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(54) A drainage unit

(57) A drainage unit comprises a frame (22) and a first lining member (23). The frame (22) supports the lining member (23), which is substantially impervious to water, in the assembled drainage unit thereby to define a water channel within the drainage unit. The frame (22) is a load-bearing frame that provides the drainage unit with all necessary structural strength and integrity; this allows the weight of the drainage unit to be made lower than the weight of a conventional drainage unit in which the base and side walls are cast in concrete or iron.

The frame may comprise a plurality of lateral frame members (25) which each have a laterally-extending portion and are spaced from one another along the axis of the drainage unit. The frame may further comprises at least one axially-extending frame member (27,28,29).

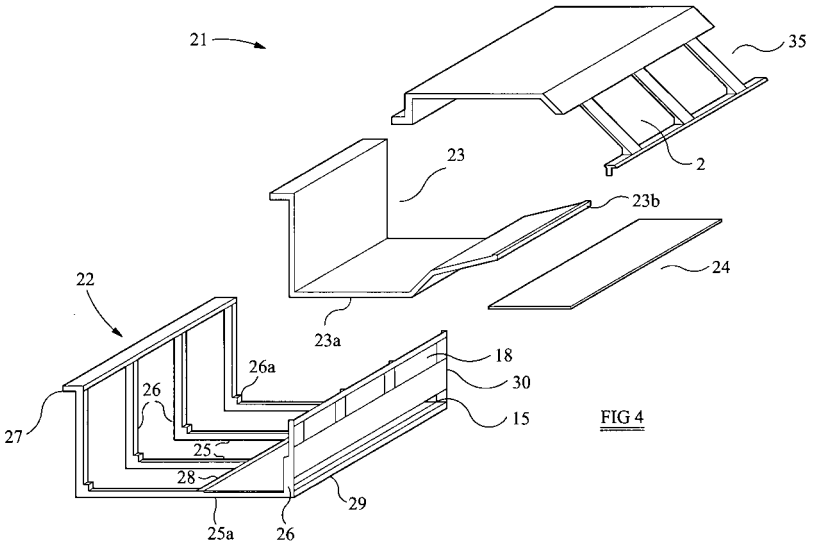

FIG 4

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Description

[0001] This invention relates to a drainage unit, which is particularly intended for use in an elevated structure such as a bridge or multi-storey car park.

[0002] Figure 1 shows a typical drainage unit 1. This is designed to be placed at the side of road on an elevated structure such as, for example, a bridge so that the road surface at the edge of the road is level with the bottom edge of the apertures 2 in the side wall of the drainage unit 1. The camber of the road causes water to run off the road surface and pass into the drainage unit through the apertures 2. The aperture 3 in the end wall of the drainage unit allows water to pass into an adjacent unit. Units are placed end-to-end next to one another, to produce a drain extending along the length of the bridge.

[0003] A drainage unit of the type shown in figure 1 is nowadays generally cast in concrete or ductile iron. This means that the drainage unit will be heavy; such a unit with a length of 500mm (a standard length in the construction industry) and a width of 300mm typically has a mass of 33-36kg, and this causes difficulties in installation since a conventional drainage unit cannot safely be carried by one person.

[0004] A drainage unit is designed to provide a given water carrying capacity (usually defined as a maximum flow rate of water that the unit can provide), and the internal dimensions of the drainage unit are essentially determined by its design maximum flow rate. The thickness of the sidewalls, base and top of the drainage unit are determined by the need to provide adequate structural strength. It is therefore difficult to reduce the weight of the drainage unit of figure 1. Making the cross-section of the unit smaller would reduce its water-carrying capacity, which is undesirable; reducing the thickness of the sidewalls, base and top of the drainage unit would reduce their structural strength, which also is undesirable. Moreover, a length of 500mm is a standard length for a drainage unit in the construction industry, and reducing the length is therefore undesirable.

[0005] A further disadvantage of the drainage unit of the type shown in figure 1 is that the internal surfaces of the unit, which make contact with water flowing in the unit, are generally not smooth. This causes resistance to the flow of water, so that the flow rate of a practical drainage unit is less than the theoretical flow rate that could be obtained if the internal surfaces of the unit were smooth.

[0006] It has been proposed to dispose a layer of low-friction material on the internal surfaces of a drainage unit of the type shown in figure 1, in order to reduce the resistance to fluid flow. However, this requires an additional manufacturing step and thus increases the manufacturing cost. A further disadvantage is that a thin layer of low-friction material is subject to abrasion in use, as a result of, for example, grit or sharp stones carried in water flowing through the unit, and such abrasion will increase resistance to flow of water and so reduce the capacity of the unit.

[0007] Figure 2 shows a cross-section through a typical bridge. A concrete deck 4 is covered with a waterproof membrane 5, and a protective layer 6 of, for example, red sand asphalt, is placed over the waterproof membrane. The road is surfaced with an asphalt layer 7, which typically comprises an asphalt base course 7A and an asphalt wearing course 7B. The asphalt layers will not be watertight, and some water will permeate into the and through the asphalt layers. The protective layer 6 will in general be less permeable to water than the asphalt layers, and the waterproof layer 5 is of course intentionally impermeable. Water will therefore accumulate within the interior of the road construction - at and above the upper surface of the waterproof layer 5 if the protective layer 6 is water-permeable, or at and above the upper surface of the protective layer 6 if the protective layer 6 has a low water-permeability. Water that accumulates within the road construction will be referred to as "sub-surface water".

[0008] When a vehicles passes along the road the weight of the wheel will cause a "pumping action" on the subsurface water in the road construction. A "bow wave " 8 is pushed through the asphalt layers 7A, 7B towards the side of the road. The water cannot enter the drainage unit 1, and it is deflected upwards as indicated by the arrows in figure 2. This causes rapid deterioration of the road surface, since the water will tend to carry the binding particles contained in the asphalt upwards out of the asphalt layers and deposit them as silt 9 on the road surface.

[0009] The drainage unit 10 shown in figure 3 has been developed to provide effective drainage of sub-surface water. The unit 10 is provided with an internal wall or partition 13 which defines an "inner channel" 14 within the unit 10. Apertures 15,16 are provided at two heights in the side wall of the drainage unit 10. The lower apertures 15 are positioned so that, when the drainage unit is installed at the side of a roadway, they will be laterally adjacent to the protective layer 6 and/or the asphalt base course 7A. Sub-surface water passes from the interior of the road construction into the inner channel 14 through the lower apertures 15, as a result either of natural drainage or of a "bow wave" caused by a vehicle. The upper apertures 16 are positioned so that, when the drainage unit is installed at the side of a roadway, they will extend above the upper surface of the asphalt wearing course 7B, so that water can drain from the surface of the road into the interior 17 of the drainage unit 10 through the upper apertures 16. Both surface water and sub-surface water are effectively drained from the road. There is preferably no communication between the inner channel 14 and the interior 17 of the drainage unit (except via the exterior of the drainage unit), so that surface water entering the interior 17 of the drainage unit cannot enter the inner channel 14 and pass back out of the drainage unit via the lower apertures 15 into the lower layers of the road construction - this can conveniently be achieved by making the inner channel 14 a closed channel as shown

in figure 3.

[0010] The drainage unit is installed on a bedding layer of mortar 19 which has a thickness of, for example, 5 mm. The end face of the unit is coated with a sealant, and the unit is pushed firmly against the previous unit to make a watertight seal between adjacent units.

[0011] The base of the drainage unit 10 is preferably provided with projections 20 at one end, and the other end of the base of the unit is provided with complementary recesses. These projections and recesses provide interlocking between two adjacent units, which lessens the chance of a unit being displaced if it is struck by a vehicle.

[0012] The drainage unit 10 may further be provided with third apertures (one such third aperture is indicated schematically at 18) positioned so that, when the drainage unit is installed at the side of a roadway, they will be laterally adjacent to the asphalt wearing course 7B. This is particularly suitable where porous asphalt is specified for the asphalt wearing course 7B - the third apertures provide effective drainage of any water that percolate into the porous asphalt.

[0013] A drainage unit of the general type shown in figure 3 is described in UK Patent Nos. 2 301 132 and 2 305 200.

[0014] A drainage unit of the general type shown in figure 3 has conventionally been cast in concrete or in ductile iron, and so also suffers from the disadvantages described above.

[0015] The present invention provides a drainage unit comprising a frame and a first lining member, the lining member being substantially impervious to water, and the frame supporting the lining member in the assembled drainage unit thereby to define a water channel within the drainage unit.

[0016] In the conventional drainage units of figures 1 and 3, the side walls of the drainage unit necessarily extend for the entire length and height of the drainage unit, and the base of the drainage unit necessarily extends for the entire length and width of the drainage unit, so as to provide a water-tight channel. As explained above, this makes it difficult to produce a lightweight drainage unit. In the present invention, however, the continuous base of a conventional drainage unit is replaced by a frame, for example formed by lateral frame members that extend along the width directions of the drainage unit and that are connected by one or more axial frame members that extend axially along the length of the drainage unit. The frame is a load-bearing frame that provides the drainage unit with all necessary structural strength and integrity. Similarly, the continuous back and front wall of a conventional drainage unit is replaced by portions of the lateral frame members that extend upwardly, preferably for the entire height of the drainage unit. The frame supports one or more lining members that are impervious to water and that define one or more water channels within the drainage unit. The lining members may be made of a lightweight material, for example a plastics material. The overall weight of the frame members and the lining members is significantly less than the weight of the base and side walls of a conventional drainage unit, so that a drainage unit of the invention is significantly lighter than a conventional drainage unit. It is expected that a drainage unit of the invention will have a mass that is at least 10kg less than the weight of a conventional drainage unit of the same flow capacity.

[0017] In a conventional drainage unit of the type shown in figure 1 the interior channel is defined by the upper surface of the base and by the internal surfaces of the side walls. Manufacturing constraints mean that most conventional cast drainage units of this type have a flat-bottomed channel as shown in figure 1. This cross-section is, however, not the most hydrodynamically efficient cross-section, and a channel having a "V-shaped" cross-section would have a lower resistance to water flow. It is however difficult to produce a channel with a V-shaped cross-section in a conventional cast drainage unit - the exterior cross-section of the unit is preferably rectangular for ease of installation, and making the interior with a V-shaped cross-section would necessitate increasing the thickness of the base, thereby further aggravating the weight problem.

[0018] In the present invention, however, the frame may be arranged to support the waterproof lining member (s) to define a channel having any desired cross-section. In particular, a channel with a cross-section that is V-shaped, or that is approximately V-shaped, and so is hydrodynamically efficient can easily be obtained.

[0019] Moreover, the waterproof member may be made of, or may be coated with, a material having a low resistance to water flow.

[0020] Accordingly, for a given water flow capacity, a drainage unit of the invention may have a smaller cross-section than a conventional drainage unit. This enables the drainage unit of the invention to be made smaller, and this allows the weight of the drainage unit of the invention to be reduced even further. As an indication, a drainage unit of the invention having an overall width of 250mm is likely to have similar flow capacity to a conventional drainage unit having an overall width of 300mm.

[0021] In a preferred embodiment, the or each waterproof member is substantially self-supporting. By "self-supporting" is meant that the waterproof member will not significantly deform under its own weight if supported only at a few separated points. Use of a self-supporting member means that the frame need support the member only at a few separated points along the length of the member. In contrast, in prior art drainage units in which the interior of a cast drainage unit is coated with a low resistance material, the coating of low resistance material is a thin coating which is not self-supporting.

[0022] Preferred embodiments of the present invention will now be described by way of illustrative example with reference to the accompanying figures in which:

Figure 1 is a schematic perspective view of a con-

ventional drainage unit;

Figure 2 is a cross-sectional view of a roadway incorporating the drainage unit of figure 1;

Figure 3 is a schematic perspective view of a second conventional drainage unit;

Figure 4 is a schematic exploded view showing the components of a drainage unit of the present invention;

Figure 5 is a schematic perspective view of the frame of the drainage unit of figure 4;

Figure 6 is a cross-section view of the drainage unit of figure 4;

Figure 7 is a schematic partial perspective view of a drainage unit according to a further embodiment of the present invention; and

Figure 8 is a cross-section view of the drainage unit of figure 7 installed in a roadway.

[0023] The present invention will be described with reference to an embodiment in which the drainage unit comprises apertures arranged at two different heights, as in the prior art drainage unit of figure 3. The invention is not, however, limited to this, and could be applied to, for example, the drainage unit of figure 1.

[0024] As shown in figure 4, the drainage unit 21 according to this embodiment of the invention comprises a frame 22, one or more waterproof lining members (two members 23, 24 are shown in this embodiment), and a cover 35.

[0025] The frame 22 defines the base of the drainage unit, the back-wall of the drainage unit, and part of the front wall of the drainage unit. The frame includes a plurality of lateral frame members 25 that have a portion that extends laterally, across the width of the drainage unit, and that are spaced from one another along the length of the drainage unit. The lateral frame members are provided with one or more upwardly-extending portions provided at an end of the laterally-extending portion. In the embodiment of figure 4, each lateral frame member 25 comprises two upwardly-extending portions 26,26', one disposed at each end of the laterally-extending portion. Thus, each lateral frame member is substantially U-shaped. In the embodiment of figure 4 each upwardly-extending portion 26,26' is substantially perpendicular to the laterally-extending portion of the lateral frame member, so that the upwardly-extending portions 26,26 will be substantially vertical in an installed drainage unit.

[0026] In the embodiment of figure 4, each lateral frame member is manufactured as a single entity so that each upwardly-extending portion 26,26' is integral with the laterally-extending portion.

[0027] The frame further comprises members 27, 28, 29 that extend axially along the length of the drainage unit, and serve to connect the lateral frame members 25 to one another.

[0028] The frame 22 further comprises a fascia 30. This defines the front wall of the drainage unit and, in the embodiment of figure 4, also defines apertures in the front wall of the drainage unit. In the embodiment of figure 4 apertures corresponding to the lower aperture 15 and the intermediate aperture 18 of the drainage unit 10 of figure 3 are provided. The exact shape, size and position of the apertures will depend on the intended application of the draining unit.

[0029] In a preferred embodiment, the frame members 25-29 are integral with one another, and are also integral with the front wall 30. For example, the frame (formed of the lateral frame members 25, the axial frame members 27,28,29 and the front fascia 30) may be cast as a single unit. The frame may be cast in any material that is durable and provides sufficient structural strength such as, for example, ductile iron. In principle, however, the frame need not be cast as a single unit - as an example, the lateral frame members 25 and the axial frame members 27,28,29 could be made integral with one another, with the front fascia 30 being a separate components that is attached to the frame members.

[0030] The lining members 23, 24 are received in the frame 22, so as to define water channels within the drainage unit. In the embodiment of figure 4 one of the lining members is a shaped lining member 23 and the other is a flat lining member 24. The laterally-extending frame members 25 are provided with a reduced-height portion at their end near the front wall 30 of the drainage unit, and the flat waterproof member 24 is received in the recess defined by the reduced-height portions 25a of the lateral frame members 25. (The flat waterproof member 24 is shown twice in figure 4; it is shown installed in the frame 22 and, for clarity, it is also shown separately from the frame.)

[0031] The shaped lining member 23 is also received in the frame 22. Steps 26a are provided in the upwardly-extending portions 26 that define the rear wall of the drainage unit, and these support one edge of a base portion 23a of the shaped lining member. The other edge of the base portion 23a of the shaped lining member rests, in use, on one of the axially extending frame members 28. (If desired, the axial frame member 28 that supports the base portion 23a of the shaped lining member 23 may also be provided with a reduced thickness portion, to ensure correct location of the lining member, as shown in the inset to figure 5.) Steps 26a' are also provided in the upwardly-extending portions 26' that define the front wall of the drainage unit, and these receive the front edge 23b of the shaped lining member 23.

[0032] Figure 5 shows the frame member 22 with the lining members not present, and so shows the reduced-height portion 25a of the lateral frame members more clearly.

[0033] Figure 6 is a cross-sectional view of the drainage unit, showing the lining members 23, 24 in position in the frame 22. The cover 35 has been omitted from figure 6 for clarity.

[0034] As can be seen in figure 6, two water channels are defined in the interior of the drainage unit 21. A first channel is defined above the shaped lining member 23.

This channel receives water entering through the apertures 2 in the cover 35, and also receives water entering via the intermediate apertures 18 in the front wall 30.

[0035] A second channel is defined between the flat lining member 24, the underside of the shaped lining member 23, and the front face 30 of the drainage unit. This corresponds to the "inner channel" 24 of the drainage unit of figure 3, and receives sub-surface water via the lower apertures 15. The two channels are not in fluid communication with one another via the interior of the drainage unit, so that water entering the drainage unit via the upper aperture 2 or an intermediate aperture 18 cannot flow back into the road construction via the lower apertures 15.

[0036] The shaped lining member 23 is preferably shaped so that the water channel defined above it (that is, the "main channel") has a internal cross-section that is substantially a V-shape. This is because a channel with a V-shape cross-section is hydro-dynamically efficient, and provides maximum flow rate for a given area of channel cross-section. When the invention is applied to a drainage unit of the type shown in figure 1, it would be possible for the shaped lining member 23 to have a symmetrical cross-section, so as to provide a water channel with a symmetrical V-shaped cross-section, to obtain the best possible hydrodynamic characteristics. Where the invention is applied to a drainage unit having the inner channel 14 of figure 3 it may however be necessary to use a lining member with an asymmetric cross-section, as shown in figure 4, in order to provide a sufficiently large cross-section for the inner channel 14. In principle, however, the shaped lining member 23 may be shaped so as to provide any desired cross-section for the main channel.

[0037] The lining members 23, 24 are secured to the frame 22 so that the two channels are substantially watertight with little or no leakage occurring. The lining members may, for example be secured to the frame 22 using an adhesive/sealant material. Alternatively, the lining members 23,24 may be secured mechanically to the frame (for example by being made a "clip-fit" in the frame) or they may be heat-sealed into the frame.

[0038] The lining members 23,24 and the frame 22 together form a self-contained drainage unit that has sufficient structural strength to resist the forces and loadings to which it will be subjected in use such as, for example, forces and loadings from motor vehicles. As indicated in figure 8 below, a drainage unit of the invention may be installed on a suitable foundation layer 34 (which may be, for example, a layer of a cement-based compound such as bedding mortar), and there is no need to provide a protective load-bearing surround (such as a concrete surround) around the installed drainage unit.

[0039] The frame 22 is a load-bearing frame, and provides the assembled drainage unit with its required structural strength. The lining members 23, 24 do not need to contribute significantly to the structural strength of the assembled drainage unit, since this is provided by the frame 22. The lining members may therefore be formed of any material that is lightweight and substantially impervious to water such as, for example, a plastics material or a composite plastics material such as a composite polyester.

[0040] The material from which the lining members 23, 24 are made preferably has a low resistance to the flow of water. (A composite polyester material can be made with a smooth surface that provides a low resistance to the flow of water.) The material from which the lining members 23, 24 are made preferably has a surface roughness of 0.0095 or less, more preferably has a surface roughness of 0.0092 or less, and even more preferably has a surface roughness of 0.0090 or less. Alternatively, the waterproof members - or at least those surfaces of the waterproof members that will, in use, make contact with water flowing through the drainage unit - may be coated with a material that has a low resistance to fluid flow (and that preferably has a surface roughness as specified above).

[0041] The cover 35 of the drainage unit is required to be sufficiently strong to withstand impact of a vehicle. Suitable materials for the cover include, for example, ductile iron. The cover corresponds generally to the cover of the drainage unit of figure 1 or figure 3, and will not be described in detail. It will however be noted that apertures 2 are provided in the cover 35, and these correspond to the apertures 16 for surface water in the drainage unit of figure 3.

[0042] The lining members 23, 24 are preferably made of a material that is substantially self-supporting, so that the members will not significantly deform under their own weight between the points at which they are supported by the frame. This ensures that unwanted dips at which water might accumulate are not formed in the channels. If the lining members 23,24 are formed of composite plastics material, making the lining members to be a few mm thick, for example 3-4mm, should be sufficient for the lining members to be self-supporting. It should be adequate to provide 4 or 5 lateral frame members over the length of a drainage unit that is 500mm long.

[0043] As can be seen from figure 5, the base of the drainage unit is not solid, but is defined by the lateral frame members 25. Similarly, the front and back walls of the frame is again not solid, but are defined by the upwardly-extending portions 26,26' of the lateral frame members 25 and by the front fascia 30. As a result, a drainage unit of the present invention will be significantly lighter than a conventional drainage unit (for a drainage unit of the same length and having the same maximum flow rate). A drainage unit of the invention can therefore be handled much more easily during installation than can a conventional drainage unit.

[0044] Furthermore, the internal cross-section of the channel(s) defined within the drainage unit is defined by the waterproof lining member(s) 23, 24, rather than by the base and side walls of the drainage unit. It is therefore possible to shape the lining member(s) so as to provide

a channel having any desired internal cross-section within the drainage unit. In particular, this allows a drainage channel having a hydro-dynamically efficient cross-section to be provided.

[0045] Providing the drainage channel(s) with a greater hydro-dynamic efficiency than in a conventional drainage unit allows the cross-sectional area of the channels to be made smaller in a drainage unit of the invention, while maintaining a given maximum flow capacity. The use of lining members 23,24 with a smooth surface further enhances the hydrodynamic characteristics of the drainage unit. This means that the width of a drainage unit of the present invention can be reduced compared to a conventional drainage unit, for a given maximum flow rate, and this provides a further reduction in weight.

[0046] A fascia (not shown) may also be provided along the back wall of the drainage unit. This would prevent material such as concrete or other constructional materials from entering the drainage unit during installation. The front fascia 30 and the rear fascia (if present) are not required to contribute to the structural integrity and strength of the drainage unit - the frame 22 provides the structural strength of the drainage unit. The front fascia and rear fascia may therefore be much thinner than the front and back walls of a conventional drainage unit, and accordingly they do not significantly increase the weight of the drainage unit. The front fascia and rear fascia may be integral with the frame; for example they may be cast integrally with the frame 22. Alternatively, the front fascia and rear fascia may be separate components that are fastened to the frame after the frame has been made - for example, the front fascia and rear fascia may be made of thin metal sheets that are adhered or welded to the frame.

[0047] The present invention is not limited to the preferred embodiment described above, and many modifications are possible, for example, the frame 22 may be provided with further frame members that provide additional support for the shaped waterproof lining member 23, and these additional members are shown schematically as 31 in figure 7, which is a partial perspective view of a drainage unit according to a second embodiment of the present invention. In this embodiment, the stepped portion 26a' of the upwardly-extending portions 26' of the frame members at the front face of the drainage unit is omitted, and the front portion of the shaped waterproof lining 23 is supported by the additional frame members 31.

[0048] Figure 7 also illustrates that an access hatch 32 may be provided in the shaped lining member 23, to allow access to the "inner channel" to allow the removal of debris from the inner channel. The access panel 32 is secured by suitable fastening means 33, and may be secured either direct to the shaped lining member 23 or may be secured to the frame 22.

[0049] Figure 8 is a schematic sectional view showing a drainage unit of the present invention installed in a roadway. The drainage unit is of the type shown in figure 7, in which the additional frame members 31 are provided to support the shaped lining member. Figure 8 shows a drainage unit in which the intermediate apertures 18 are not present and only the upper apertures 2 and the lower apertures 15 are provided. If, however, the wearing asphalt layer 7B of the roadway were a layer of porous asphalt, it would be preferable to provide the intermediate apertures 18 in the front face of the drainage unit. The layers of the roadway shown in figure 8 correspond generally to the layers shown in figure 2, and their description will not be repeated.

[0050] The invention has been described above with reference to a drainage unit having two channels defined therein. The invention is not, however, limited to this and may be applied to a drainage unit of the type shown in figure 1 by omitting the flat lining member 24.

Claims

1. A drainage unit comprising a frame and a first lining member, the lining member being substantially impervious to water, and the frame being a load-bearing frame and supporting the lining member in the assembled drainage unit thereby to define a water channel within the drainage unit.

2. A drainage unit as claimed in claim 1 wherein the frame comprises a plurality of lateral frame members, the lateral frame members being spaced from one another along the longitudinal axis of the drainage unit and each having a laterally-extending portion that extends substantially perpendicular to the longitudinal axis of the drainage unit.

3. A drainage unit as claimed in claim 2 wherein the frame further comprises at least one axially-extending frame member extending parallel to the longitudinal axis of the drainage unit.

4. A drainage unit as claimed in claim 3 wherein the lateral frame members are secured to the or each axially-extending frame member.

5. A drainage unit as claimed in claim 3 wherein the lateral frame members are integral with the or each axially-extending frame member.

6. A drainage unit as claimed in any of claims 2 to 5 wherein each lateral frame member comprises one or more first portions that extend in a direction crossed with the longitudinal axis of the drainage unit and with the laterally-extending portion of the lateral frame member.

7. A drainage unit as claimed in claim 6 wherein the or each first portion is provided at a respective end of the laterally-extending portion of a respective lateral

frame member.

8. A drainage unit as claimed in 6 wherein each lateral frame member comprises two first portions, one disposed at each end of the laterally-extending portion, whereby each lateral frame member is substantially U-shaped.

9. A drainage unit as claimed in claim 6, 7 or 8 wherein the or each first portion is substantially perpendicular to the laterally-extending portion.

10. A drainage unit as claimed in any of claims 6 to 9 wherein the or each first portion of a lateral frame member is integral with the laterally-extending portion of the lateral frame member.

11. A drainage unit as claimed in claim 1 wherein the water channel defined within the drainage unit has a substantially V-shaped internal cross-section.

12. A drainage unit as claimed in any preceding claim and further comprising a second lining member, the second lining member being substantially impervious to water, the frame supporting, in use, the first and second members in the assembled drainage unit thereby to define first and second water channels within the drainage unit.

13. A drainage unit as claimed in claim 12 wherein there is no fluid communication via the interior of the drainage unit between the first water channel and the second water channel.

14. A drainage unit as claimed in any preceding claim wherein the or each lining member is secured to the frame.

15. A drainage unit as claimed in any preceding claim wherein the or each lining member is formed of a material having a low resistance to fluid flow.

16. A drainage unit as claimed in any of claims 1 to 14 wherein the or each lining member is coated with a material having a low resistance to fluid flow.

17. A drainage unit as claimed in any preceding claim wherein the or each waterproof member is substantially self-supporting.

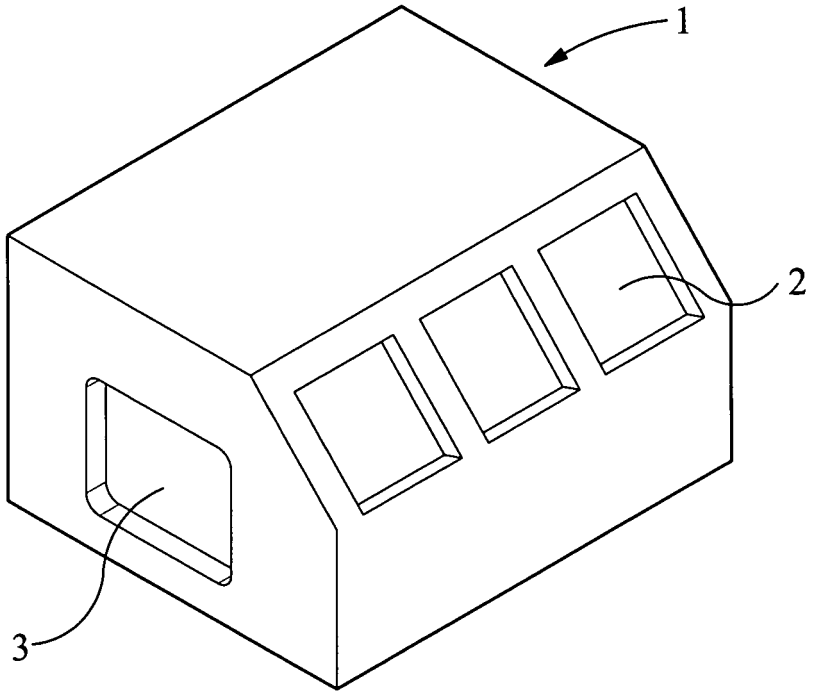

FIG 1

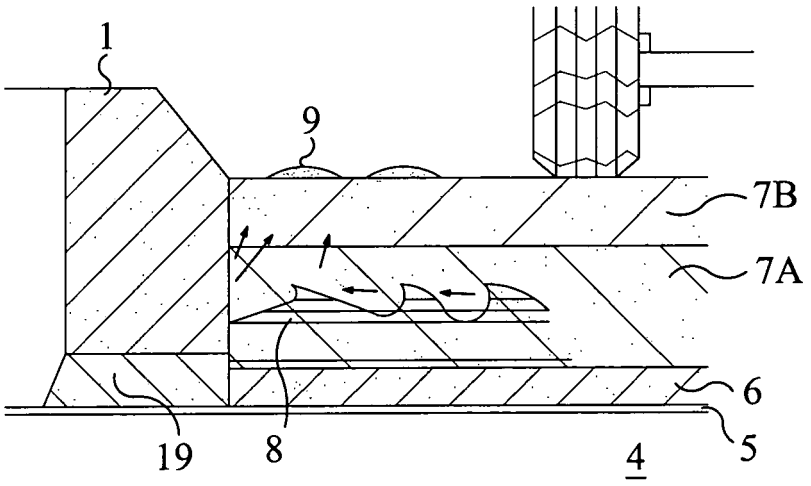

FIG 2

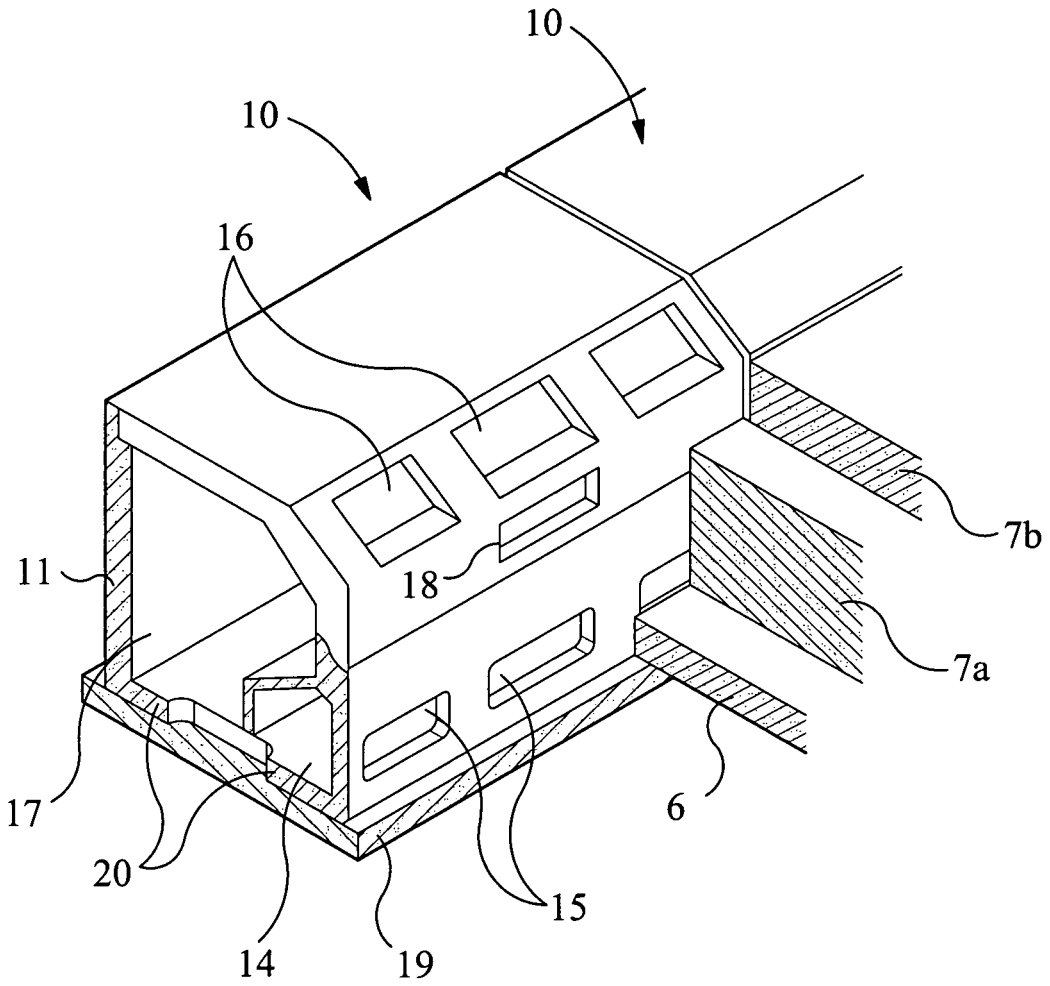

FIG 3

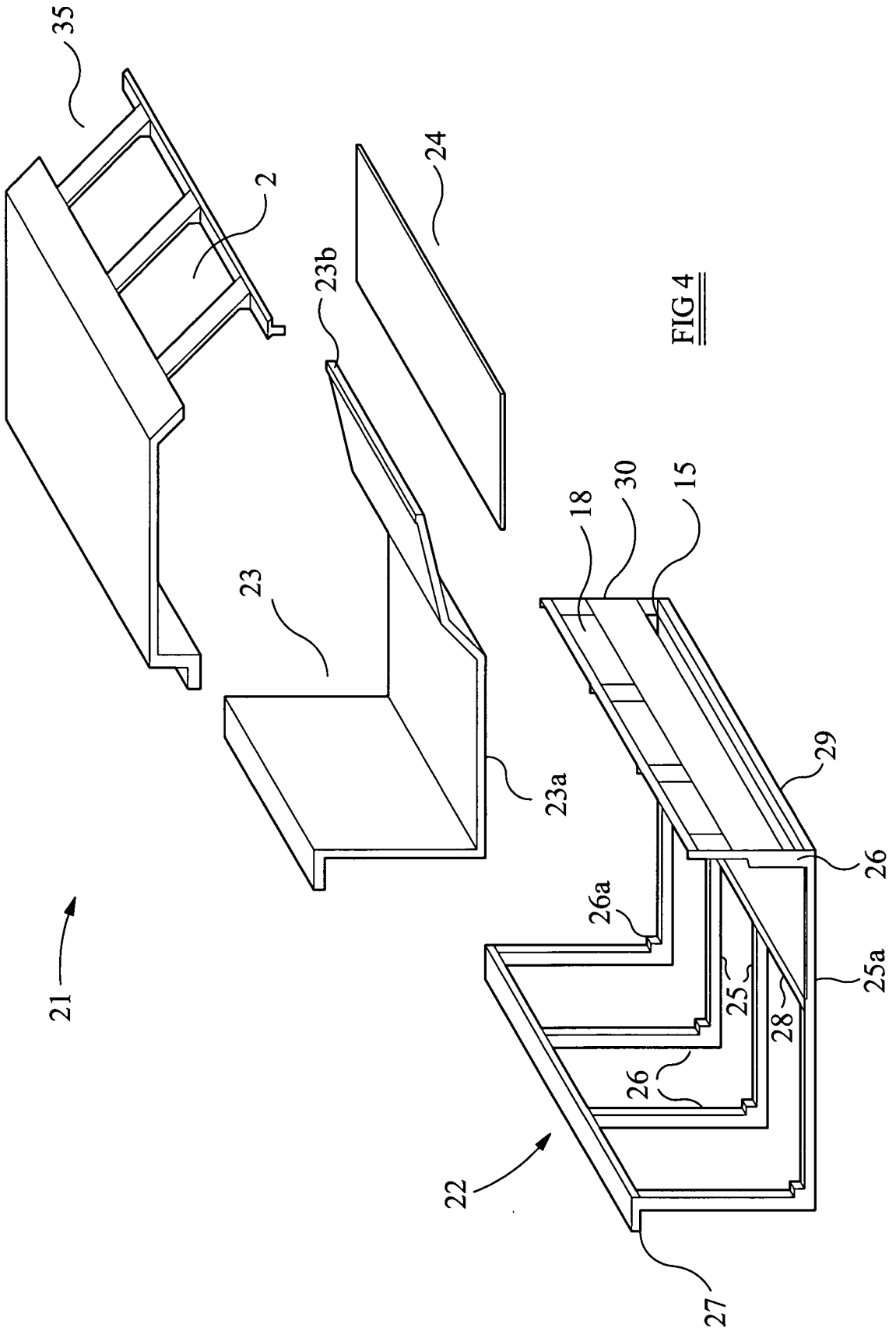

FIG 4

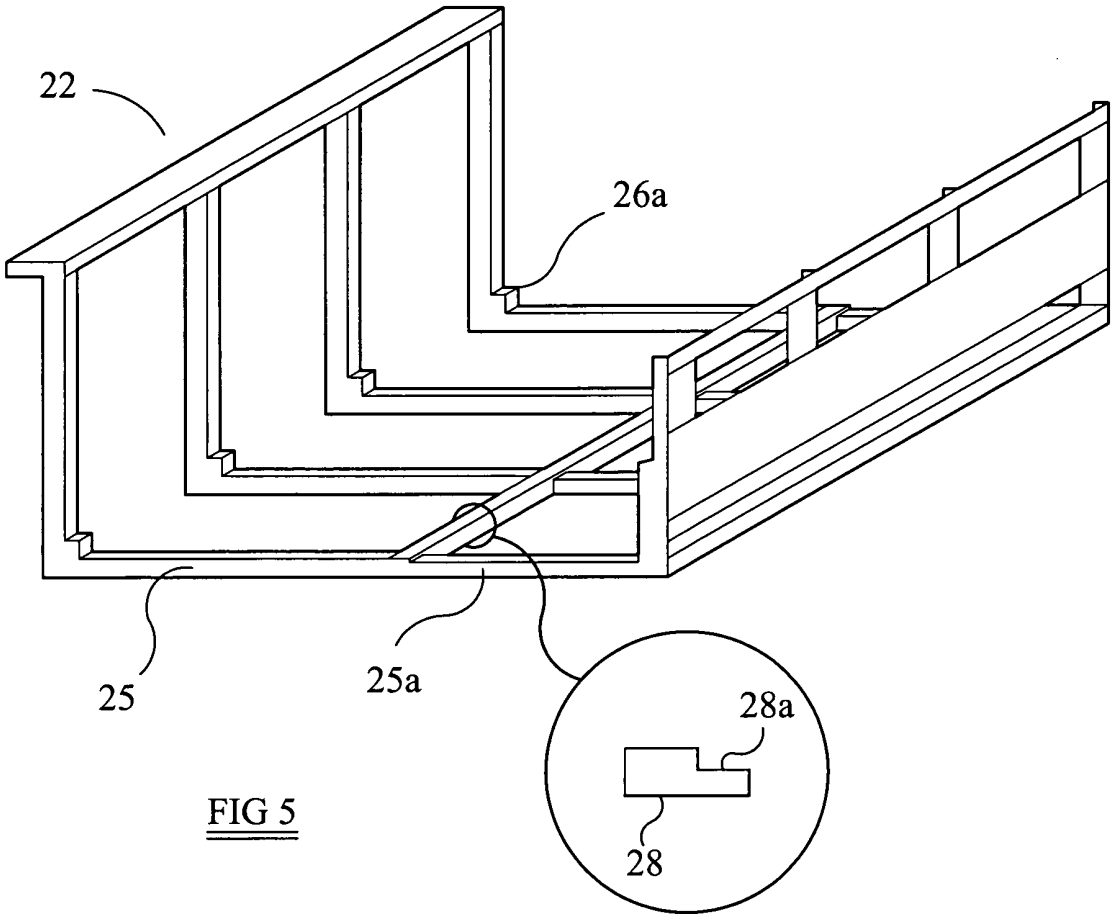

FIG 5

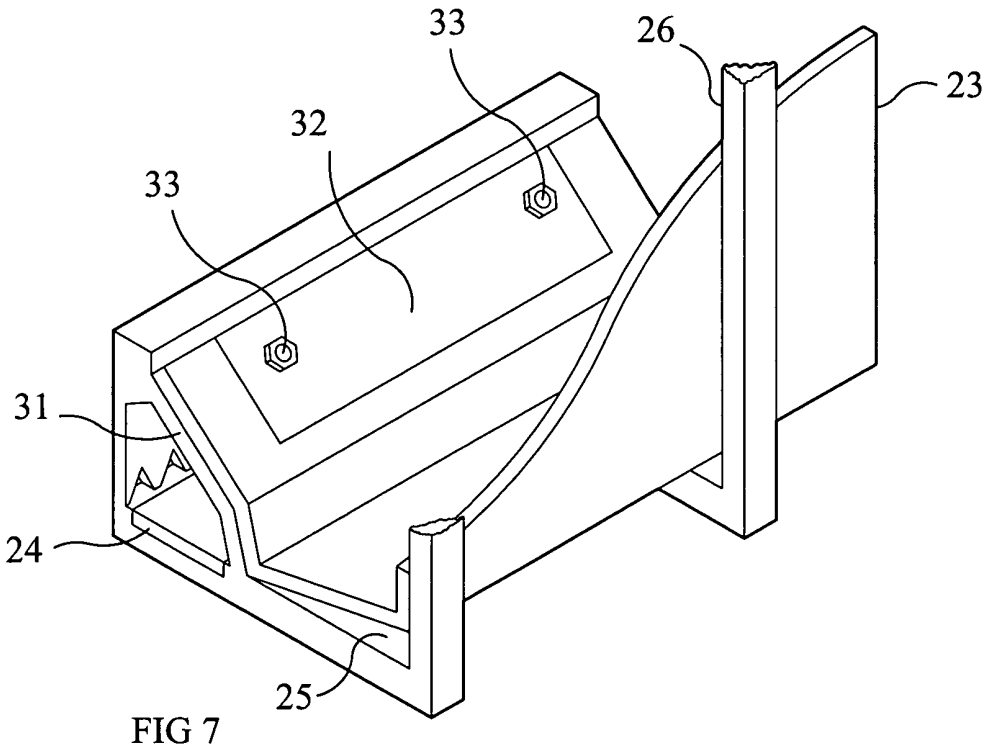

FIG 7

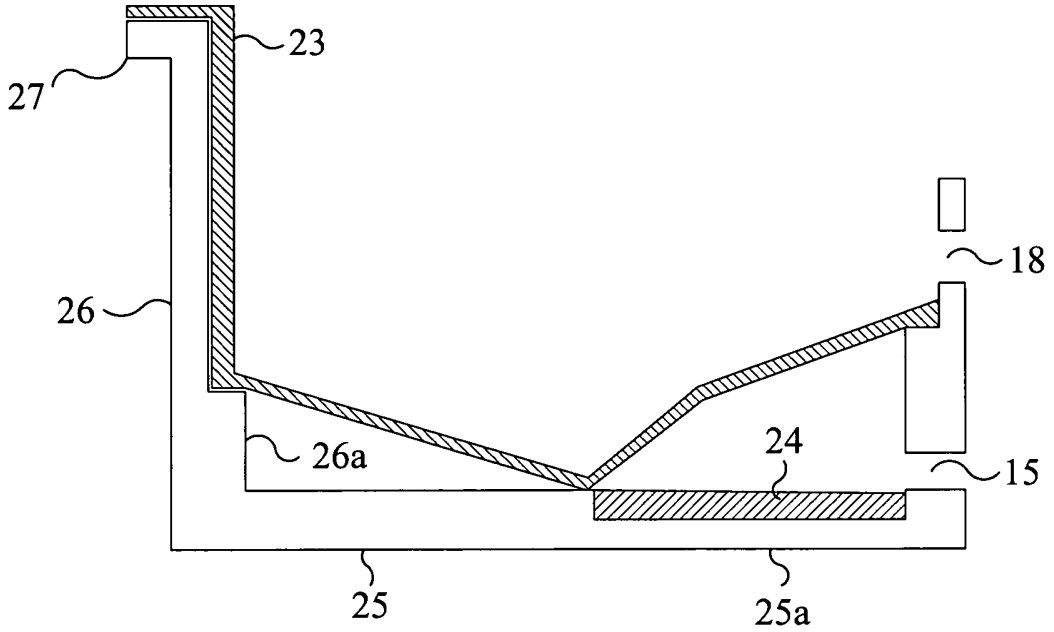

FIG 6

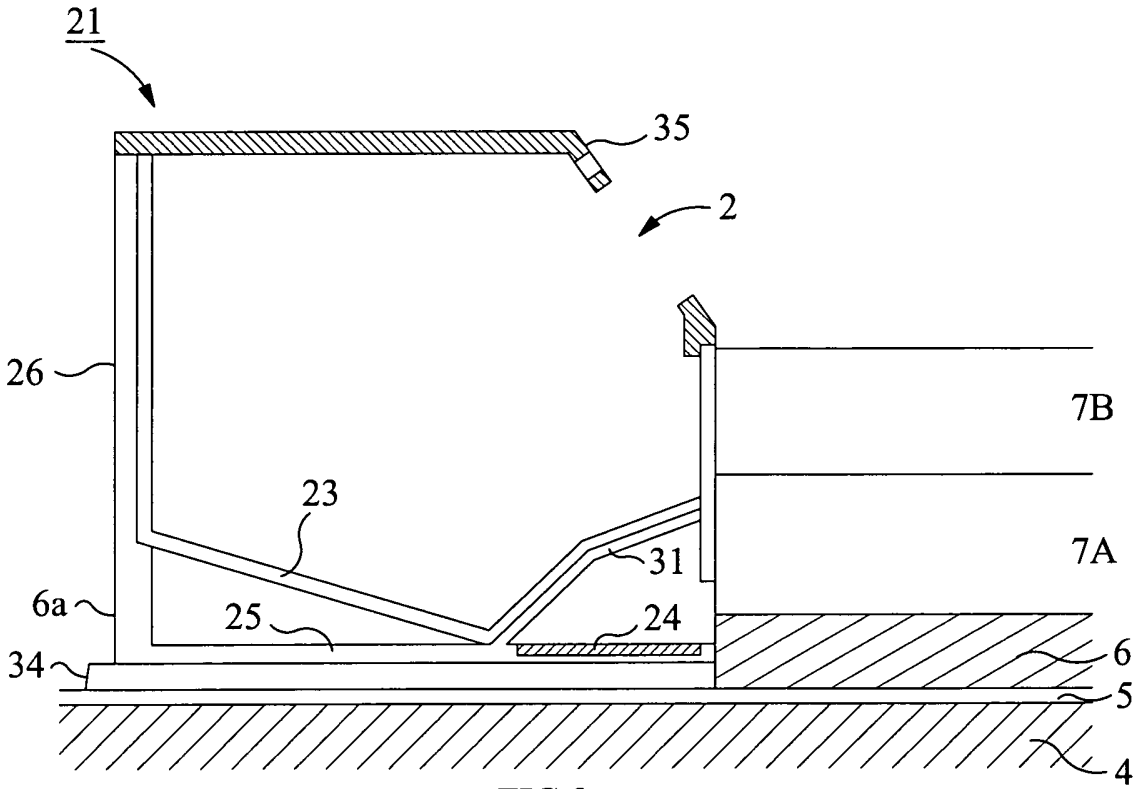

FIG 8

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EUROPEAN SEARCH REPORT

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EP 05 27 0057

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	6 December 2005	Kerouach, M

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