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(71) Applicant: **Showa Shell Sekiyu Kabushiki Kaisha**
Tokyo (JP)

(72) Inventors:
• **Sato, Isao,**
c/o Shoseki Kakoh K.K.
Tokyo (JP)

• **Sakuma, Yoshimitsu,**
c/o Shoseki Kakoh K.K.
Tokyo (JP)
• **Sasaki, Yoshiomi,**
c/o Maeda Kosen Co., Ltd.
Chuo-ku, Tokyo (JP)

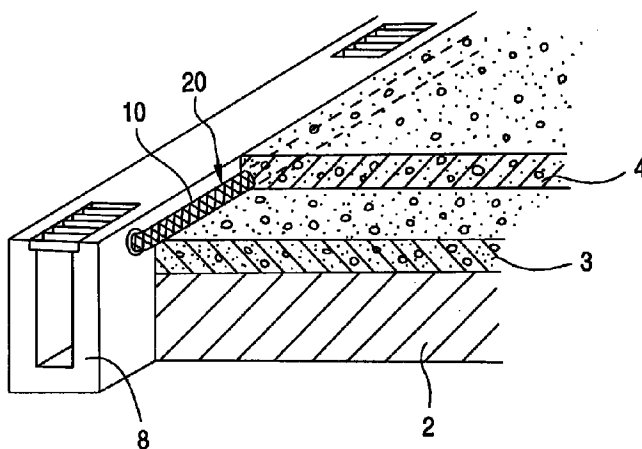
(74) Representative: **Füchsle, Klaus, Dipl.-Ing. et al**
Hoffmann, Eitle & Partner,
Patentanwälte,
Arabellastrasse 4
81925 München (DE)

(54) **Drainage system for use with paved road**

(57) The drainage system includes a base layer (2), a first layer (3) laid on the base layer, a second layer (6) laid on the first layer, a pair of gutters (8) longitudinally provided on both sides of the road, a first braided pipe (10) fabricated by weaving together a predetermined number of warps (11) and a lot of woofs (12) made of

heat resistant synthetic fiber, the braided pipe being disposed along the gutter (8) and the downstream-side end of the top surface of the first layer (5), the drainage channel being communicated to catch basins (9) located at the gutter.

FIG. 4



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Description

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to a drainage system for use with a paved surface such as a road and, more particularly, to a drainage system for draining rainwater penetrating to the base course through an asphalt layer on a road surface. Further, the present invention relates to a drainage system for use with a paved road and, more particularly, to a drainage system which prevents problems such as a drop in slip resistance, a hydroplaning phenomenon, and splashing and spray of water resulting from water floating or remaining on a road surface. Still further, the present invention relates to a secondary drainage system for use in a road bridge and, more particularly, to a secondary drainage system which prevents a drop in durability of the bridge by draining rainwater penetrating through an asphalt pavement on the surface of the bridge.

Related art

Conventionally, curbs or gutters are provided along both sides of a road, and the road is commonly surfaced with a pavement graded toward the center or the sides of the road. In the "GUIDELINES FOR ASPHALT PAVEMENT" edited by the Japan Road Association, descriptions relating to drainage only mention inflow ports formed in the side of the gutter facing the pavement with regard to surface drainage, sub-surface drainage, and permeable asphalt pavement (Paragraph 2-7-2 "Surface Drainage" on page 38 in the Guidelines For Asphalt Pavement). However, especially in the case of an asphalt pavement, the pavement contains minute pores, and rainwater penetrates through these minute pores during rainfall. If the rainwater having thus penetrated through the pores remains in the asphalt pavement, the aggregate will come away from the asphalt mixture that forms the asphalt pavement, thereby resulting in the fracturing of the pavement. In many cases, maintenance and repair of the road are carried out by cutting the surface of the asphalt pavement laying a new asphalt mixture over the base course. Rapid drainage of the rainwater penetrating to the inside of the pavement in a simple manner has been desired.

In the case of the permeable asphalt pavement, the boring of the inflow port in the side of a U-shaped gutter facing the road involves a lot of labor. Thus, the boring of the inflow port in the gutter is impractical. Further, in the case of an L-shaped gutter, rainwater remaining in the pavement may cause problems.

Particularly, road traffic hazards due to water remaining on the road surface become a major problem on highways. The highway is surfaced with a permeable asphalt pavement in order to ensure driving safety and reduce noise. However, this pavement is designed to

permit the rainwater to penetrate through to the inside of the porous pavement so as to prevent a water slick on the road surface. The rainwater passes through voids in the pavement, and the thus penetrating rainwater is drained along the top surface of the base course. However, if the voids of the pavement are filled with mud and dirt, that is, if the voids are clogged, the drainage and noise-reduction capability are impaired.

The mud and dirt in the voids are conventionally removed by squirting pressurized water onto the road surface and sucking the mud and dirt that float to the road surface from the inside of the pavement. The installation of drains and their improved draining capability may permit the flushing of the mud and dirt. However, it is unlikely that these are sufficient means for maintaining the drainage capability of the pavement.

Further, in the case of a road with multiple traffic lanes, the distance of the road from which water has to be drained is increased. In the event of heavy rain, the volume of rainwater may exceed the limit of the draining capacity of the pavement, as a result of which excess surface water arises. The draining capacity of the permeable asphalt pavement depends on the porosity of the pavement. It is evident that a greater porosity leads to better water permeability which, in turn, results in improved permeability. However, the porosity of the pavement must be to the 20% range in order to ensure the strength of the pavement.

In the case of a pavement on the surface of a bridge, an asphalt pavement is laid over the surface of a steel base or a reinforced concrete base. Rainwater, or the like, penetrates to the steel base or the reinforced concrete base through the asphalt pavement, so that steel or reinforcements in the base are eroded. The steel base or the reinforced concrete base has a small thickness, and it is directly subject to a wheel load via the asphalt pavement. If the base is repeatedly subjected to the wheel load while it remains in a wet state as a result of the penetrated rainwater, the load capacity of the base will significantly decrease.

The "Road Bridge Instructions" issued from the Ministry of Construction require that a waterproof layer be laid on the base. However, an asphalt mixture laid on the waterproof layer contains uneven voids. Further, as a result of deflection load of the base due to repeated wheel loads, minute cracks and the spread of voids develop unevenly in the asphalt mixture on the waterproof layer laid on the base. Furthermore, it is impossible to prevent the rainwater from penetrating through the asphalt pavement along the boundary between the pavement and wheel guards, curbs, or catch basins disposed along both sides of the base. For these reasons, the rainwater remaining in the asphalt pavement as a result of penetration causes the pavement to deteriorate.

To immediately drain the rainwater remaining inside the asphalt pavement to the outside, conduits are provided on both sides of the road in its longitudinal direction along the waterproof layer or a joint mixture raised straight up along the wheel guard, the curb, or the catch

basin while they are in contact with an upper part of the waterproof layer. The ends of the conduits are connected to outlets opened in the wall surface of an expansion joint or the side surface of the catch basin facing the pavement, whereby the rainwater remaining in the pavement is immediately drained to the outside of the bridge.

The outlet is covered with a wire mesh having high corrosion resistance in order to prevent the outlet from being clogged with the aggregate. In this respect, conduits having sufficient voids which guide only the rainwater while preventing the inflow of the aggregate without the use of the wire mesh have already been put forth. For example, a drain structure having such a conduit is disclosed in Unexamined Japanese Patent Publication Hei-6-26013. The drain structure disclosed in this patent publication comprises a waterproof layer which is laid on the base of the bridge and is raised straight up at both ends thereof along the wheel guards disposed on both sides of the bridge base, and an infiltrated water guide member consisting of a spirally coiled stainless steel which is laid along the inner side surface of the corner of the raised portion of the waterproof layer. The infiltrated water guide member consisting of the spiral coil is connected at given points thereof to a drainage system. A pavement material is laid on the waterproof layer and the infiltrated water guide members.

The infiltrated water guide member acting as a drainage channel, as disclosed in the above patent publication, is made up of a spiral stainless steel coil. This infiltrated water guide member has a lot of problems such as the difficult in laying it, reflection cracks, cost effectiveness, and problems arising when the infiltrated water guide member is cut to repair.

SUMMARY OF THE INVENTION

The present invention is conceived in view of the previously mentioned drawbacks in the conventional art, and its object is to provide a drainage system for use with a paved road which uses a drainage channel comprising braided pipes formed from synthetic fiber, being capable of easily draining rainwater when it is laid on the base course on the sub-base of a road, and possessing sufficient strength to support an asphalt pavement.

Another object of the present invention is to provide a drainage system for use with a paved road, specifically, a multi-lane road, which is capable of providing a superior drainage efficiency and of preventing surface water even if there is provided the insufficient drainage capability lead by the porosity of the pavement, a hydraulic gradient, and a drainage capability of a road area.

Still another object of the present invention is to solve the previously mentioned problems and to provide a secondary drainage system for use in a road bridge which is easier to lay, enables a constant intake of water, has plenty of flexibility, makes it easy to align the drainage with unevenness of catch basins, is resistant to radial pressure resistance, and can prevent the intrusion of aggregate into a conduit.

To those ends, according to one aspect of the present invention, there is provided a drainage system for use with a paved road comprising: a braided pipe which is fabricated by weaving together a predetermined number of warps and a lot of woofs using heat resistant synthetic fiber so as to form a drainage channel; a base course of a road having its top graded; gutters longitudinally provided on both sides of the road; the drainage channel being disposed along the downstream-side end of the graded top surface of the base course and along the gutter; the drainage channel being communicated to catch basins; and the base course and the drainage channel being surfaced with asphalt mixture.

According to another aspect of the present invention, there is provided a drainage system for use with a paved road comprising: a plurality of first braided pipes which are fabricated by weaving heat resistant synthetic fiber and are disposed on a base course of a road at predetermined intervals at an angle with respect to the longitudinal direction of the road; second braided pipes which are the same as the first braided pipes, are disposed along gutters on both sides of the road, and are connected to catch basins; a drainage channel being formed by connecting the ends of the first braided pipes with the second braided pipes; and the base course and the drainage channel being surfaced with a permeable asphalt pavement.

According to still another aspect of the present invention, there is provided a drainage system for use with a paved road comprising: a plurality of first braided long pipes which are fabricated by weaving heat resistant synthetic fiber and are bent substantially at the center thereof; the first braided long pipes being laid on the base course of a road at predetermined intervals while their bent portions are aligned with the longitudinal center of the road and their ends are disposed at an angle to the longitudinal direction of the road; second braided pipes which are the same as the first braided long pipes and are disposed along gutters on both sides of the road for collecting water; a drainage channel which is formed by connecting the ends of the first braided long pipes with the second braided pipes; and the drainage channel and the base course being surfaced with asphalt mixture.

According to a further aspect of the present invention, there is provided a secondary drainage system for use in a road bridge comprising: a waterproof layer which is laid on the base course of a bridge so as to be raised at their both ends along wheel guards or curbs disposed on both sides of the base course; braided pipes which are fabricated by weaving together a required number of warps and a lot of woofs using heat resistant synthetic fiber and are connected to form a conduit; the conduit being laid on the waterproof layer along its raised portion and being connected to catch basins; and the drainage channel and the waterproof layer being surfaced with asphalt mixture.

According to a still further aspect of the present invention, there is provided a secondary drainage system for use in a road bridge comprising: a braided pipe

which is fabricated by weaving together a required number of warps and a lot of woofs using heat resistant synthetic fiber so as to form a first conduit and is laid on a waterproof layer along the expansion joint side edge of a bridge; second conduits which are the same as the first conduit and are laid on the waterproof layer of the base course of the bridge along wheel guards on both sides of the sub-base; the first conduit being connected at both ends thereof to the ends of the second conduits; the first conduit being connected to a catch basin; and the waterproof layer and the first and second conduits being surfaced with asphalt mixture.

In the drainage system for use with a paved road according to the present invention, a braided pipe is fabricated by weaving together a required number of warps and a lot of woofs using heat resistant synthetic fiber so as to form a drainage channel. The thus fabricated drainage channel is disposed along a gutter on each side of a road and along the downstream-side and of a graded top of the base course of the road. The warps woven into the braided pipe prevent the braided pipe from expanding and shrinking in its longitudinal direction. As a result, the mesh of the braided pipe will not become spread out or reduced, which permits a constant volume of water to be taken at all times. Further, since the braided pipe is flexible, it can follow curves of the road or unevenness and possesses radial pressure resistance. Furthermore, there is no fear of the intrusion of aggregate into the braided pipe, and the rainwater having infiltrated into the surface layer flows in the downstream direction as a result of the gradient of the top surface of the base course. In this way, only the water flows into a drainage guide pipe, thereby preventing the permeation of the rainwater into the base course. Consequently, the rainwater never remains in the pavement, which in turn prevents the fracturing of the pavement.

In the drainage system for use with a paved road according to the present invention, a plurality of first braided pipes which are fabricated by weaving a plenty of heat resistant synthetic fiber are laid on the base course of the road at predetermined intervals at an angle with respect to the longitudinal direction of the road. These braided pipes on the base course are connected to similar second braided pipes disposed along gutters on both sides of the road, thereby forming a drainage channel. The drainage channel and the base course are surfaced with asphalt mixture, and consequently the rainwater having penetrated through the road surface flows to catch basins through the first braided pipes on the base course and the second braided pipes that are disposed along the gutters of the road and are connected to the first braided pipes.

In the case of a multi-lane road having a long graded width, the rainwater having permeated through the road surface flows into the braided pipes disposed at an angle with respect to the longitudinal direction of the road when flowing over the graded top of the base course. In this way, it is possible to reliably guide the rainwater flowing over the graded top of the base course into the braided

pipes, i.e., the drainage channel. The downstream-side ends of the first braided pipes on the base course are connected to the second braided pipes that are disposed along the gutters and are communicated to the catch basins, whereby the rainwater can be effectively drained to the gutters through the catch basins.

In the secondary drainage system for use in a road bridge according to the present invention, the rainwater having penetrated through an asphalt pavement which acts as the bridge surface reaches to the waterproof layer laid on the base. The rainwater is then drained to the outside through the conduit that is made up of the braided tubes consisting heat resistant fiber and is laid along the inner side surface of the raised portion of the waterproof layer along the wheel guards or curbs, or the conduit that is made up of the braided pipe and is disposed on the waterproof layer along the expansion joint side edge of the bridge. Further, the conduit is made up of the braided pipes which are fabricated by weaving together a required number of warps and a plenty of woofs using heat resistant synthetic fiber. The warps woven into the braided pipe prevent the braided pipe from expanding and shrinking in its longitudinal direction, as a result of which a constant inflow of the rainwater can be taken at all times. Further, since the braided pipe is flexible, it can freely follow curves or unevenness and possesses radial pressure resistance. Furthermore, since the conduit is made up of the braided pipes, there is no fear of the intrusion of aggregate into the braided pipe. The rainwater having infiltrated into the asphalt pavement is guided along the waterproof layer into the braided pipe and is eventually drained to the outside.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view showing a road according to the present invention;

Fig. 2 is a cross section of the road taken along line A-A' shown in Fig. 1;

Fig. 3 is a perspective view showing the principal elements of a drainage guide pipe;

Fig. 4 is a cross-sectional perspective view showing the drainage guide pipe communicated to a drainage gutter;

Fig. 5 is a cross-sectional perspective view showing the drainage guide pipe communicated to a catch basin which is connected to an L-shaped gutter;

Fig. 6 is a plan view showing a drainage system for use with a paved road according to a second embodiment of the present invention;

Fig. 7 is a cross section taken along line A-A' in Fig. 6;

Fig. 8 is a cross-sectional perspective view showing a drainage guide pipe communicated to a drainage gutter;

Fig. 9 is a cross-sectional perspective view showing a drainage guide pipe communicated to a catch basin which is connected to an L-shaped gutter;

Fig. 10 is a plan view showing a drainage system for use with a paved road according to a third embodiment of the present invention;

Fig. 11 is a cross section of a paved road with a drainage system according to a fourth embodiment of the present invention;

Fig. 12 is a plan view of a bridge with a drainage system according to a fifth embodiment of the present invention;

Fig. 13 is a cross section taken along line A-A' shown in Fig. 12;

Fig. 14 is a cross-sectional perspective view showing a conduit laid along a raised portion of a waterproof layer;

Fig. 15 is a cross section showing a connection between the conduit and a catch basin; and

Fig. 16 is a cross section showing a connection between the conduit in the vicinity of the expansion joint and a drainage pipe.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

First embodiment

A drainage system for use with a paved road according to a first embodiment of the present invention will now be described with reference to the accompanying drawings. In Figs. 1 and 2, as conventionally be known, a road 1 is constructed from the base course 2, and a base course 3 consisting of coarse asphalt mixtures is laid on top of the base course 2. The boundary between the base course 2 and the base course 3 and the top of the base course 3 are downwardly graded from the center to both sides of the road 1 in its transverse direction. These graded surfaces are made up of graded portions designated by 4, 4', 5, and 5'. A top layer 6 consists of hot asphalt mixtures, and the top surface of the top layer 6, i.e., the road surface, is downwardly graded from the center to both ends of the road in its transverse direction in the same manner as the top surface of the sub-base 3. In other words, the top layer 6 has graded portions 7 and 7'. In this way, rainwater flows into gutters 8 and 8' provided on both sides of the road 1. As shown in the drawings, catch basins 9 and 9' are disposed in the gutters 8 and 8', as required.

A braided pipe 10 formed from heat resistant synthetic fiber is fabricated by weaving together a required number of warps 11, 11 ... (four warps in the present embodiment) and a plenty of woofs 12, 12, 12 This synthetic fiber is required to possess heat resistance so that it will be resistant to a pavement temperature of 160 to 180 degrees Centigrade. Polyester, alamide resin, and polyamide are usable as the heat resistant synthetic fiber, and the size of thread should preferably be set to 1,500 deniers to 35,000 deniers. Further, the outer diameter of the braided pipe 10 consisting of synthetic fiber should be set to 5 to 25 mm and, preferably, to 10 to 20 mm.

Nonwoven fabric 13 is made of the same material as the braided pipe 10, and the surface of the braided pipe 10 is sheathed with this nonwoven fabric 13, thereby forming a drainage guide pipe 14.

Since the warps 11 are woven into the braided pipe 10, the braided pipe 10 is prevented from expanding and shrinking in its longitudinal direction, and the meshes of the braided pipe will not become spread out or reduced. Further, the braided pipe 10 is flexible and possesses radial strength. Furthermore, it is possible to design the size of the mesh of the braided pipe at will.

The drainage guide pipe 14 is temporarily fixed along the down-stream-side end of the graded top of the base course 3 and along the gutter 8 longitudinally disposed on the side of the road. A conduit 16 inserted into a bore 15 formed in the side wall of the catch basin 9 facing the base course 3 is connected to the drainage guide pipe 14. The hot asphalt mixtures are then laid on the drainage guide pipe 14 and the sub-base 3, thereby forming the top layer 6. The drainage guide pipe 14 is made up of the braided pipes 10 consisting of synthetic fiber, and hence any portion of the drainage guide pipe 14 can permit the flow of water.

When being laid along the downstream-side end of the base course 3 and along the gutter 8, the drainage guide pipe 14 can easily follow curves of the road because the braided pipe 10 forming the drainage guide pipe 14 is flexible. Further, the braided pipe 10 is fabricated by weaving together the warps 11 and the woofs 12, and therefore the warps 11 prevent the braided pipe 10 from expanding and shrinking, thereby facilitating the laying of the braided pipe. In addition, if it becomes necessary to extend a drainage channel consisting of the drainage guide pipe 14, it is possible to extend the drainage channel by only butt-joining a braided pipe 10 to the drainage channel.

The drainage guide pipe 14 is laid and temporarily fixed on the base course 3, and, subsequently, the base course 3 is surfaced with an asphalt mixture, thereby forming the top layer 6. As a result, the drainage guide pipe 14 is fixed. The braided pipe 10 forming the drainage guide pipe 14 and the nonwoven fabric 13 covering the surface of the guide pipe 14 are heat resistant and are made of material which can be resistant to a pavement temperature of, for example, 160 to 180 degrees Centigrade. For this reason, the drainage guide pipe 14 will not be damaged as a result of pavement. Moreover, the braided pipe 10 is cylindrically made of the synthetic fiber which has a required size, and hence it will not be deformed even when it is surfaced with the top layer 6. It is possible to cause the braided pipe 10 suitably support a required load by changing the diameter of the braided pipe. The drainage channels made up of the drainage guide pipes 14 are disposed along the gutters, and it is very unlikely that a vehicle will run over the drainage channels. In the event that the drainage channels are subject to the load as previously mentioned, it is possible to maintain the drainage function of the drainage channels over a long period of time, because the braided

pipe possesses pressure resistance and flexibility. In the drawings, reference numeral 17 designates a cover of the catch basin 9 and 9'.

In the present embodiment, the rainwater having infiltrated through the top layer 6 flows along the graded portions 5 and 5' of the top surface of the base course 3 into the drainage guide pipes 14 that are disposed along the downstream-side ends of the graded portions on the base course 3 and along the gutters 8 and 8' and are made by sheathing the surface of the braided pipe 10 with the nonwoven fiber 13. The rainwater then flows into the catch basin 9 via the conduit 16 connected thereto after having flowed through the inside of the drainage guide pipe 14. During the flow of the rainwater into the drainage guide pipe 14, the nonwoven fabric 13 provided over the surface of the drainage guide pipe 14 permits only the rainwater to enter the braided pipe 10.

In this way, the rainwater having infiltrated through the top surface 6 of the road can be drained to the outside through the drainage guide pipes 14 disposed at the downstream-side ends of the graded top of the base course 3 along the gutters 8. Therefore, the rainwater neither permeates through nor remains in the base course 3, thereby preventing the aggregate from coming away from the asphalt mixture and preventing, in turn, fracturing of the pavement.

In the previously mentioned embodiment, the explanation was given of the drainage guide pipe 14, for draining the rainwater having permeated through the top layer 6, which is sheathed with the nonwoven fabric 13 in such a way as to cover the surface of the braided pipe 10. The nonwoven fabric 13 becomes unnecessary depending on the size of the mesh of the braided pipe 10. For example, if the mesh is small, it will be possible to prevent the intrusion of the aggregate, or the like, into the braided pipe 10 without the use of the nonwoven fabric. Figs. 4 and 5 show examples in which the braided pipe 10 is used as a drainage channel 20. Fig. 4 shows an example in which the end of the braided pipe 10 forming the previously mentioned drainage channel 20 is connected to the gutter 8 on one side of the road 1. Fig. 5 is another similar example in which the braided pipe 10 forming the drainage channel 20 is connected to the catch basin 9 that is communicated to an L-shaped ditch 19. The same reference numerals are provided to designate elements corresponding to those of the embodiment shown in Figs. 1 and 2, and these elements are the same in operation as those shown in Figs. 1 and 2.

The base course 3 and the top layer 6 are downwardly graded from the center to both ends of the road 1 in its transverse direction in the present embodiment. However, they may be downwardly graded from the both ends to the center separator of the road in its transverse direction.

Second embodiment

A drainage system for use with a paved road according to a second embodiment of the present invention will

now be described with reference to the accompanying drawings.

The road of this embodiment is the same in construction as that of the first embodiment. The same reference numerals are provided to designate corresponding elements, and an explanation will be given of solely a difference between the first and second embodiments.

In Figs. 6 and 7, the braided pipes 10, 10, 10... formed from synthetic fiber are disposed on the base course 3 along its longitudinal sides at required intervals at an angle with respect to the longitudinal direction of the road 1. The downstream-side ends of the braided pipes 10 are connected to the drainage guide pipes 14 that are disposed on both sides of the road 1 for draining the rainwater to the gutters 8 and 8'. The drainage guide pipe 14 is made up of braided pipes similar to the braided pipe 10.

As mentioned above, the drainage guide pipes 14 are temporarily fixed along the downstream-side ends of the graded top surface of the base course 3 and along the gutters 8 and 8' so as to let the rainwater to flow into the gutters 8 and 8'. The conduit 16 inserted into the bore 15 that is formed in the side wall of the catch basin 9 facing the base course 3 is connected to the drainage guide pipe 14 made of the braided pipe 10. The downstream-side ends of the braided pipes 10 temporarily fixed on the graded top of the base course 3 of the road 1 at an angle with respect to the longitudinal direction of the road 1 are connected to the drainage guide pipes 14, thereby forming a drainage channel.

As previously mentioned, the drainage channel is formed by connecting the drainage guide pipes 14 with the downstream-side ends of the braided pipes 10 temporarily fixed on the graded top of the base course 3 at an angle with respect to the longitudinal direction of the road 1, and, subsequently, the top layer 6 is formed by surfacing the drainage channel and the base course 3 with an asphalt mixture. The drainage channel is fixed as a result of this paving work. The braided pipes 10 forming the drainage channel are made of material that is sufficiently resistant to a pavement temperature of 160 to 180 degrees Centigrade, and therefore the drainage channel will not be damaged as a result of the paving work. Further, since the braided pipes 10 are cylindrically formed from synthetic fiber having a required size, they never deteriorate during the paving work. Furthermore, the braided pipe can deflect by virtue of its mesh, and the end of another braided pipe can be easily inserted into the mesh. In consequence, it is easy to connect another braided pipe to the side of the braided pipe at right angles.

In the present embodiment, the rainwater having penetrated through the top layer 6 of the road 1 flows over the graded portions 5 and 5' of the base course 3 graded toward the gutters on both sides of the road 1. The thus flowing rainwater enters the drainage channel on the base course 3 which is made up of the braided pipes 10, 10, 10... disposed at an angle with respect to

the longitudinal direction of the road 1. The rainwater having flowed into the braided pipes 10, 10, 10... further flows as a result of the gradient of the braided pipes in the downward direction and flows into the drainage guide pipe 14 that is connected to the downstream-side ends of the braided pipes 10 and is made of another braided pipes consisting of the same material as the braided pipe 10. The rainwater then flows into the catch basin 9 via the conduit 16 connected to the catch basin 9 after having flowed through the inside of the drainage guide pipe 14.

As previously mentioned, it is possible for the rainwater having penetrated through the top layer 6 of the road 1 flow into the braided pipes 10, 10, 10... disposed on the top surface of the base course 3 at an angle to the longitudinal direction of the road 1. For this reason, even if the width over which the rainwater flows is increased as in a multi-lane road, the rainwater is guided to the braided pipes and easily flows through the pipes. The rainwater can be drained to the outside via the drainage guide pipe 14 that is provided at the downstream-side ends of the base course 3 and is disposed along the gutters 8 and 8'. In consequence, the rainwater neither permeates through nor remains in the base course 3, thereby preventing the aggregate from coming away from the asphalt mixture and preventing, in turn, fracturing of the pavement.

The surface of the braided pipe 10 may be sheathed with the nonwoven fabric 13, as required. As a result, it becomes possible to introduce only the rainwater into the braided pipe 10.

Figs. 8 and 9 show examples wherein the drainage channel 20 is formed from the drainage guide pipe 14 comprising braided pipes disposed along the gutter 8 and from the plurality of braided pipes 10 which are disposed on the base course 3 at an angle with respect to the longitudinal direction of the road and are connected to the drainage guide pipe 14. Fig. 8 shows an example in which the end of the drainage guide pipe 14 is connected to the gutter 8 on one side of the road 1. Fig. 9 is another similar example in which the drainage guide pipe 14 is connected to the catch basin 9 that is communicated to the L-shaped ditch 19. The same reference numerals are provided to designate elements corresponding to those of the second embodiment shown in Figs. 6 and 7, and those elements are the same in operation as those of the second embodiment.

In the second embodiment, the explanation was given of the base course 3 and the top layer 6 are downwardly graded from the center to both ends of the road 1 in its transverse direction. However, they may be downwardly graded from both ends to the center separator of the road 1 in its transverse direction.

Third embodiment

Fig. 10 shows a drainage system for use with a paved road according to a third embodiment of the present invention. The braided long pipe 10 is bent sub-

stantially at its center 31, and it is disposed on the base course 3 of the road 1 while its bent portion is aligned with the longitudinal center of the road 1. Legs 10a and 10b of the braided long pipe 10 are temporarily fixed on the portions of the top surface of the base course 3 that are graded toward the gutters 8 and 8' while being arranged at predetermined intervals at an angle with respect to the longitudinal direction of the road 1. The downstream-side ends of the legs 10a and 10b are connected to the drainage guide pipes 14 and 14 disposed along the gutters 8 and 8'. The braided pipes 10 and the drainage guide pipes 14 connected thereto are surfaced with asphalt mixture. The same reference numerals are provided to designate elements corresponding to the elements of the first embodiment shown in Figs. 1 and 2, and these elements are the same in operation as those of the second embodiment.

Fourth embodiment

Fig. 11 shows a drainage system for use with a paved road according to a fourth embodiment of the present invention. In the present embodiment, the road is grooved, for example, at an angle with respect to its longitudinal direction, so that slots 22 are formed. The braided pipes 10 consisting of the synthetic fiber are fitted into these slots 22. The second and third embodiments are applied to the braided pipes 10 fitted into the slots 22, thereby forming the drainage system for use with the paved road. The slots 22 are not only formed by grooving but by any other alternative means.

The braided pipes 10 of the present embodiment are disposed on the base course 3 at an angle in relation to the longitudinal direction of the road. Although the angle is not limited to a specific angle, they should preferably be disposed at an angle of substantially 45 degrees with respect to the longitudinal direction of the road. The interval between the braided pipes 10 is not limited to a specific value. However, the interval should preferably be determined in such a way that an imaginary line crossing the longitudinal center line of the road at right angles at the bent portion of one braided pipe 10 intersects both downstream-side ends of the adjacent braided pipe.

Fifth embodiment

A drainage system for use in a road bridge according to a fifth embodiment of the present invention will now be described with reference to Figs. 12 to 16. In the drawings, a bridge surface covered with on asphalt pavement 101 is made up of a steel or reinforced concrete base 102 (hereinafter simply referred to as a base), and a waterproof layer 103 laid on the base 102. The waterproof layer 103 is surfaced with the asphalt pavement 101. The waterproof layer 103 has its both ends raised straight up along wheel guards 104 on both sides of the base 102. The boundary between the base 102 and the wheel guards 104 is rendered waterproof along the raised portion 103a. The braided pipe 10 made of heat

resistant synthetic fiber is laid along the inner side of the raised portion 3a in the longitudinal direction of the road.

The drain channel of this embodiment is the same in construction as that of the first embodiment.

To lay a drainage channel 14, which is formed by sheathing the surface of the braided pipe 10 with the non-woven fabric 13, above the base 102, the drainage channel 14 is temporarily fixed along the inner side of the raised portion 103a of the waterproof layer 103. The drainage channel 14 is then connected to a bore formed in the wall of one of a plurality of catch basins 111 disposed along the wheel guard 104 of the base 102 of the bridge. The drainage channel 14 and the waterproof layer 103 are surfaced with an asphalt pavement, whereby the drainage channel 14 is fixed.

A drainage channel 14a made by sheathing the surface of a braided pipe 10 with the nonwoven fabric 13 is laid on the waterproof layer 103 along the edge of an expansion joint 113 of the bridge. In this case, the braided pipe 10 is fabricated by weaving together a required number of warps 11 and a lot of woofs 12 using the same heat resistant synthetic fiber as used in the previous embodiments. Both ends of the drainage channel 14a are connected to the respective ends of the drainage channels 14 that are made of the braided pipe 10 and are laid on the waterproof layer 3 along the inner sides of the wheel guards 4, 4 on both longitudinal sides of the bridge. Drainage pipes 115 are connected to the drainage channel 14a along the expansion joint 113' at several points of the drainage channel, and the waterproof layer 103 and the drainage channels 14a are surfaced with asphalt mixture. With this construction, water is drained from the vicinity of the expansion joint that is graded in the longitudinal direction of the bridge.

The braided pipe 10 that is made of heat resistant synthetic fiber and forms the drainage channel 14 can be easily laid along curves because of its flexibility. After the waterproof layer 103 has been laid on the base 102, the waterproof layer 103 has a lot of unevenness as a result of overlaying of the layer on the base. Even in such a stage, the braided pipe 10 can be laid so as to be aligned with the uneven surface of the waterproof layer 103.

The drainage channel 14 made by sheathing the surface of the braided pipe 10 with the nonwoven fabric 13 is temporarily fixed onto the waterproof layer 103 in the manner as previously mentioned. Subsequently, the drainage channel 14 and the waterproof layer 103 are surfaced with a hot asphalt mixture, whereby the drainage channel 14 is fixed. The braided pipe 10 forming the drainage channel 14 and the nonwoven fabric 13 cover the surface of the braided pipe 10 are made of material that is sufficiently resistant to a pavement temperature of 160 to 180 degrees Centigrade, and therefore the drainage channel will not be damaged as a result of the paving work. Further, since the braided pipes 10 are cylindrically formed from synthetic fiber having a required size, they do not deteriorate during the paving work. Furthermore, it is possible for the braided pipe 10

to support a required load by changing its diameter, The drainage channels 14 are disposed on both longitudinal sides of the bridge, and hence it is very unlikely that a vehicle will run over the drainage channels 14, and that the drainage channels 14 will be subject to a wheel load. Moreover, since the drainage channel 14 is flexible, the permeability of the drainage channel 14 can be maintained over a long period of time.

In the present embodiment, the rainwater having penetrated through the asphalt pavement 101 of the bridge surface flows into the drainage channels 14 and 14a below the asphalt pavement 101. These drainage channels 14 and 14a are longitudinally disposed along the portion of the waterproof layer 103 that is raised straight up along the wheel guards 104 of the base 102, and they are formed by sheathing the surface of the braided pipe 10 with the nonwoven fabric 13. Then, the rainwater is drained to the outside from the catch basins 111 and the drainage pipes 115 which are connected to the drainage channels 14 and 14a. When the rainwater flows into the drainage channels 14 and 14a, it is possible to guide only the rainwater into the braided pipe 10 by means of the nonwoven fabric 13 provided on the surface of the braided pipe 10 that forms the drainage channel.

As previously mentioned, it is possible to drain the rainwater, which has penetrated through the asphalt pavement 101 on the bridge surface, to the outside from the drainage channel 14 disposed along the wheel guards 104 on the waterproof layer 103 and the drainage channel 14a disposed along the expansion joint 13'. The rainwater does not permeate through to the base 102, as a result of which the durability of the bridge can be improved.

In general, the asphalt pavement is cut and removed from the waterproof layer for maintenance or repair after the lapse of a predetermined period, and the waterproof layer is paved again. The drainage channels 14 and 14a made of the braided pipe 10 are light and easy to operate, which in turn enables the removal of the asphalt pavement without putting a strain on or providing damage to a cutting machine when the asphalt pavement is cut. Even if the removed asphalt pavement is fed into a crusher for recycling purposes, no problems will arise. Further, it is easy to separate only the drainage channel from the water proof layer. The volume of wastes resulting from separation and discarding of the removed asphalt mixture becomes small, which provides superior workability and leads to reduced coat.

In the previous embodiment, the explanation was given of the drainage channels 14 and 14a for draining the rainwater having permeated through the asphalt pavement 101 which are sheathed with the nonwoven fabric 13 in such a way as to cover the surface of the braided pipe 10 made of heat resistant synthetic fiber. The nonwoven fabric 13 becomes unnecessary depending on the size of the mesh of the braided pipe 10. For example, if the mesh is small, it will be possible to prevent

the intrusion of the aggregate or the like into the braided pipe 10 without the use of the nonwoven fabric.

In the drainage system for use with a paved road according to the present invention, a braided pipe is fabricated by weaving together a required number of warps and a lot of woofs using heat resistant synthetic fiber so as to form a drainage channel. The thus fabricated drainage channel is disposed along a gutter on each side of a road at the end of a graded top of a base in a transverse direction of the road. The warps woven into the braided pipe prevent the braided pipe from expanding and shrinking in its longitudinal direction. As a result, the mesh of the braided pipe will not become spread out or reduced, which permits a constant volume of water to be taken at all times. Further, since the braided pipe is flexible, it can follow curves of the road or unevenness. Moreover, the pipe has a mesh structure, and hence it possesses radial pressure resistance. There is no fear of the intrusion of aggregate into the braided pipe, and the rainwater having infiltrated into the surface layer flows in the downstream direction as a result of the gradient of the top surface of the base. In this way, only the water flows into the drainage guide pipe, thereby preventing the permeation of the rainwater into the base. Consequently, the rainwater never remains in the pavement, which in turn prevents the fracturing of the pavement.

As previously mentioned, the drainage channel is made up of the braided pipe that consists of synthetic fiber, and hence any part of the drainage channel permits the flow of water. If the drainage channel is extended or is connected to another drainage channel at right angles, the drainage channel can be extended or divided by only butt-joining the braided pipe in another drainage channel or sticking the end of the braided pipe into the mesh of another drainage channel, thereby providing a degree of freedom of design for a drainage channel.

In the drainage system for use with a paved road according to the present invention, a plurality of first braided pipes which are fabricated by weaving a plenty of heat resistant synthetic fiber are laid on the base course of the road at predetermined intervals at an angle with respect to the longitudinal direction of the road. The gutter-side ends of the braided pipes are connected to a similar second braided pipe, that is, a drainage guide pipe which is disposed along a gutter on each side of the road and is connected to the catch basins, thereby forming a drainage channel. The asphalt mixture is laid on the top surfaces of the drainage channel and the base course. As a result, the rainwater having penetrated through the road surface and flowed along the graded top surface of the base course flows into the braided pipe disposed on the base course at an angle to the longitudinal direction of the road from the side of the braided pipe. The rainwater is then collected to the drainage guide pipe that is connected to the gutter-side ends of the braided pipes, and the thus collected rainwater is drained to the gutter via the drainage guide pipe. In this way, the rainwater is prevented from permeating through or remaining in the base course, which in turn prevents

the aggregate from coming away from the asphalt mixture.

Particularly in the present invention, a plurality of braided pipes are disposed on the base course at an angle with respect to the longitudinal direction of the road so as to take the rainwater flowing over the top surface of the base course. With this construction, the rainwater linearly flowing over the graded top surface of the base course in the downstream direction meets and flows into the side of the braided pipe through its meshes. For this reason, even if the width over which the rainwater flows is increased as in the multi-lane road, the rainwater is guided along the inside of the braided pipe, and it can be efficiently drained.

If the braided pipes are fixedly fitted into a plurality of slots grooved in the base course of the road at predetermined intervals at an angle with respect to the longitudinal direction of the road, the braided pipes fixedly remain in their positions while being paved. Further, it becomes possible to ensure the inflow of the rainwater into the braided pipes.

In the secondary drainage system for use in a road bridge according to the present invention, the rainwater having penetrated through an asphalt pavement which acts as the bridge surface remains in the waterproof layer laid on the base. The rainwater then flows through the drainage channel that is made up of the braided pipes consisting heat resistant fiber and being laid along the inner side surface of the raised portion of the waterproof layer along the wheel guards or curbs, or through the drainage channel that is made up of the braided pipe and is disposed on the waterproof layer along the expansion joint side edge of the bridge. The rainwater is eventually drained to the outside via the catch basins or drainage pipe. Further, the drainage channel is made up of the braided pipes which are fabricated by weaving together a required number of warps and a plenty of woofs using heat resistant synthetic fiber. The warps woven into the braided pipe prevent the braided pipe from expanding and shrinking in its longitudinal direction, which permits a constant inflow of the rainwater at all times. Further, since the braided pie is flexible, it can freely follow curves or unevenness and possesses radial pressure resistance. Moreover, since the drainage channel is made up of the braided pipes, there is no fear of the intrusion of aggregate into the braided pipe. The rainwater having infiltrated into the asphalt pavement is guided along the waterproof layer into the braided pipe and is eventually drained to the outside.

The asphalt pavement is cut and removed from the waterproof layer for maintenance or repair of the road after the lapse of a predetermined period of time, and the waterproof layer is paved again. The drainage channel that is made up of the braided pipes consisting of heat resistant synthetic fiber can be removed without putting a strain on or providing damage to a cutting machine when they are cut. Even if the removed asphalt pavement is fed into a crusher for recycling purposes, no problems will arise. Further, it is easy to separate only

the drainage channel from the water proof layer. The volume of wastes resulting from separation and discarding of the removed asphalt mixture becomes small, which results in superior workability.

Claims

1. A drainage system for use with a paved road comprising:
 - a base layer;
 - a first layer laid on said base layer;
 - a second layer laid on said first layer;
 - a pair of gutters longitudinally provided on both sides of said road;
 - a first braided pipe fabricated by weaving together a predetermined number of warps and a lot of woofs made of heat resistant synthetic fiber, said braided pipe being disposed along the gutter and the downstream-side end of the top surface of said first layer; the drainage channel being communicated to catch basins located at said gutter.
2. A drainage system for use with a paved road as claimed in claim 1, wherein said first braided pipe is sheathed with nonwoven fabric.
3. A drainage system for use with a paved road as claimed in claim 1, further comprising:
 - a second braided pipe fabricated by weaving together a predetermined number of warps and a lot of woofs made of heat resistant synthetic fiber, said second braided pipe being disposed on said first layer at an angle of substantially 45 degrees with respect said gutters, said second braided pipe being connected said first braided pipe.
4. A drainage system for use with a paved road as claimed in claim 3, wherein said second braided pipe is fitted into a slot formed in said second layer.
5. A drainage system for use with a paved road as claimed in any of claims 1 and 3, wherein said braided pipe has a diameter within 3 to 35 mm.
6. A drainage system for use with a paved road as claimed in any of claims 1 and 3, wherein said heat resistant synthetic fiber is selected from the group consisting of Polyester, alamide resin and polyamide with a size with thread being set to 1500 to 35, 000 deniers.
7. A method for producing a drainage system for use with a paved road comprising the step of:
 - forming a base layer;
 - forming a first layer on said base layer;
 - disposing a first braided pipe fabricated by weaving together a predetermined number of warps and a lot of woofs made of heat resistant synthetic fiber along the gutter and the downstream-side end

of the top surface of said first layer; said first braided pipe being communicated to catch basins located at said gutter; and
forming a second layer on said first layer.

8. A method for producing a drainage system for use with a paved road as claimed in claim 7, further comprising:
 - disposing a second braided pipe fabricated by weaving together a predetermined number of warps and a lot of woofs made of heat resistant synthetic fiber, said second braided pipe being disposed on said first layer at an angle of substantially 45 degrees with respect said gutters, said second braided pipe being connected said first braided pipe.
9. A method for producing a drainage system for use with a paved road as claimed in claim 7, wherein said first braided pipe is sheathed with nonwoven fabric.

FIG. 1

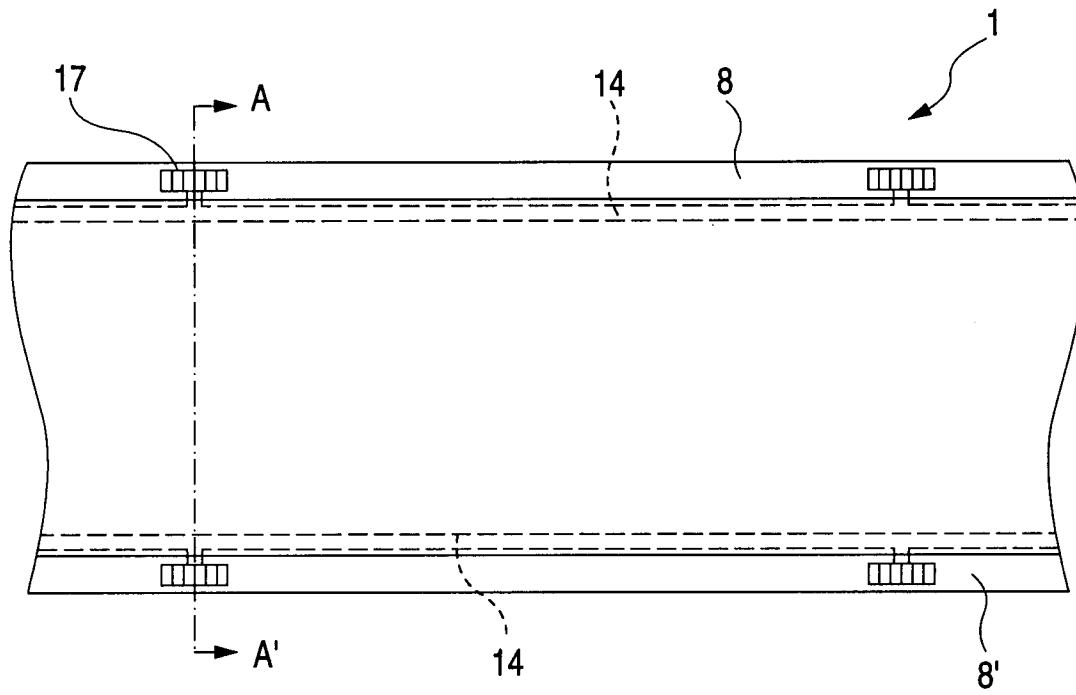


FIG. 2

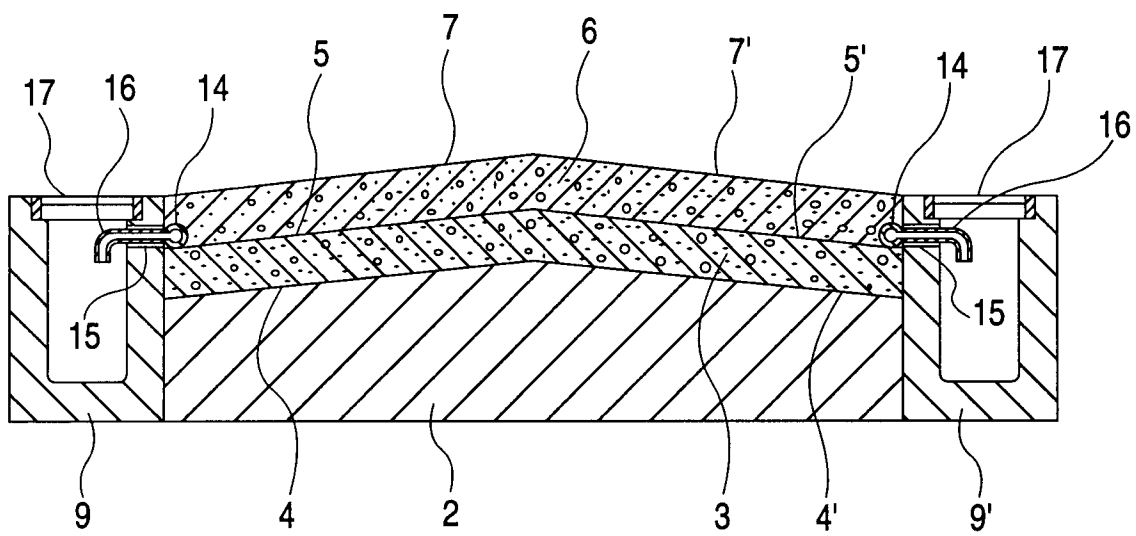


FIG. 3

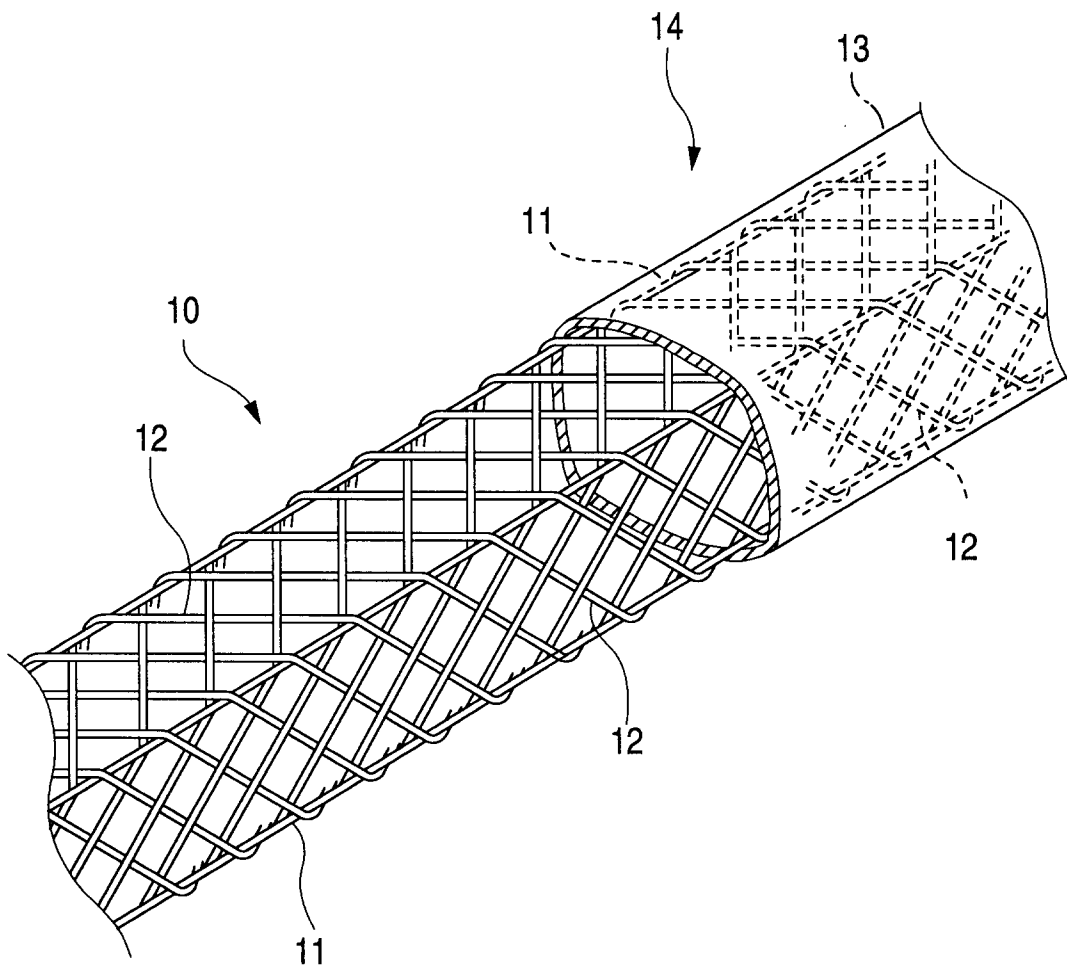


FIG. 4

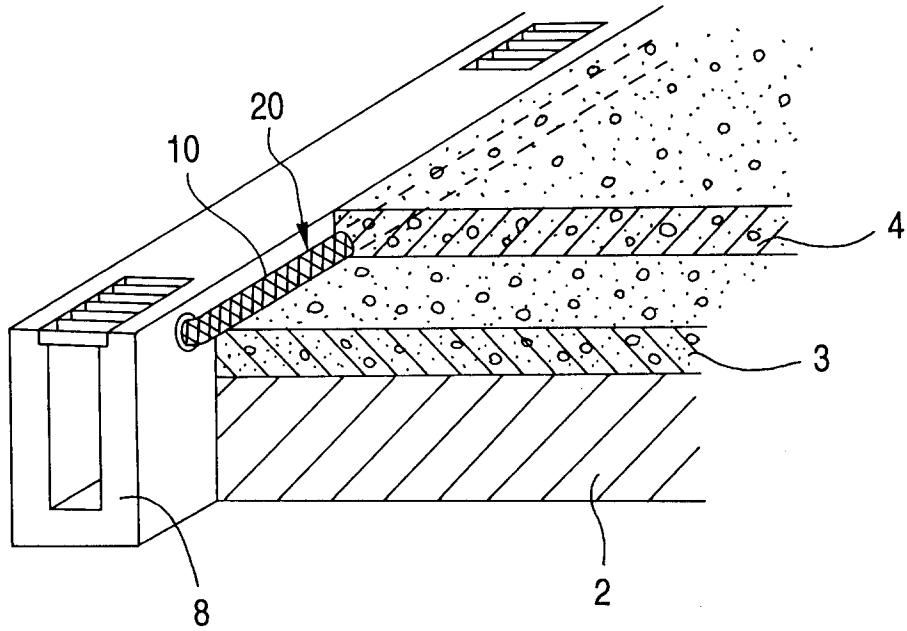


FIG. 5

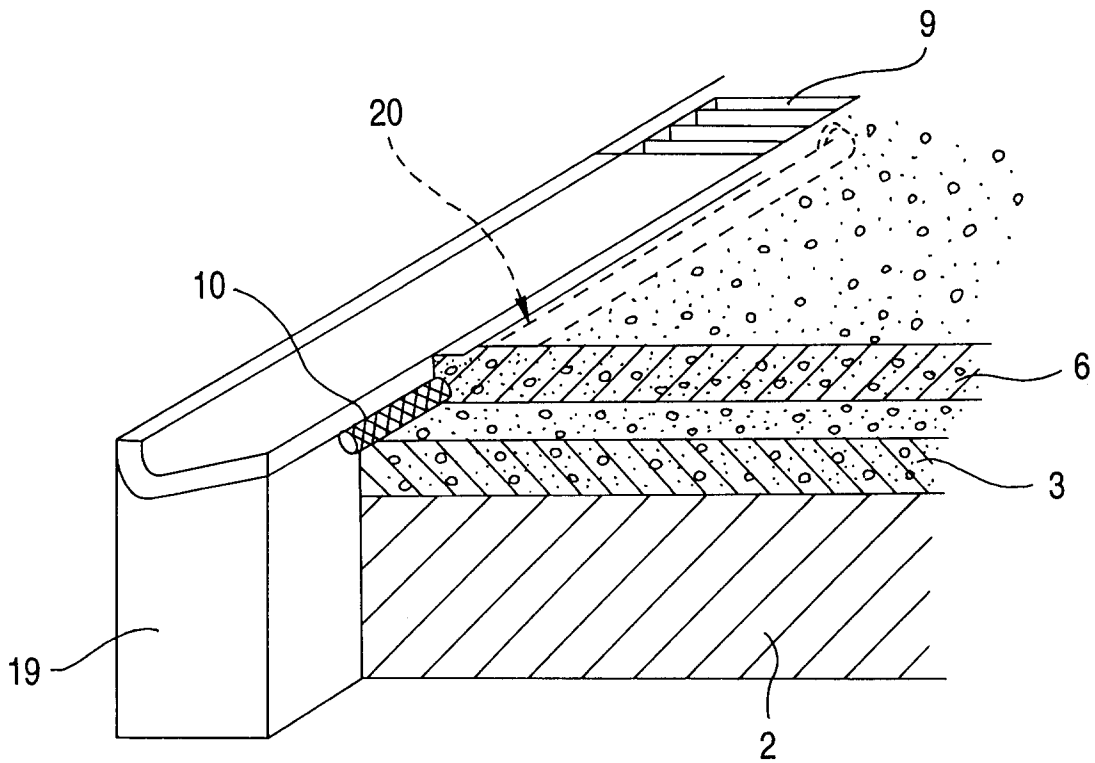


FIG. 6

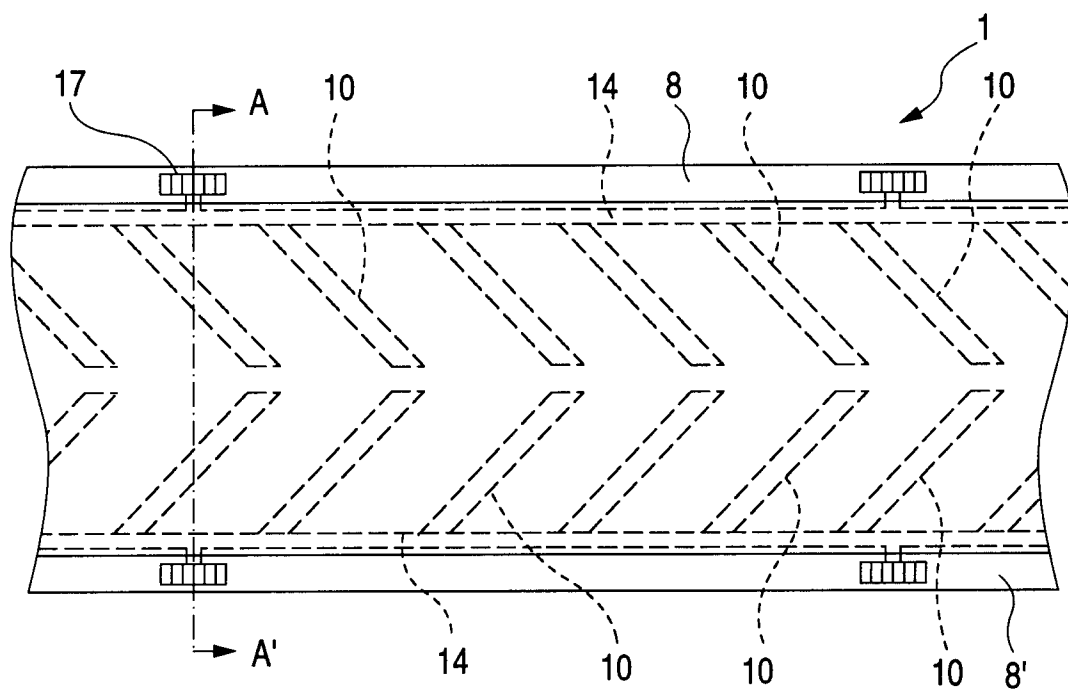


FIG. 7

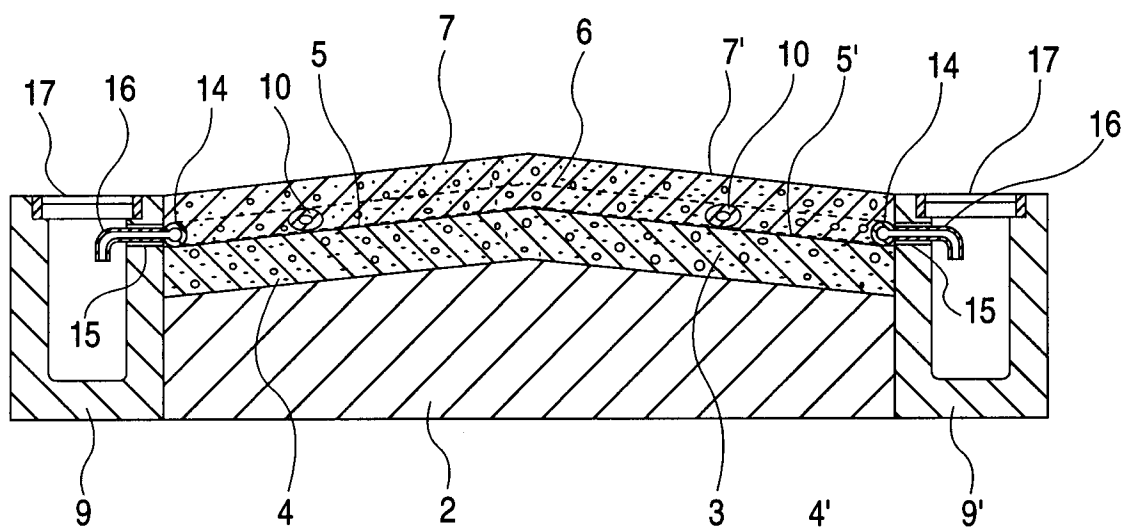


FIG. 8

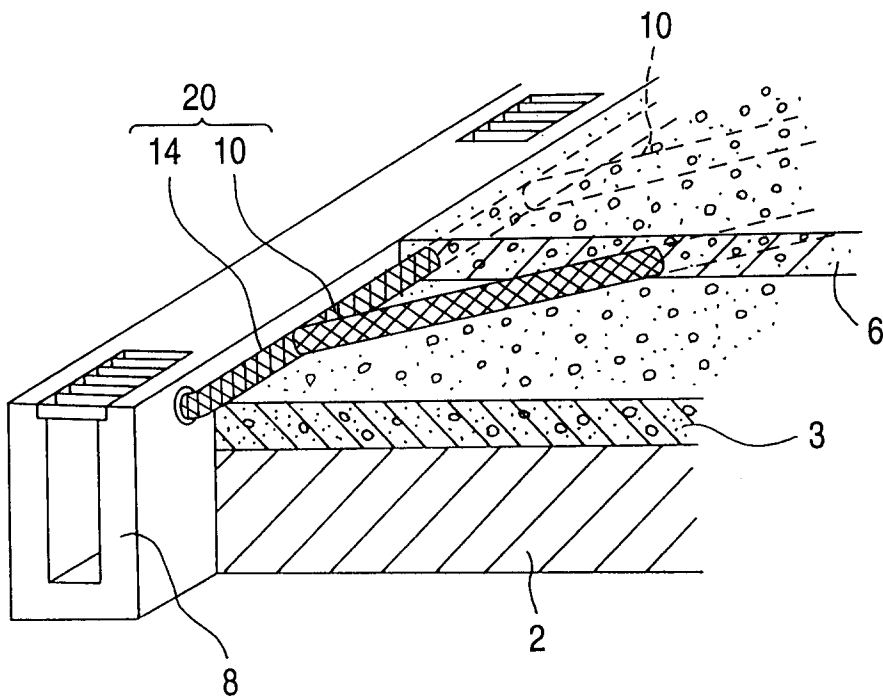


FIG. 9

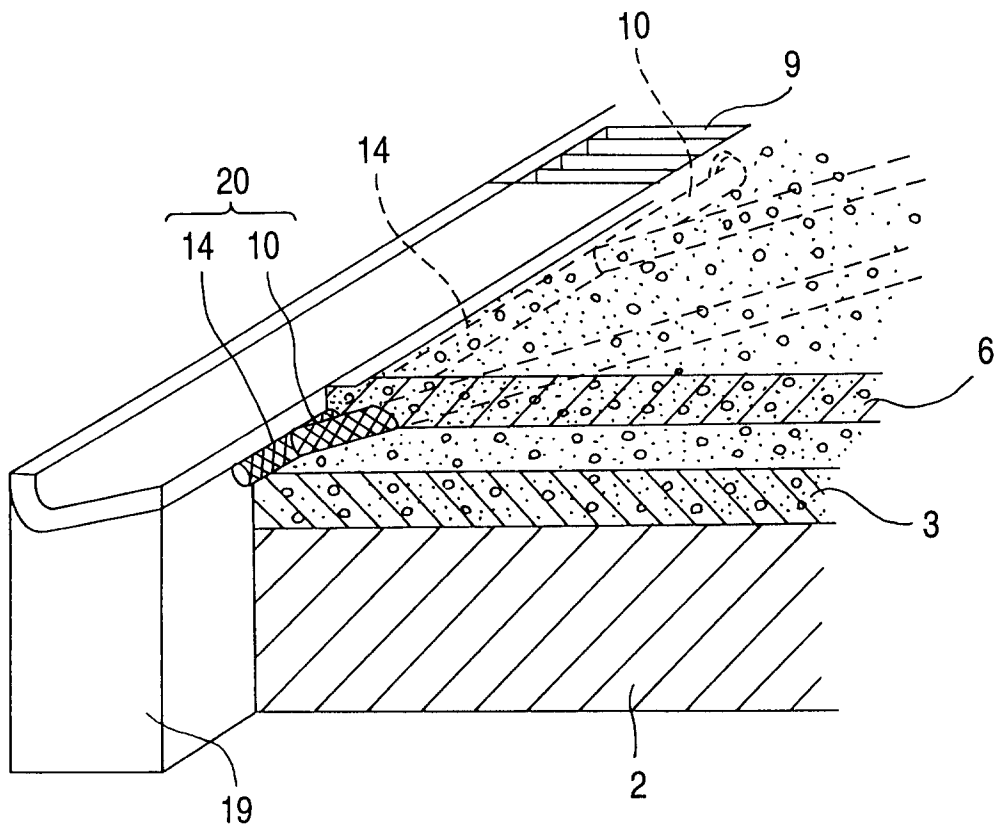


FIG. 10

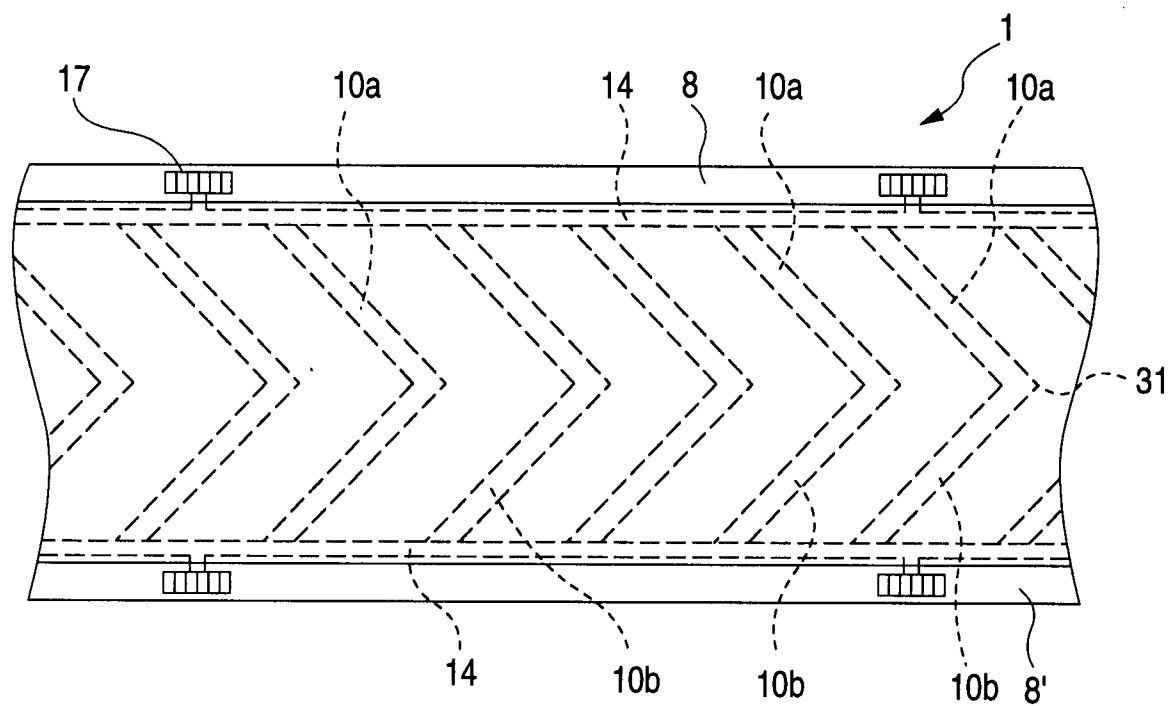


FIG. 11

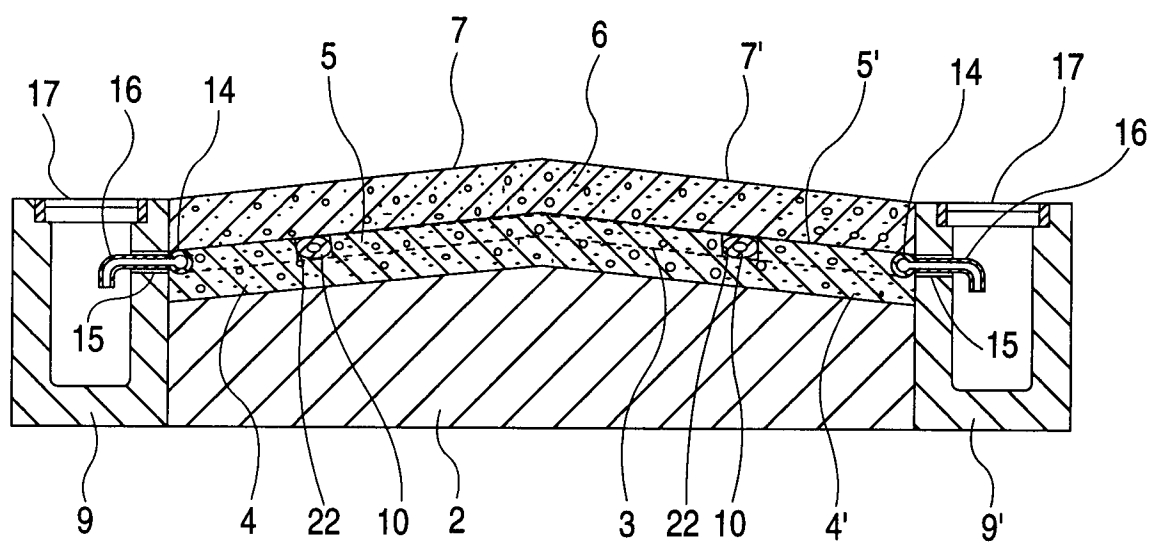


FIG. 12

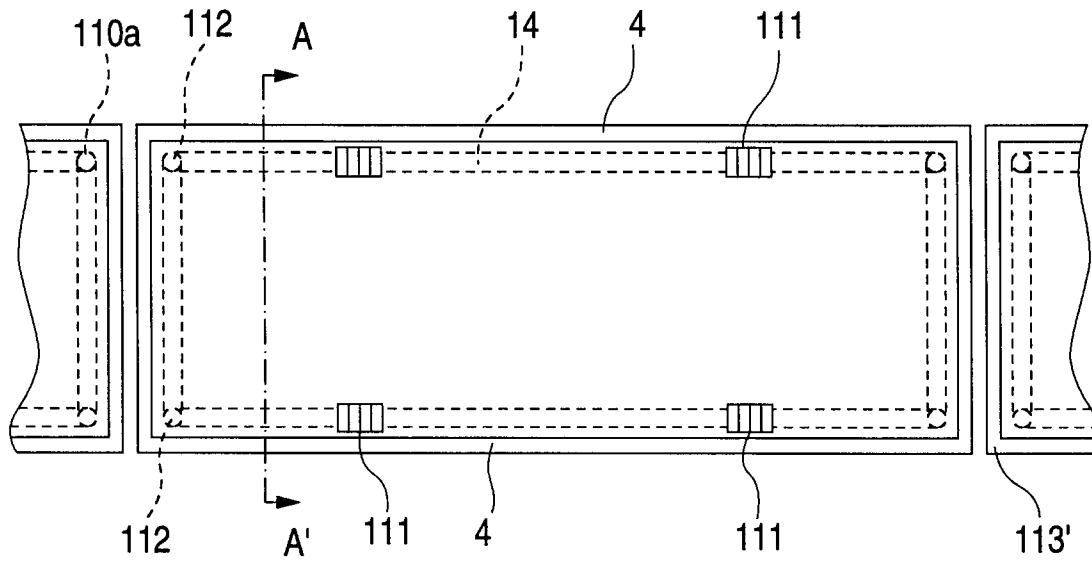


FIG. 13

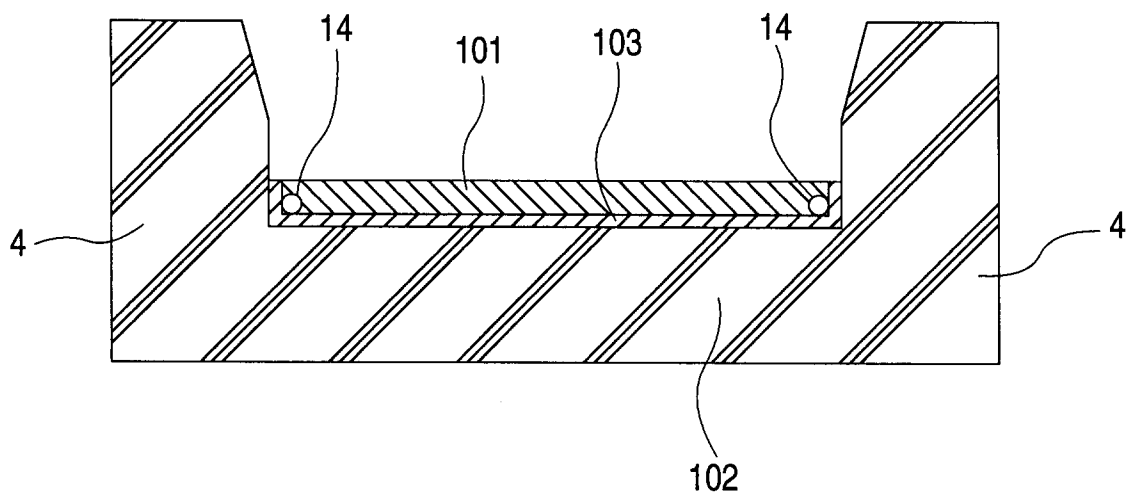


FIG. 14

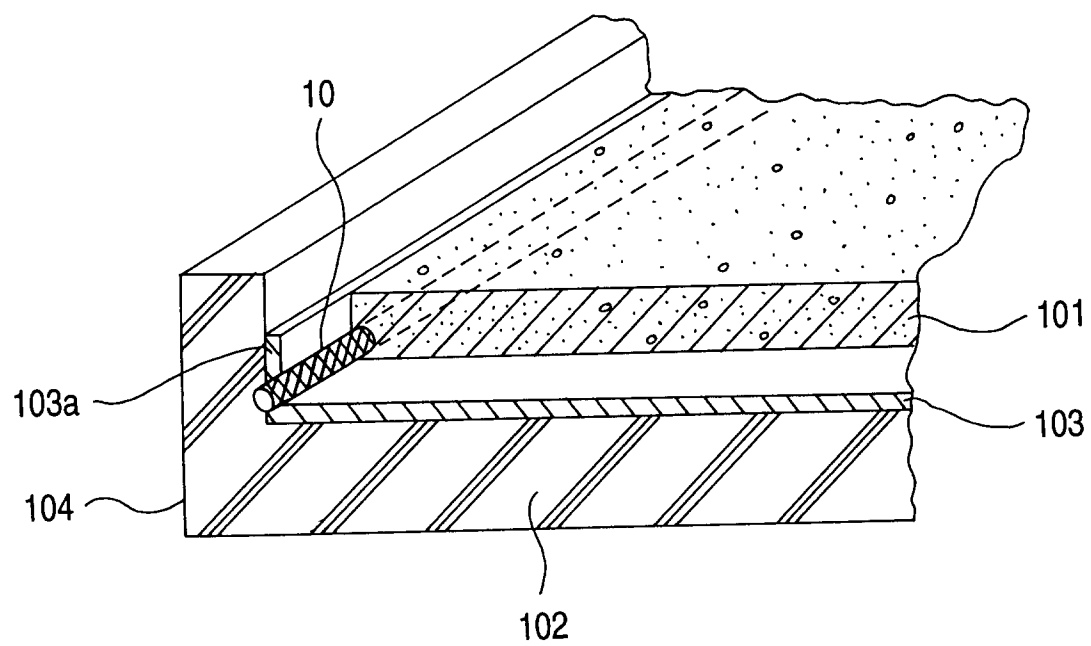


FIG. 15

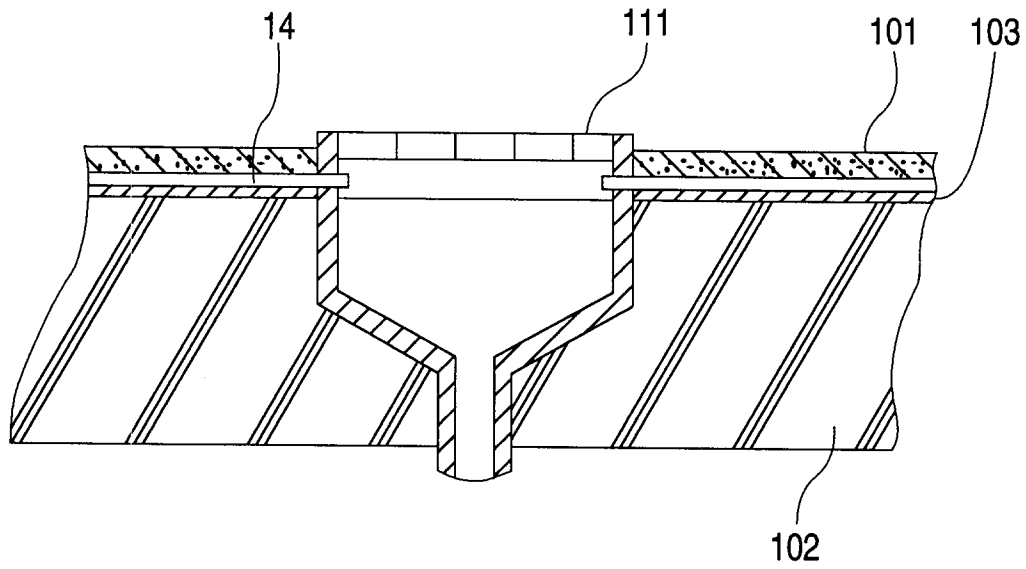
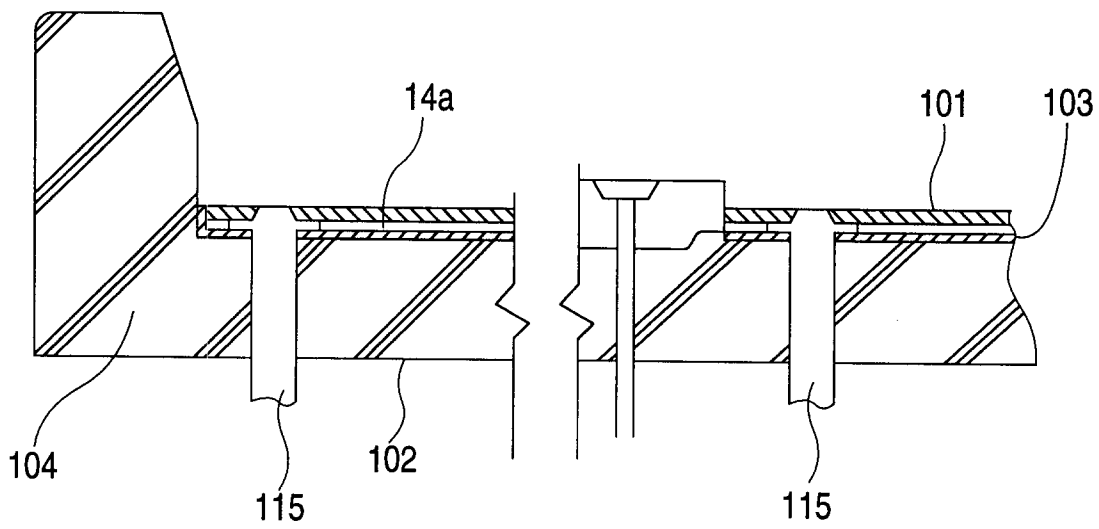


FIG. 16





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 12 0567

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	PATENT ABSTRACTS OF JAPAN vol. 006, no. 039 (M-116), 10 March 1982 & JP-A-56 156309 (TAKIRON CO LTD), 3 December 1981, * abstract *	1,7	E01C1/00 E01C11/22 E01D19/08
A	CH-A-674 383 (EGLI GARTENBAU AG) 31 May 1990 * the whole document *	1,7	
A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 052 (M-0928), 30 January 1990 & JP-A-01 280103 (DAIYATETSUKUSU KK), 10 November 1989, * abstract *	1,7	
A	DE-A-36 19 785 (PASSAVANT WERKE) 17 December 1987 * the whole document *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			E01C E01D F16L
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		16 April 1996	Dijkstra, G
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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