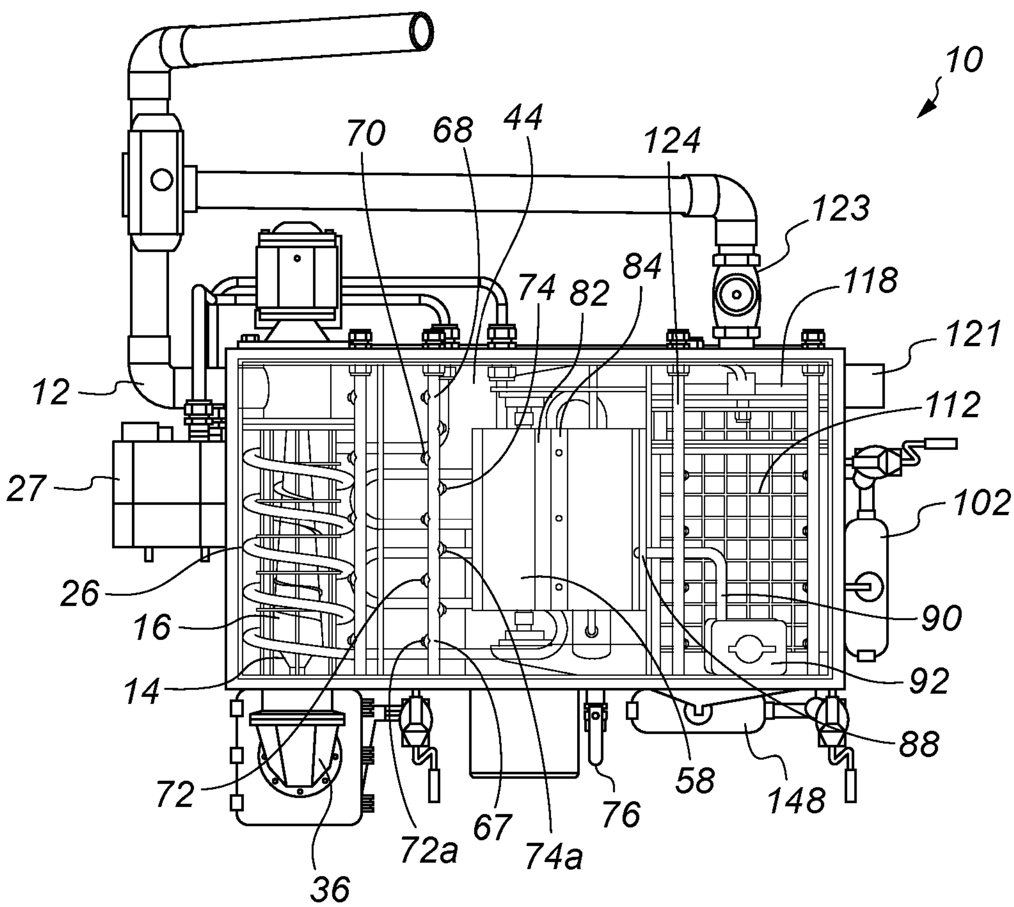
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Fig. 6

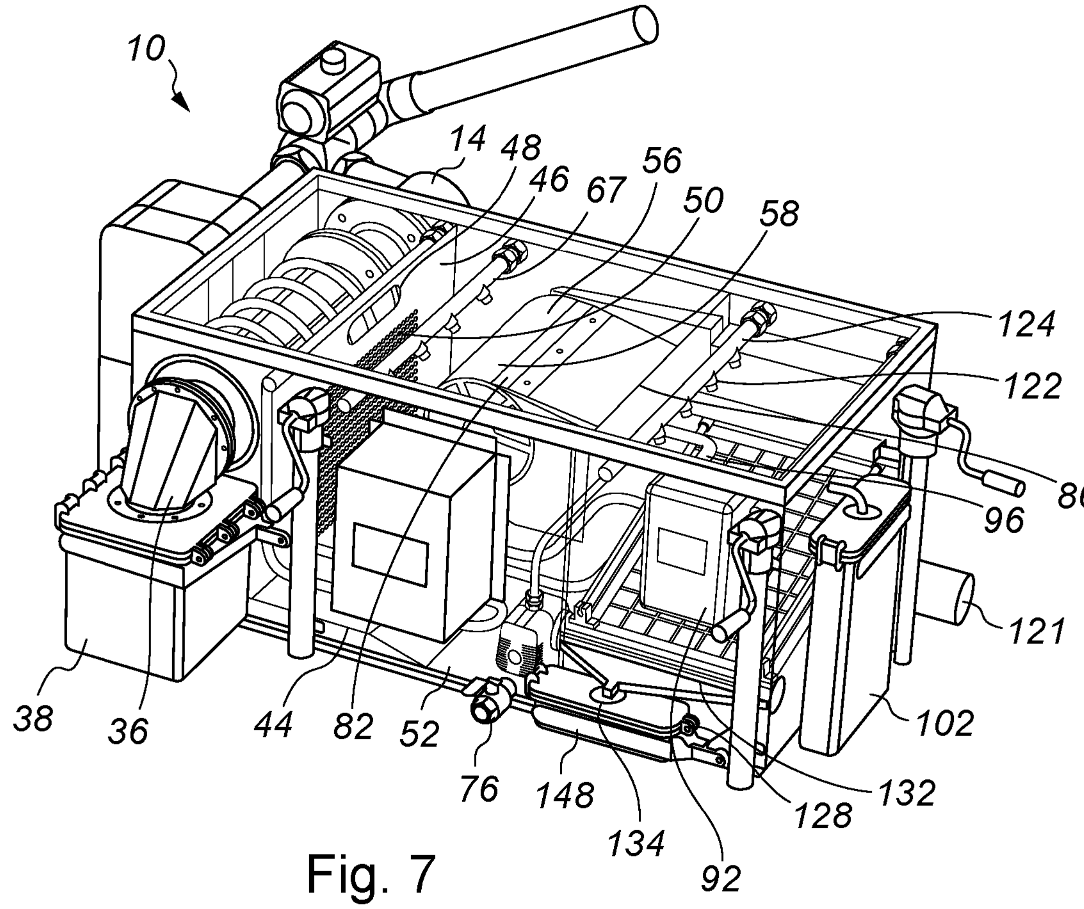
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Fig. 7

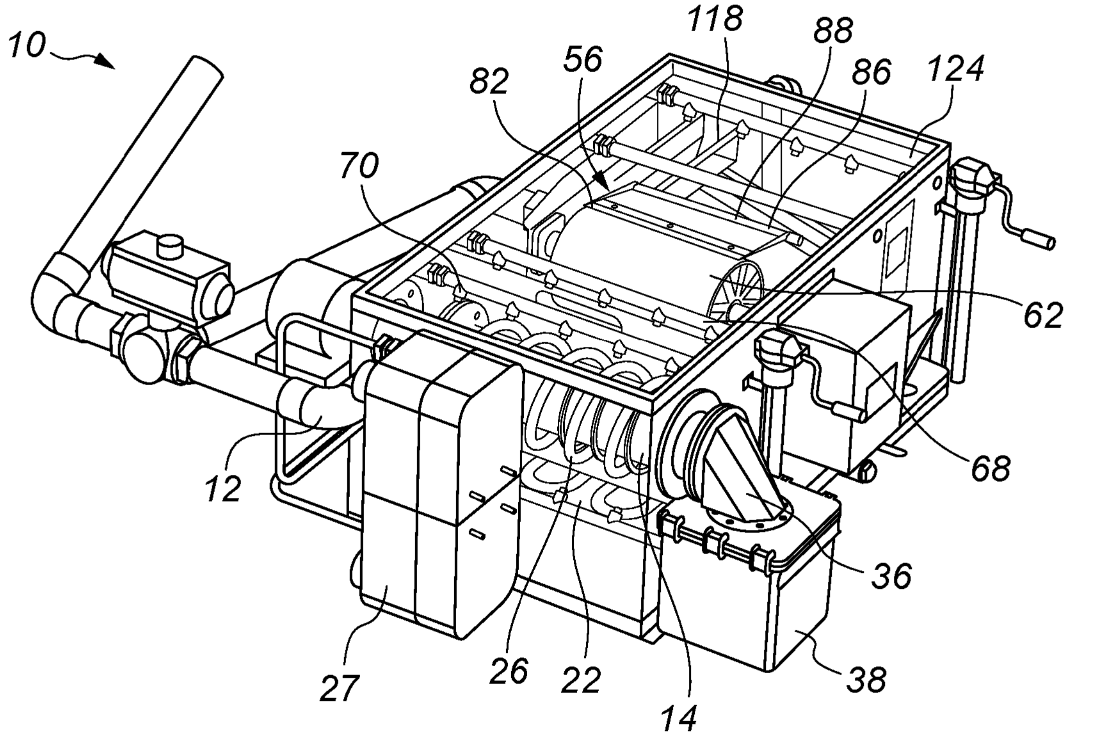
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Fig. 8

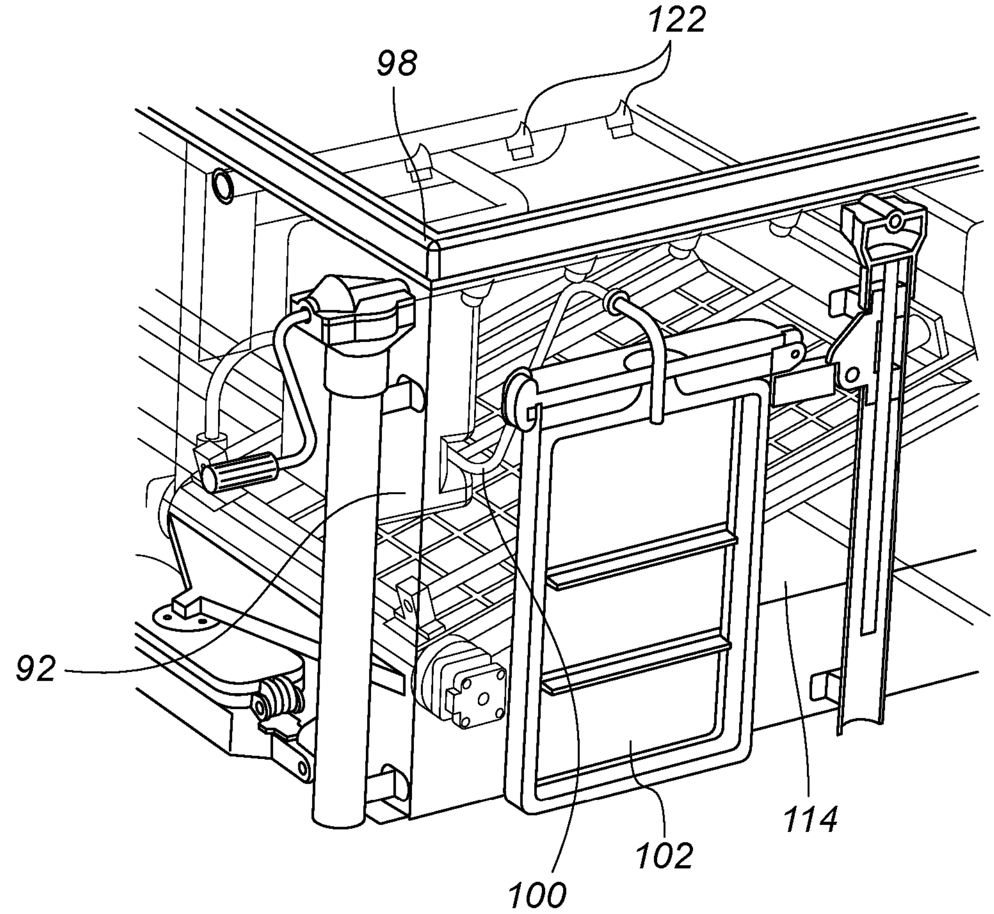

Fig. 9

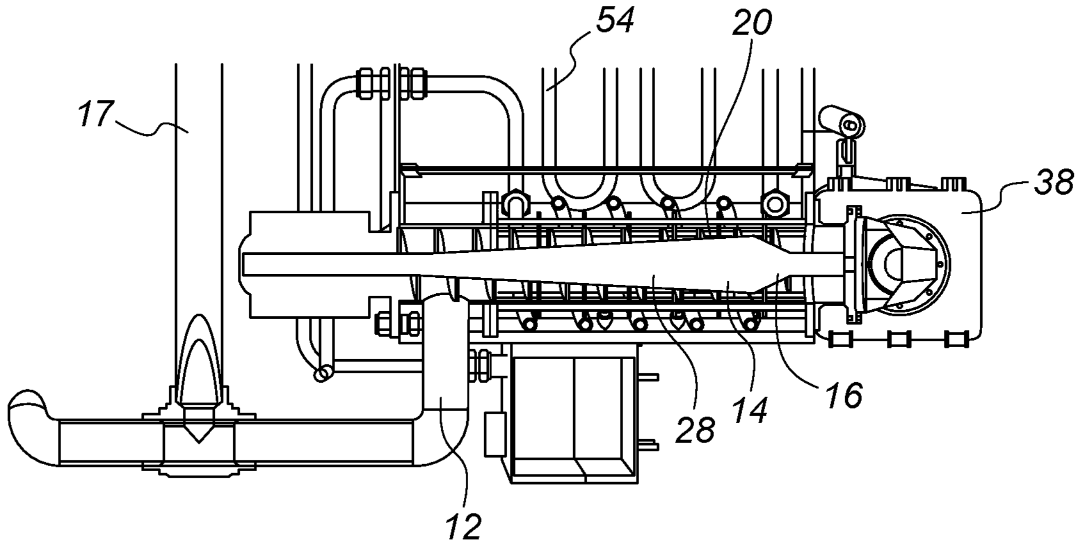

Fig. 10

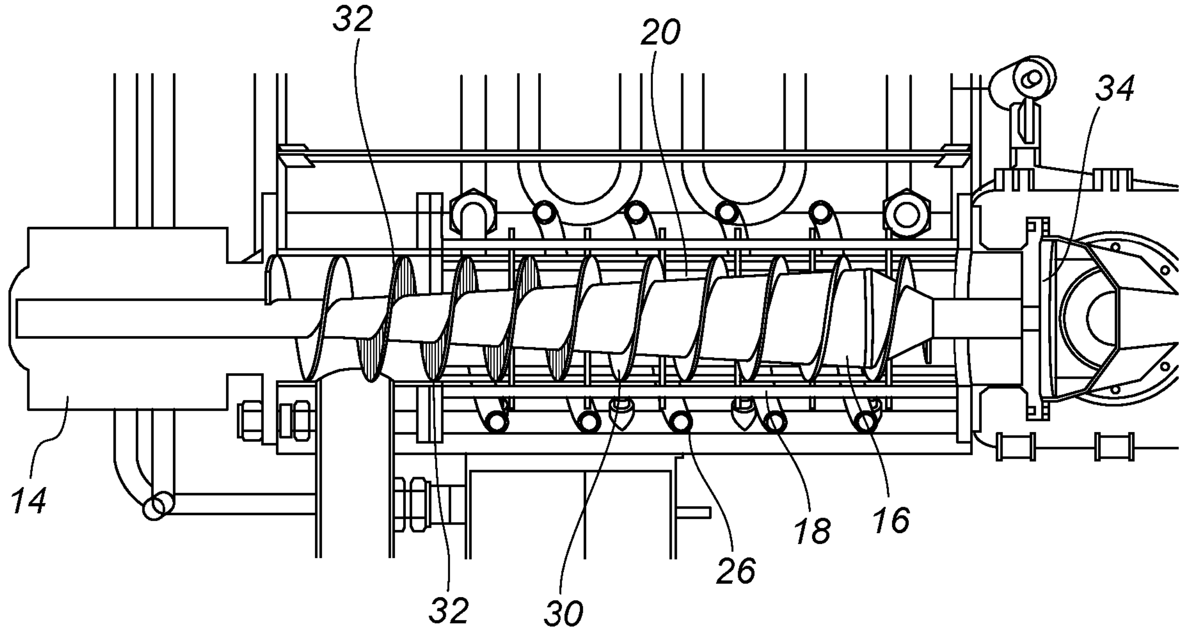

Fig. 11

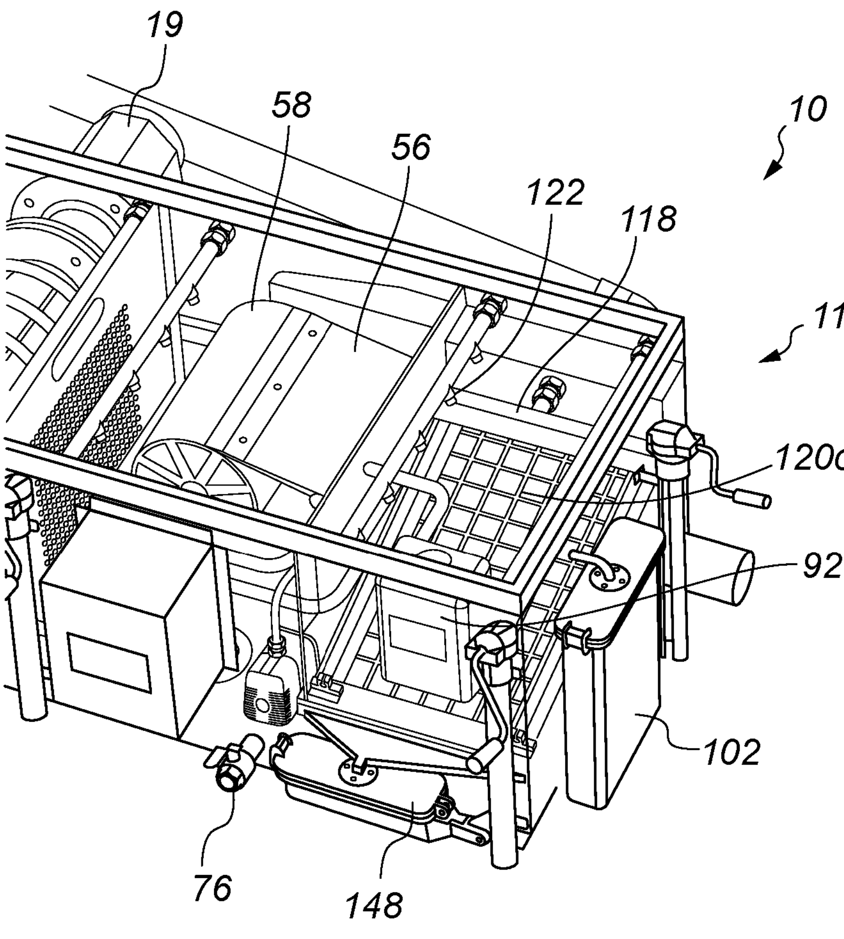

Fig. 12

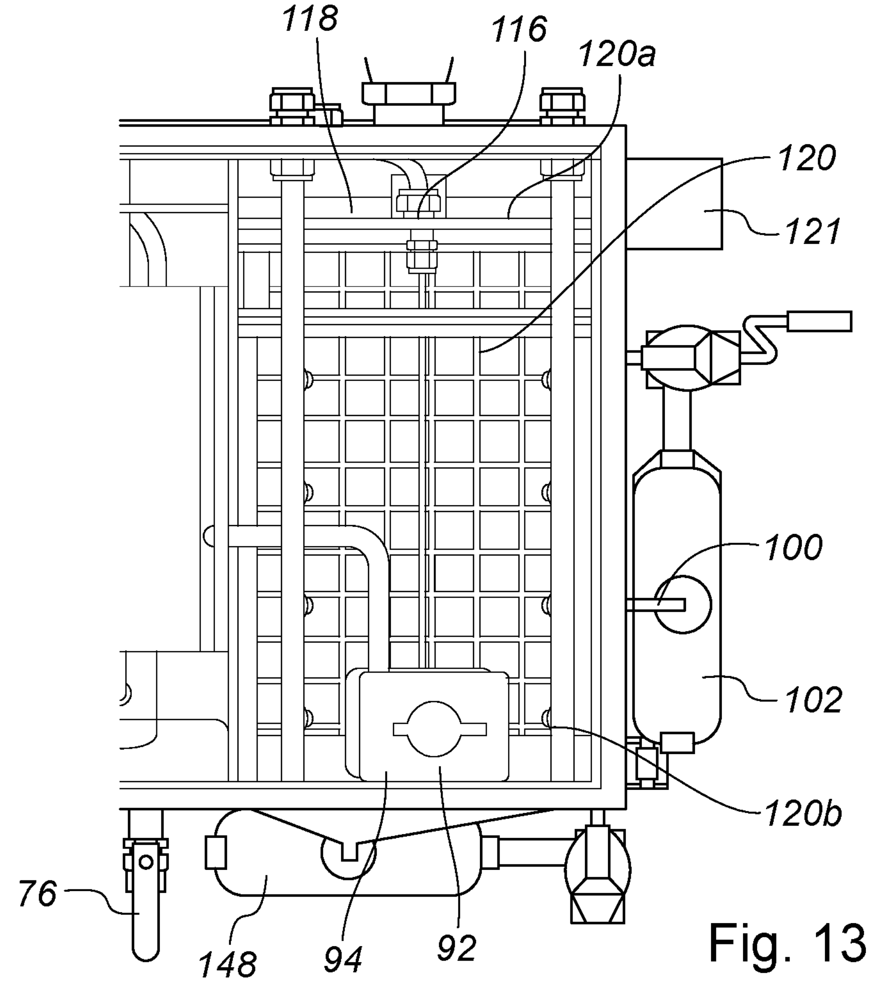
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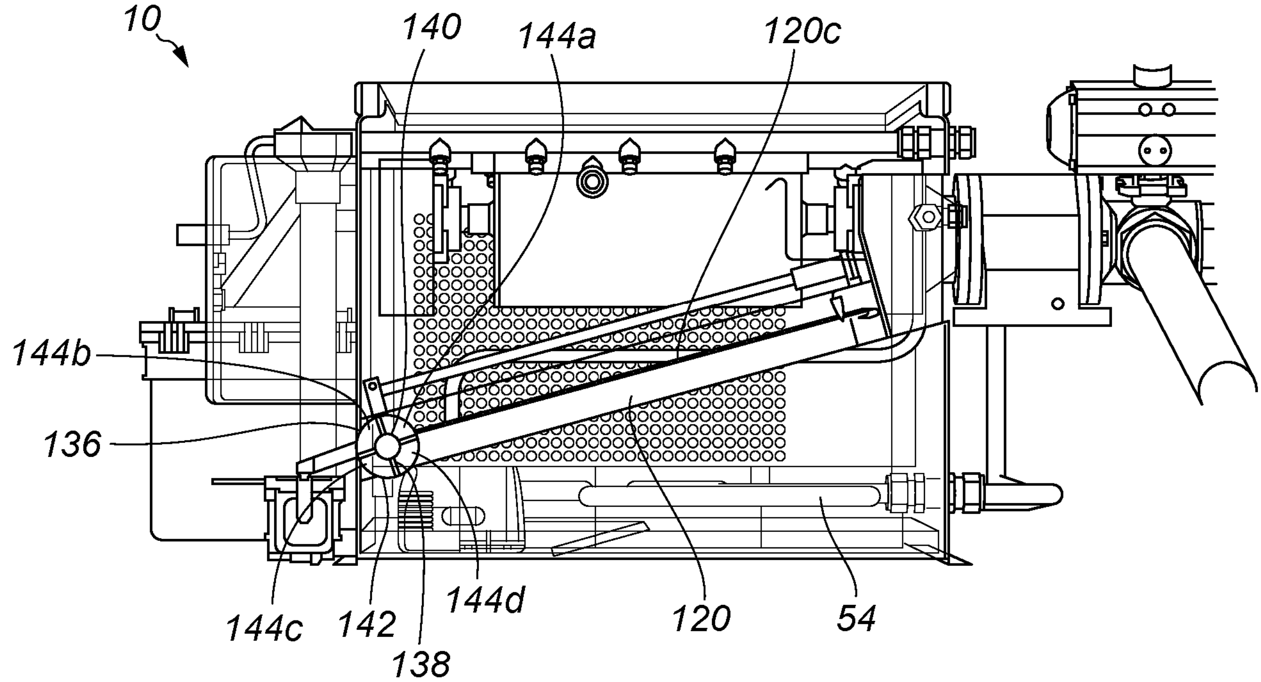
Fig. 13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144d
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54

Fig. 14

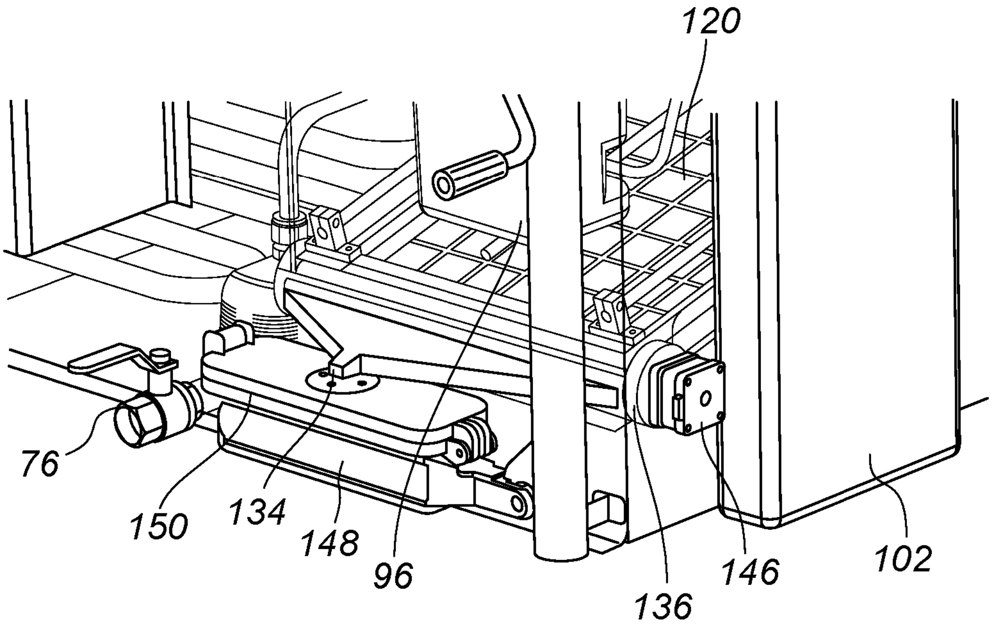
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Fig. 15

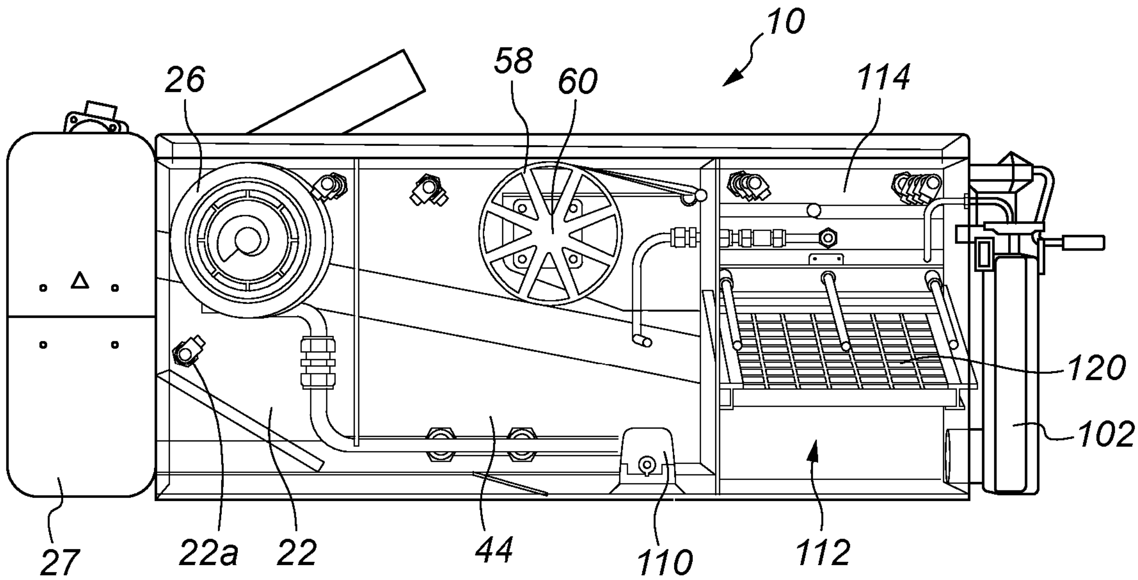
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Fig. 16

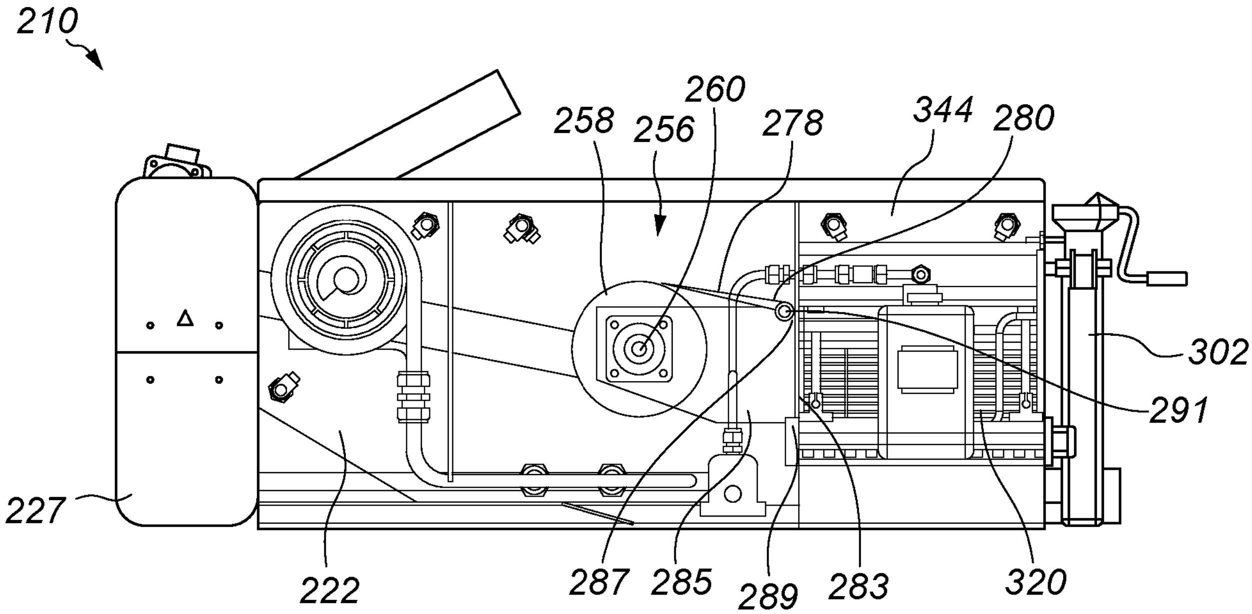
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Fig. 17

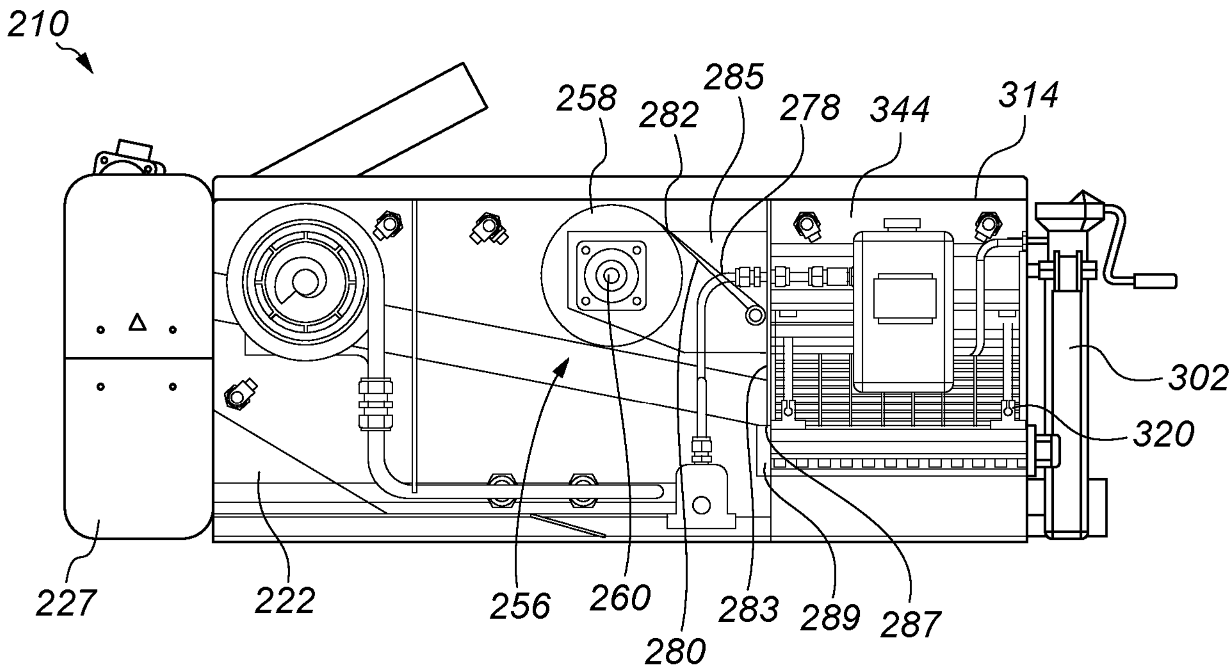
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Fig. 18