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(71) Applicant: **RIGDELUGE GLOBAL LIMITED**
[GB/GB]; Unit 4, Cothill, Fintray, Fintray Aberdeenshire
AB21 0JD (GB).

(72) Inventor: **GARDEN, Ian**; c/o Rigdeluge Global Limited,
Unit 4, Cothill, Fintray Aberdeenshire AB21 0JD (GB).

(74) Agent: **HGF LIMITED (ABERDEEN)**; 1 City Walk,
Leeds West Yorkshire LS11 9DX (GB).

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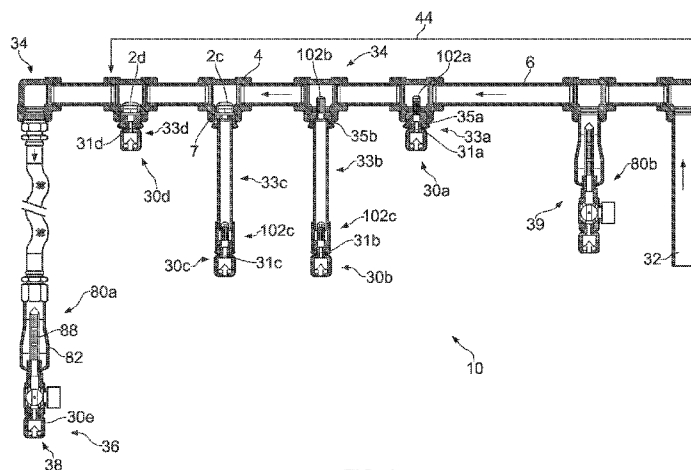


FIG. 1

(57) Abstract: A sprinkler system for salt water environments, comprising: a fluid inlet; a first and second nozzle branch each comprising a nozzle, and a fluid delivery line extending from the fluid inlet to the nozzle branches. A fluid delivery line filter is surprisingly provided outwith the fluid delivery line, on a further branch, to remove debris from the main delivery line extending to the nozzles. The fluid delivery line filter is provided in a housing, the internal diameter of the housing normally being larger than the internal diameter of the first and second nozzle branches, to facilitate the accumulation of debris. A fluid outlet is provided downstream of the fluid delivery line filter. The fluid outlet draws debris outwith the main delivery line and away from the nozzle branches, mitigating the possibility of nozzles being blocked. Fewer or less inline filters may be used in the main delivery line, thus mitigating problems associated with such inline filters blocking. Certain embodiments may be provided at the intake end, comprising a branch and filter system with an exit to atmosphere, also drawing debris away from downstream nozzle branches.



A Sprinkler System

This invention relates to a marine sprinkler system for use in firefighting, fire containment or fire suppression.

Fluid flow systems, such as sprinkler systems are widely used in onshore and offshore installations, such as oil and gas platforms, to contain or suppress fire. During operation of the sprinkler system, it is likely that scale, debris and other pollutants will build up and become a problem. Such systems normally draw on the surrounding salt water and direct it through the sprinkler system to the fire.

As well as a variety of water borne debris or particulates, such as dirt and indeed marine life, scale is typically formed by the precipitation of mineral compounds from water, such as calcium carbonate or calcium sulphate, due to pressure and/or temperature changes in the pipeline. Corrosion in pipelines can build up along the inner wall of pipe and also results in debris entering the system. Marine growth can also cause blockage problems. Salts can also crystallise and cause blockage problems. The by-products of salt water as a delivery fluid are also a problem and it is known that this has contributed to firefighting /deluge systems offshore failing where there has been loss of life, asset and indeed oil spills.

It is required to provide an inline filter in a delivery line between the salt water inlet and branches for nozzles, in order to mitigate the risk of the debris blocking the (pipe) nozzles. However the inventor of the present invention has noted that inline filters can become blocked which in turn chokes water flow to the nozzles and their filters/screens.

WO 2015/150836 discloses a filter which can mitigate blockages in a downstream nozzle.

Whilst generally satisfactory, the inventor of the present invention has developed an improved sprinkler system.

According to a first aspect of the invention, there is provided a sprinkler system for salt water environments, comprising:

- a fluid inlet;
- a first nozzle branch comprising a first nozzle;
- a second nozzle branch comprising a second nozzle;
- a fluid delivery line extending from the fluid inlet to each of the first and second nozzle branches;
- a fluid delivery line filter provided outwith the fluid delivery line, on a further branch;
- the fluid delivery line filter provided in a housing;
- the fluid delivery line filter comprising a plurality of inlets resisting particulate passage therethrough;
- wherein a fluid outlet is provided downstream of the fluid delivery line filter.

Thus surprisingly the sprinkler system of the present invention includes a fluid delivery line filter outwith the fluid delivery line. Whilst the skilled person would expect a filter for a fluid delivery line to be provided in the fluid delivery line, as is conventional, the inventor of the present invention has discovered that maintaining a flow of fluid through a filter outwith the main delivery line, caused by the fluid outlet, encourages debris to flow away from the nozzle branches, and so protects the main delivery line.

Therefore for certain embodiments of the present invention, there need be no inline filters in the fluid delivery line. Other embodiments can have fewer inline filters in the fluid delivery line, such as less than three.

Such a filter which is minimised in the present invention, is often across the cross-section of the main delivery line. It normally includes those that are attached to an inner bore of a pipe of the sprinkler network between the inlet and the second nozzle branch. They may be attached to the pipe of the sprinkler network by one or more connections or by a continuous connection. Such a filter may be provided partly upstream and partly downstream.

Such a filter is often the same size as the delivery line it is fitted to. However, including the apertures through which such a filter attempts to allow fluid and resist particulate passage, the area of the filter may be more than 30%, perhaps more than 50%, perhaps more than 75% of the cross-sectional area of the pipe of the sprinkler network to which they are attached. Not including the apertures, it may be more than 20%, 30%, or 40% of the cross-sectional area of the pipe. (Based on internal diameters).

In order to facilitate collection of debris, the internal diameter of the housing is normally larger than the internal diameter of the first and second nozzle branches.

The first and second nozzle branches may be attached to the main delivery line at their respective first ends, and the nozzles may be attached to their respective second ends. The first nozzle branch may be between a fluid inlet and the second nozzle branch, and the second nozzle branch may be between the first nozzle branch and the second end of the sprinkler network.

A branch filter may be mounted in each of the first and second nozzle branches proximate the sprinkler network, the branch filter comprising a plurality of openings resisting particulate passage into the nozzle branches.

The fluid delivery line may be part of a larger sprinkler network, the sprinkler network extending from a first end to a second end and the fluid delivery line filter provided at the second end of the sprinkler network and may be referred to as an end filter.

Accordingly to a further aspect of the present invention, there is provided a sprinkler system for salt water environments, comprising:

- a sprinkler network extending from a first end to a second end;
- a first nozzle branch attached to the sprinkler network at the first nozzle branch's first end, the first nozzle branch comprising a nozzle;
- a second nozzle branch attached to the sprinkler network at the second nozzle branch's first end, the second nozzle branch comprising a nozzle;

wherein the first nozzle branch is between the fluid inlet and the second nozzle branch, and the second nozzle branch is between the first nozzle branch and the second end of the sprinkler network;

- optionally a branch filter mounted in each of the first and second nozzle branches proximate the sprinkler network, the branch filter comprising a plurality of openings resisting particulate passage into the nozzle branches;

- a fluid delivery line filter at the second end of the sprinkler network, the fluid delivery line filter comprising a plurality of inlets resisting particulate passage therethrough;

wherein a fluid outlet is provided downstream of the fluid delivery line filter at the second end of the sprinkler network.

The sprinkler network comprises a fluid delivery line extending from the fluid inlet to each of the first and second nozzle branches.

Features described herein common to more than one aspect of the invention are independently relevant for each aspect of the invention, *mutatis mutandis*, unless stated otherwise and are not generally repeated here for brevity.

The sprinkler network includes at least one pipe.

The nozzle may be at a second opposite end of the respective branches.

The fluid inlet may be provided at the first end of the sprinkler network. A further network may extend from the first end of the sprinkler network in a different direction to the second end of the sprinkler network.

There may be further nozzle branches, normally between the first and second nozzle branches, and each of the further nozzle branches attached to the sprinkler network/delivery line at the branch's first end, and having a nozzle at their second, opposite end.

One or more nozzle branches may include a reducing bush. They may also include a branch pipe. Typically the internal cross sectional diameter of the branch pipe is less than that of the sprinkler network or main delivery line.

The internal cross sectional diameter of the branch pipe may be 0.1 - 3", especially 0.5 -3".

The internal diameter of the sprinkler network may be 1 – 8", optionally 2 – 4".

The branch filters may be mounted in the branch. Whilst they may extend into the sprinkler network to an extent, preferably they do not significantly inhibit flow therethrough. Thus the cross sectional area of the sprinkler network at the branch inlet is at least 60% clear of the branch filter, preferably at least 80%, preferably at least 90%.

The branch filters may be mounted in each of the first and second nozzle branches proximate the sprinkler network, and optionally at least one branch filter, optionally more than one, may be spaced away from the respective nozzles, for example by at least 2" or at least 4".

The branch filters may include a filter disclosed in WO 2015/150836, the disclosure of which is incorporated herein by reference.

Alternatively, the branch filter may be in the form of a guard.

The guard may comprise a first portion and a second portion.

The first portion may be dome-shaped. That is, the centre of the first portion may extend longitudinally further than an outer portion of the first portion and the first portion has an arcuate surface. The first portion may include said openings. The openings are preferably straight and optionally parallel slots. Alternatively, or additionally, the openings may be circular holes.

In cases where the inlets are slots, each slot comprises a smaller, minimum dimension, such as a width; and a longer, maximum dimension, such as a length. For example, the width of each slot may 0.2 – 5mm. When the inlets are, or include, circular holes, the diameter of each hole may, for example, be 0.2 – 5mm.

The spacing between each inlet may be 0.5 – 7.5 mm. For example, each inlet may have a width/diameter of 1mm, and be spaced apart from the adjacent inlet by 1.5mm. The inlets, in use, resist the passage of debris through the guard and into the nozzle branches.

The length of the slots may vary depending on their location on the first portion. They may be 5 – 70mm in length. Slots located in the middle of the first portion, that is at the apex of the dome, typically have the longest length. The length of each slot may decrease the further away the slot is from the middle of the first portion, and the closer it is to the outer portion of the first portion. Slots located at the outer portion of the first portion typically have the shortest length.

The second portion may be an outer circular surface with a fixing means, such as a threaded portion. The threaded portion may threadably connect the guard to the nozzle branch. The first portion and the second portion are typically formed as a one-piece item.

The second portion may comprise an inner surface and an outer surface. The threaded portion is typically located on the outer surface. The threaded portion may extend up to 99%, 75% or up to 50% and more than 20%, 30%, 40% of the height of the second portion.

The portion of the guard between the outer portion of the first portion and an adjacent portion of the second portion may be referred to as a shoulder. The shoulder may comprise a pressed anode. Alternatively, the entire guard may be coated in a pressed anode. Pressing the anode may help to improve its electrical contact with the guard and improve its connection to the rest of the guard. Coating the guard, or a portion of the guard, in an anode may help to prevent corrosion of the guard when in use, thus helping to prevent the creation of debris, which may otherwise block the inlets.

The guard is interchangeable, that is the guard can be threadably disengaged from the pipe fitting, and an alternative guard threadably engaged instead. For example, a guard with slots can be swapped for a guard with circular holes.

In use, a flow of fluid containing debris travels through the sprinkler network. The openings in the branch filter allow fluid to pass therethrough. Due, in part, to the flow of fluid through the fluid outlet provided downstream of the fluid delivery line filter, debris tends to pass the nozzle branch and continue flowing. However should any debris contact the branch filter it is more likely to rebound from the surface and continue towards the second end. Nevertheless whilst a significant amount of debris is drawn to the fluid delivery line filter, and so avoids the nozzle branch, some sufficiently small debris may pass through the openings in the branch filter.

The nozzle branches normally each include a pipe fitting. The pipe fitting is normally a T-fitting, though may be an angled fitting, such as a 45 degree fitting.

The pipe fitting normally comprises a threaded inner portion, normally located adjacent to the opening, to engage with the branch filter.

The second end/further branch of the sprinkler network may be orientated in an (at least partially) downwards direction, such that gravity can encourage debris towards the fluid delivery line filter. Thus the second end/further branch of the sprinkler network may be a branch provided on such a pipe fitting described above. Preferably it is orientated directly downwards for the same reason. The second end/further branch may extend to a working height, e.g. below 1.5m from a floor therebelow, in order to provide more convenient access to personnel such as at a workstation. For certain embodiments, this may be at least 0.5m or at least 1m lower than the second end of the first and second nozzle branches.

In contrast to the nozzle branches, no equivalent of a branch filter is provided in the further branch/second end of the sprinkler network. Instead, debris is encouraged to flow therein until it reaches the fluid delivery line filter.

A valve may be provided between the fluid delivery line filter and the second nozzle branch; and the second end/further branch may be disconnectable from the rest of the sprinkler network. In this way, the valve may be closed, and the second end/further branch detached and debris therein emptied, before being reattached and the valve opened again. An advantage of such embodiments is that this may be done when the sprinkler system is still online and operable. In contrast, clearing in-line cross-sectional filters requires intervention in the direct flow path between the inlet and the nozzles, and so requires a sprinkler system to be shut down or a bypass provided. Consequently regulations may require work on the installation protected by the sprinkler system to be suspended.

Even with a bypass, the bypass does not have an inline filter and so the system can be particularly contaminated with debris as the filtration is removed from the inlet.

Moreover, clearing of the fluid delivery line filter may be done much more conveniently wherein the second end/further branch extends 0.5m or more lower than the nozzle branches and/or within 1.5m of a floor therebelow, compared to many known nozzle systems which require rope access or scaffolding to be erected, in order to gain access to raised pipeline networks.

The fluid delivery line filter may be provided as part of a debris management device also comprising:

a housing having an inlet and an outlet;

the fluid delivery line filter provided in the housing such that fluid flow between the inlet and the outlet of the housing must pass through the fluid delivery line filter.

Optionally the debris management device comprises a fluid flow control device downstream of the fluid delivery line filter wherein the fluid flow control device is adjustable to control fluid flow downstream of the fluid delivery line filter.

The fluid flow control device may be attached to the outlet of the housing.

Thus the fluid flow control device may be in fluid communication with and downstream of the outlet of the housing. The fluid delivery line filter is typically over the outlet.

At least a portion of the internal diameter of the housing is normally equal or optionally larger than the inner diameter of the pipe of the sprinkler network from which it extends. This provides capacity to hold debris between the filter and the housing. It may be larger by a multiple of at least 1.2 or at least 1.4. For example, the pipe from which it extends may have an internal bore of 0.75 – 1.25" and the internal diameter of at least a portion of the housing is 1.5 – 2.5".

This contrasts with existing systems where the internal diameter of components reduces towards the downstream end. Therefore, the internal diameter of the housing of embodiments of the present invention is normally larger than the internal diameter of at least one, usually both of the first and second nozzle branches.

The nozzle branch's internal diameter is determined by the internal diameter of the fitting between the nozzle branch and the delivery line, taking into account, where present, of a reducing bush. Therefore if a reducing bush is present between the delivery line and the nozzle branch, the internal diameter of the reducing bush at the nozzle branch side determines the nozzle branch's internal diameter.

Said portion may be at least 25% of the length of the housing, or at least 50% or at least 75%.

The fluid delivery line filter is normally a fluid flow conduit. The fluid delivery line filter normally has an outer surface and a throughbore. The fluid delivery line filter may be tubular in shape. The fluid delivery line filter may have a first end and a second end. The throughbore of the fluid flow conduit normally has a cross-sectional area. The cross-sectional area of the throughbore of the fluid flow conduit may be referred to as an internal cross-sectional area.

The plurality of inlets typically provide fluid communication between the outer surface and the throughbore. The plurality of inlets are typically slot shaped.

The width of the slots is preferably less than the diameter of any downstream passage, such as the flow control device or the downstream fluid outlet. In this way, any debris which proceeds through the slots will not block the exit to atmosphere.

They may have a diameter of from 0.1 – 10mm, preferably 0.5 – 2mm. The spacing between the slots may be slightly larger, such as 1 – 12mm, or 1.5 – 4 mm. Preferably the solid state area (i.e. outside of the inlets) is larger than the inlet area in order to provide stability to the fluid delivery line filter.

The fluid delivery line filter typically has an end inlet and an outlet. The end inlet of the fluid delivery line filter typically has an end inlet cross-sectional area. The outlet of the fluid delivery line filter is normally positioned through the outlet of the housing. The outlet of the fluid delivery line filter typically has an outlet cross-sectional area. The cross-sectional area of the end inlet of the fluid delivery line filter is typically less than the cross-sectional area of the outlet of the fluid delivery line filter.

The housing may be referred to a debris chamber. In use, debris in the fluid flow is typically drawn into the debris chamber. It is an advantage of certain embodiments of the present invention that when the debris management device is part of a sprinkler system, debris in the fluid flow is typically managed and encouraged into specific locations, rather than more randomly distributed throughout the sprinkler system. It may be a further advantage of the present invention that this may reduce service and maintenance costs and/or the associated risks.

The fluid flow control device is typically adjustable to control the fluid flow rate and/or volume of fluid flow therethrough and therefore also through the outlet of the housing. The fluid flow control device may have at least a first and a second setting. The first setting allows a greater fluid flow rate and/or volume of fluid to flow through the fluid flow control device compared to the second setting. The first setting may use a first larger diameter aperture in the fluid flow control device. The second setting may use a second smaller diameter aperture in the fluid flow control device. The first aperture therefore allows a greater fluid flow rate and/or volume of fluid to flow through the fluid flow control device compared to the second aperture.

The inventor of the present invention has noted that on start-up more debris may have built up in the system over time. Therefore a purge of the system can clear this accumulated debris. In use, the fluid flow control device may be opened at the first larger aperture to clear the system of debris on start up, and then switched to the second smaller aperture to continue a fluid and debris flow towards the delivery line filter.

For certain embodiments therefore, the first larger aperture is larger than an aperture towards the nozzles in the nozzle branches. This allows for a greater flow rate through the delivery line filter and first aperture of the fluid flow control device, compared to the flow rate to the nozzles, and so preferentially directs the initial flow and accumulated debris through the delivery line filter rather than the nozzles.

The second aperture is sized to match the flow rate through the nozzles, so that pressure can be maintained through the nozzles. Therefore it may be $\pm 20\%$, preferably $\pm 10\%$ of the size of an aperture in the nozzle branches directing flow to the nozzles.

The diameter of the second aperture may be from 50 to 5%, normally from 50 to 25% and typically from 40 to 30% of the diameter of the first aperture.

The fluid flow control device is typically a ball valve. A ball of the ball valve may have one, typically two apertures. The two apertures may be the first and the second aperture. The first aperture therefore typically has a greater diameter compared to the second aperture. Rotation of the ball in the ball valve can therefore typically change the fluid flow rate and/or volume of fluid flow through the fluid flow control device. The first aperture with a greater diameter typically allows a greater fluid flow rate and/or volume of fluid to flow through the fluid flow control device compared to the second aperture with a smaller diameter.

The fluid flow control device may be any valve. The fluid flow control device may be a fluid flow restrictor or fluid flow limiter.

Adjustment of the fluid flow control device to control the fluid flow downstream of the fluid delivery line filter, normally through the outlet of the housing, may be remote from the debris management device and/or automatic. Adjustment of the fluid flow control device to control the fluid flow through the outlet of the housing may be timed, that is the fluid flow control device may be adjusted after a period of time to change the fluid flow rate and/or volume of fluid flow through the outlet of the housing and/or change the fluid flow control device from the first to the second setting.

The period of time varies depending on a number of system-specific variables, such as the size of the fluid delivery line filter, the size of the fluid delivery line filter outlet, the size of a header, and the volumes and pressures. Thus the period of time is very variable and may be for example as little as 10 seconds or for example more than two minutes or for example as much as 20 minutes.

When the fluid flow control device is a ball valve comprising a ball with a first aperture having a greater diameter compared to a second aperture and adjustment of the fluid flow control device to control the fluid flow through the outlet of the housing is timed, the ball of the ball valve may be rotated after for example 30 seconds to direct fluid flow from through the first aperture to the second aperture. This reduces the fluid flow rate and volume of fluid flow through the fluid flow control device.

The fluid flow control device typically has an inlet and an outlet. The inlet is typically in fluid communication with the outlet of the housing. The outlet typically provides a fluid outlet from the debris management device. The fluid flow control device may be downstream of the outlet of the housing.

The debris management device may direct the fluid flow out of the housing to a collection tray, or dump it overboard. Thus some embodiments do not have a nozzle downstream of the fluid delivery line filter. Alternatively however, it may be directed to a nozzle. Notably, the primary function of the fluid delivery line filter is to draw debris away from a primary supply line used for other nozzles, rather than to filter debris for a downstream nozzle. Any downstream nozzle may thus be a "sacrificial" nozzle. Preferably, the functioning of such a nozzle would not be necessary for the overall fire safety management plan, because debris is encouraged in order to keep other nozzles relatively clear of debris.

The nozzle is typically in fluid communication and/or attached to the outlet of the fluid flow control device.

The fluid delivery line filter typically substantially extends into the housing. The fluid delivery line filter typically substantially extends between the outlet and the inlet of the housing. The inlet is typically opposite and/or opposed to the outlet. The fluid delivery line filter may extend greater than 50%, normally greater than 75% and typically greater than 80% of the distance between the inlet and the outlet of the housing.

The ratio of the length to width of the fluid delivery line filter is normally from 2 to 20, and typically from 5 to 10. The length of the fluid delivery line filter may be at least 6", optionally at least 8". Slots may extend for at least 50% of the length of the filter, optionally at least 70% or at least 90%. Thus this is relatively long, though serves to provide capacity to the housing to contain more debris. For example, where debris has accumulated in the housing

the relatively long filter can still provide a filter length to be free to allow flow therethrough to atmosphere for a longer period of time than if the filter was covered by debris.

The debris management device may part of an open atmospheric system. The fluid flow control device is adjustable to control fluid flow downstream of the fluid delivery line filter. The inlet and the outlet of the fluid flow control device are in fluid communication such that fluid flow from the outlet of the housing may be maintained, this fluid flow being to atmosphere.

The sprinkler apparatus is designed for firefighting, fire suppression, fire containment or other unwanted heat sources. Preferably, the system is used in an offshore environment, such as on an oil and gas rig facility.

The sprinkler network may include a filter branch, the filter branch including a further fluid delivery line filter. The further fluid delivery line filter may be between the inlet and the first nozzle branch. There may be no further nozzle branches between the filter branch and the first nozzle branch.

Typically a pump is provided to move fluid from the intake to the nozzles.

A yet further filter may be provided proximate to each nozzle, to yet further control debris that may otherwise potentially block the nozzle. Certain embodiments have fluid delivery line filters optionally on yet further filter branches and/or branch filters and filters at the nozzles.

The nozzles direct the fluid outwards and may be referred to as sprinklers.

Thus one embodiment of the invention provides a filter positioned out with the main delivery line flow path, on a fitting (e.g. T or elbow) which protects the main delivery line from blocking. In one embodiment a 2" inner diameter delivery line will have a housing with a 2" or greater inner diameter.

The invention also provides a further aspect of the invention, being a method of using a sprinkler system for salt water environments, the sprinkler system comprising:

- a fluid inlet;
- a first nozzle branch comprising a first nozzle;
- a second nozzle branch comprising a second nozzle;

a fluid delivery line extending from the fluid inlet to each of the first and second nozzle branches;

a fluid delivery line filter provided outwith the fluid delivery line, on a further branch;

the fluid delivery line filter provided in a housing

the fluid delivery line filter comprising a plurality of inlets resisting particulate passage therethrough;

wherein a fluid outlet is provided downstream of the fluid delivery line filter;

the method includes creating a fire safety management plan predominantly based on fluid flow from the first, second and any further nozzle branches compared to the fluid outlet from the further branch.

Normally a fire safety management plan is required to be prepared on the basis of the number and flow rate/type of sprinklers required to contain/extinguish/heat suppress a fire in the event of an outbreak or other emergency. As the primary function of the delivery line filter is to protect the delivery line and keep the nozzles relatively free from debris, such a plan according to the method aspect predominantly, optionally exclusively, is created based on fluid flow from the first, second and any further nozzle branch rather than the further branch. "Predominantly" means more fire containment/extinguishing/heat suppression flow is calculated from one nozzle branch compared to the further branch.

The sprinkler system may also comprise:

- a. an intake from a salt water reservoir;
- b. a pipe network connecting the intake with the main delivery line; the pipe network comprising a pipe having an internal bore with a diameter of at least 5";
- c. a branch connected to said pipe, the branch comprising a filter having a plurality of inlets and an exit to atmosphere.

According to a further aspect of the present invention, there is provided a sprinkler system for salt water environments, comprising:

- an intake from a salt water reservoir;
 - a pipe network connecting the intake with a sprinkler network attached to a plurality of nozzles;
- the pipe network comprising a pipe having an internal bore with a diameter of at least 5";
- a branch connected to said pipe, the branch comprising;

a filter having a plurality of inlets;
an exit to atmosphere.

Thus despite the fluid being required by the sprinklers/nozzles, the further aspect includes a branch connected to a pipe of the pipe network, and the branch has said filter and an exit to atmosphere. The pipe with the branch, being of a diameter of at least 5" is far removed from the sprinkler pipework which has a much smaller inner diameter.

Thus the inventor has discovered that providing such an outlet at the relatively upstream end of such a sprinkler system provides the benefit of drawing debris out of the system before it continues towards the nozzles, potentially blocking them.

The internal bore of the pipe may be at least 8".

Notably, the filter is provided on a branch outwith the direct flowpath from the intake to the nozzles.

Common features between embodiments of the present aspect and earlier aspect are not always reiterated here, for brevity. Earlier options are independently options described earlier are independently options for embodiments according to the present aspect.

To facilitate debris to flow to the branch, filters in the direct flowpath towards the nozzles (outside any nozzle branches), are minimised such that there is less than three, preferably less than two, and preferably there are none. This is marked contrast to known systems where it is often a requirement to provide filters inline. The present invention prefers to minimise such filters and provides the filter outwith said direct flowpath which draws debris therein because of the fluid outlet to atmosphere.

Such an in-line filter which is minimised is described further above.

There may be further such branches from the pipe or more generally the pipe network, each filter branch including a filter and an exit to atmosphere.

Typically the internal cross sectional diameter of the branch is less than that of the pipe from which it extends.

The internal cross-sectional diameter of the branch may be 1 – 2.5” or larger if the pipe is larger.

The branch may be orientated in an (at least partially) downwards direction, such that gravity can encourage debris towards the branch. Preferably it is orientated directly downwards for the same reason.

The branch may be provided at a change in direction of the pipe.

Thus, a supply pipe of the pipe network, may continue in an at least partially upwards direction towards the sprinkler network. Thus, when the sprinkler system is deactivated, debris in the supply pipe is more likely to fall into the branch and be removed from the primary flowpath between the intake and the nozzles. Thus the branch may be provided on a T-junction opposite said supply pipe, and the “main” pipe provided generally at right angles to each.

A valve may be provided between the filter of the branch, and the pipe such that (at least a portion) of the branch is disconnectable from the rest of the pipe network; as described above for the fluid delivery line filter.

It is an advantage of certain embodiments of the present invention that when the fluid flow control device is part of a sprinkler system for helping to contain, mitigate or extinguish a fire, the sprinkler system and debris management device can operate concurrently and debris in the fluid flow may be removed from the sprinkler system while it is in operation.

Akin to the second end of the sprinkler network in the first aspect of the invention, the filter in the branch may be provided as part of a debris management device also comprising: a housing having an inlet and an outlet; the filter provided in the housing such that fluid flow between the inlet and the outlet of the housing must pass through the filter.

Other options of the debris management device are equivalent to those described above for earlier aspects.

The filter typically has an end inlet and an outlet. The end inlet of the filter typically has an end inlet cross-sectional area. The outlet of the filter is normally positioned through the outlet of the housing. The outlet of the filter typically has an outlet cross-sectional area. The

cross-sectional area of the end inlet of the filter is typically less than the cross-sectional area of the outlet of the filter.

The housing may be referred to a debris chamber and the fluid flow control device is typically adjustable to control the fluid flow rate and/or volume of fluid flow therethrough and therefore also through the outlet of the housing. These features are described above in relation to other embodiments.

The debris management device may direct the fluid flow out of the housing and dump it overboard.

The filter typically substantially extends into the housing and the ratio of the length to width of the filter is described above.

The sprinkler apparatus is also described above in reference to other aspects of the invention.

Typically a pump is provided to move fluid from the intake to the sprinklers.

The nozzles direct the fluid outwards and may be referred to as sprinklers.

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

Fig. 1 shows a sprinkler system for salt water environments in accordance with one embodiment of the present invention;

Fig. 2 shows a sprinkler system for salt water environments in accordance with another embodiment of the present invention;

Fig. 3a is a schematic sectional view of a debris management device used in a sprinkler system of the present invention;

Fig. 3b is a plan view of a filter of the debris management device;

Fig. 4 shows four enlarged views of a guard for use with the Fig. 1 or Fig. 2 embodiments;

Fig. 5 shows a side view of a filter arrangement for use with the Fig. 1 or Fig. 2 embodiments,

Fig. 6 shows a sprinkler system, at an intake end, for salt water environments in accordance with one aspect of the present invention;

Fig. 7a is a schematic sectional view of a debris management device used in a sprinkler system of the present invention; and

Fig. 7b is a plan view of a filter of the debris management device.

Fig. 1 shows a well sprinkler system 10 comprising an inlet 32 leading to a sprinkler network 34 which extends to a second opposite end 36, which has an outlet 38.

From the inlet 32, a delivery line 44 of the the sprinkler network 34 extends to a first (optional) filter branch 39 and a series of nozzle branches 33a - 33d, with respective nozzles 30a - 30d. The sprinkler network 34 then continues past the delivery line for the nozzle branches 33a – 33d to a debris management device 80a with an fluid delivery line filter 88 provided outwith the fluid delivery line, upstream of the outlet 38.

Fig. 2 shows a slightly different embodiment of a well sprinkler system, labelled 210. In contrast with the Fig. 1 embodiment, the Fig. 2 embodiment shows a first (optional) filter branch 239 at one end of the system. In use, the flow entering through the inlet 232 splits, with a proportion of the flow going to the filter branch 239, and proportion of the flow going towards the nozzle branches 230a-d and outlet 238.

A debris management device 80 is shown in more detail in Fig. 3a and can be any of the debris management devices 80a, 80b, 280a, 280b shown in the earlier figures. It comprises a housing 82 having an inlet 84 and an outlet 86 and also has the filter 88 in the housing 82, wherein fluid flow (not shown) between the inlet 84 and the outlet 86 of the housing must pass through the filter 88. The debris management device 80 comprises a fluid control device in the form of a fluid flow control device in the form of a valve 90 downstream of the outlet 86 of the housing 82. The valve 90 is adjustable to control fluid flow through the outlet 86 of the housing 82.

Surprisingly, the valve 90 is operable to control fluid through the outlet from a first position where a high flow rate is permitted, and a second position where a smaller flow rate is permitted (*ceteris paribus*).

The fluid flow control device 90 is a ball valve comprising a ball 91 with a first aperture 92 having a greater diameter compared to the second aperture 93. Adjustment of the fluid flow control device 90 to control the fluid flow (not shown) through the outlet 86 of the housing 82 may be timed. The first aperture 92 is used when the debris management device and larger sprinkler system is first put into to use. The increased fluid flow through the first aperture 92

helps to draw debris accumulated in the system into the housing 81 and away from other components of the larger sprinkler system. After 60 seconds, for example, the ball valve is rotated using the actuator 94 and fluid flow is then through the second aperture 93.

This ensures more of the fluid flow, typically water, is directed to the parts of the sprinkler system used for helping to contain, mitigate or extinguish a fire but some debris is still drawn into the housing 81 and away from other components of the larger sprinkler system. Moreover, as flow can continue through the smaller aperture, debris continues to be drawn into the debris management device, away from the sprinklers.

The size of the first aperture 92 is typically larger than apertures 31a – 31d directing fluid onto the nozzles, so that the initial flow of fluids is directed to the device 80. The size of the second aperture 93 is sized to be similar to that of the aperture directing fluid onto the nozzles, so that the system can be suitably pressurised.

The filter 88 comprises a threaded portion 87 and a filter tube 89 which comprises a plurality of apertures 83 that are slot shaped. The top 88a of the filter tube 89 is prism-shaped, with a pointed apex, and comprises an inlet comprising two slots 88b and 88c.

The slots 88b & 88c are at right-angles to each other, and the two slots 88b & 88c cross each other at the apex 88a of the prism at the top of the filter tube 89. At the four ends of the two slots 88b & 88c there is a circular hole.

In use, any large particles of debris (not shown) in the fluid flow (not shown) can be fractured and/or broken into smaller particles if they make contact with the pointed apex 88a of the filter tube 89. The slots 88b & 88c prevent any debris above a predetermined size from entering the throughbore of the filter tube 89. Debris (not shown) above this predetermined size will collect inside 81 the housing 82 and can itself facilitate filtering of the fluid towards the outlet 86.

The housing has a larger internal diameter than the inner diameter of the pipe from which it extends (and normally of the sprinkler network 34 more generally). The additional volume that results allows for a larger capacity of debris to gather between the filter and the housing. Thus, combined with the longer length of the filter, in certain embodiments, flow can continue through the filter without blockages for a much longer period of time, compared to the filter 102 mounted on a nozzle or pipe, for example.

Moreover, if the housing fills with debris it will not block the main delivery line and fail the whole system as standard in-line filters do. In this way all nozzles on the nozzle branches are protected.

This contrasts with the teaching in the art to reduce the diameter of the pipework towards fluid exits. Therefore, as can be seen from the figures, the diameter of the housing is larger than that of the nozzle branches 33a – 33d.

It is an advantage of certain embodiments of the present invention that the pointed apex 88a of the filter tube 89 can break larger particles of debris into smaller particles, because this may help to mitigate the risk of the filter becoming blocked, and also more debris can potentially be stored in the housing compared to conventional containers. It is an advantage of certain embodiments of the present invention that the debris may be collected in the housing below the slots, because this can help to mitigate the risk of the slots becoming blocked with large particle of debris. Furthermore, it is an advantage of certain embodiments of the present invention that in use, the slots can help to reduce the volume of debris, such as scale, rust particles and salt deposits, being distributed out with the debris management device, thus reducing the risk of blockages to the larger nozzle system and therefore injury to personnel nearby.

The debris management device 80 further includes a pressure gauge 98 and an isolation valve 99. The housing is disconnectable from the rest of the nozzle network. To do this, the isolation valve 99 is closed, and the housing detached and debris therein emptied, before being reattached and the isolation valve 99 opened again.

The operation will now be described with respect to Fig. 1, although it will be appreciated that the operation can be performed with the Fig. 2 system.

When the system 10 is initially started by a pump (not shown) the debris problem is often more severe due to debris which may have set/solidified or adhered to the system over time. The valve 90 is therefore set to allow a relatively large flow rate therethrough. Debris is therefore drawn towards the debris management devices 80a, 80b, by the flow of fluids into atmosphere through the outlet 38. This draws the debris away from the nozzle branches 33a – 33d, thus mitigating the amount of debris that proceed towards the nozzles 30a – 30d and in turn mitigating the possibility of blockages. In the illustrated embodiment, the fluid flow from the debris management device 80 is directed to a sacrificial nozzle 30e. Notably, the debris management device 80 is primarily provided to draw debris away from the fluid

delivery line 44 and nozzle branches 33a-d, rather than protect the downstream nozzle 30e. However, in some scenarios little debris may be present and so, an additional nozzle 30e may be used. In other embodiments, the flow from the outlet 38 may be discarded e.g. dumped offshore.

In order to provide sufficient fluid and pressure to the nozzles (not shown) the valve 90 is timed to automatically move from the relatively large flow rate to a smaller flow rate for example after 30 seconds. Thus surprisingly the valve 90 is preferably not closed entirely. During operation, debris will continue to be picked up by the inlet 32, or break away from the system generally. Having a flow of fluid towards the debris management system 90 draws some of such further debris towards the debris management system 90 rather than towards the nozzles 30a – 30d; again mitigating the likelihood of nozzles blocking.

An advantage of certain embodiments is that the distance and run of fluid, can force the debris along the delivery line towards the delivery line filter following the open flow path, caused by the fluid outlet, optionally at the second end of the sprinkler system.

The hydraulic model for the system will account for an amount of fluid being directed through the debris management devices.

It is an advantage of certain embodiments, that debris is drawn away from the nozzles on start-up and/or during operation of the system.

In alternative embodiments, a flow control device is not necessary, and the fluid will bleed out of the outlet 38. Nevertheless, this still encourages debris away from the nozzles 30a - 30d.

In order to encourage debris to be directed to the second end 36, a form of branch filter is provided at each nozzle branch 33a-d. Filters 102a, 102b are respectively provided at the nozzle branches 33a, 33b; and guards 2c, 2d are provided at the nozzle branches 33c, 33d. These discourage passage of debris and particles from entering the nozzle branches 33a-d.

They are provided proximate the sprinkler network, that is within 100mm, and may have a small portion of a dome shaped surface extending into the flow through the sprinkler network. However, it is preferred that the filters do not impede the flow through the sprinkler network significantly. For nozzle branches 33b and 33c the branch filters 102b, 2c are spaced away from the respective nozzles 30b, 30c.

Fig. 4 shows the guards 2c and 2d, herein referred to by the reference numeral 2, in more detail, specifically in plan view A, isometric view B, side view C and cross-sectional view D.

The guard 2 comprises a dome-shaped top surface 12 and a cylindrical side surface 14, as can best be seen in views C and D. The top surface 12 comprises openings in the form of slots 10 which vary in length, with the outermost slots having the shortest length and middle slot having the longest length. It may be an advantage of embodiments of the present invention that the dome-shaped top surface can direct any debris and also any salt water flowing through the guard towards the side surface of the guard. This can help to avoid salt crystallisation on the slots and thus help to prevent the guard from becoming blocked.

The side surface 14 comprises a threaded portion 8 which in use allows the guard 2 to be mounted to a fitting. In use, the guard 2 is attached to a T-fitting 4 (see Fig. 1) by inserting the threaded portion 8 of the guard 2 into a corresponding threaded portion in an opening of the T-fitting 4, and screwing the two components together. Once the guard 2 is attached to the T-fitting 4, a gap 7 is formed between the side surface 14 and the T-fitting 4. The guard 2 can subsequently be removed from the T-fitting 4 by unscrewing the threaded portion 8 of the guard 2 and the corresponding threaded portion in the opening of the T-fitting 4. The threaded portion 8 of the guard 2 allows the guard 2 to be removed and replaced with another guard; the guard 2 is thus interchangeable.

The guard 2 also comprises an anode 17 pressed around an edge 16 of the top surface 12. It may be an advantage of embodiments of the present invention that the presence of an anode can help to prevent corrosion from occurring on the slots.

In alternative embodiments, the top surface of the guard may comprise circular holes instead of, or in addition to, the slots.

The filters 102a and 102b, herein referred to by the reference numeral 102, is shown in more detail in Fig. 5.

Fig. 5 shows a side view of an embodiment of a filter 102 in accordance with one aspect of the present invention. The filter 102 is formed from a tube 120 extending from a first end to a second end. An inlet 115 is positioned through the first end of the tube 120. The inlet 115 has a cross-sectional area less than the cross-sectional area of the outlet 122 of the tube

120 and normally less than the outlet of an associated nozzle in use. The inlet 115 also has a cross-sectional area less than the cross-sectional area of the internal bore of the tube 120.

Slots 110 extend longitudinally along the first part of the side wall 113 of the tube 120 from the first end of the tube to a threaded bush 108. The slots are 1 mm and above in width and, in this example, are of a suitable length where two of the slots equals the flow required to give the corresponding K-Factor of the associated nozzle.

These filters 102 may also be used at the nozzles 30b, 30c and are labelled 102c in Fig. 1. Once the filter 102 is connected to a nozzle 30b, 30c, the inlet 115 has a cross-sectional area less than the cross-sectional area of the outlet of the nozzle 30b, 30c

The bush thread 108 is provided to connect the filter 102 to a nozzle 30a or nozzle branch 33b via a nozzle bush 35a, 35b.

The first end of the filter 102 is a debris deflector formed in a tapered or dome-shaped end 111 such that the centre of the first end extends longitudinally further than an outer portion of the first end. The shape of the first end of the tube 120 encourages debris flowing through the pipeline to proceed in a flow direction away from the inlet 115.

The curvature of the debris deflector 111 limits the availability of flat areas of impact (i.e. surfaces at substantially 90 degrees to the direction of flow) for flowing debris and encourages debris in the flow to flow beyond the inlet 115. The smooth edge/surface of the debris deflector 111 reduces friction of the filter which propels debris away from the inlet 115. The cylindrical and/or curved surfaces further reduce the areas where salt crystallisation can begin allowing a free flow area.

Thus, the system may use one or more of pressure, flow path, fluid density and gravity to draw debris down into the housing. The pressure may be provided by a pump flowing fluid into the system. The flow path may be provided by the filter and housing arrangement. The fluid density and gravity may be provided by the relative orientation of the device.

An embodiment in accordance with a further aspect of the invention is shown in Fig. 6. Fig. 6 shows a pipe network 310 including an intake 312, a main pipe 313, branches 314a, 314b, and a supply pipe 332. The supply pipe 332 leads to a sprinkler network and nozzles/sprinklers (not shown in Fig. 6).

Debris management devices 380a, 380b comprising an end or fluid delivery line filter 388a 388b is provided in each of the branches 314a, 314b.

The debris management device 380a or 380b, shown in more detail in Fig. 7a and 7b, includes similar features to the Fig. 3a, Fig. 3b debris management device 80 described earlier. The Fig. 7a, 7b embodiment comprises a housing 382 having an inlet 384 and an outlet 386 and also has the filter 388 in the housing 382, wherein fluid flow (not shown) between the inlet 384 and the outlet 386 of the housing must pass through the filter 388. The debris management device 380 comprises a fluid control device in the form of a valve 390 downstream of the outlet 386 of the housing 382. The valve 390 is adjustable to control fluid flow through the outlet 386 of the housing 382.

Surprisingly, the valve 390 is operable to control fluid through the outlet from a first position where a high flow rate is permitted, and a second position where a smaller flow rate is permitted (*ceteris paribus*).

The filter 388 comprises a threaded portion 387 and a filter tube 389 which comprises a plurality of apertures 383 that are slot shaped. The top 388a of the filter tube 389 is prism-shaped, with a pointed apex, and comprises an inlet comprising two slots 388b and 388c.

In use, any large particles of debris (not shown) in the fluid flow (not shown) can be fractured and/or broken into smaller particles if they make contact with the pointed apex 388a of the filter tube 389. The slots 388b & 388c prevent any debris above a predetermined size from entering the throughbore of the filter tube 389. Debris (not shown) above this predetermined size will collect inside 381 the housing 382 and can itself facilitate filtering of the fluid towards the outlet 386.

Referring back to Fig. 6, when the system 310 is initially started by a pump (not shown) the debris problem is often more severe due to debris which may have set/solidified or adhered to the system over time. The valve 390 is therefore set to allow a relatively large flow rate therethrough. Debris is therefore drawn towards the debris management devices 380a, 380b by the flow of fluids into atmosphere through the outlet 338. This draws the debris away from the supply pipe 332, thus mitigating the amount of debris that proceed towards the nozzles and in turn mitigating the possibility of blockages. The fluid flow from the debris management device 380 may be directed overboard.

In order to provide sufficient fluid and pressure to the nozzles (not shown in Fig. 6) the valve 390 is timed to automatically move from the relatively large flow rate to a smaller flow rate for example after 30 seconds. Thus surprisingly the valve 390 is preferably not closed entirely. During operation, debris will continue to be picked up by the intake 312, or break away from the system generally. Having a flow of fluid towards the debris management system 390 draws some of such further debris towards the debris management system 90 rather than through the supply pipe 332 towards the nozzles; again mitigating the likelihood of nozzles blocking.

The hydraulic model for the system will account for an amount of fluid being directed through the debris management devices.

It is an advantage of certain embodiments, that debris is drawn away from the nozzles on start-up and/or during operation of the system.

When the system is turned off, the alignment of the supply pipe 332 with the branch 314a, encourages debris in the supply pipe to fall into the branch 314a by gravity, outwith the primary flowpath from the intake to the nozzles.

The slots 388b & 388c are at right-angles to each other, and the two slots 388b & 388c cross each other at the apex 388a of the prism at the top of the filter tube 389. At the four ends of the two slots 388b & 388c there is a circular hole.

It is an advantage of certain embodiments of the present invention that the pointed apex 388a of the filter tube 389 can break larger particles of debris into smaller particles, because this may help to mitigate the risk of the filter becoming blocked, and also more debris can potentially be stored in the housing compared to conventional containers. It is an advantage of certain embodiments of the present invention that the debris may be collected in the housing below the slots, because this can help to mitigate the risk of the slots becoming blocked with large particle of debris. Furthermore, it is an advantage of certain embodiments of the present invention that in use, the slots can help to reduce the volume of debris, such as scale, rust particles and salt deposits, being distributed out with the debris management device, thus reducing the risk of blockages to the larger sprinkler system and therefore injury to personnel nearby.

The debris management device 380 further includes a pressure gauge 398 and an isolation valve 399. The housing is disconnectable from the rest of the sprinkler network. To do this,

the isolation valve 399 is closed, and the housing detached and debris therein emptied, before being reattached and the isolation valve 399 opened again.

Thus, the system may use one or more of pressure, flow path, fluid density and gravity to draw debris down into the housing. The pressure may be provided by a pump flowing fluid into the system. The flow path may be provided by the filter and housing arrangement. The fluid density and gravity may be provided by the relative orientation of the device.

Fig. 1 shows the nozzle end of the sprinkler system in Fig. 6. The supply pipe 332 of Fig. 6 communicates with the supply pipe 32 of Fig. 1. Fluid is directed into the nozzles 30a-d to mitigate or contain a fire.

Modifications and improvements can be incorporated herein without departing from the scope of the invention.

Modifications and improvements can be incorporated without departing from the scope of the invention.

Claims

1. A sprinkler system for salt water environments, comprising:
 - a fluid inlet;
 - a first nozzle branch comprising a first nozzle;
 - a second nozzle branch comprising a second nozzle;
 - a fluid delivery line extending from the fluid inlet to each of the first and second nozzle branches;
 - a fluid delivery line filter provided outwith the fluid delivery line, on a further branch;
 - the fluid delivery line filter provided in a housing, the internal diameter of the housing being larger than the internal diameter of the first and second nozzle branches;
 - the fluid delivery line filter comprising a plurality of inlets resisting particulate passage therethrough;
 - wherein a fluid outlet is provided downstream of the fluid delivery line filter.
2. A sprinkler system as claimed in claim 1, wherein in the main delivery line, there are less than three filters attached to the sprinkler network.
3. A sprinkler system as claimed in any preceding claim, wherein at least one of the first and second nozzle branches comprises a branch pipe having an internal cross sectional diameter of 0.5 - 3".
4. A sprinkler system as claimed in any preceding claim, wherein the internal diameter of the main delivery line is 2 - 4".
5. A sprinkler system as claimed in any preceding claim, wherein a branch filter is mounted in each of the first and second nozzle branches proximate the fluid delivery line, the branch filter comprising a plurality of openings resisting particulate passage into the nozzle branches.
6. A sprinkler system as claimed in claim 5, wherein branch filter has a dome-shaped outer surface facing the sprinkler network.
7. A sprinkler system as claimed in any preceding claim, wherein the fluid delivery line is part of a larger sprinkler network, the sprinkler network extending from a first end

to a second end and the fluid delivery line filter is provided at the second end of the sprinkler network.

8. A sprinkler system as claimed in any preceding claim, wherein the further branch of the sprinkler network is orientated in an at least partially downwards direction, such that gravity encourages debris into the further branch.
9. A sprinkler system as claimed in claim 8, wherein the further branch extends to a position less than 1.5m above a floor therebelow.
10. A sprinkler system as claimed in any preceding claim, wherein a valve is provided upstream of the delivery line filter and at least a portion of the further branch is disconnectable, proximate to this valve, from the rest of the sprinkler network.
11. A sprinkler system as claimed in any preceding claim, wherein the housing has an inlet and an outlet; the fluid delivery line filter provided in the housing such that fluid flow between the inlet and the outlet of the housing must pass through the fluid delivery line filter.
12. A sprinkler system as claimed in any preceding claim, wherein the fluid delivery line filter has an outer surface and a throughbore, the plurality of inlets providing fluid communication between the outer surface and the throughbore and wherein the plurality of inlets are slot shaped.
13. A sprinkler system as claimed in any one of claims 11 to 12, including a fluid flow control device downstream of the fluid delivery line filter which is adjustable to control fluid flow downstream of the fluid delivery line filter.
14. A sprinkler system as claimed in claim 13, wherein the fluid flow control device has at least a first and a second setting, the first setting allows a greater fluid flow rate and volume of fluid to flow through the fluid flow control device compared to the second setting which also allows a fluid to flow therethrough.
15. A sprinkler system as claimed in claims 14, wherein adjustment of the fluid flow control device to control the fluid flow through the outlet of the housing is timed, that is the fluid flow control device is adjusted after a period of time to change the fluid flow control device from the first to the second setting.

16. A sprinkler system as claimed in any one of claims 11 to 15, wherein at least a portion of the internal diameter of the housing is equal to or larger than the inner diameter of the pipe of the sprinkler network from which it extends.
17. A sprinkler system as claimed in any preceding claim, wherein the ratio of the length to width of the end filter from 5 to 10.
18. A sprinkler system as claimed in any preceding claim, wherein the length of the fluid delivery line filter is at least 6", optionally at least 8".
19. A sprinkler system as claimed in any preceding claim, comprising:
 - a. an intake from a salt water reservoir;
 - b. a pipe network connecting the intake with the main delivery line; the pipe network comprising a pipe having an internal bore with a diameter of at least 5";
 - c. a branch connected to said pipe, the branch comprising a filter having a plurality of inlets and an exit to atmosphere.
20. A sprinkler system for salt water environments, comprising,
 - a. an intake from a salt water reservoir;
 - b. a pipe network connecting the intake with a sprinkler network attached to a plurality of nozzles;the pipe network comprising a pipe having an internal bore with a diameter of at least 5";
 - c. a branch connected to said pipe, the branch comprising a filter having a plurality of inlets and an exit to atmosphere.
21. A sprinkler system as claimed in claim 20, wherein the internal cross sectional diameter of the branch is less than that of the pipe from which it extends.
22. A sprinkler system as claimed in any one of claims 20 to 21, wherein the branch is orientated in an at least partially downwards direction, such that gravity can encourage debris towards the branch.

23. A sprinkler system as claimed in claim 22, wherein a supply pipe of the pipe network continues in an at least partially upwards direction towards the sprinkler network opposite the branch.

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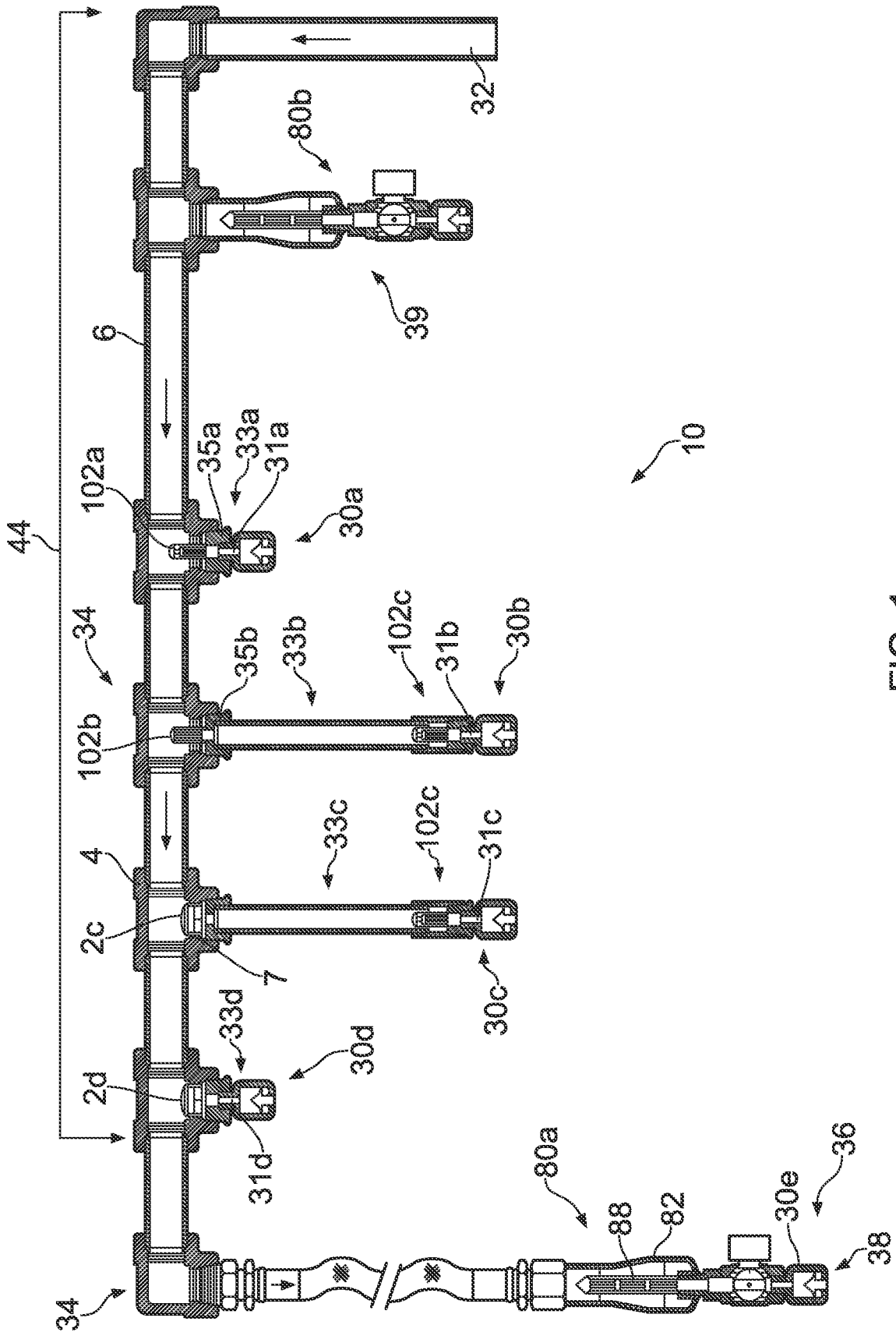


FIG. 1

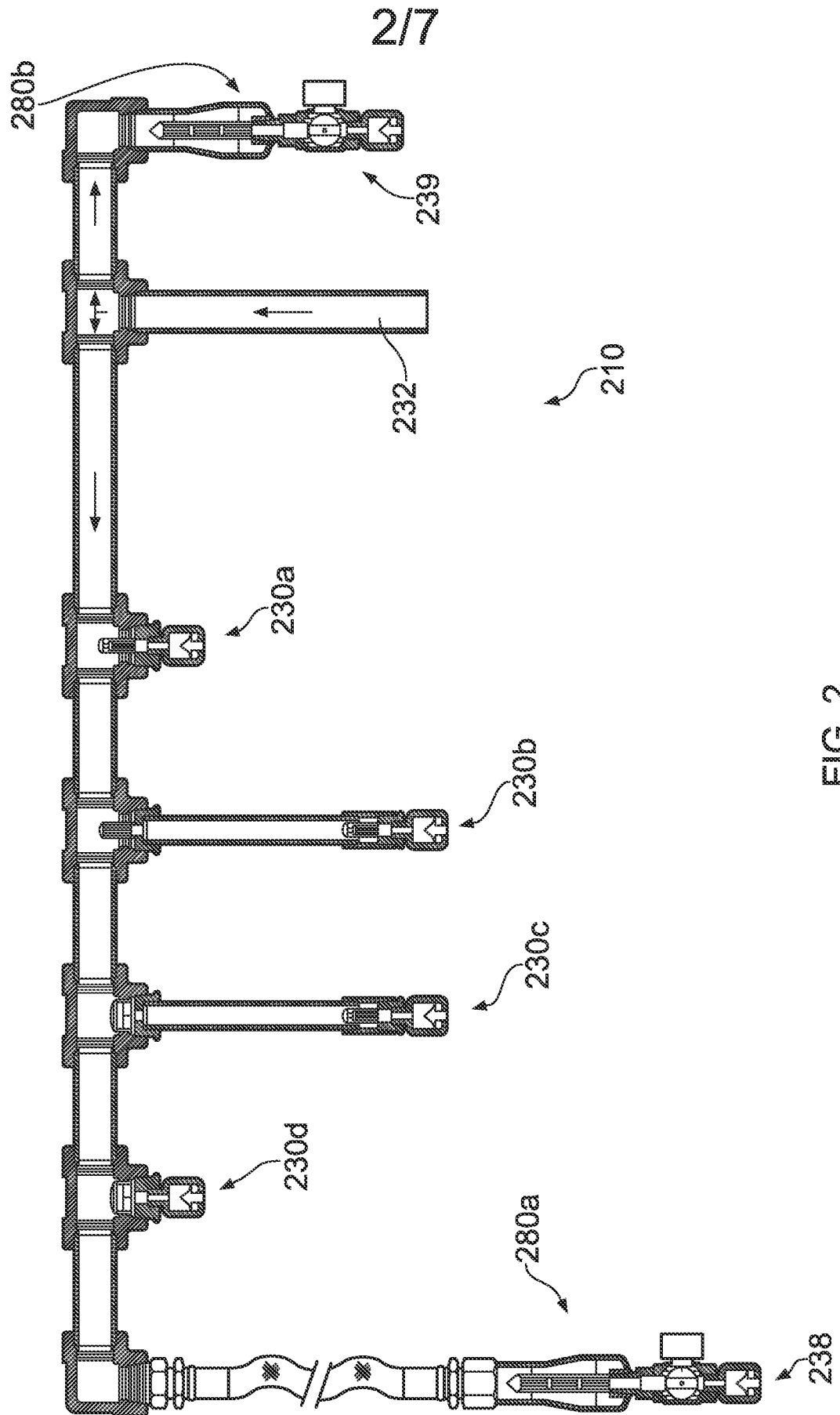


FIG. 2

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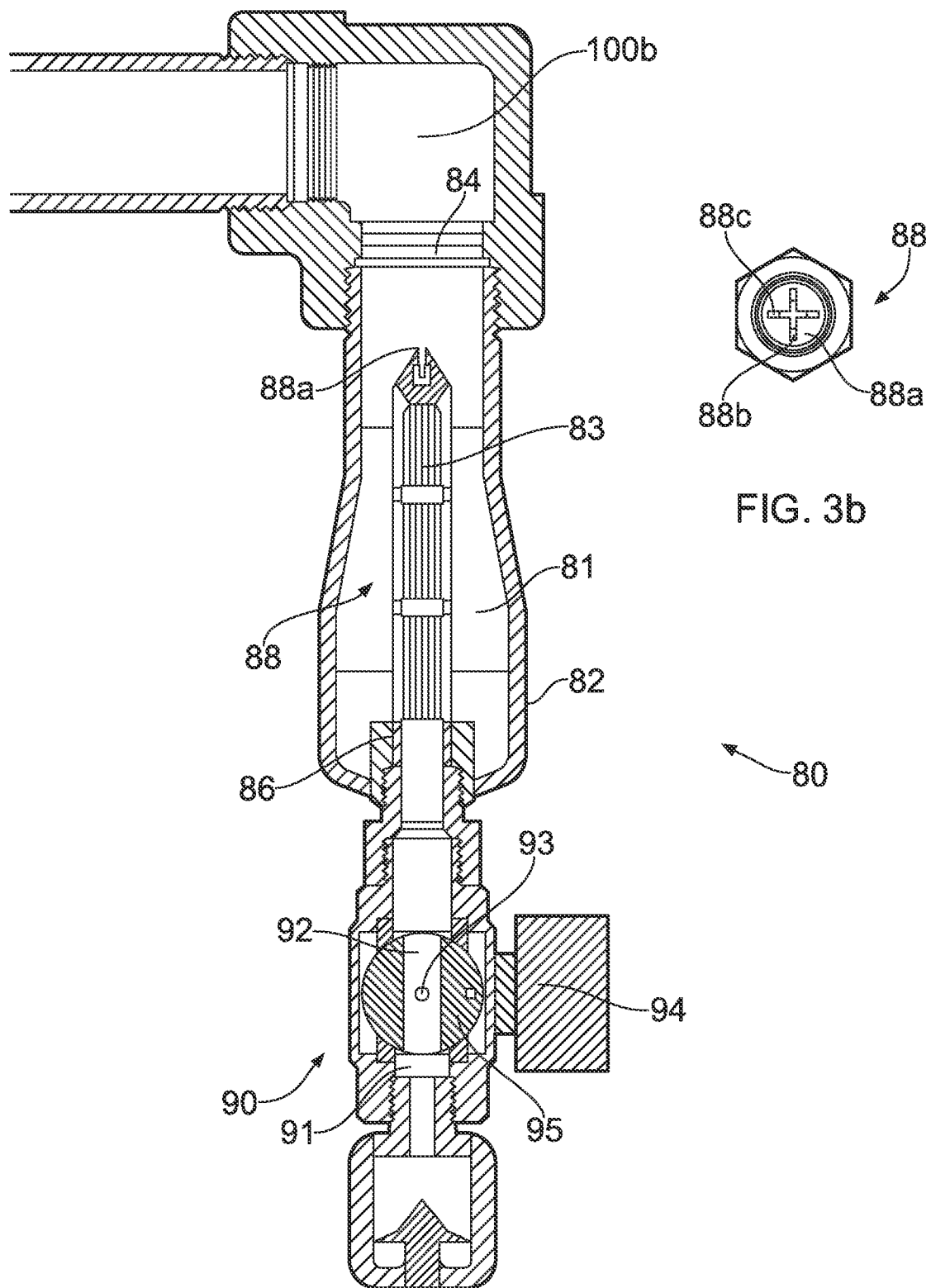
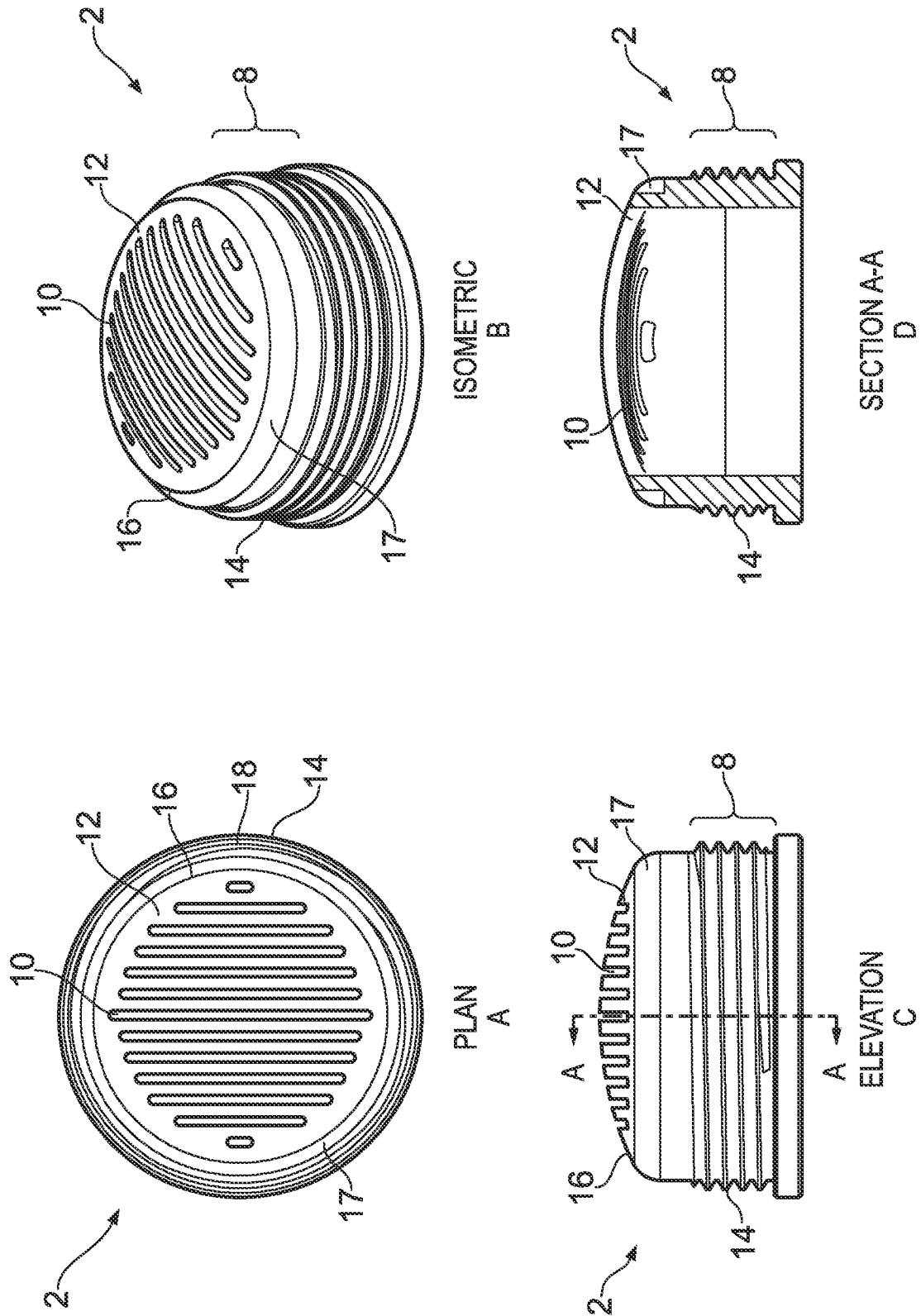


FIG. 3a

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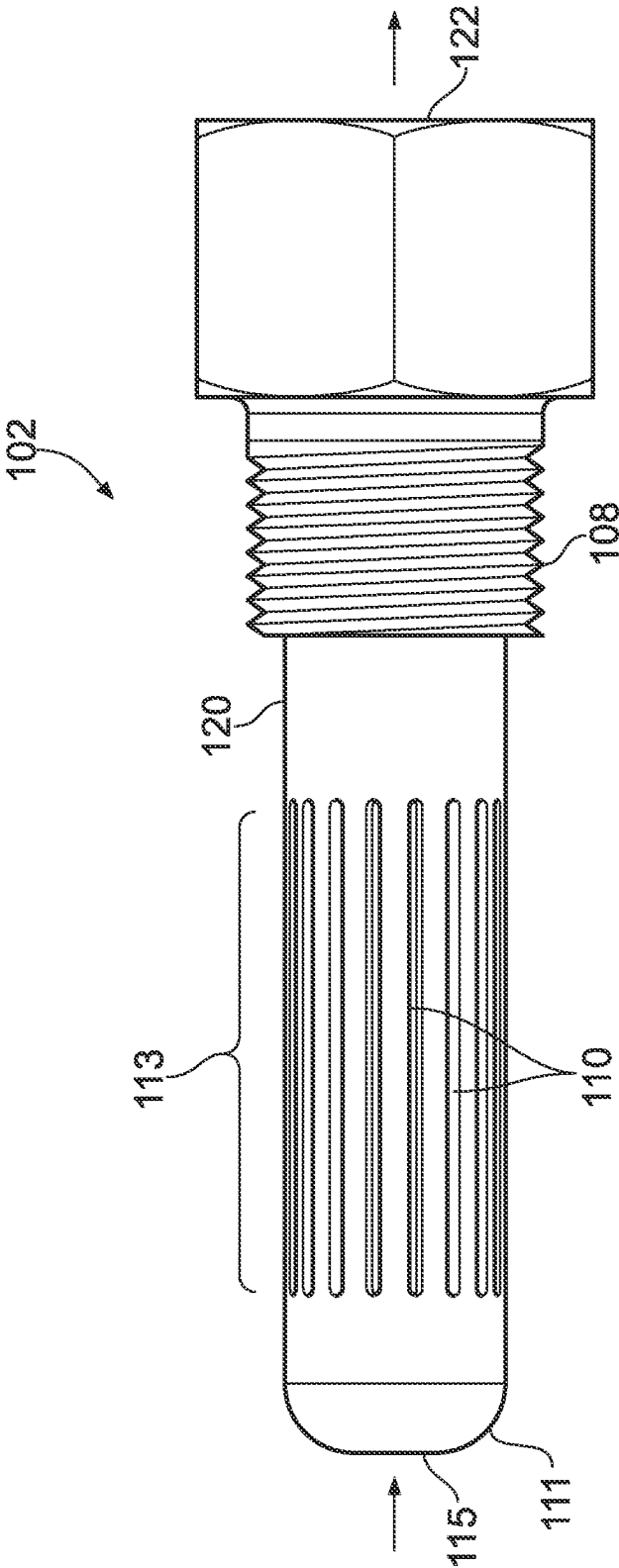


FIG. 5

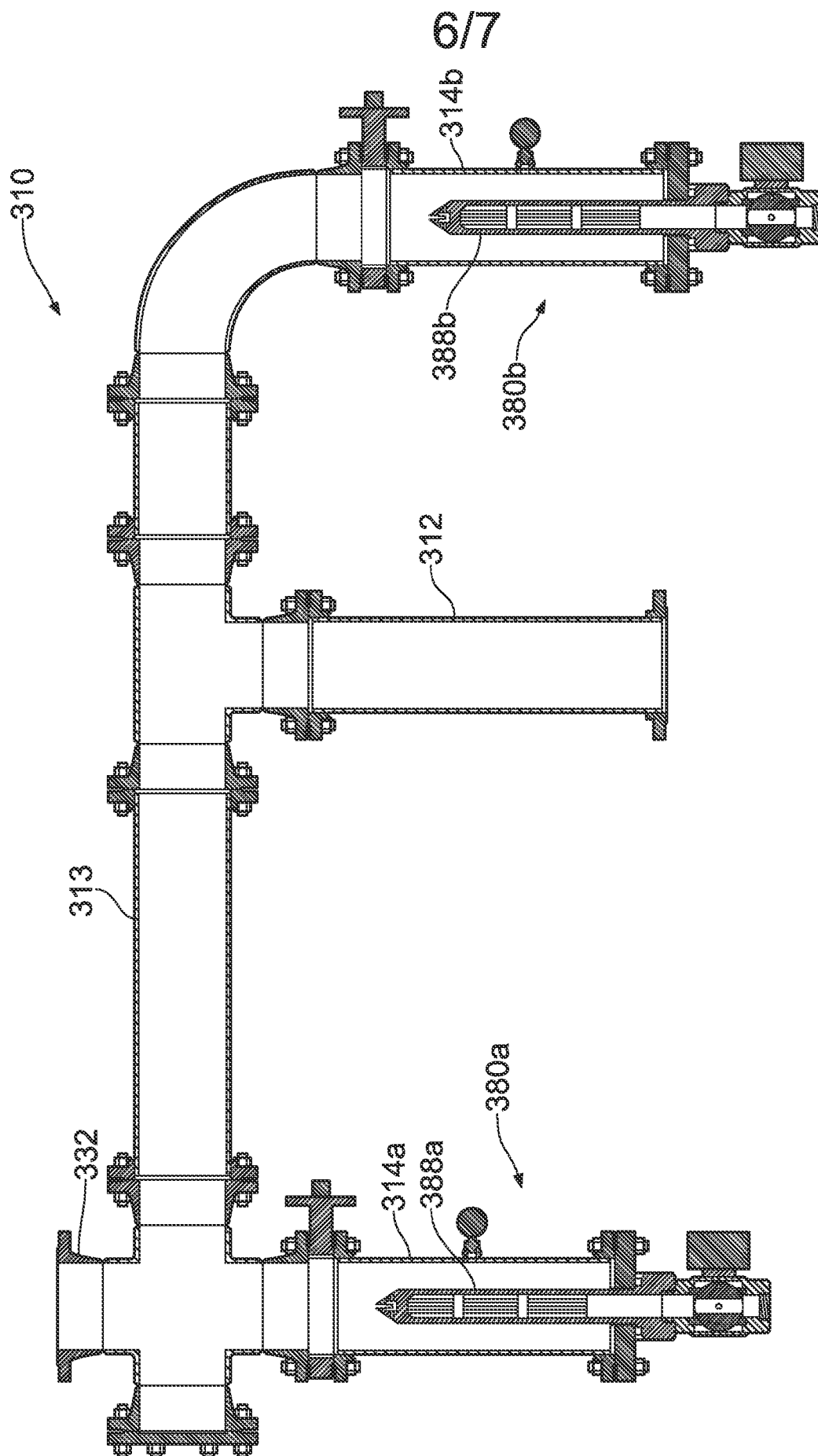


FIG. 6

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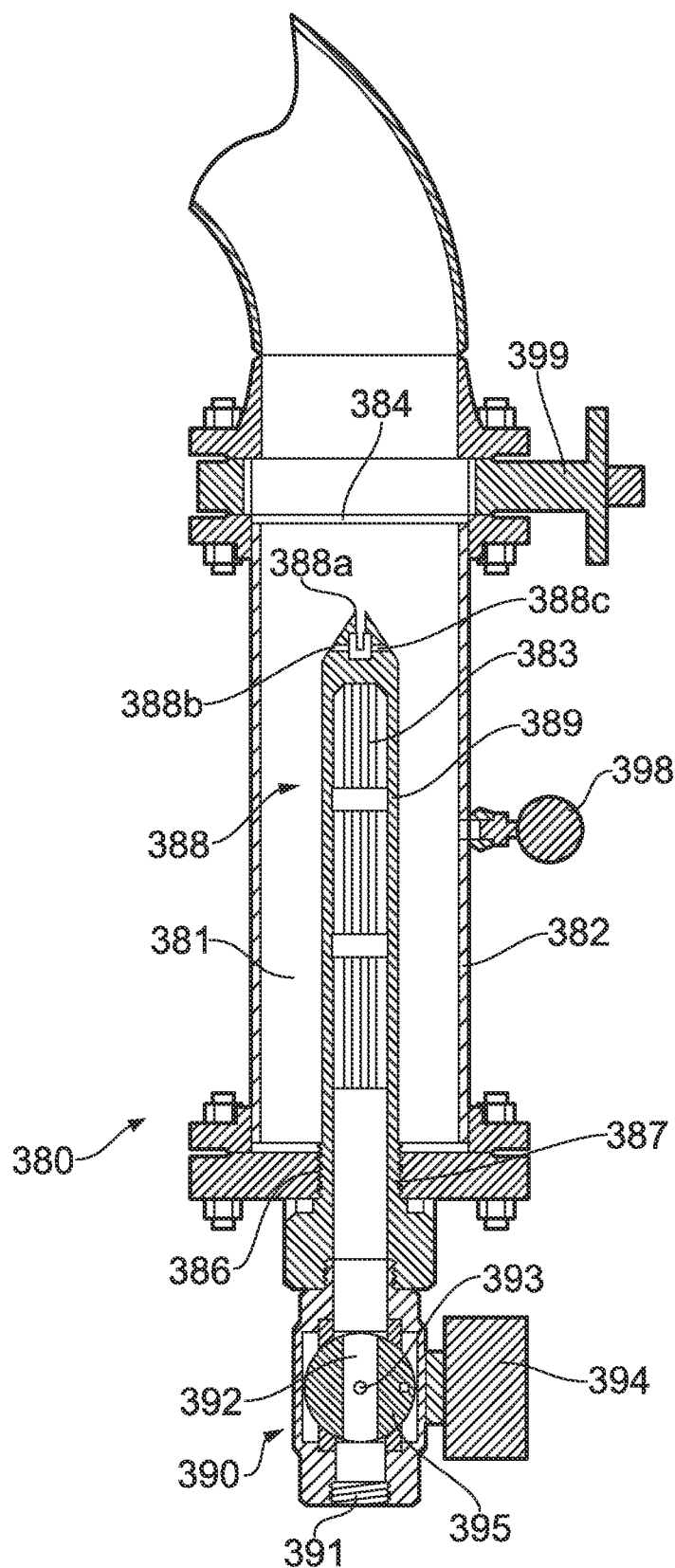


FIG. 7a

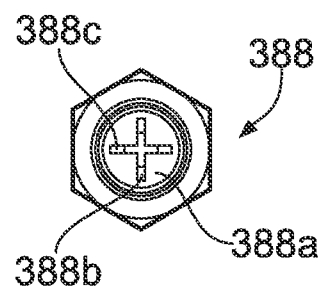


FIG. 7b

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2016/053994

A. CLASSIFICATION OF SUBJECT MATTER
INV. A62C35/58 A62C31/02 A62C35/68 B01D35/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A62C B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2015/150836 A1 (RIGDELUGE GLOBAL LTD [GB]) 8 October 2015 (2015-10-08) cited in the application the whole document	1-12, 16-19
X	US 2009/294341 A1 (BEER GERALD [US] ET AL) 3 December 2009 (2009-12-03) the whole document	1-12, 16-19
X	US 5 087 355 A (GODEC C T [US]) 11 February 1992 (1992-02-11)	1-14, 16-19
Y	the whole document	15
Y	US 2010/018911 A1 (VANZEELAND THOMAS L [US]) 28 January 2010 (2010-01-28) paragraph [0028]; figures 1,2	15
	-/--	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

8 March 2017

Date of mailing of the international search report

16/05/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Douskas, K

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2016/053994

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-19

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-19

A sprinkler system for salt water environments, comprising: a fluid inlet; a first and second nozzle branch each comprising a nozzle, and a fluid delivery line extending from the fluid inlet to the nozzle branches. A fluid delivery line filter is provided outwith the fluid delivery line, on a further branch, to remove debris from the main delivery line extending to the nozzles. The fluid delivery line filter is provided in a housing, the internal diameter of the housing normally being larger than the internal diameter of the first and second nozzle branches, to facilitate the accumulation of debris. An adjustable fluid outlet is provided downstream of the fluid delivery line filter. The fluid outlet draws debris outwith the main delivery line and away from the nozzle branches, mitigating the possibility of nozzles being blocked.

2. claims: 20-23

A sprinkler system for salt water environments, comprising,
a. an intake from a salt water reservoir;
b. a pipe network connecting the intake with a sprinkler network attached to a plurality of nozzles;
the pipe network comprising a pipe having an internal bore with a diameter of at least 5";
c. a branch connected to said pipe, the branch comprising a filter having a plurality of inlets and an exit to atmosphere.

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2016/053994

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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