

JUNCTION DEVICE, SYSTEM AND METHOD FOR FLUID DRAINAGE

Field of the Invention

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This invention relates to devices for managing fluid flow within fluid drainage systems, and more particularly to junction devices for fluid drainage systems.

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Background of the Invention

The design principle for junctions within conventional gravity rain water down pipe systems (RWDP) is based on the principle of open channel (non-pressured flow). FIG. 1 shows a conventional junction 10 commonly used in rain water down pipe systems. The conventional junction 10 has a down pipe 12 and a connecting horizontal pipe 14 that is joined in a perpendicular orientation. In drainage operation, water flows and clings along the wall of the pipe in a spiral direction indicated by arrows 30, while air flows in the opposite direction indicated by arrow 20 in the center of the pipe. Water also flows along connecting horizontal pipe 14 in the direction indicated by arrow 32.

In standard codes of practice such as the British standard and the European standard, for example, BS EN 12056-3:2000, suggests a fill rate of 33% for rain water down pipe systems for vertical pipe 12 and 70% fill rate for horizontal pipes 14. Such guidelines are intended to prevent pressure fluctuations in the rain water down pipe systems which lead to water 36 being pushed out from the horizontal branches 14. The vertical down pipe 12 is typically fluidly connected to the main drainage sources such as the roof top of a building. The horizontal branches typically fluidly connect the secondary drainage sources such as floor outlets, floor wastes, balconies, planter drainage, or the like as shown in FIG. 2 to the vertical down pipe 12. When pressure fluctuation occurs in conventional gravity rain water down pipe systems, a water plug 34 is formed in the down pipe

12 preventing the flow of air 20 causing the air to back flow 22. The air is then forced to flow back 24 into the connecting horizontal pipe 14 and pushes the water 36 out. This is commonly termed as backflow. This backflow problem has been the uncertainty factor for development, especially for high rise residential buildings where balconies drainage and lobbies drainage are linked to common rain water down pipe systems.

However, even in attempting to follow the standard code of practice of 33% fill rate, pressure fluctuations may still occur in the following situations:
 10 submerged discharge (for example, flooding in drains), occurrence of bends in the rain water down pipe systems, and/or occurrences when despite trying to comply with the standard code of practice flow rate extends beyond recommended fill rate of 33%.

15 Backflow occurs when the clear air passage in an open channel of a rain water down pipe system is completely filled with water and forms water plugs, thus preventing air from escaping upwards through the center of the pipe. Instead, air escapes through the side branches 14 causing backflow. Escaping air from the branches is known as positive air flow, whereas air
 20 being drawn into the pipe from the branches is known as negative air flow. Significant positive and negative pressures which may form inside the pipes during water flow contributes to backflow.

In such cases the air that naturally moves upwards in positive air flow is prevented from escaping. The positive air flow is then forced to escape through the nearest passages which are normally the branches linking to floor outlets. When this occurs, air brings along water and both are forced out through the floor outlet. The nature of the problem in pressure
 25 fluctuations is due to its uncertainty and unpredictability.

30 In conventional systems where a number of junctions are arranged in a stack configuration, different pressure fluctuations may be experienced at the upper most junctions in the stack compared to the lower most junctions, and backflow may be observed.

Additionally, in conventional junctions as described above are not compatible or easily adaptable in siphonic rain water down pipe (SRWDP) systems (siphonic drainage systems). Typically, in high rise buildings with siphonic drainage systems, the main drainage is completely separate from the drainage of secondary drainage such as floor outlets, floor wastes, balconies, planter drainage and the like. The main drainage is not fluidly connected with the secondary drainage because siphonic systems are drainage systems where the pipes are filled with water and contain no air and exhibit full bore water flow. Typically, pipes commonly used in siphonic drainage systems are 1/3 of the size of pipes commonly used in conventional gravity rain water drain pipe systems (non-siphonic drainage systems). For example, in siphonic drainage systems, the down pipe is typically 2" (50mm), and in non-siphonic drainage systems the down pipe is typically has a gauge of 6" (150mm). The siphonic outlets feeding the down pipes in the siphonic drainage system are specially designed to prevent air from entering the system, and the pipe gauge or diameter of the down pipe in the siphonic drainage system connected to the siphonic outlets is chosen to be relatively smaller than in non-siphonic drainage systems to ensure that the pipe is completely filled with water. It is not recommended to connect a non-siphonic pipe or junction to a siphonic system as it will introduce air into the siphonic system and prevent full bore flow in the siphonic system thereby reducing the drainage capacity of the siphonic system. It is also not recommended for a siphonic system to be connected to a conventional non-siphonic systems as it will introduce more water than what a conventional non-siphonic system can drain. This will result in occurrence of pressure fluctuations. An attempt to overcome this is to enlarge the diameter of the non-siphonic pipe and design the non-siphonic pipe with 33% filled. However, having pipes of different diameter is unsatisfactory and not economical as the down pipe required in the non-siphonic components must be enlarged for most applications. In most cases the down pipes in the non-siphonic system are required to be enlarged by 3 times or larger based on the guideline given by the code of practice. For example where the siphonic drainage system components

are 2" (50mm) and for the siphonic drainage system to connect to a non-siphonic drainage system, the minimum pipe size of the non-siphonic pipes system must be at least 6" (150mm).

- 5 Therefore, there is a need for a device and system that addresses a problem associated with conventional drainage systems, and in particular to solve the backflow problem in horizontal branches linked into rain water down pipe systems.

10 **Summary of the Invention**

In accordance with an aspect of the invention there is provided a fluid junction device for managing a first fluid flowing from at least two sources and a second fluid from at least one source, the second fluid capable of a negative pressure flow and a positive pressure flow, the device comprising
 15 a body having a first port adapted for fluid communication with the first fluid from a first source, a second port adapted for fluid communication with the first fluid from a second fluid source, a third port for the discharge of the first fluid received from first and second ports, the body forming a junction between the first and second port and third port, and a diverter formed in
 20 the junction defining a nozzle formed in the body at the junction for diverting the flow of the first fluid from the first source from the first port to the third port forming an escape for the second fluid in either a positive pressure flow or negative pressure flow through the second port.

25 In embodiments, a first port unit is adapted to be connected and in fluid communication with a second port unit forming the fluid junction device. The diverter is arranged to divert water in the junction to form a first fluid plug is formed in the proximity of the first port adjacent the nozzle formed at the junction. The nozzle may form a jet of the first fluid from the first fluid
 30 source increasing the pressure and velocity of the discharge flow of the first fluid at the third port. The body may comprise a second diverter formed at the junction of the second port for diverting the flow of the first fluid from the first diverter to the third port and forming. The first port may have a central axis that is concentricly aligned with a central axis of the third port, or the

first port may have a central axis that is misaligned with a central axis of the third port.

In accordance with an aspect of the invention there is provided a drainage
 5 system comprising a plurality of devices forming a stack of devices,
 wherein the output of an upper device is in fluid communication with the first
 port of the lower device. Each device in the drainage system may comprise
 an escape for the second fluid in either a positive pressure flow or negative
 pressure flow through the second port of each device.

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In accordance with an aspect of the invention there is provided a method
 for managing a first fluid flowing from at least two sources and a second
 fluid from at least one source, the second fluid capable of a negative
 pressure flow and a positive pressure flow, the method comprising
 15 receiving the first fluid from the first fluid source in a fluid junction device
 having a body having a first port adapted for fluid communication with the
 first fluid from a first source, a second port adapted for fluid communication
 with the first fluid from a second fluid source, a third port for the discharge
 of the first fluid received from first and second ports, the body forming a
 20 junction between the first and second port and third port;
 diverting the first fluid with a diverter formed in the junction defining a
 nozzle formed in the body at the junction for diverting the flow of the first
 fluid from the first source from the first port to the third port; and
 forming an escape for the second fluid in either a positive pressure flow or
 25 negative pressure flow through the second port.

In embodiments, a first port unit is connected in fluid communication with a
 second port unit, the first port unit comprising the first port of the fluid
 junction device, and the second port unit comprising the second port of the
 30 fluid junction device. A plurality of devices are connected to form a stack of
 devices, the output of an upper device in the stack of devices is in fluid
 communication with the first port of a lower device. An escape is formed
 for the second fluid in either a positive pressure flow or a negative pressure
 flow through the second port of each device in the stack of devices. The

first fluid is diverted to increase the pressure and velocity of the discharge flow of the first fluid from the first port to the third port.

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Brief Description of the Drawings

In order that the present invention may be fully understood and readily put into practical effect, there shall now be described by way of non-limitative
10 example only preferred embodiments of the present invention, the description being with reference to the accompanying illustrative drawings. In the drawings:

FIG. 1 shows a cross-sectional view of a conventional gravity rain water
15 down pipe junction when properly designed and working;

FIG. 2 shows a cross-sectional view of the conventional gravity rain water down pipe junction of FIG. 1 showing a formation of a water plug during pressure fluctuations;

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FIG. 3 shows a cross-sectional view of an anti-backflow junction in operation in accordance with an embodiment of the invention, the cross-sectional view taken along line A-A of FIG. 5A;

25 FIG. 4 shows the cross-sectional perspective view of FIG. 3 having a side port exposed on the second port in accordance with an embodiment of the invention;

FIG. 5A-C show top views of the anti-backflow junction in accordance with
30 an embodiment of the invention;

FIG. 6A and 6B shows cross-sectional views taken along lines B-B and C-C, respectively, of the anti-backflow junction of FIG. 4 in accordance with an embodiment of the invention;

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FIG. 7A shows a side elevation view of the anti-backflow junction of FIG. 4 having a side port in accordance with an embodiment of the invention, and FIG. 7B shows a side elevation view of an anti-backflow junction in accordance with an embodiment of the invention;

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FIG. 8 shows a front elevation view of the anti-backflow junction of FIG. 4 having the second port of the junction with multiple ports in accordance with an embodiment of the invention;

10 FIG. 9A and 9B show a top view of the anti-backflow junction in accordance with an embodiment of the invention, and a cross-sectional view of the anti-backflow junction of FIG. 9A taken along line D-D in accordance with an embodiment of the invention, respectively;

15 FIG. 10A and 10B show a top view of the anti-backflow junction in accordance with an embodiment of the invention, and a cross-sectional view of the anti-backflow junction of FIG. 10A taken along line E-E in accordance with an embodiment of the invention, respectively;

20 FIG. 11A and 11B show a top view of the anti-backflow junction in accordance with an embodiment of the invention, and a cross-sectional view of the anti-backflow junction of FIG. 11A taken along line F-F in accordance with an embodiment of the invention, respectively;

25 FIG. 12A and 12B show a top view of the anti-backflow junction in accordance with an embodiment of the invention, and a cross-sectional view of the anti-backflow junction of FIG. 12A taken along line G-G in accordance with an embodiment of the invention, respectively;

30 FIG. 13 shows a cross-sectional view an anti-backflow junction having the first port as a separate unit from the second port and the third port in accordance with an embodiment of the invention;

FIG. 14 shows a cross-sectional view of a stack system comprising a plurality of anti-backflow junctions in accordance with an embodiment of the invention;

- 5 FIG. 15 shows a cross-sectional view of a hybrid siphonic/non-siphonic stack system comprising a plurality of anti-backflow junctions in accordance with an embodiment of the invention; and

- FIG. 16 shows a flow diagram of a method in accordance with an
10 embodiment of the invention.

Detailed Description

- FIG. 3 shows a cross-sectional view of an anti-backflow junction device 100 in operation in accordance with an embodiment of the invention. FIG. 4
15 shows the cross-sectional view of the anti-backflow junction device 100 of FIG. 3 with perspective view showing a side port 142 exposed on the second port 104. The cross-sections of FIG. 3 and FIG. 4 are taken along the line A-A shown in FIG. 5A of a top view of the anti-backflow junction. The anti-backflow junction device comprises a body 108 with a cavity or
20 passages having first port 102, a second port 104 and a third port 106. The first port and the second port are in fluid communication with fluid sources (not shown) which may be draining rain water collected from rooftops, balconies, floor wastes, floor outlets, planter drainage and the like. The body 108 is configured with a lip or diverter 112 in the wall that defines a
25 nozzle 110 with the sidewall of the body of the junction device along the wall of the first port and the third port opposite the second port. In an embodiment, a section of the side wall of the second port forms provides as gradual descent, an escape cut away 114, of the branch to the third port. This cut away section 114 maintains the diameter of the pipe size to ensure
30 downward water flow exit from the second port to the third port. Also, between the first port and the second port, a support 136 is provided to provide added structural support for the second port and make the junction device rigid, however, it will be appreciated that such support may not be necessary or other means of support may be envisaged.

The diverter 112 is shown in more detail in the top view of the junction device of FIG. 5A and the cross-sectional views of FIG. 6A and 6B taken at different cross-sections of the anti-backflow junction device 100 shown in FIG. 4. The diverter 112 is a protrusion, ramp, channel, lip, bump, latch, ledge, or the like that extends from wall or within the surface of the first port. The diverter is integral with the side wall extending from the mouth of the first port such that the surface of the side wall is continuous with smooth surfaces. In other embodiments, the diverter may be formed as protrusion, ramp, channel, lip, bump, latch, ledge, or the like having smooth and/or angled configuration. It will be appreciated that the diverter may be integral with the side wall, however, the diverter may take other configurations such as structurally added and/or adhered to the side wall of the tubular pipe of the port. In this embodiment shown in FIG. 4-6B, the diverter top length extends about half of the circumference of the wall extending around the perimeter of the first port from a first point 113 to a second point 115 of the diverter as seen in the top view of FIG. 5A to the dashed line 128 of FIG. 4. The bottom length is the distance from point 113 to point 115 around the head of the nozzle in a cross-section (not shown) including the point 124 shown in FIG. 4. The depth of the diverter extends from a first point 122 and a second point 124 as shown in FIG. 4. The diverter is sculpted as shown by channel 117, and the resulting diverter width 119 is shown that changes along the length of the diverter. Diverter width is defined by the horizontal distance, relative the central axis of the first port, from point 124 to dashed line 128 in FIG. 4. More specifically, diverter width is the distance from the surface of the diverter that is exposed to the water to the first port wall of the pipe as shown in FIG. 6A and FIG. 4. In FIG. 4 the dashed line 128 is an extension of the sidewall 126 of the first port by which the width of the diverter 112 may be seen from dashed line to the surface of the diverter exposed to the interior of the junction device 100. The diverter width is the distance along a radial line diverging from the central axis 180 of the first port from the edge of the ledge of the diverter 112 to the side wall extension as shown as dashed line 128 in FIG. 4 of the opening of the first port taken along a desired cross section as shown in FIG. 6A. The

depth of the diverter is the vertical distance, relative the central axis of the first port, along the surface of the diverter forming the interior surface of the pipe that extends from point 122 and 124 shown in FIG. 4. The length of the diverter is shown in FIG. 5A and extends from the first point 113 to a second point 115. The diverter has configuration such that in operation, the diverter 112 manages to divert the flow of the downward spiraling water entering the mouth of the first port 102 as indicated by arrows, and concentrates the flow of water against the opposite wall 111 of the second port 104 and third port 106, forming a water plug 134 at the first port proximate the diverter, between the diverter in the side wall 111 of the junction device 100 opposite the diverter 112. The diverter 112 in this embodiment has a sloping, gradient or ramping orientation with respect to the side wall of the first port. In this embodiment the diverter width 119 varies along the length of the diverter 112, and remains constant for the majority of the length at each cross section along the length, however, near the point 113,115 the diverter width is tapered. It will be appreciated that the width of the diverter may vary along either the depth or length or both or remain uniform. The length and/or depth of the diverter may also vary or be uniform along the depth and/or length, respectively. Of course, other configurations may be envisaged for the diverter 112, and some variations are shown and discussed in detail below with reference to FIG. 9A-12B.

Since the side wall 111 of the wall opposite the diverter is continuous, the configuration of the side wall 111 and the diverter 112 form a nozzle 110. The diverter 112 is in a position having the orientation where the first port cross-sectional area is reduced at the tip, at point 124, of the diverter forming the nozzle head. The diverter 112 is designed to reduce the cross-sectional area of the first port within the shortest width and yet has the least resistance to the fluid flow so as to maximize fluid capacity. This desired function is achieved by the shape and angle of the diverter 112 shown. The ratio of distances of the cross-sectional openings of the nozzle head 150, from the opposite wall of the first port 111 to the tip 124 of the nozzle head (shown in FIG. 5B), and the mouth of the first port 102 (shown in FIG. 5C) is shown. Having the nozzle head opening 152 too small will cause the

fluid capacity to be low and not effective. Having the nozzle head opening 150 too small also increases the potential of having the device blocked by foreign items and debris such as leaves, twigs, soil and the like. If the nozzle head opening 150 is too large, the anti-backflow properties and functions will not be effective, and backflow may still occur. The ratio to achieve is a balance between the maximum capacity of the anti-backflow junction device and the effectiveness of the anti-backflow junction device. For example, the ratio for percentage of reduction may be from approximately 10% to 25%. It will be appreciated that the ratio of the opening of the first port and the opening of the nozzle head may vary for specific applications, and may be less than 10% or more than 25%.

Additionally, the junction of the second port 104 with the first port 102 to the third port 106 as shown is a graduated junction with smooth edges and curves with escape cut away section 114. Another function of an embodiment of second port section 114 besides allowing air to escape is to maintain the pipe diameter of the second port. Maintaining the pipe diameter in the second port also helps to prevent blockages by foreign items and debris such as leaves, twigs, soil and the like at the second port. This also allows the overall size of the anti-backflow junction device 100 as small and compact as possible.

In operation, the anti-backflow fitting 100 provides a controlled situation at the junctions to prevent uncontrolled pressure fluctuation in rain water down pipe systems that may contribute to back flow. FIG. 16 shows a flow diagram of a method 400 in accordance with an embodiment of the invention. The flow of water 130 from the first source 402 is channeled or diverted by diverter 112 in the side wall which forms the nozzle 110 that increases the velocity of the flow of water 132 downstream of the nozzle 110 and out third port 106. The first fluid directed from the first port away from the second port 404. The air flow 120 is left clear for the air to escape 406 through the second port 104.

The configuration ensures a controlled situation at every junction within the body of the device. The nozzle 110 formed by the diverter 112 at the junction ensures the formation of the water plug 134 and therefore ensures that the pressure build up at above the nozzle. The forming of the pressure
5 above the nozzle 110 creates a pressure jet which passes through the nozzle at increased velocity. Pressure is released after the nozzle 110. In a system comprising multiple or a plurality of such anti-backflow fittings, the pressure builds and increases again above the next downstream nozzle. This situation is repeated at every junction and may be predicated and
10 controlled.

The pressure jet that is formed by the nozzle 110 may cause a high velocity pressure jet that accelerates the water beyond the junction, thereby ensuring a clear air passage at the junction. The anti-backflow fitting works
15 in both negative and positive pressure which is a phenomenon that occurs with water and air flowing in pipes and drainage systems. In most cases the air inside the anti-backflow fitting 100 is forced downwards through the next nozzle together with water traveling at high velocity. In such cases the high velocity pressure jet causes the junction to be under negative
20 pressure. In cases where the discharge is submerged or where the nozzle do not allow sufficient amount of air discharging downwards, the junction of the anti-backflow fitting is under positive pressure. Air escapes through the clear air passage created by the nozzle.

25 In either positive or negative pressure situations, the configuration of the anti-backflow fitting 100 in accordance with an embodiment of the invention ensures a clear air passage is maintained at each junction of the anti-backflow fitting, such that water is being prevented from being brought up through the passage by the downward pressure jet.

30 The device 100 having this configuration provides predictability and controllability. The flow capacity of the anti-backflow fitting can be determined by physical testing. Empirical testing has shown that a flow rate of 20 l/s without any backflow, whereas conventional junctions

experience backflow at as little as 2-3 l/s. Due to the principle that each junction forces the formation and release of pressure, there are no unpredictable pressure fluctuations at the junctions.

- 5 The action of the nozzle configuration 110 increases the velocity of the fluid to jet flush the junction and the entire system. This jet action enables the self-cleansing of the pipe interior and minimizes blockages.

10 With this configuration, the pressurized system allows a significantly higher flow rate through a pipe as compared to the conventional gravity system.

It will be appreciated that the junction may be fitted for pipes of any number of dimensions and cross-sections. For example, the ports of the junction may be adapted for a gauge of 3" (75mm) for the first port and 2" (50mm) for the second port, 4" (100mm) for the first port and 3" (75mm) for the second port, and the like. Other gauges or sizes are contemplated for example the 6" (150mm) first port and 4" (100mm) second port, 6" (150mm) first port and 3" (75mm) second port, 4" (100mm) for the first port and 2" (50mm) for the second port, or the like. The ports may be adapted to receive the same or different sized pipes. For example, the first port may be adapted to receive larger dimensioned pipe than the second port and/or the third port. The third port may have a dimension that is equal to the first port and/or second port, or may have a different gauge than the first and second ports. Additionally, the pipes may be tubular and the cross-section of the pipe may be circular or any number of other cross-sections, such as rectangular, square, oval or the like. The thickness of the pipe walls may be any thickness conventionally used, for example, about 2-3mm.

30 The anti-backflow junction device 100 may be manufactured from polyvinyl carbonate (PVC), high density polyethylene (HDPE), hubbless, cast iron, metallic materials and other such materials. The manufacturing process may be by any conventional pipe manufacturing process such as by PVC extrusion or the like. It will be appreciated that the manufacturing process depends on the particular material selected.

In another embodiment, multiple connections to the same anti-backflow fitting are possible, as shown in FIG. 4, 5, 6A, 6B, 7A, 7B, and 8. FIG. 7A shows a side elevation perspective view of the anti-backflow junction having a side port 144 in accordance with an embodiment of the invention, and FIG. 8 shows a front elevation perspective view of the anti-backflow junction having the second port of the junction with multiple ports in accordance with an embodiment of the invention. FIG. 8 specifically shows at multiple ports at the second port 140 having ports 104, 142 and 144. It will be appreciated that any of the ports may be configured with one, two or multiple ports. Each of the ports may be in fluid connection with the same source or different sources of fluid. It will be appreciated that the connection between the ports may be made with a pipe, connecting pipe, another junction or fitting, or the like. The port may form a socket, straight or plain end pipe, or the like, and may be fitted and joined together in any manner. FIG. 7B shows a side elevation perspective view of the anti-backflow junction 292 that may be adapted to receive a separate accessory 294 fitting or pipe that may contain an additional or multiple ports.

Other configurations of the diverter as discussed above with reference to FIG. 4 are shown in FIG. 9A-12B. For example, FIG. 9A-B shows a diverter 220 having a configuration that is a protrusion that extends perpendicular to the first port wall 222 forming a ledge. In this configuration there is no gradient or sloping of the protrusion relative to the first port wall, or the opposing side wall 224 and the protrusion has a perpendicular orientation with respect to the first port wall. The diverter 220 protrudes about the first port wall 222 having a length from a first point 223 to a second point 225 in a straight configuration 227 (not indicated in drawings) edge of the diverter ledge. The diverter is not sculpted and no channel is formed in the diverter, resulting in different diverter width along the length of the diverter. However, this basic diverter configuration still achieves diversion of the water to form the water plug as desired, although in this embodiment higher resistance is observed in operation when the fluid runs

through. Also, this embodiment reduces the cross-sectional area of the first port, which also lowers drainage capacity.

Additionally, in FIG. 9A and 9B the junction of the second port 104 with the first port 102 to the third port 106 as shown is a graduated junction with smooth edges and angle cut away section in the second port section 114. The second port has a horizontal orientation with respect to the first port and third port that have central axis in alignment.

FIG. 10A and 10B show an embodiment of the anti-backflow junction device 100 having another configuration of diverter 230. The diverter in this configuration is more like the diverter shown in FIG. 5, 6A and 6B, than FIG. 9A and 9B, since the diverter is sculptured resulting in a smaller diverter width that is uniform across the length of the diverter and the surface of the diverter forms a cut away or channel 236. The diverter extends about half the circumference of the wall forming the first port. Similar to the diverter of FIG. 9A and 9B, the diverter 230 is a protrusion that extends perpendicular to the first port wall 232. In this configuration there is no gradient or sloping of the protrusion relative to the first port wall 232 or the opposing side wall 234. The nature of the diverter being perpendicular to the side wall of the pipe also yields an increased resistance to the fluid flow similar to the embodiment shown in FIG. 9A and 9B, however the resistance observed is less than the embodiment shown in FIG. 9A and 9B.

FIG. 11A and 11B show an embodiment of the anti-backflow junction device 100 having another configuration of diverter 240. The diverter in this configuration is more like the diverter shown in FIG. 5, 6A and 6B, than FIG. 9A and 9B or FIG. 10A or 10B, since the diverter is sculptured forming a cut-out or channel 246 resulting in a smaller diverter width that is uniform across the length of the diverter, and the diverter is graduated along the length of the diverter. The diverter extends about half the circumference of the wall forming the first port. The diverter in this embodiment has a sloping, gradient or ramping orientation with respect to the side wall of the

first port. This embodiment has a fluid capacity that results from the reduction of the cross-sectional area of the first port that is gradual along the depth of the diverter, i.e. the ratio between the first port opening mouth 152 and the nozzle head opening 150 at point 124 along the depth of the diverter.

Additionally, in FIG. 11A and 11B the junction of the second port 104 with the first port 102 to the third port 106 as shown is a graduated junction with smooth edges and curves with escape cut away 114, with the second port having a vertical orientation.

FIG. 12A and 12B show another embodiment of the anti-backflow junction device 160 having a double or multiple diverter configurations. The first diverter 162 is shown and is similar to the diverters discussed previously with respect to FIG. 3 to 11B. The second diverter 164 is formed in the side wall 264 opposite the first port wall 262 that the first diverter 162 protrudes. The water is diverted twice in this configuration to form a water plug and resulting air flow 170 as shown and the water is diverted toward the second port wall 268.

Additionally, in FIG. 12A and 12B the junction of the second port 104 with the first port 102 to the third port 106 as shown is graduated junction with escape cut away or gradual part 114 and a sharp edge join between the second and third port walls. The second port 168 is shown with pipe having rectangular cross-section.

FIG. 12A and 12B show that the first port and third port do not necessarily need to be aligned. The central axis of each of the ports, first, second and third ports 166,168,167 is shown by dashed lines 272,274,276. In this embodiment, the first, second and third ports have central axis that are in misalignment. The sidewall 264 of the first port is misaligned with the sidewall 266 of the third port. Likewise, the sidewall 268 of the third port 167 is misaligned with the sidewall of the second port 168. Whereas the embodiment shown in FIG. 4, the first port and third port share a common

central axis 180,186 and are concentric. Additionally, in FIG. 4 the central axis of each port 180,184,186 is shown in parallel orientation with each other. The junction between the second port and the third port is in an unparallel orientation as shown in FIG. 4 by dashed lines 182. Of course it will be appreciated that other orientations may be configured, such as the central axis of the first port, central axis of the second port, and central axis of the third port are in parallel or non-parallel orientation and vertical, non-vertical or horizontal alignment or misalignment.

FIG. 13 shows another embodiment of the anti-backflow junction 280 having the first port 282 as a separate unit from the second port 284 and the third port 286. The first port unit 283 has a diverter 283. The first port unit 288 may be fitted or joined with the second port unit 284 to form a junction device 280. Additionally, a third port unit 286 may be fitted or joined to the second port junction unit 284. In this embodiment the first port unit 282 may be a reducer and the second port junction unit 284 may be a y-tee that are standard in the industry. The units are fitted together and are concentrically aligned as shown by dashed line 288. The third port unit 286 may also be a reducer that is standard in the industry. This is also shown in the flow diagram of method 400 FIG. 16 as an embodiment in dashed box 408. It will also be appreciated that the anti-backflow junction device may be adapted to receive a separate accessory 294 fitting or pipe that may contain an additional or multiple ports as shown and discussed with reference to FIG. 7B.

In another embodiment, a stack 200 is a drainage system with a plurality of junctions 100 connected in a series configuration joined by connecting piping 202, as shown in FIG. 14. The stack 200 is in fluid communication with a rainwater outlet 204 and rainwater pipe 214 at the top of the stack and a drain pipe 206 and drain 208 at the bottom of the stack. The junction device 100 is in fluid communication with other junction devices 100 in the stack such that the third port of an upper junction device is in fluid communication with the first port of the junction device positioned below the upper junction device. In an embodiment a horizontal pipe 210 and source

212 is also in fluid communication with each junction device 100. Although it is preferred that all junctions in the stacks be the anti-backflow junctions 100, the inclusion of one or more in a conventional gravity rain water down pipe configuration may improve the system at that junction. It will be appreciated that a stack designed to function with the anti-backflow fitting may be mixed with conventional junctions. This is also shown in the flow diagram of method 400 of FIG. 16 as an embodiment in dashed box 410.

Additionally, it will be appreciated that the dimensions of the anti-backflow junction device 100 may be sized to maximize overall flow rate while remaining within the certified flow rate of the anti-backflow fitting.

It will be appreciated that the anti-backflow fitting may be implemented in a fully conventional gravity RWDP systems, as well as to connect to siphonic and non-siphonic systems. Siphonic systems are drainage systems where the pipes are filled with water and contain no air and exhibit full bore water flow. Typically, in high rise buildings with siphonic drainage systems, the main drainage is completely separate from the drainage of balconies. In an embodiment shown in FIG. 15, the junction device allows the combination of both siphonic drainage systems and non-siphonic drainage systems to form a hybrid system 300 without significant enlargement in pipe size that would have been required in the conventional non-siphonic drainage system while controlling the pressure fluctuation and preventing any backflow. The pipe size or gauge may be maintained on either side of the junction 320. For example in one embodiment the siphonic outlet may be in fluid connection with rainwater pipe 314, and connecting pipe 302 having a gauge or dimension of 2" (50mm), and after junction 320 and anti-backflow junction 100 the connecting pipe 302 may have a gauge or dimension of 3" (75mm) where without the anti-backflow junction the connecting pipe 302 would need to be enlarged at least 3 times this size. Of course it will be appreciated that the anti-backflow junction device 100 may have ports ready to receive the different dimensioned pipes at different ports, such that junction 320 would not be required.

Whilst there has been described in the foregoing description preferred embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations or modifications in details of design or construction may be made without departing from the present invention.

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CLAIMS:

1. A fluid junction device for managing a first fluid flowing from at least two sources and a second fluid from at least one source, the second fluid
 5 capable of a negative pressure flow and a positive pressure flow, the device comprising:
 a body having a first port adapted for fluid communication with the first fluid from a first source, a second port adapted for fluid communication with the first fluid from a second fluid source, a third port for the discharge of the first
 10 fluid received from first and second ports, the body forming a junction between the first and second port and third port, and a diverter formed in the junction defining a nozzle formed in the body at the junction for diverting the flow of the first fluid from the first source from the first port to the third port forming an escape for the second fluid in either a positive pressure
 15 flow or negative pressure flow through the second port.

2. A first port unit adapted to be connected and in fluid communication with a second port unit forming a fluid junction device for managing a first fluid flowing from at least two sources and a second fluid from at least one
 20 source, the second fluid capable of a negative pressure flow and a positive pressure flow, the device comprising:
 a body having a first port of the first port unit adapted for fluid communication with the first fluid from a first source, a second port of the second port unit adapted for fluid communication with the first fluid from a
 25 second fluid source, a third port for the discharge of the first fluid received from first and second ports, the body forming a junction between the first and second port and third port, and the first port unit comprising a diverter formed in the junction defining a nozzle formed in the body at the junction for diverting the flow of the first fluid from the first source from the first port
 30 to the third port forming an escape for the second fluid in either a positive pressure flow or negative pressure flow through the second port.

3. A second port unit adapted to be connected and in fluid communication with a first port unit forming a fluid junction device for managing a first fluid

flowing from at least two sources and a second fluid from at least one source, the second fluid capable of a negative pressure flow and a positive pressure flow, the device comprising:

- a body having a first port of the first port unit adapted for fluid communication with the first fluid from a first source, a second port of the second port unit adapted for fluid communication with the first fluid from a second fluid source, a third port for the discharge of the first fluid received from first and second ports, the body forming a junction between the first and second port and third port, and a diverter formed in the junction defining a nozzle formed in the body at the junction for diverting the flow of the first fluid from the first source from the first port to the third port forming an escape for the second fluid in either a positive pressure flow or negative pressure flow through the second port.
- 4. The device of any one of claims 1-3 wherein the nozzle forms a clear passage for the second fluid to escape through the second port.
- 5. The device of any one of claims 1-4 wherein the diverter is arranged to divert water in the junction to form a first fluid plug is formed in the proximity of the first port adjacent the nozzle formed at the junction.
- 6. The device of any one of claims 1-5 wherein the nozzle forms a jet of the first fluid from the first fluid source increasing the pressure and velocity of the discharge flow of the first fluid at the third port.
- 7. The device of any one of claims 1-6 wherein the diverter has a depth extending from a first depth point in a side wall of the first port and extending to a second depth point in the side wall of the first port.
- 8. The device of claim 7 wherein the second depth point in the side wall of the first port is the nozzle head of the nozzle.
- 9. The device of any one of claims 1-8 wherein the diverter has a surface having a length extending from a first length point in a side wall of the first

port along the surface of the diverter to a second length point in a side wall of the first port.

10. The device of any one of claims 1-9 wherein the diverter has surface
5 with a channel in the surface.

11. The device of any one of claims 1-10 wherein the diverter has a uniform width along the length of the diverter.

10 12. The device of any one of claims 1-10 wherein the diverter has a non-uniform width along the length of the diverter.

13. The device of any one of claims 1-12 wherein the diverter has a uniform width along the depth of the diverter.

15 14. The device of any one of claims 1-12 wherein the diverter has a non-uniform depth along the depth of the diverter.

15. The device of any one of claims 1-14 wherein the diverter forms a
20 ledge.

16. The device of any one of claims 1-15 wherein the body comprises a second diverter formed at the junction of the second port for diverting the flow of the first fluid from the first diverter to the third port and forming.

25 17. The device of any one of claims 1-16 wherein the first port has a central axis that is concentricly aligned with a central axis of the third port.

18. The device of any one of claims 1-16 wherein the first port has a central
30 axis that is misaligned with a central axis of the third port.

19. The device of any one of claims 1-18 wherein the first fluid is water.

20. The device of any one of claims 1-19 wherein the second fluid is air.

21. The device of any one of claims 1-20 wherein the first port, second port and third port are adapted to receive pipes of various cross-sections such as rectangular, square, oval and the like.

5

22. The device of claim 21 wherein the pipe has a circular cross-section.

23. The device of claim 21 or 22 wherein the diameter of the pipe adapted to be received by the first port is greater than the diameter of the pipe adapted to be received by the second port.

10

24. The device of any one of claims 21-23 wherein the diameter of the pipe adapted to be received by the first port is the same as the diameter of the pipe adapted to be received at the third port.

15

25. The device of any one of claims 1-24 wherein the device is adapted to an open channel gravity drainage system.

26. The device of any one of claims 1-24 wherein the device is adapted to a siphonic drainage system.

20

27. The device of any one of claims 1-26 wherein the second port comprises multiple ports adapted for fluid communication with the first fluid from a third fluid source and proximate the second port.

25

28. The device of any one of claims 1-27 wherein the body comprises a plurality of ports proximate adapted for fluid communication with the first fluid from respective plurality of fluid sources and proximate the second port.

30

29. The device of any one of claims 1-28 wherein the first port comprises a first port unit, and the second port comprises a second port unit, the first port unit and the second port unit being arranged to be connected together.

35

30. The device of claim 29 wherein the first port unit is a reducer.

31. The device of claim 29 or 30 wherein the second port unit is a y-tee.

32. The device of any one of claims 1-31 wherein the opening of the nozzle
5 is 10% to 25% the opening of the first port.

33. A drainage system comprising a plurality of devices in accordance with
any one of claims 1-33 forming a stack of devices, the output of an upper
device in fluid communication with the first port of the lower device.

10

34. The drainage system of claim 33 wherein the first port of the upper
device is fluidly connected to a siphonic outlet.

35. The drainage system of claim 33 or 34 wherein each device comprises
15 an escape for the second fluid in either a positive pressure flow or negative
pressure flow through the second port of each device.

36. A method for managing a first fluid flowing from at least two sources
and a second fluid from at least one source, the second fluid capable of a
20 negative pressure flow and a positive pressure flow, the method
comprising:

receiving the first fluid from the first fluid source in a fluid junction device
having a body having a first port adapted for fluid communication with the
first fluid from a first source, a second port adapted for fluid communication
25 with the first fluid from a second fluid source, a third port for the discharge
of the first fluid received from first and second ports, the body forming a
junction between the first and second port and third port;
diverting the first fluid with a diverter formed in the junction defining a
nozzle formed in the body at the junction for diverting the flow of the first
30 fluid from the first source from the first port to the third port; and
forming an escape for the second fluid in either a positive pressure flow or
negative pressure flow through the second port.

37. The method of claim 36 further comprising connecting a first port unit in fluid communication with a second port unit, the first port unit comprising the first port of the fluid junction device, and the second port unit comprising the second port of the fluid junction device.

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38. The method of claim 36 or 37 further comprising connecting a plurality of devices forming a stack of devices, the output of an upper device in fluid communication with the first port of a lower device.

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39. The method of claim 38 further comprising forming an escape for the second fluid in either a positive pressure flow or a negative pressure flow through the second port of each device in the stack of devices.

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40. The method of any one of claims 36-39 wherein diverting the first fluid increases the pressure and velocity of the discharge flow of the first fluid from the first port to the third port.