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(54) **Sustainable urban drainage device and system**

(57) There is provided a paving unit for provision of a paved, cobbled or flagged surface of an urban drainage system comprises a paving layer (19) and a drainage section disposed below the paving layer (19). The drain-

age section comprises at least one drainage means and the unit is adapted to allow surface water to pass into the drainage means of the drainage section. The invention also extends to a drainage device, system, method and kit of the drainage device (2, 9).

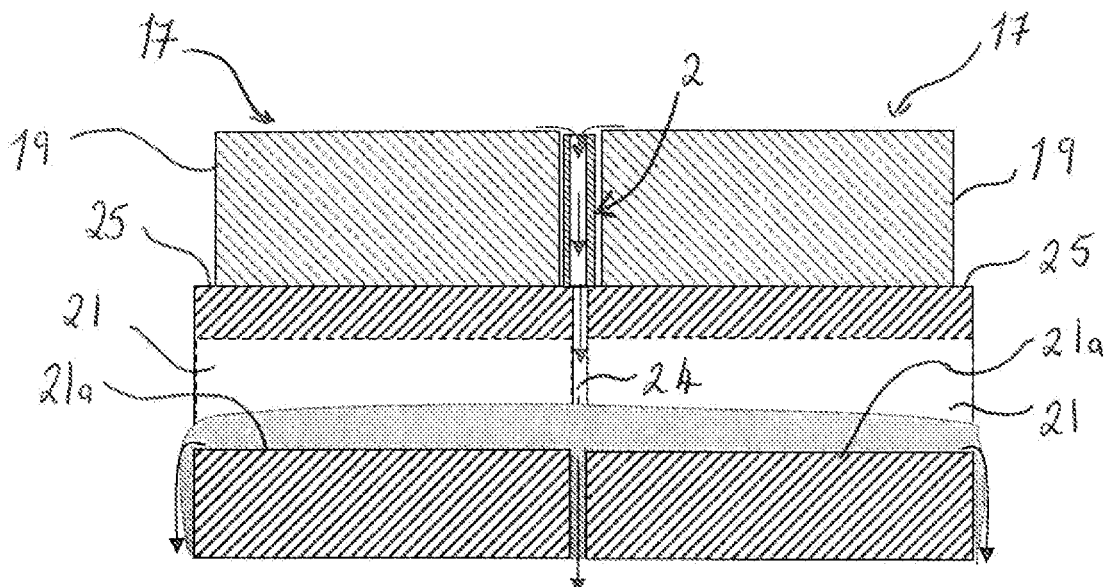


FIGURE 6c

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Description

[0001] The invention relates to a sustainable drainage device and system for addressing surface flooding and particularly relates to a device and system of this kind for use with tiled or paved flooring/ surfaces.

[0002] Currently known existing drainage systems often inefficiently address surface flooding, pollution or damage to the environment. In addition, many known systems are not proving to be environmentally sustainable as they are frequently expensive to install and/or run and/or maintain.

[0003] Surface flooding is often the result of limited or no drainage opportunities on a water impermeable surface and/or because the ground water level within the sub-base and/or substrate is at saturation point.

[0004] Guidelines concerning the requirements for new drainage systems in the urban environment have been drafted (SUDS - sustainable urban drainage systems), in an effort to tackle these problems.

[0005] One known existing urban drainage system uses an underground reservoir, which employs an underground, open-celled infrastructure installed below a floor surface and a pump. The open-celled infrastructure is constructed from a plurality of open-walled cells or boxes, which must be installed in a pit or basin below the required flooring level, prior to any paving stones or upper surface being laid thereon. The cellular infrastructure provides a substantially hollow cavity below the ground surface for water storage. However, these systems are not appropriate for every location due to the requirement of ample space below floor level and the expense of installation and operating the pump continuously to remove standing water out of the reservoir.

[0006] There is therefore, a need for drainage systems, which are more effective than conventional drainage methods, but which address the problems with rapid water runoff and surface water in the urban environment, whilst being inexpensive and/or, sustainable and/or environmentally friendly. There is also a need to provide a system, which not only addresses these problems, but is efficient and easy to install, in addition to being extremely cost effective.

[0007] An aim of the invention is to provide an urban drainage device and system, which address the problems with water runoff and surface water in the urban environment.

[0008] Another aim of the invention is to provide an urban drainage device and system, which is sustainable.

[0009] A further aim of the invention is to provide an urban drainage device and system, which is efficient and easy to install.

[0010] Another aim of the invention is to provide an urban drainage device and system, which takes into account the environmental impact of such systems.

[0011] According to one aspect of the invention there is provided a paving unit for provision of a paved, cobbled or flagged surface of a drainage system on a supporting

surface of ground, wherein the paving unit comprises a paving layer and a drainage section disposed below the paving layer, the drainage section comprising at least one drainage means and the paving unit being adapted to allow surface water to pass into the drainage means of the drainage section.

[0012] Advantageously, water is directed away from the surface to reduce flooding thereon and the water can be stored in the drainage section when the ground below is saturated, or naturally drained from the drainage section when ground water levels permit.

[0013] Preferably, the drainage means may also comprise a water storage means to hold water.

[0014] Preferably, the paving layer is an upper layer, in use, and comprises an upper paving stone, cobble or paving flag component or part thereof. The upper component may be a natural stone component.

[0015] The drainage section may therefore comprise a breeze block or cement/concrete aggregate.

[0016] Preferably, the drainage means comprises at least one open-ended laterally extending conduit from a side face to another side face of a drainage section. A number of such conduits may be provided. Most preferably, the drainage means comprises a network of intersecting conduits, linking each side face of a drainage section.

[0017] Preferably, between adjacent paving units a passageway/water storage void is provided, which links a top surface of the unit to the drainage means so as to be effective to direct water downwards. Preferably, each passageway/water storage void comprises a generally vertical channel defined by at least two side walls. Each paving unit preferably comprises at least one of said side walls of the passageway, such that each passageway/water storage void is provided by abutting paving units together to complete the passageway.

[0018] The passageway/ water storage void may also comprise a base wall. A base wall may be provided by cooperation of protruding shelves disposed on the drainage section of adjacent units, disposed below the conduits. Preferably, the shelf extends around the entire periphery of the drainage section so as to allow the unit to be used in any orientation.

[0019] Preferably, each paving unit is adapted to facilitate the accommodation of at least one drainage device in a gap between the paving layers. Therefore, each paving unit may provide a partial base support means for the drainage devices.

[0020] Preferably, each partial base support means comprises a protruding ledge at the junction of the paving layer and the drainage section. Preferably, to achieve this, at least one, preferably all paving layer side walls are stepped inwardly from the corresponding side walls of the drainage section. Preferably, the partial base support means on adjacent units co-operate to provide a full base support for the drainage device.

[0021] Preferably, each unit side face provides a partial support means. Most preferably, all of the side faces of

the paving unit provide a partial support means so as to allow the units to be used in any orientation.

[0022] Preferably however, the partial base support means is provided by a ledge formed in at least one side face of each unit. Each ledge preferably forms the base part of a recess in the respective side face of the unit. Preferably, the recess is accessible from the top surface of the unit. Preferably, the recess side walls extend perpendicularly upwardly from the opposite ends of the ledge and terminate at the surface of the unit. Most preferably, each recess aligns in use with a recess of an adjacent unit to provide a sunken cavity. Most preferably, the sunken cavity is accessible from the top surface between the two adjacent units, for ease of disposal and/or replacement of a drainage device therein from the top surface.

[0023] Preferably, each side face of a unit comprises a recess. Preferably, the recesses are disposed in corresponding positions on each side face. Most preferably, the recesses are disposed centrally on each respective side face.

[0024] Advantageously, a paving block of this arrangement in use, provides one or more discrete cavities for accommodation of a drainage device for ease of installation.

[0025] In the alternative, the whole paving unit may be manufactured as a single paving block comprising the passageway, drainage section and the support means.

[0026] According to a second aspect of the invention there is provided a drainage device for disposal between individual paving stones, cobbles or paving flags of a paved, cobbled or flagged surface provided on a ground surface, the device comprising a means for allowing passage of water therethrough to facilitate direction of water away from the paved, cobbled or flagged surface in use and into the ground below and inlet and outlet ends, wherein the device has a height Z and the inlet end has a width Y, a length X and wherein $Z \geq Y$.

[0027] With this arrangement, the build-up of surface water, which contributes to surface flooding on a paved, cobbled or flagged surface, can be minimized/ potentially prevented by providing a means for the water to drain into the ground through the drainage device(s).

[0028] According to a third aspect of the invention there is provided a drainage system for use on a ground surface, comprising a paved, cobbled or flagged surface and at least one drainage device disposed between individual paving stones, cobbles or paving flags, the device comprising a means for allowing passage of water therethrough to facilitate direction of water away from the paved, cobbled or flagged surface in use and into the ground below and inlet and outlet ends, wherein the device has a height Z and the inlet end has a width Y, a length X and wherein $Z \geq Y$.

[0029] Preferably, the width Y is approximately 5mm - 12 mm and the device is adapted to be installed between and uninstalled from between individual paving stones, cobbles or paving flags, either before or after (i.e. retro-

fitted) the installation of the individual paving stones, cobbles or paving flags.

[0030] Preferably, the inlet and outlet ends are substantially elongated having a length X and a width Y. The body of the device may be substantially rectangular in section with, preferably, parallel sides along its full height Z.

[0031] Preferably, the device is disposed between the individual paving stones, cobbles or flags such that the inlet end is upwardly facing and is flush with an upper surface of the paving stones, cobbles or flags, in use.

[0032] Most preferably however, the inlet end is disposed just below the upper surface of adjacent paving stones, cobbles or flags, i.e. the device does not protrude above the surface provided by the paving stones, cobbles or flags. The height Z of the device may therefore be substantially the same as the depth of the side walls of the paving stones, cobbles or flags. Most preferably, the height Z of the device is just shorter than the depth of the side walls of the paving stones, cobbles or flags.

[0033] Preferably, the drainage device comprises a substantially hollow body and the inlet and outlet ends are generally open. At least one open-ended channel may extend between the inlet and outlet ends. Most preferably, the drainage device comprises a plurality of channels extending between the inlet and outlet ends. This arrangement of channels provides a more rigid drainage device.

[0034] Preferably, the arrangement of the paving stones, cobbles or paving flags is such as to provide gaps between adjacent paving stones, cobbles or paving flags and the at least one drainage device is installed in one of said gaps.

[0035] Therefore, due to the relative dimensions of the device, the drainage devices are easy to install at various locations in the normal gaps provided between paving stones, cobbles or flags, in normal use.

[0036] According to a fourth aspect of the invention therefore there is provided a method for the installation of a drainage system for a paved, cobbled or flagged surface and wherein the method comprises the steps of:

- a) arranging a plurality of paving stones, cobbles or flags on a ground surface with gaps therebetween, the gaps being approximately equal;
- b) inserting at least one drainage device in at least one gap between said paving stones, cobbles or flags;
- c) ensuring that an inlet end of the drainage device is in the same plane as, or below the paved, cobbled or flagged surface provided by the paving stones, cobbles or flags adjacent to the said at least one gap; and
- d) filling remaining gaps between the paving stones, cobbles or flags with a suitable filling material to joint the paving stones, cobbles or flags in place.

[0037] The width of the gaps may be up to 25% of the

width of the paving stones, cobbles or flags, preferably still, up to 20%, most preferably up to 15%.

[0038] Preferably, the gaps have a width of up to 12 mm. Preferably, the drainage devices have a width Y which is less than that of the gaps provided. Most preferably, the devices have a width Y which is less than that of the gaps to enable a snug fit therein.

[0039] Preferably, the width Y is approximately 8mm - 10 mm. Most preferably, the width Y is approximately 10 mm.

[0040] The filling material may be mortar and may be wet (cement) or dry (sand), although any other suitable mortar, grouting or filling material may be used.

[0041] Preferably, the device has opposing inlet and outlet ends defined by the corresponding edges of the front and rear and connecting side faces of the device. Preferably, the front, rear and side faces of the device are co-extensive with the front and rear faces and the opposite, side faces respectively spaces and parallel. Each device is preferably disposed between the paving stones, cobbles or flags with the front and rear faces lying in generally parallel arrangement with the adjacent stone, cobble or flag.

[0042] Preferably, the drainage device provides a means of retaining the device between the paving stones, cobbles or paving flags. The retaining means may be provided by contact with the surrounding paving stones, cobbles or flags and the filling material, i.e. using friction and a snug fit. Alternatively, spikes or protrusions may be disposed on one or more walls of the body to interact with the paving stones, cobbles or paving flags and/or the grouting or filling material. Additionally or alternatively, the retaining means may be provided by the body being wedge-shaped. The body may be held in place by the subsequent application of wet or dry mortar or sand in the gaps provided between the paving stones, cobbles or paving flags.

[0043] The devices may comprise recycled plastics material, although non-recycled plastics may be used. The devices may be formed using extrusion techniques or injection moulding or similar techniques.

[0044] In an alternative embodiment, the drainage device may comprise a textile component which is permeable to the passage of water therethrough. Preferably, the textile component comprises a geo-textile or an environmentally friendly non-biodegradable textile.

[0045] What is meant by geotextile is a permeable fabric which, when used in association with soil, has the ability to separate, filter, reinforce, protect, or drain. The term "geotextiles" is intended to cover geotextile composites such as geogrids and meshes. Typically, geotextiles are woven, or needle punched, or heat bonded.

[0046] Preferably, the textile component is made from recycled plastics.

Preferably, a minimum of three devices are installed per square metre of a paved, cobbled or flagged surface, more preferably, a minimum of five is installed per square metre of a paved, cobbled or flagged surface, most pref-

erably, a minimum of seven is installed per square metre of a paved, cobbled or flagged surface. The more devices per square metre, the more effective the drainage, although it will be appreciated that this will depend greatly upon the substrate below the paved, cobbled or flagged surface.

[0047] Where the device(s) comprise(s) open-ended channels as discussed above, a temporary blocking means may be provided for use during jointing to prevent the blocking up of the channel(s).

[0048] The blocking means may comprise a tape, which is applied to one open face of the drainage device (s). The tape is preferably a biodegradable or water soluble tape or substance, e.g. starch. The tape may be applied to said open face of each device prior to or during installation, or during manufacture of said device.

[0049] Alternatively, a blocking device may be used to cooperate with said channels during the application of cement or proprietary mortar or dry sand or other dry materials such as a recycled ground glass joint filling. The blocking device may comprise one or more plugs for temporary engagement with the channel(s).

[0050] The plug portion preferably comprises a plurality of plugs for inter-engagement with the plurality of channels and a handle to facilitate use through engagement and removal of the blocking device.

[0051] An alternative blocking device may comprise a moulded elongate body, which sits over a drainage device with at least a portion of the body being located between adjacent paving stones, in use. Preferably, an upper surface of the blocking device is substantially flush with a top surface of the adjacent paving stones, in use.

[0052] Preferably, this blocking device comprises an elongate body portion having elongate side walls, end walls, a base wall and said upper surface. Preferably, the elongated side walls taper outwardly towards the upper surface to form overhanging flanges.

[0053] Preferably, this blocking device comprises a gripping means to prevent accidental removal of the device from between the adjacent paving stones. Most preferably, the gripping means comprises resiliently deflectable protrusions on one or more of the elongate side faces of the blocking device. Preferably, the protrusions are thin fin-like projections. Preferably, protrusions comprise free ends or edges, which are directed towards the upper surface of the blocking device. The projections may decrease in thickness towards the end or edge. The protrusions may be continuous along the length of the side walls, or provided intermittently there along. The protrusions are preferably located along the length of the body so as to cooperate with the side faces or walls of a paving unit, in use.

[0054] The blocking device may be made through continuous plastics extrusion. Preferably, the blocking device is coloured so as to contrast with the paving stone/joint filling colour to aid identification during removal.

[0055] Alternatively still, a retaining means may be used to retain a cavity in the mortar during application

for subsequent installation of a drainage device therein or to produce a cavity drainage channel whilst jointing. The retaining means preferably comprises a block, normally wedge shaped, which closely reflects the size and shape of the drainage device body to be used or the cavity to be created. A handle may be provided to facilitate use.

[0056] According to a fifth aspect of the invention there is provided a drainage kit for use on a ground surface, the kit comprising:

at least one drainage device for disposal between individual paving units, paving stones, cobbles or paving flags, the at least one drainage device comprising at least one means for allowing passage of water therethrough to facilitate direction of water away from a paved, cobbled or flagged surface into the ground and inlet and outlet ends, wherein the device has a height Z and the inlet end has a width Y, length X and wherein $Z \geq Y$; and optionally a plurality of paving units, paving stones, cobbles or paving flags for installation on the ground surface.

[0057] Preferably, the width Y is approximately 5mm - 12 mm and the device is adapted to be installed between and uninstalled from between individual paving stones, cobbles or paving flags, either before or after the installation of the individual paving stones, cobbles or paving flags

[0058] Preferably the kit further comprises a blocking means as described above.

[0059] Additionally or alternatively, the kit may include a retaining means as described above.

[0060] According to a sixth aspect of the invention there is provided a paving unit, wherein the paving unit comprises a paving layer/ part and a drainage section disposed below the paving layer/part, the drainage section comprising at least one drainage means and the paving unit being adapted to allow surface water to pass into the drainage means of the drainage section.

[0061] The paving unit may comprise any feature as described in relation to the first aspect.

[0062] The invention will now be described further by way of example only and with reference to the accompanying drawings in which:

Figure 1a is a diagrammatic cross-sectional side view of one embodiment of a sustainable urban drainage system according to the invention;

Figure 1b is a diagrammatic plan view of the sustainable urban drainage system shown in figure 1a;

Figure 2a is a diagrammatic cross-sectional side elevation of one embodiment of a device for use in the system shown in figure 1a;

Figure 2b is a diagrammatic cross-sectional end elevation of the device shown in figure 2a;

Figure 2c is a diagrammatic plan elevation of the device shown in figure 2a;

Figure 3a is a diagrammatic cross-sectional side elevation of a second embodiment of a device for use in the system shown in figure 1a;

Figure 3b is a diagrammatic plan elevation of the device shown in figure 3a;

Figure 4a is a diagrammatic side elevation of a blocking device for use with either of the devices shown in figures 2 and 3;

Figure 4b is a diagrammatic side elevation of the blocking device of figure 4a in use in the system shown in figure 1;

Figure 5a is a diagrammatic side elevation of a retaining device for use in the system of figure 1;

Figure 5b is a diagrammatic side elevation of the retaining device of figure 5a in use in the system shown in figure 1;

Figure 6a is an end elevation of a unit for use in a sustainable urban drainage system according to a second embodiment of the invention;

Figure 6b is a diagrammatic cross-sectional side elevation of two units shown in figure 6a arranged for use in the sustainable urban drainage system;

Figure 6c is a diagrammatic cross-sectional side elevation of the arrangement shown in figure 6b demonstrating the passage of water;

Figure 7a is a diagrammatic plan view of a sustainable urban drainage system using an alternative unit;

Figure 7b is a diagrammatic perspective view of the alternative unit of figure 7a;

Figure 8a is a diagrammatic end view of an alternative blocking device for use with either of the devices shown in figures 2 and 3; and

Figure 8b is a diagrammatic perspective view of the blocking device of figure 8a.

[0063] As shown in Figure 1a and 1b, one embodiment of a sustainable urban drainage system for a tiled or paved flooring comprises a plurality of paving stones 1 laid side by side in a spaced relationship on a supporting surface and a plurality of devices 2 disposed in gaps 3

therebetween, the paving stones 1 being secured in place by filling the gaps 3 with a wet (e.g. cement mortar) or dry (e.g. sand) jointing material. The stones 1 can sit on a bed of sand or textile material if required and can be any desired shape and laid in any pattern or arrangement.

[0064] Each device 2, as shown in figures 2a - 2c, comprises a substantially hollow rectangular body 4, which is divided internally, into a plurality of open-ended channels 5, by a number of partition walls 6, which each extend between opposing side walls 7, 8 of the body 4.

[0065] The channels 5, allow water to drain from a top surface of the paving stones through the device 2 into the ground, thereby reducing surface flooding.

[0066] Figures 3a and 3b show an alternatively shaped device 9, which comprises a substantially wedge-shaped body 10, e.g. a trapezoid, which is also divided internally, into a plurality of open-ended channels 11, by a number of partition walls 12, which extend between opposing side walls 13, 14 of the body 10. This type of device 9 is placed between the stones 1 with the wide end directed downwards towards the supporting surface, so that when the gaps 3 have been filled with mortar, the devices 9 are more difficult to remove.

[0067] The devices 2, 9 are constructed of a recycled or non-recycled plastics material and are formed using any suitable method, e.g. extrusion, although any other suitable material and construction method could be used.

[0068] A further alternative, not shown, is a textile device, e.g. a device comprising a textile material, which comprises woven, non-woven or knitted permeable sheets. Such a device can be formed from recycled materials. Geotextiles such as geo-membranes, geo-grids, and geo-matrices, which are permeable to water are suitable materials for such devices. A textile device of this kind allows water to permeate therethrough.

[0069] The width Y of each device is approximately 5mm - 12 mm, although widths of approximately 8 mm, 9 mm and 10 mm are preferred.

[0070] In use, the devices 2, 9 (or textile) are placed between the paving stones 1 at intervals, so that the channels 5, 11 are orientated substantially vertically. Where a textile device is used, the orientation of the device may not matter. Once the devices 2, 9 have been positioned accordingly, the remaining gaps 3 are filled with wet or dry jointing material as discussed above. A geo-textile device is advantageous by providing a compressible unit, which allows for some variance in the joint gap sizes, without the need for different sizes of the device.

[0071] To comply with the SUDS guidelines, the devices 2, 9 (or textile) are installed with a minimum of 3 per m² (square meter).

[0072] To prevent the channels 5, 11 of the devices 2, 9 from being blocked during mortaring, a blocking device 15 can be used, as shown in figures 4a-4b. In one embodiment, the blocking device 15 comprises a handle 15a and a number of plugs 15b, which cooperate with

the channels 5, 11 in use and are therefore of an appropriate size and distance from one another accordingly.

[0073] In use the plugs 15b engage with the channels 5, 11 whilst the wet or dry mortar is being applied to the surrounding gaps 3, as shown in figure 4b.

[0074] In an alternative embodiment, as shown in figure 8, the blocking device 50 comprises a moulded elongate body 51, which is substantially the same length as the drainage device 2, 9. The body 51 comprises opposing elongate side faces 52, end faces 53, a base 54 and an upper surface 55. The opposing side faces 52 taper outwardly towards the upper surface to provide overhanging flanges 56, which taper to a point. The side faces 52 further comprise a plurality of resiliently deflectable protrusions 57. These protrusions 57 extend from the side faces 52 and comprise free edges, which are directed towards the upper surface 55 of the blocking device 50. The protrusions 57 are fin-like and are tapered to decrease in thickness towards the free edges. The protrusions 57 are provided in pairs, with one of the pair being disposed above the other and are provided continuously or intermittently along the side faces 52 of the device 50.

[0075] When the blocking device 50 is pushed between the pavers, the free ends of the protrusions 57 are deflected towards the body portion 51. Once in place, the upper surface 55 is substantially flush with the top surface of the adjacent pavers with the overhanging flanges 56 resting on an edge portion of each adjacent paver, like a temporary cap. The protrusions 57 grip the side walls of the pavers to prevent accidental dislocation.

[0076] Further alternative blocking means can be used to prevent the channels 5, 11 from being blocked during mortaring and this comprises a tape (not shown), which stretches across one open end of the channels to act as a temporary seal. The tape is biodegradable and/or water soluble for minimum impact on the environment and reduction of labour, e.g. having to remove each tape individually once mortaring is complete. The tape is either supplied with the devices 2, 9 as a separate component or is already applied to the devices 2, 9 covering one open end (an upwardly facing open end) of each device 2, 9. When the geo-textile is used, no blocking device is required.

[0077] Once mortaring has been completed, the device 15, 50 is removed and can be used elsewhere with another device 2, 9, or discarded, or recycled for re-use.

[0078] Yet another alternative is the use of a retaining block 16 as shown in figures 5a and 5b. The retaining block 16 comprises a body 16b shaped like a drainage device 2, and a handle 16a. The body 16b is placed in an appropriate gap 3 prior to mortaring and acts to retain a space in the mortar. Once the mortar has been applied and is stabilized, the block 16 can be removed from the gap 3, for installation of the appropriate device 2, or the dry mortar mix can be simply left to set off in contact with moisture, leaving an appropriate void or channel to direct water into the ground rather than as run-off water. It is to

be appreciated that the space can receive an alternatively shaped device 9, although this would not be ideal, as the device 9 would not be secure without further mortaring or another means of securing being applied subsequently.

[0079] The blocking device 15 and/or the retaining block 16 can be formed from brightly coloured plastics to facilitate identification of the location of these devices once mortaring is complete, to ensure that removal of the devices is efficient.

[0080] According to a second embodiment of the invention, a sustainable urban drainage system for a tiled or paved flooring comprises a plurality of integrated pavers 17 laid side by side in a spaced relationship on a supporting surface and a plurality of devices 2, 9 disposed in gaps 18 provided between the integrated pavers 17.

[0081] Each integrated paver 17 comprises a thin fascia or paving stone 19 and a block 20, e.g. a breeze block or concrete aggregate backing as an overall laminated product.

[0082] The block 20 of each paver 17 comprises a pair of open-ended conduits 21 which extend from one end of the paver to an opposite end. The conduits 21 are disposed side-by-side, although it will be appreciated that this is not a necessity and they could be provided at different levels and/or they could be disposed perpendicularly to one another for additional flexibility, although it will be appreciated that on a sloped surface, care should be taken to ensure that the conduits do not direct water directly down the slope. Furthermore, the conduits 21 could meet at an intersection.

[0083] The conduits 21 are circular in cross-section, although this is not a functionally limiting feature and it will be appreciated that the conduits 21 could be any cross-sectional shape, e.g. square. The circular cross-section improves load-bearing strength relative to most other cross-sectional shapes.

[0084] When installed, each paver 17 is disposed adjacent to a like paver 17, to provide a vertical passage or joint gap 24 for water to travel down to the conduits 21. The passage 24 is wide enough for a device 2, 9 to be disposed therein.

[0085] If the pavers 17 are to be installed on a sloped surface, the pavers 17 should be laid so that the conduits 21 direct the flow of water across the slope, as opposed to down the slope, to control the rate of flow of water down the slope and prevent or minimize localized flooding at the bottom of the slope.

[0086] In one embodiment, (not shown in figures), the block 20 comprises an outcrop or protruding step on each face having an open end of a conduit 21, the step being provided at conduit 21 floor level 21a, or the floor level 21a of the lowest disposed conduit 21. When installed, each step of a paver 17 abuts the step of an adjacent paver 17, to provide a base wall for the vertical passage 24. The base wall guides a major proportion of water travelling down the passage 24, into the conduits 21.

[0087] The block 20 and the fascia 19 are sized relatively to one another so that the fascia 19 is disposed on the block 20 to provide a small peripheral rim 25 therearound. The peripheral rim 25 provides support means between the pavers 17 for a device 2, 9 to sit upon, so the devices 2, 9 are disposed between adjacent fascias 19 of adjacent units 17. Each peripheral rim 25 is of a width suitable to ensure that an edge 7/13, 8/14 of a device 2, 9 can be supported thereby. When the pavers 17 are laid in side-by-side arrangement, a device 2,9 can be inserted into the gap between the fascias of two abutting pavers 17, to be supported by the cooperating rims 25, without blocking the passage 24. A suitable depth of the rim 25 is approximately 2mm (Y) and the rims 25 are disposed at a distance of approximately 8mm from one another, to provide a gap of approximately 12mm between the fascias 19 to easily receive a device 2, 9 of approximately 10mm in width.

[0088] It will be appreciated, however, that the pavers 17 and the devices 2, 9 can be manufactured to any suitable dimension, bearing in mind the preferential small channel 5, 11 dimensions of a device 2, 9 to avoid interference to persons, e.g. through a shoe heel becoming jammed in the channels.

[0089] The pavers 17 are secured in place by filling the joint gaps 18 with a wet (e.g. cement mortar) or dry (e.g. sand) jointing material.

[0090] The passage of water through a sustainable drainage system according to the second embodiment of the invention is shown in figure 6c. When the pavers 17 are laid in side-by-side arrangement with the devices 2, 9 disposed in the gaps 18, by sitting on spaced-apart adjacent rims 25, water can pass from a surface of the fascias 19, through the channels 5, 11 (or membranes) of a device 2, 9 (or textile) into the passage 24 and into the conduits 21. Once in the conduits 21, the water can be stored there and/or the water can drain away into the ground water in due course.

[0091] In a third embodiment of the invention, a paving unit 25 (figures 7a and 7b) comprises a substantially cuboidal block having a pair of open-ended conduits 27, which extend from one end of the block to an opposite end thereof, as described above in relation to figures 6a and 6b.

[0092] The unit 25 comprises a recess 28 (a) - (d) in each side wall 26 (a) - (d). The recess is open at the upper end 32 where it meets the upper surface 30 and is centrally located with respect to its edge thereof and extends from the upper surface edge nearly half way down the respective side wall 26(a) - (d) to terminate in a ledge 34 defining the base wall of the recess. The ledge is located above the conduits 27. The ledge is parallel with the upper surface 30 of the paving unit and terminates at each end with the perpendicular edge walls (36, 38) of the recess, which co-extend from the ends of the ledge 34 to the upper surface 30. The back wall of the recess 40 is parallel with its respective side face 26 (a) - (d).

[0093] In use, two side faces 26(d), 126(b) of two separate units 25, 125 are abutted together with a thin gap 29 of approximately 1-2mm therebetween. This is a suitable width for dry jointing pavers, using sand. The two recesses 28(d), 128(b) of the respective side faces 26(d) form a rectangular-section open-topped cavity 42. If the units 25, 125, 225, 325 are to be installed on a sloped surface, the units 25, 125, 225, 325 should be laid so that the conduits 21 direct the flow of water across the slope, as opposed to down the slope.

[0094] The cavity 42 has a length X, a width Y and a depth Z that are all slightly larger than the length X, the width Y and the depth Z of the drainage device 2,9 to be used therewith, such that the drainage device 2,9 can be slotted into close fitting engagement with the cavity 42 easily with the top of the inlet end of the device 2,9 being disposed just below (e.g. 2mm below) the fascia surface 30 of the respective units 25, 125.

[0095] For example, where the paving units 25 are intended for use with a device 2, 9 that has a length X of approximately 100mm, a width Y of approximately 10mm and a depth of approximately 100mm, the cavity 42 would have a length X' of approximately 102 - 105mm, a width Y' of approximately 11 - 12mm and a depth Z' of approximately 102 - 105mm. With a gap 29 between the side faces 26(d), 126(b) of approximately 1 - 2mm, each recess 28 would therefore be recessed by a width of approximately 5mm.

[0096] The cavity 42 maintains access to the gap 29, which extends below the ledge 34 thereof. Therefore, the cavity 42 and the gap 29 disposed thereunder comprise a passageway 31 leading to the conduits 27 and into the ground below.

[0097] The advantage of this arrangement is that the unit 25, 125, 225, 325 is preferable for use as dry (sand) jointed paving, because the small gaps 29 can be provided between the units 25, 125, 225, 325 whilst still accommodating the drainage devices 2,9. The installation of drainage devices 2,9, in a paved arrangement using this kind of paving unit is very efficient.

[0098] In this embodiment, the unit 25, 125, 225, 325 can comprise a laminated fascia layer comprising the fascia surface 30, 130, 230, 330 which could be a natural or man-made stone paver, cobble stone or the like and a separate drainage layer comprising the conduits such as 27. This arrangement would result in a less expensive unit 25 and can be made with materials suitable for the intended weight-bearing of the surface, i.e. a greater weight-bearing material may be used for the drainage layer if the surface will receive vehicles as opposed to just pedestrians. Alternatively, the entire unit 25, 125, 225, 325 can be formed from a single block of a natural or man-made stone paver, cobble stone or the like with the man-made paver being the most economically viable option.

[0099] With the above arrangements, water is not able to build up on top of the paving and therefore, this reduces the chance of surface flooding, as the water is directed

away from the surface and into the conduits 21 below to be later dissipated by a gravity feed into the ground or substrate below.

[0100] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0101] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0102] The invention is not restricted to the details of the foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A paving unit (17, 25, 125, 225, 325) for provision of a paved, cobbled or flagged surface of a drainage system on a supporting surface of ground, wherein the paving unit (17, 25, 125, 225, 325) comprises a paving layer (19) and a drainage section (20) disposed below the paving layer (19), the drainage section (20) comprising at least one drainage means and the paving unit (17, 25, 125, 225, 325) being adapted to allow surface water to pass into the drainage means of the drainage section (20).
2. The paving unit (17, 25, 125, 225, 325) according to claim 1, wherein the drainage means (21) comprises a water storage means (21) to hold water.
3. The paving unit (17, 25, 125, 225, 325) according to any one of claims 1 or 2, wherein the paving layer (19) is an upper layer, in use and comprises an upper paving stone, cobble or paving flag component or part thereof.
4. The paving unit (17, 25, 125, 225, 325) according to claim 3, wherein the upper layer is a natural stone component.
5. The paving unit (17, 25, 125, 225, 325) according to any one of claims 1 - 4, wherein the drainage means comprises at least one open-ended laterally extending conduit (21) from a side face (26a-d) to another side face (26a-d) of the drainage section (20).

6. The paving unit (17, 25, 125, 225, 325) according to any one of claims 1 - 5, wherein a passageway (24) is provided, which links a top surface of the unit (17) to the drainage means. 5
7. The paving unit (17, 25, 125, 225, 325) according to claim 6, wherein each passageway (24) comprises a generally vertical channel defined by at least two side walls (26a-d, 126a-d, 226a-d, 326a-d) and each paving unit (17, 25, 125, 225, 325) comprises at least one side wall (26a-d, 126a-d, 226a-d, 326a-d) of the passageway (24), such that each passageway (24) is provided by abutting paving units (17, 25, 125, 225, 325) together to complete the passageway (24). 10
8. The paving unit (17, 25, 125, 225, 325) according to any one of claims 1 - 7, wherein each paving unit (17, 25, 125, 225, 325) is adapted to facilitate the accommodation of at least one drainage device (2, 9) in a gap between the paving layers (19). 15
9. The paving unit (17, 25, 125, 225, 325) according to claim 8, wherein each side wall (26a-d, 126a-d, 226a-d, 326a-d) provides a partial support means for a drainage device (2, 9). 20
10. The paving unit (17, 25, 125, 225, 325) according to claim 8, wherein the unit (17, 25, 125, 225, 325) is manufactured as a single paving block comprising the passageway (24), drainage section (20) and the support means. 25
11. A paving unit (17, 25, 125, 225, 325), wherein the paving unit (17, 25, 125, 225, 325) comprises a paving layer/ part (19) and a drainage section (20) disposed below the paving layer/part (19), the drainage section (20) comprising at least one drainage means and the paving unit (17, 25, 125, 225, 325) being adapted to allow surface water to pass into the drainage means of the drainage section (20). 30
12. A drainage device (2, 9) for disposal between individual paving stones, cobbles or paving flags (1) of a paved, cobbled or flagged surface provided on a ground surface, the device comprising a means for allowing passage of water therethrough to facilitate direction of water away from the paved, cobbled or flagged surface in use and into the ground below and inlet and outlet ends, wherein the device (2,9) has a height Z and the inlet end has a width Y, a length X and wherein $Z \geq Y$. 35
13. A drainage system for use on a ground surface comprising a paved, cobbled or flagged surface, and at least one drainage device (2,9) disposed between individual paving stones, cobbles or paving flags (1), the device (2,9) comprising a means for allowing passage of water therethrough to facilitate direction 40

of water away from the paved, cobbled or flagged surface in use and into the ground below and inlet and outlet ends, wherein the device (2,9) has a height Z and the inlet end has a width Y, length X and wherein $Z \geq Y$. 45

14. A method for the installation of a drainage system for a paved, cobbled or flagged surface and wherein the method comprises the steps of: 50

- a. arranging a plurality of paving stones, cobbles or flags (1) on a ground surface with gaps (3) therebetween, the gaps (3) being approximately equal;
- b. inserting at least one drainage device (2,9) in at least one gap (3) between said paving stones, cobbles or flags (1);
- c. ensuring that an inlet end of the drainage device (2,9) is in the same plane as, or below the paved, cobbled or flagged surface provided by the paving stones, cobbles or flags (1) adjacent to the said at least one gap (3); and
- d. filling remaining gaps (3) between the paving stones, cobbles or flags (1) with a suitable filling material to joint the paving stones, cobbles or flags (1) in place. 55

15. A drainage kit for use on a ground surface, the kit comprising: 60

- a. at least one drainage device (2,9) for disposal between individual paving stones, cobbles or paving flags (1), the at least one drainage device (2,9) comprising at least one means for allowing passage of water therethrough to facilitate direction of water away from a paved, cobbled or flagged surface into the ground and inlet and outlet ends, wherein the device (2,9) has a height Z and the inlet end has a width Y, length X and wherein $Z \geq Y$. ; and
- b. optionally a plurality of paving stones, cobbles or paving flags (1) for installation on the ground surface. 65

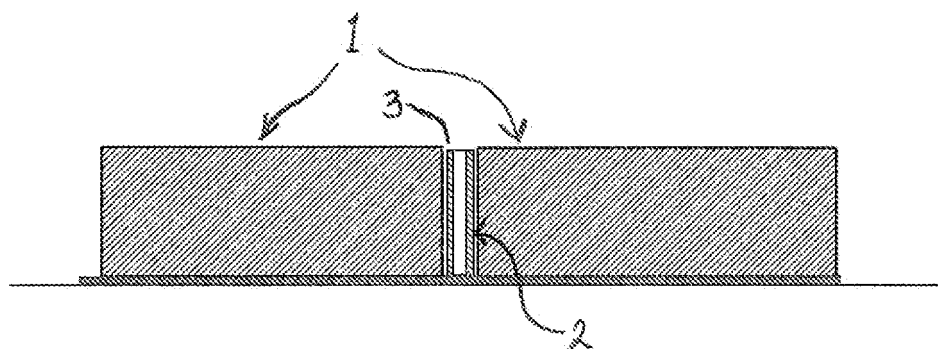


FIGURE 1a

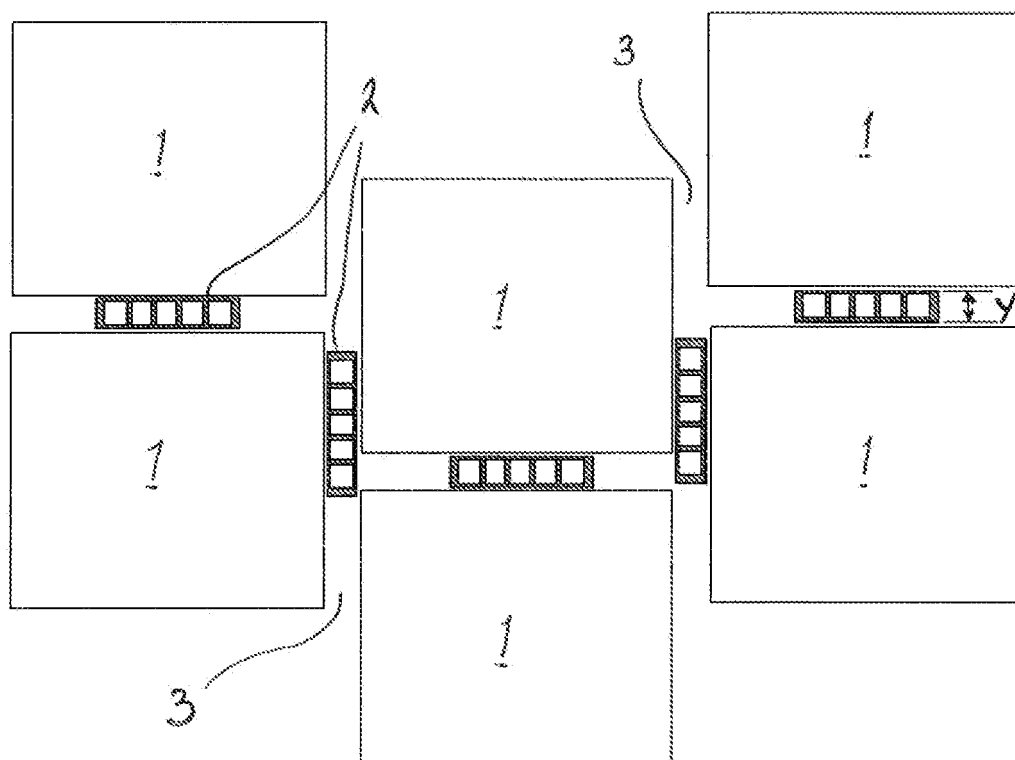


FIGURE 1b

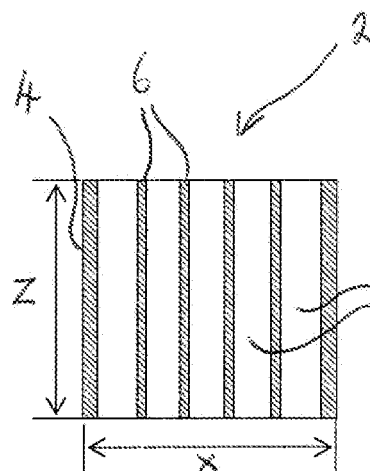


FIGURE 2a

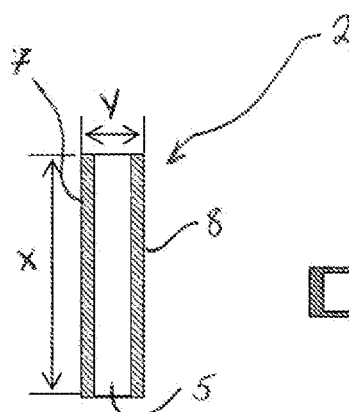


FIGURE 2b

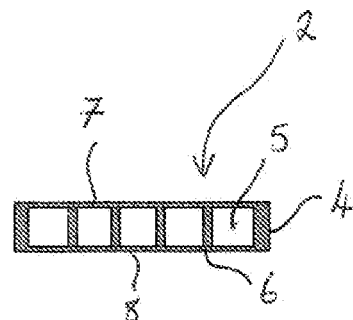


FIGURE 2c

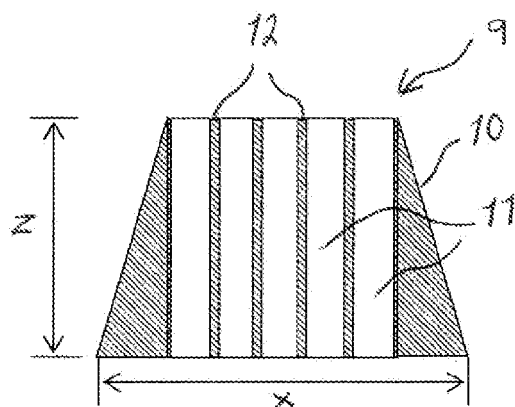


FIGURE 3a

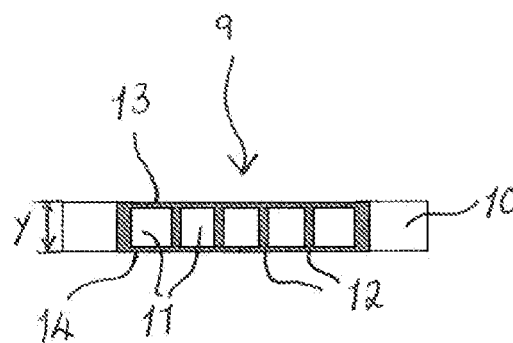


FIGURE 3b

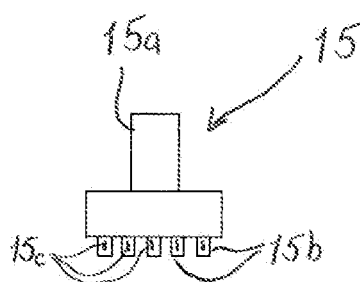


FIGURE 4a

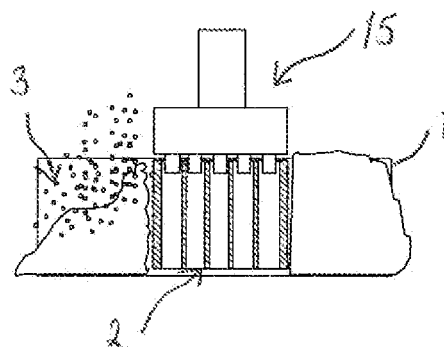


FIGURE 4b

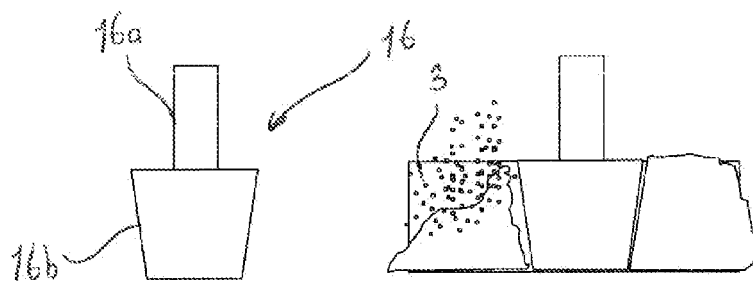


FIGURE 5a

FIGURE 5b

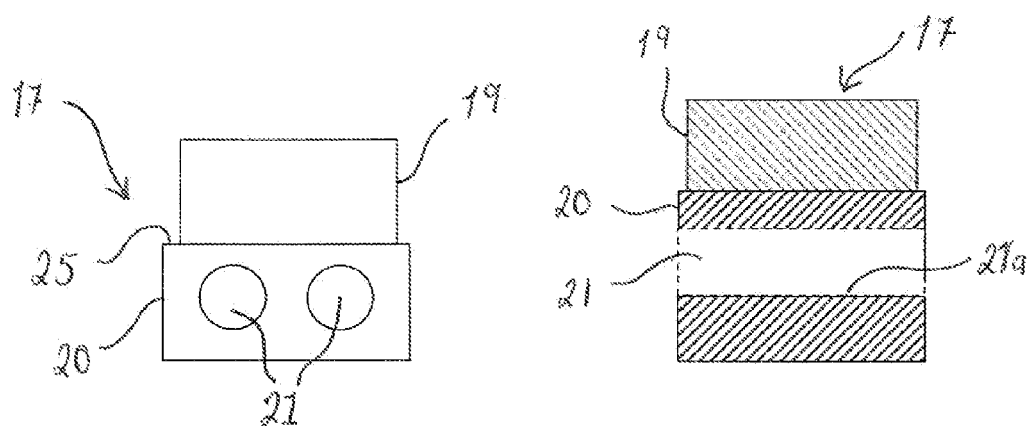


FIGURE 6a

FIGURE 6b

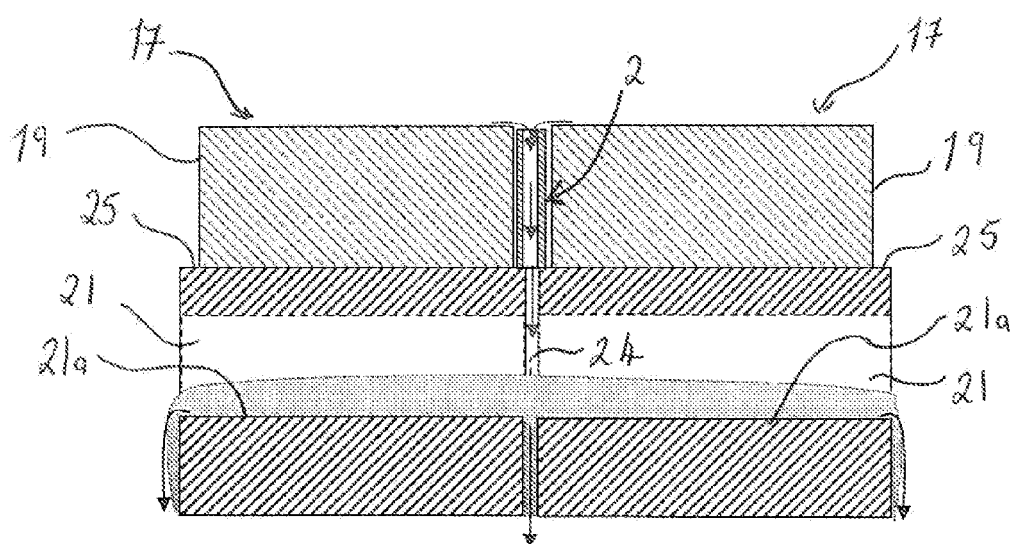


FIGURE 6c

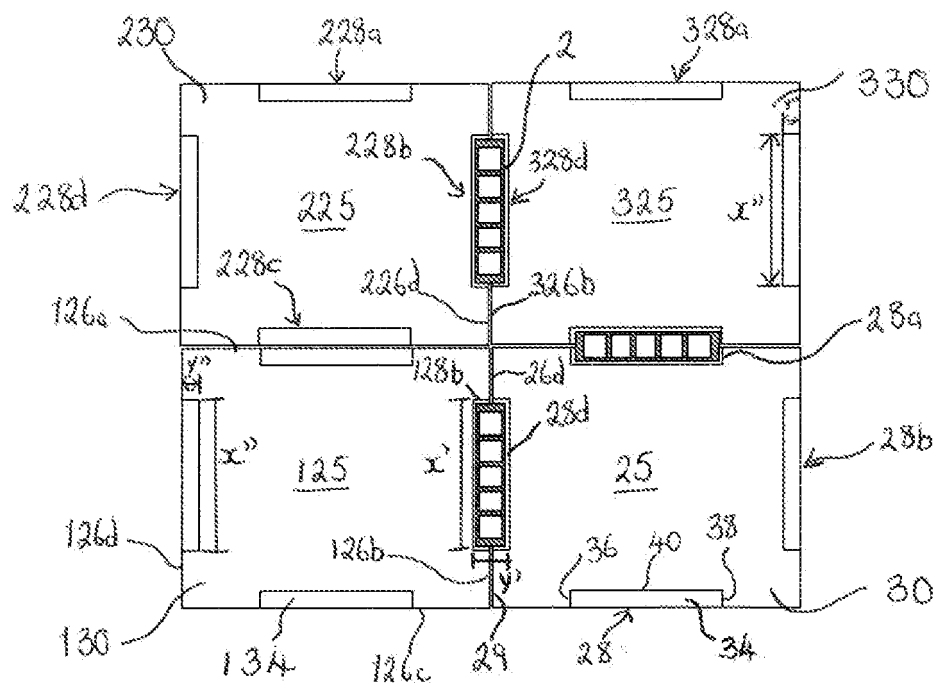


FIGURE 7a

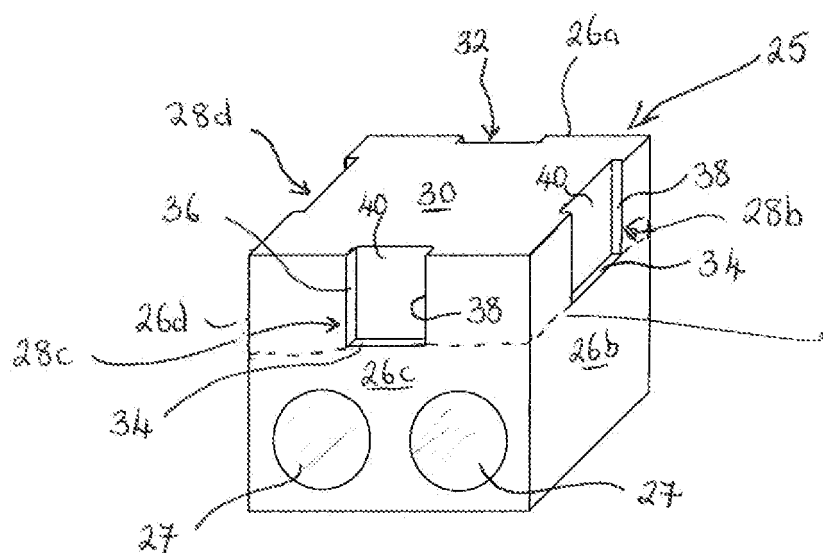


FIGURE 7b

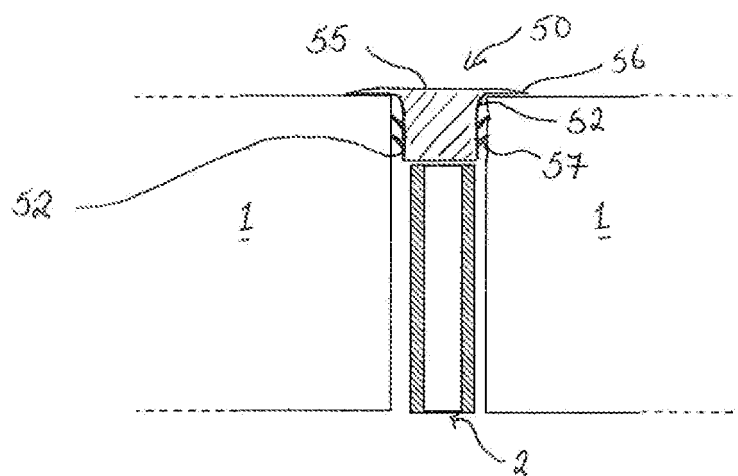


FIGURE 8a

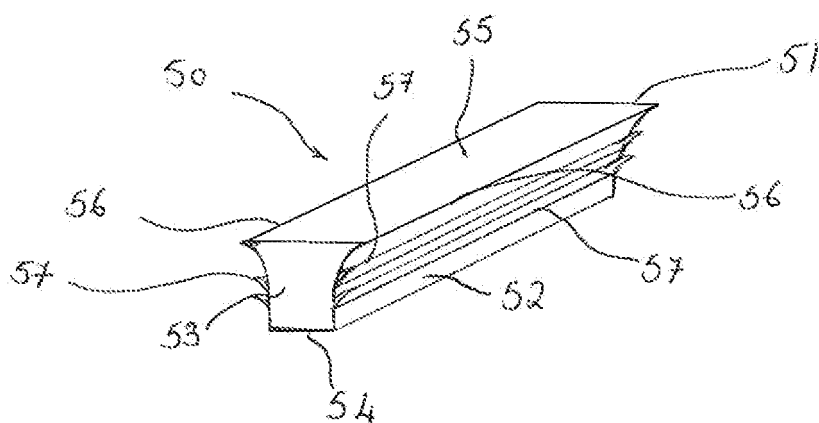


FIGURE 8b