

SUBMERSIBLE FILTER SYSTEM

TECHNOLOGICAL FIELD

This invention relates to submersible filter systems of the type configured for submersing in a liquid and filtering said liquid.

BACKGROUND

5 Filtration systems used for filtering raw liquids from reservoirs such as sea, pond, lake, etc. are typically positioned external to the reservoir, for example, offshore or on a raft. However, under these circumstances, treating large volumes of liquid requires transfer of the raw liquid to the filtration systems and use of offshore platforms.

 Alternatively, positioning the filtration systems within deep water reservoirs
10 such as at the seabed would require the filtration systems to be housed in shells adapted to withstand high atmospheric pressures for long periods of time, leading to high production and maintenance costs of the filtration systems.

 Thus, there is a need for filtration systems configured to filter raw liquids when substantially submerged and to eliminate the high maintenance and servicing costs.

15 GENERAL DESCRIPTION

 According to the present disclosed subject matter there is provided a submersible filter system for submerging within a liquid, wherein said filter system is configured for filtrating the liquid and further wherein the filter system is configured with a cleaning/rinsing arrangement.

20 The filter according to the disclosed subject matter comprises an exposed filtration media, a raw liquid inlet flow path into a filtering side of the filtration media, a filtered liquid outlet flow path at a filtered side of the filtration media extending to a filtered liquid collecting port, a liquid pump for propelling liquid through the filtration media, and a rinsing mechanism for removing filtrate from the filtering side of the
25 filtration media.

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The term '*filtering side*' of the filtration media denotes a face of the filtration media which is exposed to and in direct flow communication with the raw liquid, and the term '*filtered side*' of the filtration media denotes a face of the filtration media which is in flow communication with the filtered liquid.

5 The filtering side of the filtration media is exposed to the raw liquid, i.e. extending in free/direct flow communication with the raw liquid in which the filter system is immersed.

Any one of more of the following features and designs can be incorporated in a filter according to the present disclosed subject matter, independently or in combination
10 with one or more features or designs:

- The filtration media can be any one or combination of liquid filtration media, i.e. disc filters, thread filters, solid filters, screen filters, etc. According to a particular design the filtration media is in the form of a cylindrical cartridge;
- Filtration through the filtration media can take place in a radially inwards
15 or in a radially outwards oriented direction;
- The filter system is configured for submersing at any depth, i.e. suited for use at shallow water and at deep water, namely even thousands of meters below sea level.
- A course screen can be configured at the raw liquid inlet flow path, to
20 prevent egress of large particles into the system. A course screen can have a mesh with apertures greater than about 1mm;
- Rinsing/cleaning of the filtration media can take place simultaneously while the filter system is a filtering liquid;
- Rinsing liquid for a rinsing/cleaning process can be obtained directly
25 from the filter system during a filtration process, or from an accumulator accumulating a portion of the filtered liquid, or from an external source of liquid, e.g. a fresh liquid supply or filtered liquid from a neighboring filtering system;
- A filtered liquid accumulator extends between the outlet flow path and the rinsing mechanism, said filtered liquid accumulator being a flexible
30 container;

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- Filtrate and waste rinsing liquid are washed to the environment liquid in which the filter system is immersed, and wherein natural or artificial currents carry them away from the vicinity of the filter system;
- Liquid flow into the raw liquid inlet flow path is facilitated through flow of the raw liquid, e.g. when the filter system is submerged in a river and the like, or by a liquid propelling mechanism. a liquid propelling mechanism can be any sort of mechanical pump or a liquid motion inducing mechanism, e.g. a gas bubbles generator, flow current generator etc.;
- Rinsing/cleaning the filtration media can take place by either or both of liquid jets applied to the filtering side of the filtration media, and suction applied to the surfaces of the filtration media. According to particular examples, suction is applied to the filtration face of the filtration media and rinsing jets can be applied to either or both the filtering face and the filtration face of the filtration media;
- The cleaning mechanism is configured with a cleaning pump for propelling a rinsing liquid through the filtration media in direction from the filtered side to the filtering side thereof.
- A single pump can be used as the liquid pump and the cleaning pump, wherein suitable valve arrangements are required. Alternatively the liquid pump and the cleaning pump are separate pumps;
- The rinsing liquid or vacuum applied over respective surfaces of the filtering side and filtered side, is applied through nozzles mounted on arms configured for at least one of rotary and linear motion, wherein at least said linear motion is reciprocal.
- Rotary and linear motion of the cleaning mechanism are imparted by a motion unit. The motion unit can be an electric motor, a hydraulic motor, piston, and the like, with appropriate gear mechanism applies when necessary;
- The filter system can comprise an array of filter units having their filtered liquid collecting port coupled to a common collecting manifold, with one or more liquid pumps for propelling liquid one or more of filtration media;
- Each filter system of an array of filter units can be configured with an independent rinsing mechanism associated with an independent motion unit;

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- In a filter system comprising an array of filter units, one or more such filter units can operate in a filtering mode while one or more other such filter units operate in a cleaning mode
- The filtration media is exposed to and in direct flow with the raw liquid in which it is to be submersed, and the filter system is devoid of a housing sealingly isolating the filtration media from the environment (i.e. the raw liquid).

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the disclosed subject matter and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

Fig. 1A is a schematic illustration of a filter system in accordance with a first example of the present disclosed subject matter, configured with a screen-type filtration media and wherein filtration takes place radially outwardly, the system illustrated at a filtration mode;

Fig. 1B is a cross-section along line I-I in Fig. 1A;

Fig. 1C illustrates the filter system of Fig. 1A at a rinsing mode;

Fig. 2A illustrates a filter system in accordance with a different example, configured with a screen-type filtration media and wherein filtration takes place radially inwardly, the system illustrated at a filtration mode;

Fig. 2B illustrates the system of 2A at a rinsing mode;

Fig. 3A illustrates a different configuration of a filter system configured with a mesh-type filtration media, with filtration taking place radially inwardly, said system further comprising a rinsing liquid reservoir, the system illustrated at its filtration mode;

Fig. 3B illustrates the system of Fig. 3A in a rinsing mode;

Fig. 4A illustrates a filter system similar to that disclosed in Fig. 3A, however devoid of a rinsing liquid accumulator, the system illustrated at its filtration mode;

Fig. 4B illustrates the system of Fig. 4A at the rinsing mode;

Fig. 5A illustrates a cross-flow type filter system configured with a mesh-type filtration media, the system further configured with a rinsing liquid reservoir, the system illustrated at a filtration mode;

Fig. 5B is a cross-section along V-V in Fig. 5A;

Fig. 5C illustrates the filter system of Fig. 5A in a rinsing mode;

Fig. 6A is directed to a configuration of the present disclosed subject matter wherein the filter system comprises an array of disk-type filtration medias and further configured with a rinsing liquid reservoir, the system illustrated at its filtration mode;

5 **Fig. 6B** illustrates the system of Fig. 6A at the rinsing mode;

Fig. 7A is a modification of the configuration illustrated in connection with Fig. 6A, each filter unit configured with control valve and the system devoid of a rinsing liquid reservoir and illustrated at its filtration mode;

Fig. 7B illustrates the filter system of Fig. 7A at the rinsing mode;

10 **Fig. 8A** illustrates a modification of the configurations illustrated in Figs. 6 and 7, wherein the filter system comprises several clusters of disk-type filtration medias and a rinsing liquid reservoir, the system illustrated in its filtration mode;

Fig. 8B illustrates the system of Fig. 8B in its rinsing mode;

15 **Fig. 9A** illustrates a filter system in accordance with yet an example of the present disclosed subject matter configured with a thread-type filtration media and a rinsing liquid reservoir, the system illustrated at its filtration mode;

Fig. 9B illustrates the filter system of Fig. 9A at its rinsing mode;

Fig. 10A illustrates a filter system configured with a plurality of filtering units each configured with a thread-type filtration media, the system further comprising a
20 rinsing liquid reservoir and the system being illustrated in its filtration mode;

Fig. 10B illustrates the system of Fig. 10A at its rinsing mode;

Fig. 11A illustrates a filter system similar to that disclosed in connection with Fig. 10A however wherein the rinsing mechanism extends within each of the filtering units, the system illustrated at a filtration mode;

25 **Fig. 11B** illustrates the filter system of Fig. 11A at a rinsing mode;

Fig. 12A illustrates a cross-flow filter system wherein liquid is propelled through the plurality of filter units by a bubble generator, the system illustrated at its filtration mode;

Fig. 12B illustrates the filter system of Fig. 12A in a rinsing mode;

30 **Fig. 13A** illustrates a filter assembly composed of clusters of filter systems of the type disclosed in Fig. 12A, the system illustrated at its filtration mode; and

Fig. 13B illustrates the filter system of Fig. 13A at its rinsing mode.

DETAILED DESCRIPTION OF EMBODIMENTS

Attention is first directed to Figs. 1A – 1C illustrating a filter system in accordance with a first example of the present disclosed subject matter generally designated **20** and designed as a submersible filtration system, i.e. suitable for submersing within a liquid, at any desired depth, and further wherein said liquid is to be filtered by the filter system **20** (i.e. serves as the raw liquid).

In the following description, the examples illustrated in Figs. 1 to 5 are configured with a mesh type (screen-type) filtration media.

The filter system **20** comprises a cylindrical housing **22** coaxially accommodating a mesh type (screen-type) filtration media **24** defining therebetween an annular space **26** serving as a filtered liquid collecting port.

In the following description, the examples illustrated in Figs. 1 to 5 are configured with a mesh type (screen-type) filtration media.

The filtration screen **24** is secured and retained at its respective ends, within the housing **22**, by two sealing rings at **28** and **30**. A raw liquid inlet flow path extends through a rough screening grid **34** (configured for filtering large objects and dirt from entering the filter system and further to prevent marine life from entering thereto, the screen having a grid with apertures larger than about 1mm), the raw liquid inlet flow path extending into an inside space **36** of the filter **24** wherein the space **36** is in fact in free liquid flow communication with the environment (raw liquid) in which the filter system is submerged.

The filtration liquid outlet flow path **26** extends into a filtration liquid collecting port designated **40** for conveying filtered liquid to a consumer designated **42**, with a liquid pump **46** extending along said collecting port for propelling liquid from the internal space **36**, through the filtration media **24**, into the filtered liquid space **26** and then out towards the downstream consumer at **42**.

Received within the space **36** there is a cleaning system generally designated **50** configured with a coaxially positioned nozzle carrying tube **52**, fitted with a plurality of suction tubes **54**, said suction tubes **54** radially extending and each fitted at a free end thereof with a suction nozzle **56** extending in close proximity to the inside surface, namely filtering side **64** of the filtration media **24**.

The hollow tube **52** extends through an end plate **68** dividing the casing **22** into a filtration zone designated **F** (Fig. 1C) and a cleaning mechanism chamber designated **C**.

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The cleaning chamber **C** is configured with an outlet port **70** with a cleaning pump **72** fitted thereon.

The cleaning mechanism **50** further comprises a motor **M** (e.g. an electric motor, hydraulic motor, etc.) with a gear mechanism **74** articulated to a shaft **76** which in turn
5 is articulated to the hollow tube **52**, wherein the gear **74** is configured for imparting the shaft **76** reciprocal linear motion (arrowed line **80** in Fig. 1C) and rotary motion (reciprocal or not, as illustrated by arrowed line **82** in Fig. 1C). The hollow tube **52** sealingly projects through an opening in the wall **68** and extends into the cleaning space **C**.

10 In a filtration process (Fig. 1A) raw liquid represented by dashed arrows designated **90** enters through the coarse grid **34**, along the raw liquid inlet flow path and into the central space **36** whereupon operation of the liquid pump **46** the raw liquid is forced through the filtration screen **24** into the filtered liquid outlet flowpath, namely the annular space **26** and from there the filtered liquid designated by fine arrows
15 designated **92** flows through the filtered liquid collecting port **40** towards the consumer **42**.

A rinsing/cleaning process (Fig. 1C) takes place however whilst the filtration process is active, wherein a portion of the filtered liquid **92** entering into the annular space **26** now serves for the rinsing process. In the rinsing process the motor **M** is
20 activated, giving rise to combined linear reciprocal motion of the hollow tube **52** along with rotational motion thereof, and simultaneously the cleaning pump **72** is activated, causing a vacuum within the cleaning chamber **C**, resulting in suction force through the nozzles **56** whereby as they progress along the filtering side **64** of the screening filtration media **24** they suck any filtrate residing thereon, sucking it into the cleaning
25 chamber **C**. The rinsing liquid together with the removed filtrate and dirt, represented by dotted arrows and designated **93** (Fig. 1C), then flows into the outlet port **70** and out directly to the liquid ambient environment in which the filter is submersed, where the filtrate and dirt are carried away by currents and turbulent. A rinsing process ends upon halting the operation of the cleaning pump **72** and the motor **M**.

30 Further attention is now directed to Figs. 2A and 2B of the drawings illustrated to a different example of a filter system in accordance with the present disclosed subject matter and generally designated **90**. In the example of Figs. 2A and 2B the filter system **90** comprises a cylindrical filter unit comprising a screen-type filtration media **92**

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secured at an end thereof by a rigid support structure **94**), wherein the filtration media is completely exposed to the environment, namely to the raw liquid in which the filter system is submersed, such that when the filter system is submersed within a liquid, it is in full and direct contact therewith. The filtration media **92** is sealed by a sealing plate **98** at its fore end with the external surface thereof, namely filtering side **100** exposed to the raw liquid. A raw liquid inlet flow path extends through the grid of the filtration media **92** into a filtered liquid outlet flow path **108**, extending within the tubular filter unit **92**, and into a filtered liquid collecting port **110** which is in flow communication with a liquid pump **112** generating liquid flow through the filtration media **92**, into the filtered liquid collecting port and out to the consumer **114**.

The filtration media **92** is exposed within the raw liquid within which the filter system is submersed, the system being devoid of any housing.

A rinsing mechanism generally designated **120** is disposed external of the filter unit, the rinsing mechanism **120** comprises a central suction tubular axle **122** articulated to a drive and motion unit designated **M** for imparting same with rotary motion and at least reciprocal linear motion, about the longitudinal axis of the tube **122**. The tube **122** is articulated to a cleaning pump **126**, open to the environment, namely to the liquid in which the filter system is submersed. The opposite end of the tube **122** splits into a bifurcated arm arrangement comprising two arms designated **124**, each fitted with a plurality of suction fingers **126** radially extending towards the external surface, namely the filtering side **100** of the filtration media **92**, with suction nozzles **128** extending in close proximity to the external surface **92** of the filtration media **92**.

It is however appreciated that reciprocal linear motion of the cleaning mechanism **120** can be avoided, however depending on the number of suction nozzles and their density along the external surface of the filtration media.

During a filtration process (Fig. 2A) raw liquid (designated by solid dashed lines **136**) flow through the filtration media **92**, owing to the propelling force imparted by the pump **112** wherein the filtered liquid (dash-dotted arrows designated **138**) flow through the internal space into the filtered liquid collecting port **110** and out to the consumer at **114**. During a filtering process, the cleaning pump **126** is halted.

A rinsing/cleaning process takes place simultaneously during a filtration process, and is illustrated in Fig. 2B. During a rinsing process, the cleaning pump **126** is activated, giving rise to suction force extending through the bifurcated arms **124**

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wherein the suction nozzles **128** traveling in close proximity over the external surface **100** (filtered side) of the filtration media **92** suck any filtrate, dirt, debris residing over the filtered side **100** and discards same to the open liquid wherein by turbulence is carried away.

5 The rinsing liquid together with the removed filtrate and dirt, represented by dotted arrows and designated **139** (Fig. 2B), then flows through tube **122** and the pump **126** out directly to the liquid ambient environment in which the filter is submersed, where the filtrate and dirt are carried away.

 In the examples of 3A and 3B there is illustrated a filter system generally
10 designated **150** comprising a filtering unit, namely a filtration screen **152** extending substantially exposed within the raw liquid in which the filter system is immersed. The tubular filtration media **152** is secured by and extends into a support unit **154** configured with a filtered liquid chamber **158** with a filtered liquid outlet path extending from the inside space **160** within the filtration member **152**, through the chamber **158**, out
15 towards a filtered liquid collecting port **162** from which it is propelled by a liquid pump **164** to a downstream consumer at **166**.

 A free end **170** of the tubular filtration media **152** is blocked by a plate **172** supporting a motor **M** articulated via appropriate gear transmission **G** to a hollow rinsing tube **176** which in turn is configured with a plurality of radially disposed rinsing
20 arms **178**, each configured at its free end with a rinsing nozzle **180** for emitting a liquid jet in close proximity to the filtering side **182** of the filtration media **152**, wherein the motor **M** and gear transmission **G** are provided for imparting the rinsing tube **176** with reciprocal linear motion about its longitudinal axis as indicated by arrowed line **186** and rotary motion (reciprocally or not as indicated by arrowed line **188**).

25 An opposite end of the rinsing tube **176** is articulated via coupling tube **190** to a rinsing booster **194** being in flow communication with a flexible rinsing liquid reservoir **198** which in turn is coupled via tube segment **200** and via pump **164** to the filtered liquid collecting port **162**.

 In a filtration mode of the filtering system **150** (Fig. 3A) raw liquid within the
30 environment in which the filter system is submersed is forced to enter (owing to propelling motion of the liquid pump **164**) through the filtration media **152** into the internal space **160**, as represented by dashed arrows **204**, wherein the filtered liquid (now designated by dot-dashed lines **206**) flows about the filtered liquid outlet flow path

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into the chamber **158**, through the port **162** and then out to the consumer **166**. However, a portion of the filtered liquid is allowed to flow through tube section **200** into the flexible reservoir **198**, wherein during a rinsing mode of the system, as illustrated in Fig. 3B, the booster **194** is activated simultaneously with the motor **M** giving rise to liquid jets emitted through the nozzles **180** towards the internal surface (filtering side) of the filtration media, whereby filtrates and dirt accumulated over the external face of the filtration media (filtering side) **183** is rinsed away into the raw liquid reservoir in which the filter system is immersed wherein it is drifted away. It is appreciated that during a filtration process the rinsing booster **194** as well as the motor **M** are arrested.

10 It is however appreciated that the rinsing process (Fig. 3B) takes place whilst the filtering process is still active. Further noted the liquid reservoir **198** is a flexible reservoir e.g. made of suitable rubber material and the like.

The filter system illustrated in Figs. 4A and 4B and generally designated **210** is substantially similar to the filter system designated **150** and depicted in Figs. 3A and 3B, however devoid of the flexible rinsing liquid reservoir **198**. The system **210** is particularly suitable for use in considerable depth. For sake of clarification, like elements have been designated with like reference numbers.

In the filter system **210** of Figs. 4A and 4B the pump **164** is directly connected to the cleaning pump/booster **194** by a connecting pipe section **214** and wherein the cleaning pump **194** is in turn connected with the rinsing tube **176** via the coupling tube **190**.

25 The filtering mode takes place similarly to the disclosure made in connection with Fig. 3A above and reference is made thereto. However, at the rinsing mode (Fig. 4B) a portion of the filtered liquid (designated by dashed-dotted arrows designated **206**) flows from the liquid pump **164** directly towards the cleaning pump **194** and then, via tube **190** into the cleaning tube **176** so as to generate rinsing jets of liquid against the inside surface **182** of the filtration media **183**. It is noted that the filtration mode takes place simultaneously whilst filtration is ongoing.

In the example depicted in Figs. 5A – 5C there is illustrated a filter system in accordance with yet an example of the present disclosed subject matter, generally designated **230**, the system being a so-called *cross flow* filtration system, comprising a tubular filtration media **232** received within a sleeve **236** in a fashion defining between

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them a space **238**, wherein the filtration media tube **232** is sealingly secured within the external sleeve **236** by sealing gaskets at **240** and **242**.

A raw liquid inlet flow path **246** extends into the inner space **248** of the filtration media tube **232** and a filtered liquid outlet flow path **252** extends at an opposite, open
5 end of the tubular filtration media **232**. The filtration media **232** is a screen-type (fine mesh filter) with a liquid outlet port **252** extending at an opposite, open end of the tubular filter system. A filtered liquid collecting port **256** extends from the intermediate annular filtered liquid space to a liquid pump **258** and therefrom the liquid is transferred to a consumer **260**.

10 The filtering system **230** is suitable for submersing within a source of flowing raw liquid, e.g. in a river, adjacent an outlet of a hydraulic station and the like, wherein the liquid is propelled through the tubular filter system. However, at low flow rates and insufficient liquid propelling force, a liquid propelling system is engaged so as to propel liquid at sufficient flow rate through the system. The propelling system comprises a
15 central axis **268**, coupled to a motor unit schematically represented at **M** wherein a plurality of impeller blades **270** are mounted on the axel **268** such that upon rotating the motor **M** the propeller blades rotate thereby propelling liquid through the space **248** at sufficient flow rate.

A rinsing mechanism of the filter system **230** comprises a bypass tube **280**
20 extending from the liquid pump **258** into a flexible filtered liquid reservoir **282** which by means of a cleaning pump **284** and a connecting tube **286** is configured for propelling rinsing liquid into the annular space **238** as will be explained hereinbelow.

During a filtration mode of the system (Fig. 5A) raw liquid (designated by dashed arrows **290**) is propelled along the raw liquid inlet flow path whereby upon
25 activating the liquid pump **258** the raw liquid is forced to pass through the filtering screen of the filtration media **232** upon which the liquid is filtered. The filtered liquid, now represented by dash-dotted arrows designated **292** flows from the annular space **238**, through the filtered liquid collecting port **256**, via liquid pump **258** and out to the downstream consumer **260**.

30 During a rinsing mode (Fig. 5C) the filtering process is not halted but rather, a portion of the filtered liquid which was accumulated within the flexible reservoir **282** during the filtration process, is now propelled by cleaning pump **284**, through tube **286** back into the annular space **238** whereby the liquid forced in a reverse direction

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removes filtrate from the inside surface **297** of the filtration media, where said filtrate (dotted arrow **294**) flows out to directly to the open waters, i.e. the raw liquid reservoir in which the filter system is immersed.

Figures 6 to 8 illustrate filters systems according to further examples of the present disclosed subject matter, wherein at these example the filtration media is a compact stack of filtration disks.

Turning now to the example illustrated in Figs. 6A and 6B there is illustrated a filter system generally designated **300** and comprising a plurality of parallelly disposed filter units **302**, each filtering unit being a compact array of filtration disks, as known in the art. The interior space of each of the filter units **302** extends into a filtered liquid collecting port, namely collecting manifold **306**, coupled to a liquid propelling pump **308** configured for propelling liquid from the environment i.e. from the raw liquid within which the filter system is submersed, through the filter unit **302** into the filtered liquid collecting port **306** and out to a consumer at **312**. A portion of the filtered liquid flows through a connecting tube **318** towards a flexible filtered liquid reservoir **320** which is further coupled by tube section **322** to a cleaning pump **324**.

The arrangement is such that during a filtration process of the system (Fig. 6A) raw liquid (designated by dashed arrows **330**) is propelled through the filtration media (namely compacted filtration disks) owing to the suction generated by the liquid pump **302**, wherein the liquid forced through the filtration disks is filtered and filtered liquid (now designated by dash-dotted arrows **332**) now flows through the liquid pump **308** towards the downstream consumer **312**, wherein a portion of the filtered liquid **332** flows into the filtered liquid reservoir **320**, though during the filtration mode the cleaning pump **324** is halted.

Turning now to Fig. 6B, the filter system **300** is illustrated during a cleaning mode, wherein the liquid pump **308** is now halted whilst the cleaning pump **324** is activated, giving rise to filtered liquid, now serving as rinsing liquid **332** flowing from the reservoir **320** into the internal space of each of the filter units **302**, thus flowing in a reverse direction and flushing away any filtrate which may have accumulated on the external surface **338** of the filter units **302**, rinsed away by the rinsing liquid **340** into the raw liquid in which the liquid system is submersed.

Whilst in Figs. 6A and 6B the filtration units **302** are illustrated in a position where they extend substantially parallel to one another and upright, it is appreciated that

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the filter units may extend radially from the central collecting hub manifold **306** thereby increasing the effective number of filtering units.

Turning now to Figs. 7A and 7B there is illustrated yet another example of a filtering system in accordance with the present disclosed subject matter, generally designated **350**. The filter system **350** resembles that illustrated in connection with Figs. 6A and 6B and comprises a plurality of filter units **352** projecting radially upwardly (as an example only) from a filtered liquid collecting manifold **354**, wherein each of the filter units **352** is a tower of compacted filtration disks. The interior space of each of the filter unit **352** is coupled via a three-way valve **360** to a rinsing line **362** and to the filtered liquid collecting pipe **354** the latter coupled to a liquid propelling pump **364** which in turn is coupled to a downstream consumer **366** with a branching off to the rinsing pipe **362** via a rinsing valve designated **370**. It is however appreciated that rather than a three-way valve other valve arrangements can be used for liquid flow control, e.g. two tow-way valves, etc.

In a filtering mode (Fig. 7A) the liquid pump **364** is activated to draw raw liquid (dashed arrows designated **374**) through the filtration media, namely the compacted filtration disks of each of the filter units **352**, into the interior space of each filter unit **352** and then, through the respective three-way valves **360** into the filtered liquid collecting manifold **354**, wherein filtered liquid is designated by a dashed-dotted arrow designated **376**, which then flows through the liquid pump **364** downstream to the consumer at **366**.

At a cleaning process of the filter unit **350** (designated in Fig. 7B) filtration continues simultaneously at one or more of the filtering units **352** whilst one or more other filter units **352** are switched into a rinsing mode. In the present illustrated example, the left filter unit designated **352A** is switched into a rinsing mode by means of the respective three-way valve **360A** now switched into a position where part of the filtered liquid (filtered by the other units active at their filtering modes) now serving as a rinsing liquid flows through the respective rinsed filter unit **352A**, whereby the rinsing liquid is forced from the interior space of the filter unit outwardly thereby rinsing and removing filtrate and other dirt (dotted arrows **379** in Fig. 7B) into the raw liquid environment in which the filter system is submersed, wherein the filtrate and dirt is washed away by turbulence.

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It is however appreciated that in the configuration of Figs. 7A and 7B the pressure generated by the liquid pump **364** should be slightly higher than the ambient liquid pressure within which the filter system is submersed, so as to facilitate rinsing of the filter units.

5 The configuration disclosed in Figs. 8A and 8B is principally similar to that disclosed in connection with the previous example of Figs. 7A and 7B, however wherein the filtering units are arranged in a different configuration, namely in clusters. In the example of Fig. 8B the filter system **390** comprises a central housing **392** from which laterally project in opposite directions, several clusters **394** of filter units, each
10 with a unit designated **396**. The filter units **396** are each a power of compacted filtration disks, configured for radially inwardly filtration, into an interior space of each filter unit which opens into a central filtered liquid collecting space within the housing **392**, which in turn is coupled to a three-way control valve **400**.

One port of the control valve **400** is coupled to a liquid propelling pump **402**
15 having an outlet port extending towards a consumer downstream at **404** and another port of the valve **400** is selectively coupled to a cleaning pump **408** which is connected via a tube section **410** to a flexible filtered liquid reservoir **412** coupled via a pipe section **414** downstream to said liquid pump **402**.

In a filtering mode of the filter system **390** (Fig. 8A) the cleaning pump **408** is
20 halted and the valve **400** is opened so as to facilitate liquid flow from the common filtered liquid collecting space of the housing **392** with the pump **402**. Upon activating the liquid pump **402**, raw liquid (represented by dashed arrows **418**, from the liquid environment within which the filter system is submersed) is forced through the filtration media (filtering disks in the present case) and then into the interior space of each filter
25 unit **396** collected into the central filtered liquid collecting space and then, filtered liquid (designated by dash-dotted arrow **422** flows down stream to the consumer **404**, with a portion of the filtered liquid flowing into the flexible filtered liquid reservoir **412**. It is appreciated that at this position the cleaning pump **408** is halted.

Turning now to the cleaning mode illustrated in Fig. 8B, the process of which
30 takes whilst filtration is stopped, whereby the three-way valve **400** is now converted so as to allow liquid flow only in direction from the cleaning pump **408** into the collecting space within the central housing **392** whereby filtered liquid within the reservoir **412** now serves as a rinsing liquid (dotted arrows **413**) is propelled by means of the cleaning

pump **408** and forced into the interior space of each of the filter units **396** and then out through the filtration disks rinsing away any filtrate and dirt accumulating on the external surface **427** of the filtration media, said filtrate and dirt being drifted and carried away by currents within the liquid in which the filter system is submersed.

5 The examples illustrated from here on are directed to filter systems wherein the filtration media is a thread-type filter. With reference first being made to Figs. 9A and 9B there is illustrated a filter system generally designated **450** comprising a filter unit **452** composed of a plurality of thread-type filter cassettes/segments configured into a plurality of filtration disks compacted about a longitudinal support axel **454**, wherein
10 each of the filtration segments has an opening into a central filtered liquid collecting path extending within the hollow tube of axel **454**.

 The filtration unit is revolvable together with the axel **454** by means of a motor designated **M** which may be an electric motor, an hydraulic motor and the like, configured for revolving the filter unit **452** about the longitudinal axis of the tube **454**
15 during a rinsing process, as will become apparent hereinafter.

 A filtered liquid outlet flow path extends from the collecting tube **454** into a filtered liquid collecting port at **458** which in turn extends into a flexible rinsing liquid reservoir **460**, said reservoir being connected to a main liquid pump **462** at one side and to a cleaning pump **466** at another side, where the main pump **462** is connected for
20 propelling filtered liquid to a downstream consumer designated **468**. The cleaning pump **466** is in turn coupled via a pipe link **472** into the central collecting manifold **454** the purpose of which will become apparent hereinafter. The pipe segment **472** extends into a rinsing sprinkler divider **475** from extend several sprinkler arms **476** each fitted with a plurality of rinsing nozzles **477** extending in close proximity with the external surface
25 **479** of the filtration segments.

 During a filtration mode, as illustrated in Fig. 9A, the cleaning pump **466** is not active whilst the main liquid pump **462** is activated to propel liquid and generate a suction for raw liquid (represented by dashed lines **476**) forced through the filtration media namely threaded filters **452** into the central filtered liquid collecting tube **454**
30 whereby filtered liquid (represented by dash-dotted arrows designated **479**) flows through the collecting port **458**, through the flexible reservoir **460** and then via liquid pump **462** to the downstream consumer at **458**. At the filtration mode, a portion of the filtered liquid accumulates at the flexible reservoir **460**.

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During a rinsing mode of the filter system **450**, as depicted in Fig. 9B, the main liquid pump **462** is halted whilst the cleaning pump **466** is now activated to thereby propel filtered liquid from the rinsed liquid reservoir **460**, through pipe segment **472** into the array of rinsing sprinklers at **477** wherein the plurality of jets immersed against the external surface of the filtering threads rinse filtrate and dirt accumulated thereto, said filtrate and dirt (represented by dotted arrows designated **477**) being washed directly into the ambient liquid in which the filter system is submersed.

In the example of Figs. 10A and 10B there is illustrated yet a modification of a filter system in accordance with the present disclosed subject matter, generally designated **500**, wherein the system comprises a plurality of filter units **502**, each configured as a coil of filtration threads, rather than filtration cassettes as disclosed in the previous example, though other forms of filtration media can be utilized as well.

Each of the filtration units is configured with an external filtration surface **504** and with an internal space (not seen) extending into a central filtered liquid collecting flow path within the liquid collecting manifold **506** which is connected at one end to a filtration pump **510** and at an opposite end to a flushing pump **512**, the latter open to the ambient raw liquid within which the filter system **500** is submersed. Extending from the liquid pipe **510** there is an outlet port **516** extending to a downstream consumer **518**, however with a branching off pipe line at **522** coupled to a flexible filtered liquid reservoir **524**.

A cleaning pump **526** is configured for pumping liquid from the filtered liquid reservoir **524** into a rinsing liquid manifold **528** from which extend a plurality of rinsing mechanisms generally designated **530**, each configured with a central pipe **534** coupled to a motion generating unit designated **M** configured for imparting the pipe **534** with at least a rotary motion though reciprocal linear motion may be applied as well. The pipes **534** extend into bifurcated rinsing arms **538** parallelly extending with rinsing rods **540** extending therefrom in a substantially radial direction with rinsing nozzles **542** at their ends, said rinsing nozzles extending in close proximity to the external surface **504** of each of the filtration units **502**. It is noted that rinsing mechanism can comprise one or more rinsing arms, rather than a bifurcated arrangement as illustrated in the drawings.

In the filtration mode, as illustrated in Fig. 10A the flushing pump **512** and the cleaning pipe **526** are halted, whilst the main liquid pump **510** is activated so as to propel liquid through the system. The raw liquid from the ambient is forced to enter the

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filter units **502**, said raw liquid represented by dashed arrows designated **546** whereby as the raw liquid flow is forced through the filter units **502** it is filtered, whereby the filtered liquid (represented by dash-dotted arrows designated **548**) flow into the central filtered liquid collecting manifold **506**, and then through the pump **510** downstream to
5 the consumer **518**, with a portion of the filtered liquid **548** flowing also into the filtered liquid reservoir **524**.

When it is now desired to rinse/clean the filter system **500**, the main liquid pump **510** is halted whilst the flushing pump **512** and the cleaning pump **526** are activated whereby filtered liquid from the reservoir **524**, now serving as a rinsing liquid flows
10 through the manifold **528** into each of the cleaning mechanisms **530** thereby, upon rotating of the motors **M** the arms of the cleaning sprinklers rotate whilst emitting a cleaning jet against the external surface **504** of the filter units. As this takes place, part of the rinsing liquid with the filtrate and dirt residing on the external surface of the filter units is washed away to the ambient (arrows **547**), whilst liquid entering into the interior
15 space of each of the filter units **502** flows into the collecting manifold **506** and then is expelled to the ambient liquid by the flushing pump **512** (the rinsing liquid is represented by dotted arrows designated **549**).

It is appreciated that reciprocal linear motion of the rinsing arms, namely sprinklers **538** may be omitted proving there is a sufficient number of rinsing jets
20 applied over the filter units and depending on their density.

Turning now to Figs. 11A and 11B there is illustrated a variation of the example disclosed in connection with Figs. 10A and 10B wherein the filtration system **550** comprises a plurality of filter units **552** being coiled thread-type filter units, with an interior space of each one extending into a central filtered liquid collecting port, namely
25 manifold **554** which in turn is coupled to a liquid pump **556** extending to a downstream consumer at **558** with a branching off pipe section **560** extending into a flexible filtered reservoir **562**. Extending from the reservoir **562** there is a cleaning pipe **566** which in turn is coupled to a rinsing manifold **568** from which extend a plurality of rinsing sprinklers **570**, each articulated with a rotary motor **M** and with a plurality of radially
30 extending rinsing arms **576**, each configured at its free end with a rinsing nozzle **578** extending in close proximity with an internal surface **580** of each of the filtration units **552**.

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During a filtration process, as depicted in Fig. 11A, the cleaning pump **566** is halted whilst the main liquid pump **556** is operated to thereby propel liquid through the system. Raw liquid, illustrated by dashed lines designated **584** is forced through the filtering threads of the filter units **552** into the central space of each filter unit and
5 therefrom, the filtered liquid, now illustrated by dash-dotted arrows **586** flows into the central filtered liquid collecting manifold **554** from where it is propelled by pump **556** to the downstream consumer **558**.

Turning now to Fig. 11B, when the filter system is converted into a cleaning mode, the main liquid pump **556** is halted whilst the cleaning pump **566** is operated to
10 thereby propel liquid from the filtered liquid reservoir **562** into the manifold **568** wherefrom the liquid is diverted into each of the cleaning sprinklers **570** to thereby emit rinsing jets through the nozzles **578** against the inside surface **580** of each of the filter units **552**, whereby any filtrate and dirt accumulating on either the internal surface **580** or the external surface **583**, is washed away by the rinsing liquid represented by dotted
15 arrows **579**, into the ambient raw liquid within which the filter system is submersed.

In Figs. 12A and 12B there is illustrated a different concept of propelling liquid through a filter system in accordance with the present disclosed subject matter. The filter system generally designated **600** comprises a plurality of thread-type filter units **602** which in the present example are parallelly disposed in an upright orientation and
20 are all received within a collecting manifold **606** forming a liquid tight environment around the external surface of the filter units **602**. However, the filter system is a cross-flow system wherein each filter unit **602** has at a bottom portion thereof a raw liquid inlet port **610** and a raw liquid outlet port **612** at a top thereof. Extending from the casing **606** there is a filtered liquid collecting port **616** extending to a liquid pump **618**
25 which in turn is configured for propelling liquid to a downstream consumer **620**.

Extending below the raw liquid inlet ports there is a liquid propelling generator generally designated **626** in the form of a bubble generator configured with a pump **628** coupled to a manifold **630** configured with a plurality of openings **634** extending below each of the raw liquid inlet ports such that upon activating the pump **628** liquid is
30 turbulent giving rise to flow in an upwards direction along with generating bubbles directing flow in an upwards direction.

In the filtration mode of the system **600** (Fig. 12A) the liquid propelling mechanism **626** is activated by activating the pump **628** and likewise the pump **618** is

activated. Raw liquid **631** flowing in a cross-flow manner through each of the open cylindrical filter units **602** is partially forced to filter through the thread filter media of each of the filter units, wherein the filtered liquid **633** collected within the filtered liquid collecting case **606** and then flows through the collecting port **616**, via pump **618**
5 downstream to the consumer **620**.

In the rinsing mode of the filter system **600**, as illustrated in Fig. 12B, the liquid pump **618** is operated in a reversed sense, in a back-flush manner whereby liquid **639** is forced through the cassette **606** and forced through the filtration media, namely the coiled thread, into the central space of each of the filter units, wherein the dirt is then
10 washed away by the raw liquid flowing upwards owing to the continuous flow of raw liquid propelled by the liquid propelling mechanism **626**, as discussed herein in connection with Fig. 12A.

It is appreciated that the propelling mechanism **626** requires an ongoing supply of gas for proper operation thereof.

The example of Figs. 13A and 13B is based on the concept in connection with Figs. 12A and 12B, the system generally designated **650** and comprises a plurality of clusters **652** (four in the present example) each composed of several filtering clusters (four in the present example) wherein each such cluster **652** operates in the same fashion as discussed in connection with Figs. 12A and 12B. Each filtration cluster **652**
20 comprises a plurality of filter units **654** received within a sealed collecting case **658** from which extends a filtered liquid collecting pipe **662** coupled to a liquid pump **654** which in turn is coupled to a central collecting manifold pipe **668** connected to a downstream consumer **670**.

Each of the filter clusters **652** is configured with a liquid propelling generator
25 **674** configured with a bubble generating pump **676** and a distributing unit **678** for propelling liquid in an upwards direction through the cross-flow filter unit **654**, as discussed hereinabove in connection with the example of Figs. 12A and 12B.

An advantage of a system of the configuration disclosed in connection with Figs. 13A and 13B is such that all filtration clusters can simultaneously operate in a filtration
30 mode or, alternatively one or more filtration clusters may undergo rinsing/cleaning as discussed hereinabove whilst other clusters continue the filtration process as discussed hereinabove, wherein the a filtration cluster is rinsed using liquid simultaneously filtered by another cluster in the system.

CLAIMS:

1. A filter system comprising at least partially exposed filtration media, a raw liquid inlet flow path into a filtering side of the filtration media, a filtered liquid outlet flow path at a filtered side of the filtration media extending to at least one filtered liquid
5 collecting port, at least one liquid pump for propelling liquid through the filtration media, and a rinsing mechanism for removing filtrate from the filtering side of the filtration media.
2. A filter system in accordance with claim 1, wherein the filter system is devoid of a housing sealingly isolating the filtration media from the environment and wherein the
10 filtration media is substantially exposed to the environment.
3. A filter system in accordance with Claim 1 or 2, wherein the filtration media is exposed to and is configured for being in a direct flow with the raw liquid in which it is to be submersed.
4. A filter system in accordance with claim 1, wherein the filtration media is in the
15 form of a cylindrical cartridge.
5. A filter system in accordance with claim 1, wherein the filtration media is a screen filter.
6. A filter system in accordance with claim 1, wherein the filtration media is any one or combination of disc filters, thread filters, solid filters, screen filters.
- 20 7. A filter system in accordance with claim 1, wherein filtration through the filtration media can take place in a radially inwards or in a radially outwards oriented direction.
8. A filter system in accordance with claim 1, wherein filter system is configured for submersion at any depth.
- 25 9. A filter system in accordance with claim 1, wherein filter system further comprises a coarse screen configured at the raw liquid inlet flow path.
10. A filter system in accordance with claim 1, wherein the rinsing mechanism is configured for rinsing simultaneously while the filter system is filtering the raw liquid.
11. A filter system in accordance with claim 1, wherein the rinsing liquid is obtained
30 from the filter system during a filtration process.

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12. A filter system in accordance with claim 1, wherein the filter system further comprises a filtered liquid accumulator configured for accumulating a portion of the filtered liquid and wherein the rinsing liquid is obtained from the accumulator.

13. A filter system in accordance with claim 12, wherein the filtered liquid
5 accumulator extends between the outlet flow path and the rinsing mechanism, said filtered liquid accumulator being a flexible container.

14. A filter system in accordance with claim 1, wherein the rinsing mechanism is configured with a cleaning pump for propelling a rinsing liquid through the filtration media in direction from a filtered side to a filtering side thereof.

10 **15.** A filter system in accordance with claim 1, wherein the liquid pump is further configured for propelling a rinsing liquid and wherein the pump is fitted with a valve arrangement.

16. A filter system in accordance with claim 1, wherein the filter system comprises an array of filter units, each filter unit having at least partially exposed filtration media
15 and a filtered liquid collecting port coupled to a common collecting manifold, and wherein the filter system further comprises one or more liquid pumps for propelling liquid from and/or to the filtration media.

17. A filter system in accordance with claim 16, wherein each of an array of filter units is configured with an independent rinsing mechanism associated with an
20 independent motion unit.

18. A method for filtering liquid comprising filtering said liquid through a filtration system submerged in the liquid, said system comprising at least partially exposed filtration media, a raw liquid inlet flow path into a filtering side of the filtration media, a filtered liquid outlet flow path at a filtered side of the
25 filtration media extending to at least one filtered liquid collecting port, at least one liquid pump for propelling liquid through the filtration media, and a rinsing mechanism for removing filtrate from the filtering side of the filtration media.

19. A method in accordance with claim 18, further comprising rinsing the filtration media by propelling a rinsing liquid through the filtration media in direction from a
30 filtered side to a filtering side thereof.

20. A method in accordance with claim 19, wherein the rinsing liquid is obtained from the filter system during a filtration process.