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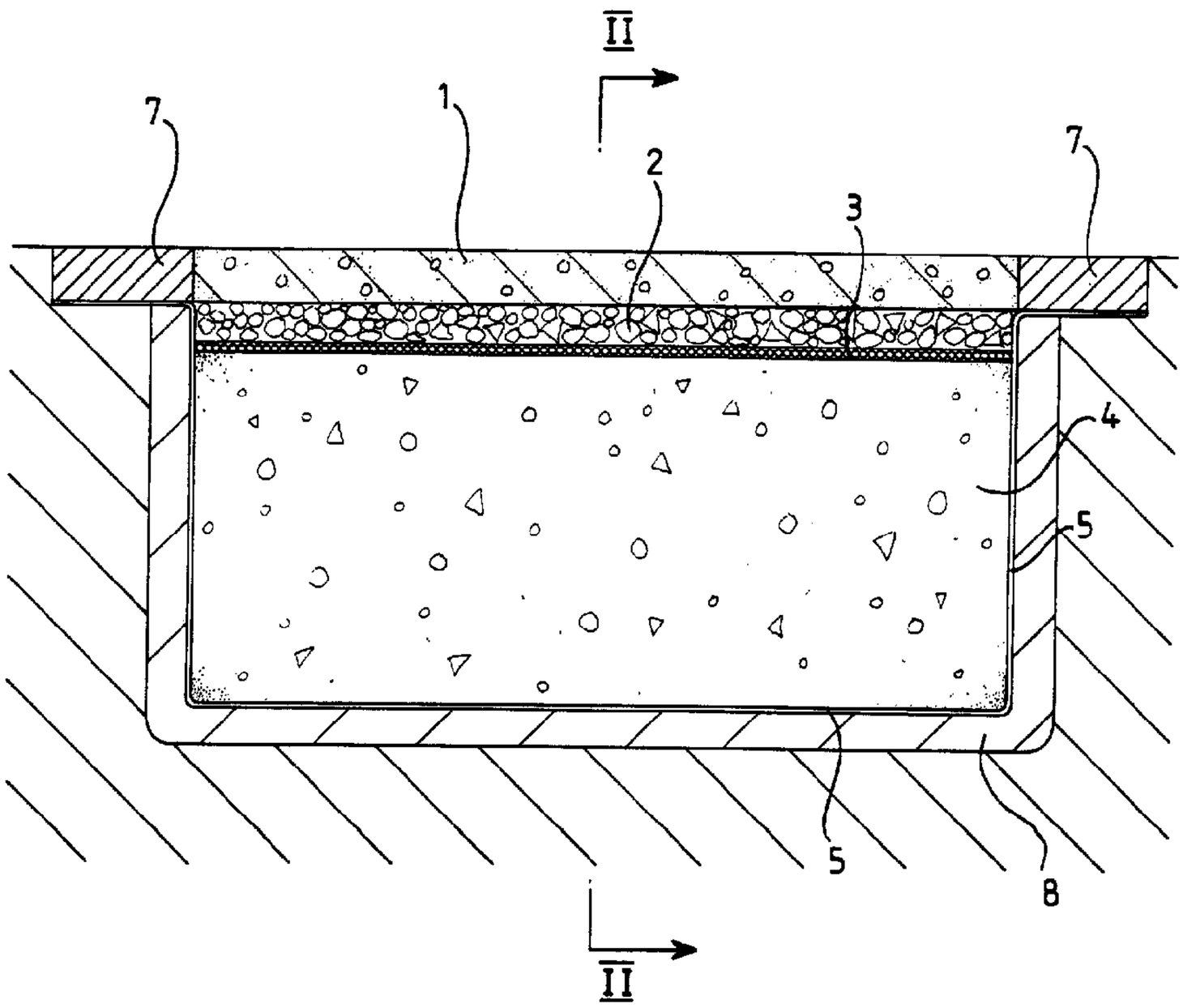

(57) Abrégé/Abstract:
The paving system has a perforated pavement (1) covering a deep substrate of mainly hard nodules or shells, the whole being surrounded by impervious walls (5) to provide temporary storage in the interstices for chemical spillage or flood water, wherein liquids may be chemically treated or biologically decomposed, and whence the rate of outflow may be regulated. The pavement may consist of preformed pavings of brick, concrete or other material, laid edge to edge without mortar or cement. These pavings may be perforated or notched to allow liquids to run down into the substrate. The pavings are laid on a screen (2, 3) which filters out solid particles to stop the system clogging. This system allows biological substances to grow, or be introduced with or without additional nutrients, or chemical treatments to be introduced, from above, when needed. The whole pavement system can be lifted out for cleaning or substitution, and relaid as new.

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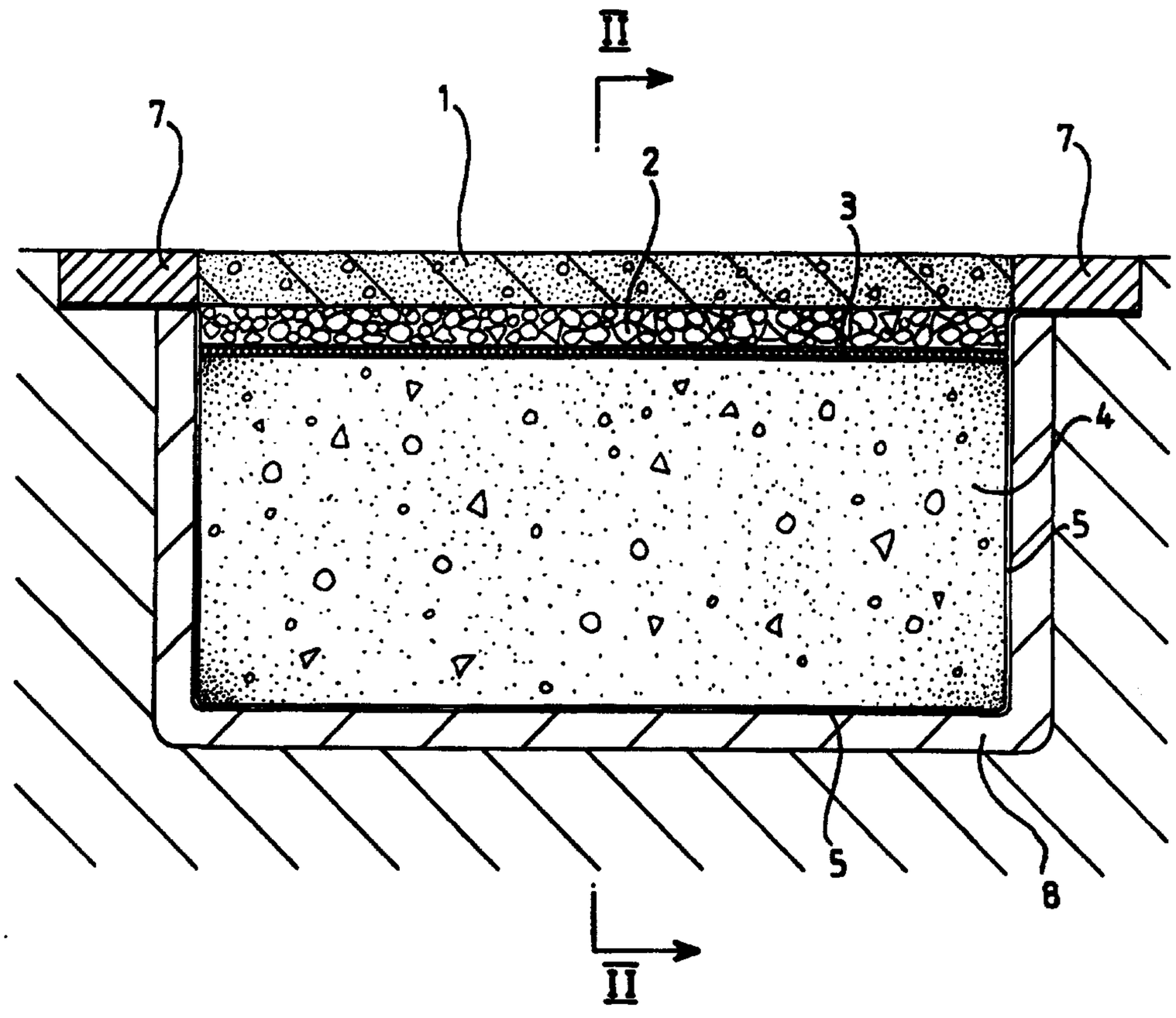
(54) Title: PAVING SYSTEM FOR SPILLAGE AND FLOOD MANAGEMENT

(57) Abstract

The paving system has a perforated pavement (1) covering a deep substrate of mainly hard nodules or shells, the whole being surrounded by impervious walls (5) to provide temporary storage in the interstices for chemical spillage or flood water, wherein liquids may be chemically treated or biologically decomposed, and whence the rate of outflow may be regulated. The pavement may consist of preformed pavings of brick, concrete or other material, laid edge to edge without mortar or cement. These pavings may be perforated or notched to allow liquids to run down into the substrate. The pavings are laid on a screen (2, 3) which filters out solid particles to stop the system clogging. This system allows biological substances to grow, or be introduced with or without additional nutrients, or chemical treatments to be introduced, from above, when needed. The whole pavement system can be lifted out for cleaning or substitution, and relaid as new.



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Paving System for Spillage and Flood Management

This invention relates to a system of construction for paved surfaces.

Paved surfaces are required in many situations where the impermeability of a conventional pavement is essential, but not without disadvantages. In some situations - refuelling stations, chemical loading bays and vehicle parks, for instance - there may be risk of spillage of fluids which must be prevented from entering the drainage system and so passing by uncontrolled discharge into the environment, and must be prevented from entering the environment at all without preliminary treatment.

Where there are large areas of pavement - motorways, for instance - flash storms may cause such flooding that existing storm-water provisions become overloaded. There have been occasions, too, when emergency treatment of spillage after accidents involving chemical tankers has resulted in serious damage to the environment over wide areas.

Where risks of chemical contamination are low, various forms of porous pavement have been employed, allowing spillage to soak away into the ground beneath. There is, however, a limited rate at which ground can absorb moisture, and there remains a risk of flooding when rainfall is very high.

WO-A-8 500 631 describes a structure for controlling an artificial water table beneath a tennis court or agricultural land in which a ballast layer of generally uniform size rock is laid on top of a watertight membrane in a basing, the ballast layer being extremely permeable by water. The ballast layer is covered by a permeable membrane which is covered by a layer of finely divided particles which are prevented from penetrating the ballast layer by the permeable membrane. Water diffuses through the fine layer by capillary action. Water is inserted in the ballast layer, causing the water table in it to rise to and above the permeable membrane. The amount of water provided to a finished layer above the fine layer can be adjusted by raising and lowering the water level.

DE-A-3 041 624 describes a method of sealing and draining an area of ground where the regions to be sealed are limited by kerb stones, some of which have discharge channels.

According to the present invention, there is provided a paving system for spillage or floodwater management comprising:

a permeable layer formed by a plurality of discrete pavings having lateral abutting edge surfaces, providing an upper surface; a supporting substrate layer thereunder which is permeable to liquid; and a containment membrane of impermeable material containing said substrate layer for controlled retention of liquid therein;

wherein:

said permeable layer enables the drainage of spillage or floodwater therethrough into the substrate layer and the introduction of treatment material into said substrate; the substrate layer is of particular material and is of a material which is non-friable and non-susceptible to frost; the particles of the substrate layer are of irregular shape thereby to provide interstitial cavities therebetween in which draining spillage or floodwater or introduced treatment material can dwell, and are of a size in the range 15 mm to 300 mm; said permeable layer has openings of slot-like form for the drainage of spillage or floodwater therethrough into the substrate layer and for the introduction of treatment material into the substrate layer; each discrete paving is provided with at least one groove in at least one of said abutting edge surfaces, each said groove extending for the thickness of said paving thereby to form said slot-like holes; and the system is arranged to enable biological decomposition of pollutants to occur in said substrate layer.

The term paving system as used herein refers to a system which is capable of supporting repeated vehicular loading.

In a preferred form of the invention a filtering layer is provided intermediate the paving and substrate layers for filtering solids from liquid permeating through the

paving layer, and a dispersing layer is located intermediate the paving and filtering layers for dispersing liquid permeating from the paving layer over the filtering layer.

The openings of slot-like form are of small span to stop ingress of foreign objects, but of long periphery to facilitate dispersion of the fluid underneath the pavement. Slot-like holes are therefore attractive, and these are provided by grooves on the outside of prefabricated pavings.

The pavement may be formed by pavings of such size and mass as to be convenient to handle continually without fatigue, and designed to be laid close-fitting without mortar or cement. They may be made in any material suitable for any particular application, such as brick, concrete, or cast iron, and must be of sufficient depth to ensure dispersion of the concentrated loads applied. Concurrently, they are of sufficient depth to prevent them tipping over under load, given the lateral freedom allowed by close-fitting laying. Pavings may have holes through them, in addition to the grooves in the interfaces separating adjacent pavings. Paviours find this type of pavement cheap and easy to lay, with the further advantage that pavings can easily be lifted when required.

The incorporation of raised pads on the upper surfaces of at least some of the pavings prevents compression of the gravel filling around the paving and reduces the danger of hydroplaning in storm conditions, and is a preferred feature.

Underneath the pavings, the filtering layer is a geotextile layer used to filter out unwanted solids. This is preferably between 1mm and 1.5mm thick.

The pavings are laid on a bed of gravel or crushed gravel or other small grained particulate

material (the dispersing layer) which covers the geotextile layer, and the same or similar material is dropped into the perforations and around the raised pads. The layer is a material which is not readily friable, dissolved or susceptible to frost and is substantially inert to water. The particle size is preferably of a minimum 5mm diameter to a maximum of 10mm diameter. The particle size may vary within the above range in the layer.

This particulate layer provides a flat surface for the pavings and ensures that the geotextile layer is uniformly loaded. Moreover, it helps to disperse the fluid from the perforations uniformly over the surface of the geotextile layer, and provides an initial screening of the fluid to minimise clogging of the geotextile layer beneath. The particulate infill provides a relatively smooth surface for humans and animals to walk on, and is easily weeded when necessary.

Beneath the geotextile layer is the substrate proper (the substrate layer) which lies on, and is contained by, the impermeable membrane described above. This is a deep layer of mainly hard nodules. These could be hollow, and there may be advantage in some being hollowed out or drilled as described below, but they are most efficient when solid. They are preferably of irregular or lobate form so that they remain firmly in place under load but are surrounded by interstitial cavities in which the drained fluid can dwell.

These nodules may be of any suitable material: crushed stone, pebbles and blast furnace slag are typical examples, but special materials or shapes may be needed in particular applications. The size and type of nodule affects the storage and release capabilities of the paving system. The material used for the substrate is also a material which is not readily friable, dissolved or susceptible to frost. It is also substantially inert to water. The material can consist of particles of differing sizes in the range 15mm to 200 to 300mm and the particle size may vary within the substrate layer. However, the majority of particles in the material should be of a size nearer the lower end of this range.

This system ideally meets the requirements for biological decomposition of certain types of harmful spillage. Bacteria breed on the substrate walls if spillages are not infrequent, and

fresh cultures or cultures of different bacteria can be introduced into the substrate cavities when needed. It may be advantageous to provide 'nests', perhaps in porous or hollow nodules, in which suitable bacteria can breed awaiting the next spillage. It may be necessary in some cases to provide nutrient occasionally to ensure that the bacteria do remain available. Cultures and nutrient can be introduced from above the pavement when necessary without disturbing the pavement.

Chemicals also may be introduced in this way for spillages that are not amenable to biological treatment.

It is an important advantage of this construction that all its elements can easily be lifted out for examination, flushing or other cleaning, or substitution if needed, and the geotextile member can be replaced when it is clogged.

Weirs or dividers can be introduced into the substrate to isolate sections of the tank or channel, either for floodwater control in sloping channels or to allow chemical or biochemical treatment of spillage. Such weirs might be built within the impermeable membrane, but there may be advantage in some cases in embedding a smoothly grooved U-shaped component into the ground before the impermeable membrane is laid, and then sliding a pre-fabricated mating weir into position within the membrane lying over the U-shaped component, or sealingly attached to it, to trap the membrane without damaging it. Depending on the application, weirs may be porous, as for floodwater control, or impervious, as for chemical or biochemical treatment of spillages.

Where the cavity within the impermeable membrane is compartmentalised by end closures or impermeable weirs there will be need for valves and discharge ducts for drainage. The provision of the valves and ducts that are sealingly connected to an impermeable membrane is well understood by those skilled in the art and need not be considered here.

This ability to process spillages in situ is regarded as a highly desirable feature of the newly invented system described here. Appropriate chemicals can be admitted into specific

containment sections so that hazardous fluids are rendered harmless before they are diluted in more general effluent systems. Added chemicals may themselves be hazardous or harmful in some instances, so by treating the spillage in exact proportions in isolation the overall damage can be minimised. It is much more difficult to do this when the spillage has already been intermixed with fluids from other sources.

The present invention is further described hereinafter, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows a transverse cross-section on the line 2-2 of Figure 2 through one embodiment of a paving system according to the present invention;

Figure 2 shows a longitudinal cross-section on the line 1-1 of the system of Figure 1; and

Figure 3 illustrates a typical paving suitable for use in this paving system.

Referring to the drawings, pavings 1 are laid on a bed of gravel as shown at 2, and underneath this bed of gravel is a geotextile layer shown at 3.

A substrate of crushed stone is shown at 4.

The impermeable plastics membrane is shown underneath the substrate at 5 and up the sides of the duct. The top of the impermeable membrane is trapped in this case under border stones as shown at 7.

A suggested U-frame used to retain a divider in the form of a weir 9, is shown at 8.

The weir fits inside the U-frame 8. Here, the impermeable membrane 5 is shown trapped between the weir 9 and the U-frame 8. The weir relies upon the support given by the substrate 4. The weir 9 may extend at least a portion of the height of the substrate 4.

A difference in fluid levels on the two sides of the weir 9 is indicated by the two arrows at 10, and a drain valve and outlet pipe is indicated at 11. Since the weir is always at the lowest point of any containment, the valve mounting could be included in the U-frame 8, but it is shown discrete here for clarity.

CLAIMS:

1. A paving system for spillage or flood water management comprising:

a permeable layer formed by a plurality of discrete pavings having lateral abutting edge surfaces, providing an upper surface;

a supporting substrate layer thereunder which is permeable to liquid;

and a containment membrane of impermeable material containing said substrate layer for controlled retention of liquid therein;

wherein:

said permeable layer enables the drainage of spillage or floodwater therethrough into the substrate layer and the introduction of treatment material into said substrate;

the substrate layer is of particular material and is of a material which is non-friable and non-susceptible to frost;

the particles of the substrate layer are of irregular shape thereby to provide interstitial cavities therebetween in which draining spillage or floodwater or introduced treatment material can dwell, and are of a size in the range 15 mm to 300 mm;

said permeable layer has openings of slot-like form for the drainage of spillage or floodwater therethrough into the substrate layer and for the introduction of treatment material into the substrate layer;

each discrete paving is provided with at least one groove in at least one of said abutting edge surfaces, each said groove extending for the thickness of said paving thereby to form said slot-like holes;

and the system is arranged to enable biological decomposition of pollutants to occur in said substrate layer.

2. A paving system as claimed in claim 1 wherein the substrate layer is partially or fully divided by one or more impermeable divider or weir means into sections within the containment membrane containing the substrate layer for spillage or floodwater control or to allow for effective treatment of spillage in said substrate layer.

3. A paving system as claimed in any of the preceding claims wherein the divider or weir means or each thereof extends from the bast of the containment membrane for at least a portion of the height of said substrate layer for preventing or restricting passage of drained spillage or floodwater or introduced treatment material from one section of the substrate layer to an adjacent section or sections.

4. A paving system as claimed in claim 3 wherein the divider or weir means or each thereof extends for the height of said substrate layer.

5. A paving system as claimed in any of claims 2 to 4 wherein the divider or weir means or each thereof is supported by a respective support member, said containment membrane being retained between the divider or weir means and the support member.

6. A paving system as claimed in claim 5 wherein the support member is substantially U-shaped having an inner groove extending the length thereof so as to slidable receive said divider or weir means.

7. A paving system as claimed in any of preceding claims 2 to 6 wherein the containment membrane is formed as an elongate channel having a base portion and side portions wherein each side portion extends up to the permeable layer and the divider or weir means on each thereof extends for the full width of the channel .

8. A paving system as claimed in any of the preceding claims wherein at least some of discrete pavings of the paving are provided with raised pads on an upper surface thereof.

9. A paving system as claimed in any of the preceding claims having means for enabling gas to be drawn through at least said substrate layer.

10. A paving system as claimed in claim 9 wherein said gas is atmospheric air.

11. A paving system as claimed in claim 9 wherein said gas is substantially oxygen or carbon dioxide.

12. A paving system as claimed in any of the preceding claims wherein a filtering layer is provided intermediate the permeable and substrate layers for filtering solids from spillage or floodwater draining through the permeable layer.

13. A paving system as claimed in claim 12, wherein a dispersing permeable layer is provided between the permeable and filtering layers for dispersing spillage or floodwaters draining through the permeable layer over the filtering layer.

14. A paving system as claimed in claim 12 or 13 wherein the filtering layer is of geotextile material.

15. A paving system as claimed in any of claims 12 to 14 wherein the thickness of the filtering layer is in the range of 1mm to 1.5mm.

16. A paving system as claimed in claim 13 or claim 14 or 15 when appendant to claim 13 wherein the dispersing permeable layer is of particulate material.

17. A paving system as claimed in claim 16 wherein the average particle size of said dispersing permeable layer is smaller than that of the substrate layer.

18. A paving system as claimed in claim 16 or 17 wherein the particles of the dispersing permeable layer have a diameter in the range of 5mm to 10mm.

19. A paving system as claimed in claim 13 or any of claims 14 to 18 when appendant to claim 13 wherein the dispersing permeable layer is of a material which is non-friable and non-susceptible to frost.

20. A paving system as claimed in any of the preceding claims wherein the containment membrane is of impermeable plastics material.

21. A paving system as claimed in any of the preceding claims wherein the particle size of the substrate layer is in the range of 15mm to 300mm with the particles being predominantly of a size nearer to the lower end of the range.

22. A paving system as claimed in claim 21 wherein the particle size of the substrate layer is in the range of 15mm to 200mm with the particles being predominantly of a size nearer to the lower end of the range.

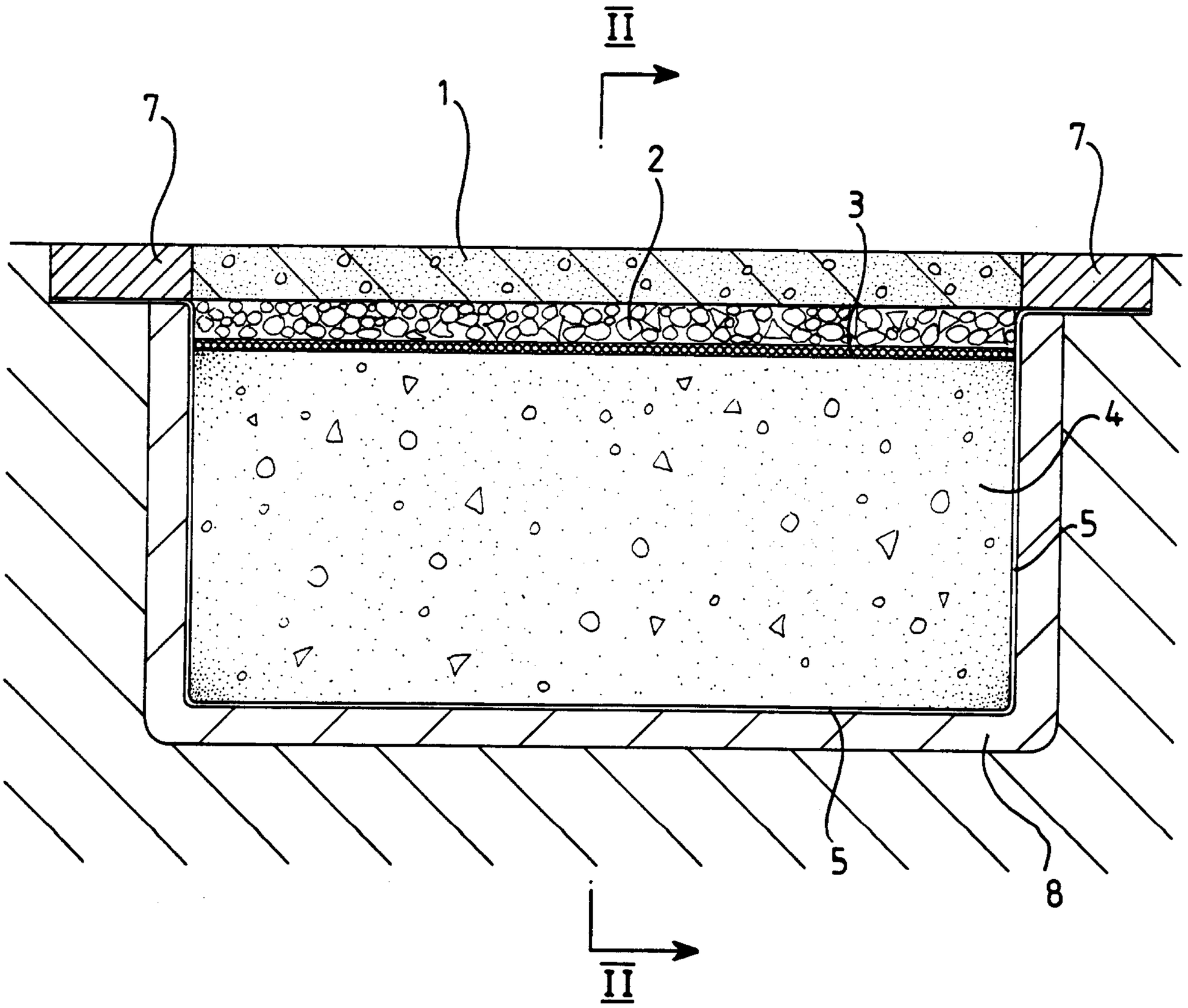
23. A paving system as claimed in any of the preceding claims wherein said particles are of lobate form.

24. A paving system as claimed in any of claims 21 to 23 wherein said particles are porous or hollow.

25. A paving system as claimed in any of the preceding claims wherein draining means is provided for enabling spillage or floodwater such as treated spillage to be drained from said containment membrane and substrate layer.

26. A paving system as claimed in claim 25 wherein said draining means comprises valve means.

FIG 1



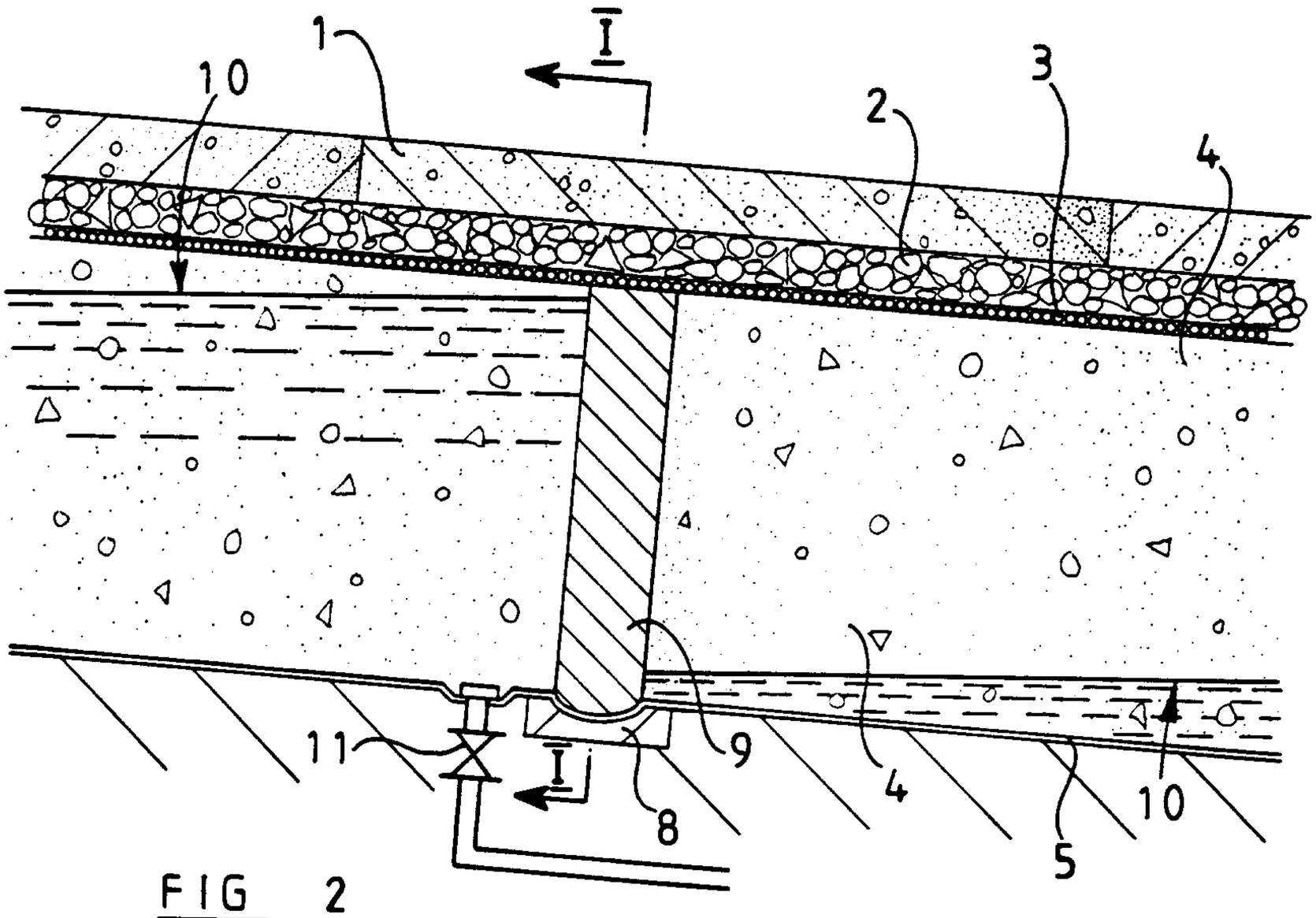


FIG 2

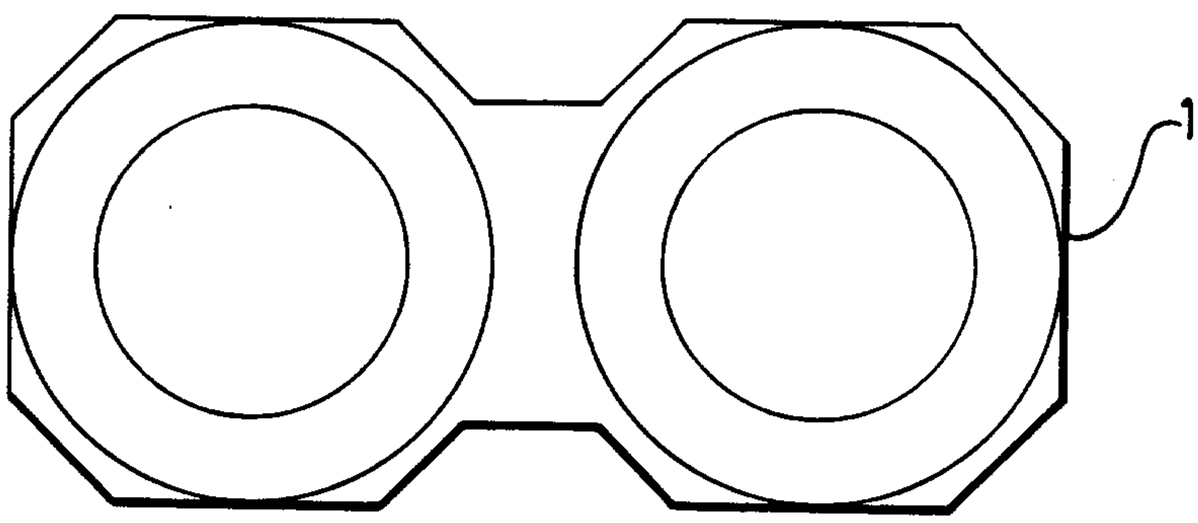
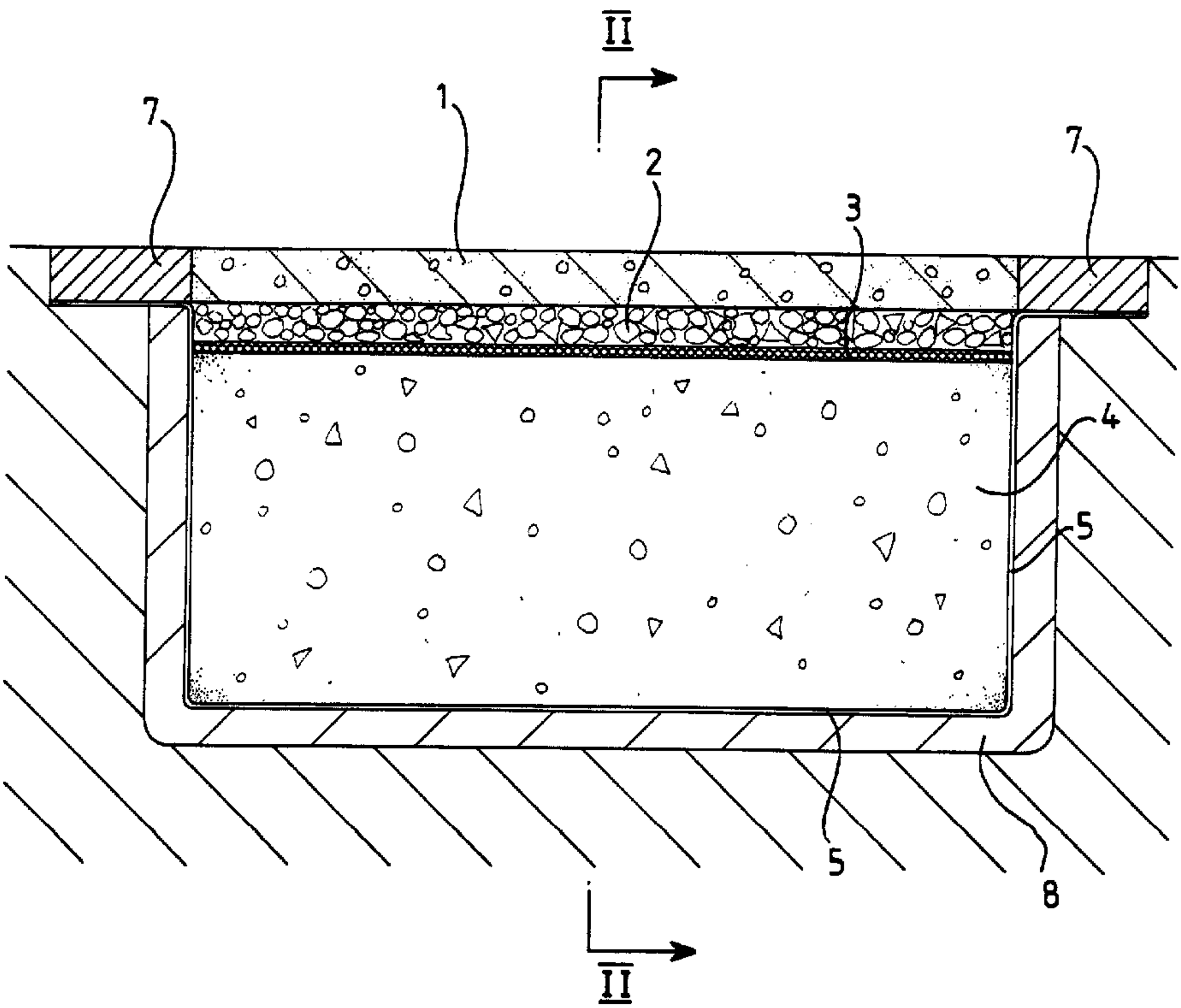


FIG 3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