

WATER FLOW APPARATUS

Field of the Invention

The present invention relates to an improved rain water collection system.

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Background to the Invention

Gutters are predominantly designed to channel rainwater from roofs and buildings to various water drainage systems to avoid accumulation of high volumes of water which can cause flooding and water damage to building and roofing materials.

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Various types of gutter systems are well known in the art. Figure 1 depicts one of the simplest forms of gutter system known in the art. The gutter comprises a narrow open trough (101), which collects rainwater from the roof of a building. The gutter is configured to have a water outlet at a first end (102) at which there is attached a downpipe (103) down which water is diverted away from the building, typically into a drain (not shown).

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In a conventional gutter system as shown in figure 1, the rate of water flow is dictated by the amount of rainwater that falls on the roof via rainfall, and by gravity pulling water down the drainpipe. In many gutter systems, the trough is inclined so that water flows by force of gravity, by locating a first end of the trough at a lower position to a second end, thus so that water flow is directed towards drain pipe (103).

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Such gutter systems have been adapted as to incorporate multiple drainage outlets which further enhance the volume of water that can be collected by a drainage system in a given time. However, there is an inherent limit in the number of drainage outlets that can be inserted into a given length of gutter channel. This also leads to the need for multiple downpipes which is a disadvantageous as it can lead to obstruction issues for other structural building works and access points.

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-2-

can lead to obstruction issues for other structural building works and access points.

Another major problem is that the flow rates can only be increased to a certain level due to the constraints of gravitational pull. This is especially a problem during heavy rainfall. If the flow rate in the gutter is not the same or greater than the flow rate of water entering the gutter system, then the gutter system will overflow.

The problems mentioned above have led to the development of known siphonic drainage systems. Siphonic drainage systems typically used in buildings having roofs with a large surface area, for example airports, warehouses, stadiums and the like.

Referring to figure 2 herein, there is shown one example of a known siphonic drainage system comprising a plurality of siphonic inlets and a connecting collection pipe. Siphonic systems work by having substantially closed pipe systems where by the level of water entering the system is manipulated by the size of the water system (110, 114, 112) and/or the use of baffle plates at water inlets (111) to restrict the air entering the drainage system. When a system becomes full of water and therefore void of air, the action of water dropping down the downpipe (112) will cause a negative pressure to form at a top end of the downpipe (113). This negative pressure can be utilised to 'suck' water along the water pipe (114) installed horizontally connecting the water outlets at a higher level.

By using siphonic drainage processes, the rate of water flow is significantly increased relative to simple gravity dependent systems, and the need for multiple downpipes is reduced, because each downpipe carries water at a higher flow rate.

-3-

However, in pipe based siphonic systems, The pipe work is positioned inside the building adjacent or under the roof. Under high rainfall rates, overflow of the open channel into the building can occur. This is often incorrectly attributed to leaking joints, leading to unnecessary maintenance which does not actually
5 solve the problem of overflow over the sides of the channel .

For large buildings, one face of the building can span over 300 metres long. Drainage systems are required to run the whole length of such building faces. However, known drainage systems are unmanageable and impractical at
10 distances of more than approximately 200 metres long due to the effective balance and operation of the siphonic action limitation aabove this distance.

Referring to Figure 3 herein, there is shown a shown gutter assembly as disclosed in international patent application WO/2007/080380. Figure 3 shows a
15 gutter assembly (302) comprising an elongate gutter (304) for receiving water and defining a primary water transport channel (310) and a secondary water transport channel (312) is disclosed. The primary water transport channel (310) is connected to a drainage downpipe (338) and vortex reduction members (324) reduce formation of vortices in the vicinity of primary water inlets (316) of the
20 primary water transport channel (310). When sufficient water flows into the gutter (304), the primary water transport channel (310) fills with water to become free of air to enable water to be transported along the channel (310) by means of suction in the drainage downpipe (338).

25 An advantage of this system is that the predominantly closed system enables all water transport channels to be provided externally to a building. This is an advantage because the risk of water leaking from the gutter system into the building is minimised.

30 Figure 3 shows two transport channels, (310) and (312) of which the two channels lie side by side and where at least one part of a said transport channel has an increasing cross-sectional area in a direction toward a first water outlet,

-4-

whereas a second transport channel has an increasing cross-sectional area in a direction toward a second water outlet. A major disadvantage of this invention is that the shape of the tapered water transport channels means that the water transport channels have to be placed so that the first water outlet and the second water outlet have to be placed at opposite ends to each other. This means that the water flow in each of the separate channels flows in opposite directions to each other. As a result, downpipes and drainage means are needed at two different outlets of the gutter system, one at each end.

10 The water transport channels disclosed in international patent application WO/2007/080380 are disadvantageous as they have to be shaped in a way that they not conventionally symmetrical, therefore the water transport channels will undergo tessellation problems with the rest of a building development if an odd number of water transport channels are incorporated into the gutter assembly.

15 Referring to Figure 4 herein, there is illustrated schematically in plan view from above a section of a roof of a building, fitted with six separate runs of guttering of a type as disclosed in WO/2007/080380. First and second roof sections (401, 402), in this case each having a triangular pitched roof, are fitted with first to sixth elongate guttering systems (403-408) respectively, running parallel to the valleys of the pitched roofs. A maximum span of building, which can be drained using a system disclosed in WO/2007/080380 between downpipes is approximately 200 metres. Where a roof span of more than 200 meters needs to be drained, for example the 300 meter span as shown on figure 20 4 herein, this can be accommodated by fitting two 150 metre length gutters end to end, for example (407, 408). Since each run of gutter requires a downpipe at each end, this means that a drainage point must be installed into the ground, both at each side of the building (409, 410) and at the centre of the building (411, 412). Consequently, drainage points and underground drains (413, 414) need to be laid underneath the concrete slab foundation and along the centre of the building to drain the water to either one or both ends of the building. Additionally, there will be a plurality of downpipes (415 420) which need to run vertically down

-5-

the centre of the building, from the roof to the drains in the floor slab which limit the amount of an obstructed open free space within the building.

Where guttering is being fitted to an existing building, the drainage points and underground drains may have not been already provided underneath the concrete slab. Fitting those underground drains and drainage points can be a laborious and disruptive procedure, involving breaking the concrete slab foundation of the building, and the damp proofing course underneath the building and digging a trench in order to retrospectively fit the necessary drainage points and pipes to the edge of the building.

On a building with a wide fascia, a result of having a two-directional water flow (420 and 421) means that there would be a water downpipe located at each side or end of the building as well as a down pipe located toward the middle of the building. The non-centralised drainage section of a known gutter assembly causes problems with the regulation of drainage, as well as increasing obstructions.

Summary of the Invention

Embodiments of the present invention aim to provide an improved gutter system which can have multiple water transport channels whereby the water is directed to a single drainage position. Furthermore, the proposed system may be utilised to incorporate a siphonic process so as to achieve an overall increased flow rate relative to a simple gravity based gutter system.

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According to a first aspect there is provided a guttering system comprising:

a first elongate covered channel member capable of carrying water flowing in a first direction;

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at least a second elongate covered channel member positioned above or below said first elongate covered channel member, said second channel capable of transporting carrying water flowing in said first direction.

5 In use, the first channel may provide primary drainage under normal rainfall conditions, and the second channel may provide secondary or overflow drainage under conditions of abnormal or increased rainfall conditions.

10 Preferably said first and/or second channel has a cross sectional area which increases in the direction of water flow. This may promote the onset of siphonic operation of the channel(s), thereby increasing their drainage capacity.

15 Preferably, said first and/ or second channel is of a substantially constant height along its full length. This may provide convenience of manufacture of the gutter.

Preferably, said gutter comprises:

20 a first water inlet positioned at a first end of said gutter for allowing water to enter said first channel;

a first water outlet positioned at a second end of said gutter for draining water from said first channel;

25 a second water inlet positioned at said first end of said gutter for allowing water to enter said second channel; and

a second water outlet positioned at said second end of said gutter for draining said second channel.

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The inlets may be provided with at least one vortex reducing means for minimizing vortex formation in and around said inlets.

-7-

Preferably, said first channel is formed within a first cavity, said first cavity having a substantially trapezoidal cross sectional area as viewed in a direction perpendicular to a main length of said gutter;

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said first channel is defined by at least one elongate tapered insert fitted inside said first cavity;

said second channel is formed within a second cavity, said second cavity having a substantially trapezoidal cross sectional area as viewed in a direction perpendicular to a main length of said gutter; and

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said second channel is defined by at least one tapered insert member fitted within said second cavity.

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Having substantially trapezoidal shaped cavities enables a trough shaped gutter to be made in a single operation, with the cavities being formed by fitting first and second covers between the sides of the trough, with the channels being formed between single insert members or pairs of insert members fitted within each cavity.

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said first and/or second channel may have a substantially rectangular cross sectional area in a direction perpendicular to any main length of said gutter.

According to a second aspect there is provided a gutter system comprising:

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an elongate trough having a floor, a first elongate upright side wall and a second elongate upright side wall;

an elongate cover member spaced apart from said floor and extending between said upright side walls, and closing off an upper part of said trough at a first height, so as to define an enclosed cavity there between;

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characterised by:

5 a single enclosed channel being provided across said trough between said floor and said cover member and extending along a length of said trough;

a water inlet for allowing water to enter said channel; and

10 a water outlet for allowing water to drain from said channel;

said inlet and outlet being provided spaced apart from each other along a length of the gutter, such that water entering said channel via said inlet passes through said channel to said outlet.

15 said enclosed channel having a variable cross sectional area in a direction transverse to a main length of said trough, and which increases along a main length of said trough in a direction from said inlet to said outlet, so as to be relatively increased at said outlet compared to at said inlet.

20 said gutter may comprise at least one insert member located between said floor and said cover, said insert member having a cross sectional area in a direction perpendicular to its main length which varies between first and second ends of said insert member.

25 Preferably the gutter comprises a pair of insert members located between said floor and said cover, at least one of said insert members being tapered, wherein said channel is positioned between said pair of insert members.

30 Preferably, said gutter comprises a second elongate cover member positioned above said first cover member, so as to define a second cavity between said second cover, said first cover and said first and second upright side walls;

a single second enclosed channel being provided across said trough between said first cover, said second cover and said first and second upright side walls, said second channel extending along a length of said trough;

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said second enclosed channel having a variable cross sectional area in a direction transverse to a main length of said trough, and which increases along a main length of said trough in a same direction as said first channel increases in cross sectional area.

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Preferably, the gutter further comprises:

a second water inlet for allowing water to enter said second channel; and

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a second water outlet for allowing water to drain from said second channel;

said second inlet and second outlet being provided spaced apart from each other along a length of the gutter such that water entering said second channel via said second inlet passes through said channel to said second outlet.

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The gutter may comprise at least one insert member located between said floor and said cover, said insert member having a cross sectional area in a direction perpendicular to its main length which varies between first and second ends of said insert member.

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Preferably, the gutter comprises a pair of insert members located between said floor and said cover, at least one of said insert members being tapered, wherein said channel is positioned between said pair of insert members.

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According to a third aspect there is provided a gutter system comprises: a first elongate covered channel member capable of carrying liquid flow in a first direction; at least a second elongate covered channel member positioned above

-10-

or below said first elongate covered channel, capable of transporting liquid in a same said direction of liquid flow.

5 Preferably the first elongate covered channel member has at least one impermeable three dimensional member located at a side of an inner wall of said channel member to form a channel within said first elongate covered channel member which increases in cross section from said first end to said second end.

10 Preferably the second elongate covered channel member has at least one impermeable three dimensional member located at a side of an inner wall of said channel member to form a channel within said second elongate covered channel member which increases in cross section from said first end to said second end.

15 Preferably said first elongate covered channel member has a first end and a second end, said second end defined by a water outlet.

Preferably said at least second elongate covered channel member has a first end and a second end, said second end defined by a water outlet.

20 Preferably the said system gutter system comprises at least one elongate trough for receiving and transporting liquids to said first and said at least second elongate covered channel member.

25 Preferably said at least one elongate trough comprises at least one liquid inlet.

Preferably said at least one liquid inlet comprises debris guard vortex reducing means.

30 Preferably the said first elongate covered channel member has a channel width that is substantially constant throughout the length of the said channel member.

Preferably the second elongate covered channel member has a channel width that is substantially constant throughout the length of the said channel member.

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Other aspects are as recited in the claims herein.

Brief Description of the Drawings

For a better understanding of the invention and to show how the same may
10 be carried into effect, there will now be described by way of example only, specific embodiments, methods and processes according to the present invention with reference to the accompanying drawings in which:

Figure 1 is a diagram of a simple gravity based gutter system as known in
15 the art;

Figure 2 shows schematically a siphonic gutter system which is known in the art;

20 Figure 3 shows in schematic view, a known siphonic drainage system as disclosed in WO 2007/080380;

Figure 4 shows schematically in view from above a roof fitted with a known gutter system, as disclosed in international patent application WO 2007/080380
25 depicting direction of water flow along the gutters;

Figure 5 shows a diagrammatic view of a novel drainage system according to one specific embodiment of the present invention;

30 Figure 6 shows in cut away view, the drainage system of figure 5 herein;

-12-

Figure 7 shows schematically the part of drainage system of figures 5 and 6 in cut away view from above;

Figure 8 shows a partial view from one end of the drainage system of figures 5 to 7, showing an elongate cavity containing a channel and with the incorporation of a pair of three dimensional impermeable insert members;

Figure 9 shows schematically from above a roof fitted with a plurality of novel gutters as described in figures 5 to 8 herein, illustrating the direction of water flow within the gutters to drainage points positioned at outside walls of a building;

Figure 10 illustrates schematically in view from above first and second gutter sections abutting each other for forming a joint.

Figure 11 illustrates schematically in cut away view from one side, the first and second gutter sections of figure 10 during joint formation;

Figure 12 illustrates schematically the first and second gutter sections of figures 10 and 11 during a second stage of joint formation;

Figure 13 shows in cut away view from one end the gutter under a first level of rain fall in which a first enclosed channel drains water from the gutter;

Figure 14 shows schematically in cut away view from one end, the gutter of figure 13, under an increased level of rain fall in which first and second enclosed channels drain rain fall;

Figure 15 shows schematically in view from above a further embodiment gutter, having a plurality of in line water inlets;

-13-

Figure 16 shows schematically in cut away view from one side across a cross section X – X' the gutter of figure 15 herein;

5 Figure 17 shows schematically in plan view, a first water inlet having a leaf guard / debris guard vortex reducing means;

Figure 18 shows in cross section view from one side the water inlet of figure 17 herein;

10 Figure 19 shows in partial cut away view from one side, a part of the water inlet of Figures 17 and 18 herein;

Figure 20 shows in view from above a second water inlet having a debris guard vortex reducing means; and
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Figure 21 shows schematically in cross section view from one side, the second water inlet of Figure 20 herein.

Detailed Description

20 There will now be described by way of example a specific mode contemplated by the inventors. In the following description numerous specific details are set forth in order to provide a thorough understanding. It will be apparent however, to one skilled in the art, that the present invention may be practiced without limitation to these specific details. In other instances, well
25 known methods and structures have not been described in detail so as not to unnecessarily obscure the description.

Referring to figures 5 and 6 herein, in one preferred embodiment of the invention, a rainwater collection system comprises a gutter section (500) and a
30 plurality of down pipes (501, 502) positioned at one end of the gutter section.

The gutter section (500) comprises an elongate trough member 501 for collecting water, said trough member comprising an elongate floor portion (502) which extends along a full length of the trough, a first upright side wall (503) extending along the whole length of the floor portion (502) and positioned on one side of the floor portion, a second upright side wall member (504) positioned on an opposite side of the floor member to the first side wall (503), and extending substantially in parallel with the first side wall member, the floor member and first and second upright side wall members preferably being formed in one piece so as to be inherently water tight; a first cover portion (505) positioned above the first floor portion and extending across the full width of the gutter between the first and second side walls and extending substantially in parallel with the first floor portion so as to form a first cavity (506) bounded by the first floor portion (502), the first side wall (503), the second side wall (504) and the first cover portion (505), the first cavity being enclosed by the side walls and first cover portion; a second cover portion (507), the second cover portion extending fully across a width of the gutter between the first and second side walls, so as to enclose a second cavity (508) bounded by the first cover portion (505), the second cover portion (507), the first side wall and the second side wall; at least one first water inlet (509) which provides a passage from above the second cover (507) into the first cavity (506); at least one second water inlet (510) which provides water passage from above the second cover portion (507) into the second cavity (508); at least one first outlet aperture (511) positioned in the first floor member, for draining water from the first cavity into at least one first down pipe (512); at least one second aperture (513) positioned in the first cover member (505) for draining water from the second cavity (508) into at least one second down pipe (514).

The first cavity (506) has a substantially trapezoidal shaped cross section as viewed in a direction along a main length of the gutter section. Similarly, the second cavity (508), which is bounded by the first cover portion (505), second cover portion (507), and the first and second sides (503, 504) respectively, has a second substantially trapezoidal cross section as viewed in a direction along a main length of the gutter.

At least one first inlet (509) comprises a substantially circular or square plate which is spaced apart from and positioned above the second cover member (507), the substantially circular or square plate having a plurality of downwardly projecting arms (515), which collectively act as a grille to prevent any leaves, twigs or debris entering into the first water inlet and into the first water channel (506), and allowing only the passage of water. The at least one first water outlet (509) is positioned such that a plurality of apertures between the arms drain water from a position immediately on the upper surface of the second cover member (507), so that water collected in the gutter on top of the second cover member (507) flows through the first water inlet (509) into the first water channel (506). At least one second water inlet (510) comprises a tubular upright portion (516) on top of which is provided a circular plate (517) spaced apart from an upper edge of the tubular portion (516), and between the upper rim of the tube (516) and the circular plate, are positioned a plurality of radially extending arms (517), which hold the circular plate above the tube (516), there being provided a plurality of apertures between successive ones of the radially extending arms, which allow inlet of water to the second water inlet, whilst at the same time blocking debris such as leaves, twigs or the like which may have collected in the gutter on the upper surface of the second cover member (507).

Within the first cavity are provided one or preferably a plurality of elongate water impervious tapered insert members which define a first water channel within the first cavity. Whilst the first cavity may have a substantially constant cross sectional area along its full length, the first channel defined by the space between the floor 502, first cover 505 and the first and second insert members, has a gradually and linearly increasing cross sectional area in a direction substantially perpendicular to the main length of the gutter.

Similarly, the second cavity encloses one or more tapered insert members which define a second water channel, the second water channel having a gradually increasing cross sectional area towards the outlet end of the second

-16-

cavity. The cross sectional areas of the first and second channels, in the best mode, are each substantially rectangular, with the width of the rectangular cross section increasing linearly towards the outlet end of each respective cavity, and increasing in the direction of water flow, so that water entering each channel
5 experiences a widening channel as it flows along the gutter towards the outlet of the respective channel.

The first channel may be configured as a primary channel, that is a channel which under normal rainfall conditions will carry the water from the adjacent roof
10 to a drainage point, and the second channel may be designed as a secondary channel which only comes into operation under high level of rainfall. For example the gutter may be designed such that the secondary channel only comes into operation during stage two of a category 3 severity or above rainstorm, as set out in BSEN12056.

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Thus, the gutter has a plurality of enclosed channels, one on top of the other, and an open channel on top of the enclosed channels. Water collects in the open channel and drains into one or both of the enclosed channels.

20 The gutter can be formed from any material known in the art that is suitable and commonly used within the building trade. Preferably the gutter is formed from extruded plastic or aluminum. At least one perforation is present at various points in the trough floor(s) to form water inlets. The water inlets allow rainwater to be transported to any one of the water transport channels (506 and 508). The
25 direction of water flow is shown as arrowed (519) in figure 5.

The exact water transport channel that water enters at any one particular time is dependent on the height of the corresponding water inlet compared with the water level in the upper part of the trough. As can be ascertained by figure 6,
30 in one embodiment of the invention, one water inlet (510) is manufactured to be higher from the upper floor of the trough than the other water inlet (509). When water enters the trough, water will firstly channel through the lower water inlet

-17-

(509) and into first elongate covered channel (506). Water runs along the first channel and out of first water outlet (511), down a downpipe and then into a drainage system (not shown). If the water flow increases and the water level in the trough rises to a level at or above the higher water inlet (510), then water will
5 then additionally proceed to flow into the second water inlet (510) and into second elongate covered channel (508) and down second water outlet (513) and out of the gutter system via a second downpipe and drainage system (not shown).

10 The water inlets (e.g. 509 and 510) can be produced in various different ways to increase flow rate and efficiency. In one preferred embodiment, the water inlet would comprise a baffle plate as a means to reduce vortex formation in and around the inlet. Vortex formation is detrimental to the flow rate of a system because it allows air to enter the channel and decreasing vortex formation is
15 therefore advantageous in creating a siphonic effect.

A further embodiment would be to produce a water inlet as a bowl shape. The bowl shape itself would be in the form of an inverted hollow pyramid with a hole at the bottom to allow water flow. This configuration is known in the art to
20 reduce vortex formation.

However, having individual siphonic inlets is not essential to operation of the gutter system, since the diverging shape of the internal channels of the gutter system themselves encourage the creation of a siphonic effect in the gutter
25 system as a whole. Therefore, non-siphonic inlets, which allow both water and air into the channels may be provided, and the gutter system will still operate siphonically without the need for individual siphonic inlets, since a siphonic effect begins to form with increasing water flow rate at the downpipes, and the position of formation of the siphonic flow moves back along the channels towards the
30 inlets, as the amount of water passing through the channel increases.

-18-

A yet further embodiment may comprise a grill or a mesh-type structure to substantially cover the water inlet. This would be advantageous to prevent large objects from entering the system causing a blockage.

5 The water may flow through the gutter system in either a gravity dependent manner or in a siphonic water flow. In a preferred embodiment, water will initially flow into first elongate covered channel (506) and will fall down the first water outlet (511, 512) under gravitational pull. However, as the channel becomes full with water, the first channel will become void of air. The action of the channel
10 becoming full and water dropping down the downpipe will cause a negative pressure to form within the channels and pipework. This negative pressure will cause water to be sucked along the elongate covered channel member, which will thus increase the water flow.

15 At full design capacity, the water builds up around first inlet (509), first channel (506) becomes full of water, and although working siphonically, reaches its maximum capacity. Water builds up in the top of the trough on top of the second cover (507) and raises to a depth whereby it can flow over the top of the upright tube (516) of the second water inlet (518) and into the second water inlet.

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 The second channel (508) fills up similarly as the first channel (506). Initially, at low water flow rates the channel operates as a normal drain with the water flowing under force of gravity. However, as the channel fills up with water the channel begins to act in a siphonic manner, with the volume of water in the
25 second down pipe (514) causing negative pressure which draws more water into the channel at the second inlet (518). When the second channel is full of water and the second down pipe (518) is full of water, the channel operates at its full siphonic rate of flow, with water being drawn in through the second inlet (518) at a relatively high rate.

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From above, when fitted, the gutter may visually resemble a conventional gutter, since only the upper cover can be seen, which presents an open trough with one or a pair of drain points.

5 Referring to figure 7 herein, the diagram shows in plain view a preferred embodiment of an elongate channel member (700) where the first and second covers have been omitted. The figure shows a pair of three dimensional impermeable blocks (701, 702), which may be inserted on either or both sides of the side walls of an elongate channel member. Each three dimensional block is
10 tapered so as to produce a continuously variable channel cross sectional area where the cross-section of the channel increases from a first end (703) to a second end (704), where the second end is defined as being the end at which at least one water outlet is provided, and being the end towards which the water flows. The manipulation of channel size in varying degrees along an elongate
15 covered channel member is advantageous, as by allowing for a narrow cross section in the vicinity of a water inlet, this increases the ability of the system to run under siphonic conditions as the volume of water entering the elongate covered channel member will fill a narrowed channel rendering it void of air at a lower water than if the channel was wide.

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Also shown in figure 7 are a plurality of optional locating straps 705 – 707 which extend across the channel to locate the insert members in spaced apart relationship to each other. The straps each comprise a PVC coated rigid steel strap or similar having a pair of downward pointing ends which can be pressed
25 into the inserts to retain the inserts in position, without obstructing the channel.

Referring to figure 8 herein, there is illustrated schematically in view from one end, a gutter as described with reference to figures 5 to 7 in partially assembled view. Water channel (506) is defined between the first and second
30 tapered insert blocks (701, 702) respectively. The tapered insert blocks are preferably made of a high-density foam, which is both light and durable and can easily be shaped into a tapered form by moulding or by cutting from a larger

-20-

sheet of material. Preferably, the tapered members are made from sheets of relatively dense Isocyanate or poly-isobutylene, or mechanically similar equivalent foam, which are water impervious, have high thermal insulation properties and have at least a 25 year operational life span without significant degradation of performance.

In the embodiment shown, the channel (506) has a constant height, and expands in width at a constant rate between the inlet end (705) and the drain end (704), with the wider channel portion being positioned at the drain end of the gutter. As the water enters the channel at the inlet end (704), water flows down the channel and experiences an increasingly wider channel, of continuously increasing cross sectional area as viewed in a direction perpendicular to the main length of the gutter, with the cross sectional area and width of the channel increasing lineally towards the drain end of the gutter.

Figure 9 herein, shows the water flow of the present embodiment of the gutter system where a plurality of gutters are installed in a roof of a building. Where referring to figure 4b, prior art systems have disclosed two water transport channels for gutter assemblies where the water flow in each channel travels in opposite directions this is disadvantageous as it means that water outlets, downpipes and drainage entry positions have to be located within a building. When a building face is long i.e. over 200 metres, therefore two or more gutter systems may need to be introduced on one face which gives rise to multiple positions where downpipes, water outlets and drainage entry positions would be needed.

The water flow in each covered channel member would flow in the same direction (901 or 902) in any single gutter system and the channels would sit above or below one another. Thus the number of positions needed for downpipes 903, 904, water outlets and drainage entry points is significantly reduced. Moreover all water flow could be directed to the outer edges of the building faces,

-21-

thus causing less obstruction due to down pipes, and underground systems within the building.

Referring to figures 10 to 12 herein, a method of manufacture and
5 installation of the gutter system will now be described.

Firstly, having assessed the area of roof to be drained, and the positions of available drainage points, and the specification of the gutter, i.e. the maximum amount of rainfall that the system is to cope with, the length and design of the
10 gutter is determined using computer modelling to optimise the performance of the gutter. An overall length of gutter is determined, and an optimum number of individual gutter sections is determined, to be joined together to provide the fully assembled gutter, together with the widths and profiles of the channels, number and positioning of the inlets, and specifications for inlet types and heights, and
15 downpipe diameters and lengths. A computer model calculates at each position along the length of the gutter, the optimum cross sectional area of the channel, the volume of water per second at various fill levels of the channel, under siphonic and non siphonic modes, and the negative pressure in the channel. The data for the optimum channel cross sectional area can be converted to a program
20 data for a laser cutting machine to cut the tapered inserts to the optimum tapering profile, which could be linear, or a stepped or curved tapering shape, to provide an optimum channel shape in the trough. Preferably, the channels are shaped such that at the slowest part of the channel, which is usually the part furthest from the outlet, the speed of water flow is always at least 0.7 metres per second,
25 because water travelling at this speed is makes the channel self cleansing of debris, mould etc. Preferably, the system is designed to operate at negative pressures of less than 8 metres of water to obtain reliably predictable performance.

30 Each run of gutter, for example, a 150-metre long run may be manufactured in a factory as a plurality of shorter sections, to be assembled on site. Each section of gutter comprises a trough component, a first cover component,

-22-

optionally, a second cover component, and for each cover component, a corresponding one or pair of respective foam tapered insert members as described herein before. For systems designed to accommodate a category 3 or greater rainstorm, the first and second cover members will be fitted at the factory
5 so as to provide a two-tier channel system. However, for systems which are designed for a category 1 or 2 storm, the gutter may have a single tier enclosed channel.

In the factory, lengths of steel, aluminium or plastic are formed into a trough
10 shape as described herein before with reference to figures 5 onwards. Metal upright spacers may be welded across the trough at periodic intervals to support the first cover, and/ or the second cover, at a predetermined design height above the floor of the trough. For example the heights of the first cover may be set at 40mm, 60mm, or 80mm from the trough floor to provide the correct optimum
15 design heights of the first and second covers, to achieve the optimum channel heights.

Sheets of foam or similar are cut to a shape corresponding to the correct taper for the particular section of gutter being made, and are glued, adhered or
20 otherwise secured inside the trough. In one method, the tapered insert members may be secured in the channels by a plurality of upright spikes or pins welded to the trough floor or side walls. In another method, the inserts may be positioned in the troughs, and a plurality of PVC coated steel or aluminum straps may be pressed into the foam inserts. The straps may comprise a horizontal part and two
25 downwardly projecting parts, one at each side which may be positioned above the foam insert members, as shown in figure 7 herein, to locate the foam tapered blocks each side of the channel. The first cover member is then placed over the trough to form a lid to a cavity containing the insert members and the channel. The edges of the first cover member are welded or otherwise fixed in a watertight
30 manner to the up right sides of the trough, thereby enclosing the cavity and the channel, the cover forming both an airtight and watertight lid to the cavity.

-23-

The cover members are preferably made of 1.2 mm sheet steel, aluminium or plastic with or without a plastics coating, which enables the cover to be joined to the edges of the trough using a heat weld, or a PVC sealant giving a watertight and airtight seal.

5

The sections of gutter at the inlet end and the drain end have apertures cut for the inlet and outlet respectively at the factory, although cutting of the apertures may also be possible at the installation site. The section of gutter at the outlet end may have an initial section of down pipe factory fitted with a watertight seal, for connection of a down pipe on site.

10

For the section of channel at the inlet end, cover grills as shown in figure 6 herein are fitted to the inlet apertures for the first channel and (where fitted) the second channel. These are preferably factory fitted prior to shipping, but could alternatively be fitted at the installation site.

15

In the case of a two tier gutter system, in the factory a further set of foam insert members are cut to shape and fixed on top of the first cover member, similarly as herein before described for the first channel, and above which is fitted a second cover member. The second cover member is welded, heat sealed or otherwise adhered to the upright sides of the trough member to ensure a watertight seal.

20

The individual gutter sections are transported to the site, and are lifted on to the roof either manually, or using a crane. The gutter sections are bolted in place at the edges of the roof and/or to the frame of the building, and in the case of a building having a multiple apex roof, in the valleys between the roof sections.

25

Referring to figure 10 herein, there is shown schematically in view from above the ends of two gutter sections 1000, 1001 positioned end to end for joining on site.

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-24-

As shown in figures 10 to 12, the ends of the gutter sections are manufactured such that a portion of the floor of the trough is exposed and accessible from above, and the first and second cover portions are stepped with respect to each other, to allow access to the joint for connecting the gutter sections on site.

Referring to figure 10 herein, there is shown in view from above a first stage of joining two gutter sections 1000, 1001. Each gutter section has its upper and mid covers, 1002, 1003 respectively, exposed and extending short of the end of the gutter section. The ends of the trough are abutted together. Shown are the protruding ends of the foam inserts 1004, 1005 of the upper and lower cavities respectively, which in this example protrude from the ends of their respective cover members, so as to allow a platform across which to span a further section of cover over the joint.

Referring to figure 10 herein, there is shown the first and second gutter members (900, 901 respectively) of figure 9 herein, in cut away view from one side during a jointing operation. The first and second gutter sections (900, 901) are placed abutting each other end to end. Each section is supplied from the factory with the first and (where fitted) second cover members cut slightly short of the end of the gutter, to leave room for creating a joint between the ends of the two gutters. The two gutters are placed end to end and are fixed in place to the roof or adjoining building structure. To create a joint, a plastics membrane and/or tape strips 1004 may be fitted either inside the trough members and/or outside the trough members and heat sealed to create a watertight seal. Additionally, the two ends of the gutter may be bolted together at their ends with one or a plurality of plates (1003) extending across the joint. A plurality of optional waterproof stick pins 1100 may protrude upwardly to locate the tapered foam inserts which are pressed down into positions across the joint.

Referring to figure 12 herein, one or a pair of insert members (1200), which are pre-cut to shape in the factory, or which can be cut from block of foam

-25-

material on site, are inserted across the joint in order to provide continuity of the tapered insert members on one or either side of the channel as appropriate. Once the inserts (1200) are fixed in place, a first section of cover (1201), which is preferably pre-cut to shape in the factory, or which can be cut to exact size on site is laid across the trough and across the joint, and is heat welded, taped, sealed or otherwise joined in a watertight manner to the two lengths of first cover member either side on each gutter section, thereby enclosing the joint around the first (lower) channel in a watertight and airtight manner.

Joining of the second cavity and second channel across the joint between gutter sections is similarly carried out with a further one or more blocks of insert member cut to shape and size to provide continuity of the second channel shape, and a further cover section being welded or glued in place over the second channel and between the upper (second) cover portions of each gutter section, thereby creating a watertight and airtight seal.

The most important joint to make is the joint between the abutting trough members, since this is the joint which keeps the water out of the building. The other joints on the cover members are preferably water tight and airtight to promote negative pressure in the channel and the siphonic behaviour, but if there is some degree of leakage on these joints, it is not critical since it only marginally affects the siphonic behaviour, and there is no risk of water leaking into the building. Under conditions of heavy rainfall, since the upper open channel will be full of water, then any minor leaks between channels through the cover joints will not significantly affect siphonic operation since only water will pass through the leaks.

Referring to figure 13 herein, there is illustrated schematically in cross sectional view from one end operation of the gutter system of figures 5 to 12 herein under conditions of moderate rain fall. Under conditions of moderate rain fall, for example a category 1 or category 2 shower, water collects on top of the upper cover member and flows into the first inlet 509), along the first channel

-26-

(506) and down the first outlet (511) into first downpipe (512). As the water fills up above the top of the first inlet and flows into the inlet to the first channel (515), and as the first channel (506) fills up with water, the shape of the gradually expanding first channel towards the outlet creates a negative pressure and siphonic operation of the channel begins, which sucks water down the first inlet (509) at an increasing rate until the first channel is operating fully siphonically. It is important that the channel is watertight and airtight along its length except for the inlets and outlets, to avoid air entering the first channel and reducing the siphonic effect caused by reduced pressure in the channel.

10

At this level of rainfall, because the water level in the top part of the trough is below the water intake level of the second inlet (510), little or no water enters the second inlet (510) and the second channel (508) remains unused.

15

As shown in figure 14 herein, under conditions of increased rain fall, for example a category 3 storm, water fills up in the top part of the gutter above the levels at which both the first inlet (509) and the second inlet (510) can intake water. Under these conditions, the first channel (506) is filled with water and operates siphonically, and water also enters the second inlet (510) and the second channel (508). Both the first and second channels fill with water, and the second channel also begins to operate siphonically.

20

The rain fall rate at which the first and second channels begin to accept water is a design selectable parameter, by altering the height of the first and second second inlets (510) above the upper cover. At one extreme, the inlet of the second channel can be placed at the same height as the inlet of the first channel, in which case the first and second channels may drain water at a similar rate as each other and operate in parallel, whatever the level of rain fall, and the onset of siphonic operation may occur at approximately the same time for each channel.

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-27-

Alternatively, the second inlet (510) may be raised above the first inlet, so that the water level builds up in the upper part of the trough to such a level that the first channel is operating fully siphonically before any water enters the second inlet, and therefore the second channel operates as an overflow channel only.

5

Alternatively, by placing the height of the first inlet higher than the height of the second inlet, the roles of the two channels may be reversed, so that the upper channel acts as the primary channel for lower levels of rainfall, and the lower channel acts as the secondary or overflow channel.

10

Further, the diameter and/or area of the inlets and outlets may be varied as a design parameter to affect the rate of water flow through the inlets and outlets. In the example shown in figure 12 and 13, the outlet of the first channel has a slightly larger diameter and is fitted to a slightly large diameter down pipe than the outlet (513) of the second channel.

15

Referring to figure 15 herein, there is illustrated schematically in view from above a further embodiment gutter in plan view, showing a plurality of water inlets 1500, 1501 along the length of the upper open channel for accepting water in to the first (primary) enclosed channel; a second plurality of inlets 1502, 1503 for accepting water from the upper open channel in to a secondary enclosed channel. In this case, the inlets are positioned in line along the length of the upper open channel, but in other embodiments, the inlets to the primary and secondary channel could be staggered, or placed side to side. Similarly, a first and second outlets 1504, 1505 to the primary and secondary channels respectively may be positioned length wise along the gutter, or may be placed side by side at the end of the gutter.

20

25

A plurality of inlets corresponding to each of the primary and secondary channels may be provided at various distances along the length of the gutter. The inlets may each comprise a debris guard vortex reducing means, or may

30

comprises one or a plurality of apertures 1704 which enable the inlet cover to be fixed, for example by bolts, to either a tubular inlet pipe, a siphonic bowl, or a conventional gravity down pipe.

5 The plurality of inner arm portions 1705 define a plurality of inner apertures 1707 which face inwardly towards the centre of the plate member 1700, arranged around the plate member in a circle. Each inner aperture is defined by a perimeter of the plate, a pair of adjacent arms, and the upper ring member 1702.

10 The plurality of outer arm portion 1706 define a second set of apertures, which face outwardly from the centre of the water inlet, each aperture defined an adjacent pair of outer arm portion 1706, at an upper end by the inner circular connecting member 1702, and at a lower end by the outer circular connecting member 1703.

15 An upwardly facing surface of the plate 1700 comprises a shallow dome shape, such that water entering inside the upper ring 1702 and resting on the dome flows in a direction outwardly towards the inner apertures 1707.

20 The water inlet cover comprises two main functional parts. Firstly, the central plate member acts to exclude air from entering the downpipe or bowl (depending on which type of rainwater system the inlet cover is fitted to) during high flow conditions. Excluding air from immediately above the centre of the pipe or bowl promotes a greater water flow and can encourage the onset of siphonic
25 behaviour.

Secondly, the radially extending arms act as an outer grill which prevents debris over a particular size from entering the inlet, since the debris (primarily leaves, but also including items of litter roofing materials such as bolts, or roof
30 panel fragments etc.) from entering the drainage system. The arms create a ridged grill consisting of grill members (the arms) with a plurality of apertures there between. The ridged shape of the arms tends to keep the debris on the

-30-

outer perimeter of the inlet cover under lower and moderate levels of water flow, as the debris cannot pass over the top of the ridge into the centre of the cover.

Referring to figure 18 herein, there is illustrated schematically in cut away
5 view from one side, the inlet cover of figure 17, along the line Y-Y'. Each arm 1701 comprises an inner inclined section 1705 extending between a perimeter of the central plate member and the inner connecting ring 1702, and a second inclined portion 1706 extending between the inner connecting ring 1702 and the outer connecting ring 1703. The inner inclined arm portion 1705 is arranged so
10 as to be relatively shorter compared to the outer inclined portion 1706, an upper end of the inner inclined arm portion meeting an upper end of the outer inclined arm portion 1706 at the position of the inner ring member 1702. As viewed in cut away profile, the arm portion is of a substantially inverted "V" shape having a relatively longer outer arm portion, so that the arm resembles a spider leg
15 arrangement.

In a modified embodiment, the outer ring member 1703 may be omitted, so that the lower ends of each outer arm portion 1706 are unconnected to each other. The substantially circular plate member 1700, viewed in cross section from
20 one side comprises a smooth underside.

Referring to Figure 19 herein, there is shown in partial cut away view from on side a single arm of the inlet cover of figures 17 and 18 herein, showing the peaked inverted "V" shape of the arm, and the connecting ridge portion 1702.
25 Debris collects preferentially on the outside of the arm, at the longer length of the arm in preference to inside the ring 1702 due to the overall crater like shape of the cover, and the ridged grill formed by the arms.

Referring to figure 20 herein, there is illustrated schematically a second
30 water inlet cover. The second water inlet cover comprises a substantially square plate member 2000; a plurality of outwardly extending arm members 2001 arranged peripherally around an outer perimeter of the plate member 2000; a

-31-

plurality of apertures 2002 positioned on the plate 2000 for attaching the water inlet to a drain pipe, water inlet tube, or siphonic inlet bowl; a connecting ring 2003 which connects together an upper portion of the plurality of radially extending arms 2001, and which surrounds and is spaced apart from the centrally located plate 2000; and a plurality of annular locating rings 2004, each of which is
5 located at a lower end of a corresponding respective radially extending arm, for securing the cover to a surface of a gutter, around an inlet aperture.

Each radially extending arm has a relatively shorter upright inner portion,
10 and a relatively longer upright outer portion, similarly as shown with reference to figure 19 herein, but without the lower ends of the arms being connected by a lower connecting ring (although in yet another variation of the second inlet cover, the lower arms could be connected to each other). The plurality of radially extending arms define a plurality of inwardly facing apertures 2005 through which
15 water which collects inside the ring 2003 can drain from the plate and in to an underlying drain pipe or collecting bowl. The outer portions of the radially extending arms define there between a plurality of outwardly facing apertures, through which water can drain from a position outside of the inlet cover, for example water collecting on a flat surface of a gutter channel, and which can
20 drain through the outer apertures in to the underlying rain water collection pipe, enclosed channel or siphonic bowl.

Referring to Figure 21 herein, there is shown schematically the second inlet cover of Figure 20, in cut away cross sectional view along the line Z-Z'.

25

Each arm has an inner upright portion and an outer upright portion, connected at an upper ridge 2102, so that the plate member 2000 forms a crater floor shape inside the ring of arms, with the peripheral ridge formed by the plurality of peripheral radially extending arms. Individual ones of the arms have
30 an annular molding 2004 containing an aperture, by means of which the inlet cover may be bolted or screwed to a flat surface around an inlet.

-32-

In use, operation of the first and second inlets is very similar, and as follows. Under moderate water flows, water encountering the inlet will flow between the outer apertures and down in to the rain water collection pipe or collection bowl underneath. Any debris such as leaves, twigs or litter will be prevented from
5 flowing in to the drain by the outwardly extending arms. However, the leaves, litter and debris may still lie across the apertures, which means that further debris and standing water may build up behind the leaves and debris. Water flowing over the leaves and debris may flow over the top of the ridge and the ring connecting member, and in to the centre of the "crater" surrounded by the ridge.
10 Water entering the centre of the inlet will flow outwardly towards the inner apertures, and down in to the rain water pipe or collection bowl. Clearly, if there is enough debris, litter or leaves such that the inlet is completely blocked with debris, then having both an outwardly facing and an inwardly facing sets of apertures will not prevent blockages and the inlet cover becoming blocked
15 altogether. However under less extreme volumes of debris, debris will be preferentially retained outside the centre of the crater, leaving the inner apertures unobstructed and capable of draining water.

Where the inlet cover is fitted directly to a gutter floor, over an aperture in the
20 gutter floor, an upper surface of the plate is positioned at a height above a height of an outer perimeter of said cover, such that when the cover is fitted to a gutter floor, the plate lies substantially parallel to, and above a level of said gutter floor. In various modifications to the embodiments, the inlet cover may be designed to be vortex preventing, or not. Where a simple flat, circular or flat rectangular plate
25 is provided with a flat underside then vortex prevention may be left un-optimised. However, where the shape of the inner circular or square plate is domed on the upper surface, and provides a convex cusp shaped protrusion in the centre, this may effectively exclude air in the waterflow under high flow conditions, and aid the prevention of vortices.

30 It will be appreciated by the skilled person that the embodiments of figures 17 to 21 may be formed in a variety of ways, such as by plastics mouldings, or as

-33-

a metal casting. In other embodiments, the surrounding grill barrier may be formed from wire mesh shaped into a ridged ring.

A further advantage of the specific embodiments disclosed herein is that using a same trough width and cover width, the widths and the cross sectional areas of the internal channels can be varied over a range to optimise the onset of siphonic behaviour gutter to different roof areas and designed for rainfall rates using a single set of trough and cover dimensions, by inserting different widths of tapered insert member. The system can be designed to meet various different levels of rain fall and roof area, using the same trough second and cover members, with the design changes occurring only on the foam inserts, the diameters and/or cross sectional areas of the inlets and outlets, and the relative heights of the first and second inlets. This has the advantage of standardising components for the trough and covers and thereby reducing overall system costs by avoiding the need to manufacture different trough and cover sizes. Optimisation of the water flow rates, sizes of inlet and outlet apertures, and the shape and cross sectional area of the internal channels at each position along the channel can be determined by computer implemented calculations, to give an optimum designed system for each building, roof area and climate. Both the height and the width of the channels are design parameters which can be easily varied, by use of different height vertical spacers and different width or shaped insert members, using a single trough shape.

Specific embodiments disclosed herein may have an advantage of permitting, through the use of a multi-storey channel system, siphonic behaviour of one or more inclined or substantially horizontal water channels, where each channel drains to a same end of a gutter system. Further, two such gutter systems can be placed end to end, with their outlet ends placed opposite to each other, and their respective inlet ends placed adjacent to each other so as to enable drainage of a length of roof of the order of 400 metres or more using siphonic guttering, without the need for any down pipes to be present in the middle of the span between the two outlet ends of the end to end gutter lengths.

This may avoid the need to fit drains in the centre of a building's concrete floor slab, or at least reduce the amount of such drains needed.

Further, since the internal shape of the channels promotes siphonic behaviour in the channels themselves, there is no need for an additional horizontal or shallow inclined parallel pipe inside the building, as in the prior art case shown in Figure 2 herein. This avoids additional piping internal to the building, and avoids the additional jointing with its associated inspection and maintenance and risk of leakage inside the building.

Further, conventional siphonic systems comprising lengths of pipe and siphonic inlets as shown in figure 2 herein, have step changes in pipe size at every inlet, and are restricted by the available pipe diameters to a limited range of cross sectional areas of water channel in the pipe. In contrast, in the specific embodiments herein, the channel cross sectional area is continuously variable as a design parameter, allowing greater optimisation of cross sectional area at any distance along the water channel and enabling greater optimisation of the water flow. Whereas conventional pipe based siphonic systems are designed to be optimised around a single rainfall rate, and the pipe sizes are fixed once installed, this means that the conventional systems may not perform optimally at other ranges of rainfall, for example 60% of "design for " rainfall rate. In contrast, the embodiments presented herein have a continuously tapered channel cross section and can therefore be designed for optimised performance over a range of rainfall rates, rather than just one target rainfall rate, because they are not restricted by predetermined pipe sizes. The embodiments described herein may be designed to operate siphonically over a greater range of rainfall rates than a known pipe based siphonic drainage system, and can be designed to become siphonic at a large range of fill levels of the primary channels, compared to known pipe based siphonic systems. In turn, this means that the risk of overflow of the open channel which collects the rainwater prior to entering the inlets is reduced compared to known systems, because the open upper channel is drained more quickly. This has the advantage of reducing the risk of flood or water damage

-35-

inside the building due to gutter overflow compared to known systems, the occurrence of which is often incorrectly attributed to leaking joints, resulting in unnecessary system maintenance in prior art pipe systems.

Claims

1. A gutter system comprising:

5

a first elongate covered channel capable of carrying water flowing in a first direction;

10 a second elongate covered channel positioned above said first elongate covered channel, said second channel capable of carrying water flowing in said first direction.

15 2. The gutter system as claimed in claim 1, comprising an open channel positioned above said first and second channels, for collection of rainwater.

20 3. The gutter system as claimed in any one of the preceding claims, wherein said first and/ or second channels are substantially sealed along their whole lengths, except at their ends.

4. The gutter system as claimed in any one of the preceding claims, having a channel cross sectional area which is continuously variable along its length.

25 5. The gutter system as claimed in any one of the preceding claims, wherein said first and/or second channel has a cross sectional area which increases in the direction of water flow.

30 6. The gutter system as claimed in any one of the preceding claims, wherein said first and/ or second channel is of a substantially constant height along its full length.

-37-

7. The gutter system as claimed in any one of the preceding claims, wherein said first and/or second channel has a substantially rectangular cross sectional area in a direction perpendicular to a main length of said gutter.

5 8. The gutter system as claimed in any one of the preceding claims comprising:

a first water inlet positioned at a first end of said gutter for allowing water to enter said first channel;

10

a first water outlet positioned at a second end of said gutter for draining water from said first channel;

a second water inlet positioned at said first end of said gutter for allowing
15 water to enter said second channel; and

a second water outlet positioned at said second end of said gutter for draining said second channel.

20 9. The gutter system as claimed in any one of the preceding claims, comprising a debris guard vortex reducing means for minimizing vortex formation in and around at least one water inlet.

25 10. A gutter system as claimed in any one of the preceding claims, wherein:

said first channel is formed within a first cavity, said first cavity having a substantially trapezoidal cross sectional area as viewed in a direction perpendicular to a main length of said gutter;

30

said first channel is defined by at least one elongate tapered insert fitted inside said first cavity;

said second channel is formed within a second cavity, said second cavity having a substantially trapezoidal cross sectional area as viewed in a direction perpendicular to a main length of said gutter; and

5

said second channel is defined by at least one tapered insert member fitted within said second cavity.

11. A gutter section comprising:

10

an elongate trough having a floor, a first elongate upright side wall and a second elongate upright side wall; and

an elongate cover member spaced apart from said floor and extending between said upright side walls, and closing off an upper part of said trough at a first height, so as to define an enclosed cavity there between;

15

characterised by:

a single enclosed channel being provided across said trough between said floor and said cover member and extending along a length of said trough.

20

12. The gutter section as claimed in claim 11, further comprising an open channel positioned above said enclosed channel and defined between said first and second side walls of said trough.

25

13. The gutter section as claimed in claim 11 or 12, wherein said enclosed channel has a variable cross sectional area in a direction transverse to a main length of the gutter section.

30

14. The gutter as claimed in any one of claims 11 to 13, comprising at least one insert member located between said floor and said cover, said insert

-39-

member having a cross sectional area in a direction perpendicular to its main length which varies between first and second ends of said insert member.

15. The gutter as claimed in any one of claims 11 to 14, comprising a pair of insert members located between said floor and said cover, at least one of said insert members being tapered, wherein said channel is positioned between said pair of insert members.

16. The gutter section as claimed in any one of claims 11 to 15, comprising a water inlet for allowing water to enter said enclosed channel.

17. The gutter section as claimed in any one of claims 11 to 16, comprising a water outlet for allowing water to drain from said enclosed channel.

18. The gutter section as claimed in any one of claims 11 to 17, comprising at least one insert member located between said floor and said cover, said insert member having a cross sectional area in a direction perpendicular to its main length which varies between first and second ends of said insert member.

19. The gutter section as claimed in any one of claims 11 to 18, comprising a pair of insert members located between said floor and said cover, at least one of said insert members being tapered, wherein said channel is positioned between said pair of insert members.

20. The gutter section as claimed in any one of claims 11 to 19, comprising a second elongate cover member positioned above said first cover member, so as to define a second cavity on top of said first cavity and running substantially parallel therewith, between said second cover, said first cover and said first and second upright side walls.

-40-

21. The gutter section as claimed in any one of claims 11 to 20, comprising a single second enclosed channel being provided across a width of said trough, between said first cover, said second cover and said first and second upright side walls, said second channel extending along a length of said trough;

5

said second enclosed channel having a variable cross sectional area in a direction transverse to a main length of said trough, and which increases along a main length of said trough in a same direction as said first channel increases in cross sectional area.

10

22. The gutter section as claimed in claim 20 or 21, further comprising a second water inlet for allowing water to enter said second channel.

23. The gutter section as claimed in any one of claims 20 to 22, further comprising a second water outlet for allowing water to drain from said second channel.

15

24. A gutter comprising:

20 an elongate trough having a floor, a first elongate upright side wall and a second elongate upright side wall;

an elongate cover member spaced apart from said floor and extending between said upright side walls, and closing off an upper part of said trough at a first height, so as to define an enclosed cavity there between; and

25

an open channel above said elongate cover member for collecting rainwater;

30 characterised by:

-41-

a single enclosed channel being provided across a width of said trough between said floor and said cover member, and extending along a length of said trough;

5 a water inlet for allowing water to enter said enclosed channel from said open channel;

a water outlet for allowing water to drain from said enclosed channel.

10 25. The gutter as claimed in claim 24, wherein said inlet and outlet are spaced apart from each other along a length of the gutter, such that water entering said channel via said inlet passes through said enclosed channel to said outlet; and

15 a cross sectional area of said enclosed channel increases in a direction from said inlet to said outlet.

20 26. The gutter as claimed in claim 25 or 26, comprising a second elongate cover member spaced apart from said first cover member floor and extending between said upright side walls, and closing off an upper part of said trough at a second height, so as to define a second enclosed cavity running above and in parallel to said first enclosed cavity.

25 27. The gutter system as claimed in claim 26, comprising a single enclosed second channel extending across a width of said trough between said first cover member and said second cover member, and extending along a length of said trough;

30 a second water inlet for allowing water to enter said second enclosed channel from said open channel; and

-42-

a second water outlet for allowing water to drain from said second enclosed channel.

28. A cover for a rain water inlet, said cover comprising:

5

a plate member;

a grill positioned around a perimeter of said plate member;

10 said grill having a plurality of spaced apart members, with apertures between said spaced apart members;

said grill being formed into a ridge around an outer perimeter of said central plate member, such that in use, a peak of said ridge lies above an upper surface
15 of said plate member.

29. The cover as claimed in claim 28, wherein said grill comprises a plurality of inwardly facing apertures positioned between said plate member and said peak of said ridge.

20

30. The cover as claimed in claim 28 or 29, wherein said grill comprises a plurality of outwardly facing apertures positioned around a perimeter of said grill.

25 31. The cover as claimed in any one of claims 28 to 30, , wherein a plurality of said spaced apart members, each extend in a first direction transverse to a main plane of said plate; and

a second plurality of spaced apart members, extend in a second direction
30 transverse to said main plane of said plate,

-43-

said first and second transverse directions being transverse to each other and transverse to said main plane.

32. The cover as claimed in any one of claims 28 to 31, wherein said
5 plate member and said grill form a substantially cratered shape, wherein said grill forms a ridge around said central plate, and said central plate is positioned in a floor of said crater.

33. The cover claimed in any one of claims 28 to 32, wherein said
10 central plate is substantially circular.

34. The cover as claimed in any one of claims 28 to 32, wherein said central plate is substantially square.

15 35. The cover as claimed in any one of claims 28 to 34, wherein said plate member comprises a substantially cusped shaped underside.

36. The cover as claimed in any one of claims 28 to 35, wherein said
20 plate member comprises a substantially convex upper surface.

37. The cover as claimed in any one of claims 28 to 36 comprising a plurality of outwardly extending substantially inverted "v" shaped arms, having a plurality of said apertures there between.

25 38. The cover as claimed in any one of claims 28 to 37, wherein an upper surface of said plate is positioned at a height above a height of an outer perimeter of said grill.