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A BUILDING STRUCTURE, PARTICULARLY A ROAD BRIDGE STRUCTURE, AND A METHOD OF MAKING SUCH A BUILDING STRUCTURE.

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Description

The invention relates to a building structure of the kind set forth in the introductory part of claim 1.

A particularly important field of use of such a building structure is for road bridges, and the invention will in the following be described with particular reference to that field of use, but it will be realized that the invention may likewise be used for other building structures where similar problems exist.

A road bridge structure covering a span of a bridge typically comprises a lower part consisting of a supporting beam of reinforced concrete and an upper part comprising e.g. a base layer of concrete and a top layer of asphalt.

It is important that rainwater or other liquids collecting on the surface of the road bridge should be drained away as quickly as possible through the layers of the upper part, which is the reason for constructing these layers from liquid permeable materials.

It is equally important, however, to prevent the penetration into the beam of water, oil or chemicals, that may occur on the surface of the top layer, e.g. as a consequence of rainfall, melted snow or ice, thawing salt, exhaust and leakage from vehicles passing the bridge, wreckage of chemical cargo vehicles, or environmental conditions, such as acid rain. This is the reason for interposing a liquid-impermeable membrane between the two parts.

A road bridge building structure of the kind set forth in the introductory part of claim 1 is known from German patent no. 3339638.

In this known structure the membrane consists of a strongly adhesive layer of material, e.g. consisting of blocks of bitumen-butadiene-styrol-butadiene embedded in a matrix of bitumen, and the force transfer means consist of bolts or iron rods embedded in the concrete of the lower part and extending into the layers of the upper part. A strongly adhesive layer on a bituminous basis has the disadvantage that the layer will unavoidably be subjected to a certain amount of shearing forces in some situations of load and/or temperature variations, whereby after a period of ageing small cracks may be formed impairing the liquid-impermeability of the layer. Besides the layer cannot be expected in the long run to maintain a perfect liquid proof seal against the bolts or iron rods piercing the layer. A further disadvantage is that the upper surface of the beam must be thoroughly cleaned, degreased and dried up before the adhesive layer can be applied. In the case of repair or renovation of the layers of the upper part, the adhesive membrane has to be chipped off together with the upper layers, to which it adheres, thus exposing the surface of the beam to weather conditions during the period of repair or renovation.

It is the object of the invention to provide a building structure having improved properties in respect of

the factors mentioned above.

This object is achieved by means of the features set forth in the characterizing clause of claim 1.

A membrane as therein defined will not be subjected to substantial tearing or shearing forces in its own plane, but practically only to compressional forces perpendicular to its plane.

Synthetic thermoplastic sheet or cloth materials having the properties of non-adhesiveness and low friction are available in the trade. Particular reference is made to that marketed by Du Pont under the registered trademark Hypalon®. This material is impervious to water and oils and has a high resistance to a wide range of chemicals, including acids and dissociated salts. Moreover, it is unaffected by both high and low temperatures and has a very long lifetime. It can easily be pressed into the shape of hoods with collars, and the latter can be heat-sealed to the plane sheet laid out on top of the lower part.

The non-adhesion and low friction of the membrane towards the upper part can be further secured by means of a lubricant.

It will be realized that horizontal forces are transferred from the upper part to the flanks of the projecting elements through the hood areas enclosing the flanks, and thus perpendicularly to the membrane material in these areas.

When applying the membrane to the surface of the lower part, it is not necessary beforehand to clean, degrease and dry up that surface because no adhesion is to be established.

In the case of repair or renovation of the layers of the upper part, the membrane incl. the hoods, can be left in position to protect the beam against the intrusion of rain water or other liquids during the period of repair or renovation.

The invention also relates to a method of making a building structure of the kind referred to. The method is characterized by the steps set forth in claim 3. By this method the correct positioning of the block-like elements relative to the lower part is greatly facilitated, because no great accuracy is required in performing the steps.

The invention will now be further described with reference to an example illustrated in the accompanying drawings in which

Figs. 1-5 are vertical longitudinal sections through a bridge structure in various stages of its production and

Fig. 6 is a vertical cross section through the bridge structure.

In Fig. 1, 1 is the bottom of a shuttering in which a reinforced concrete beam is to be moulded. 2 is the principal reinforcement, 3 iron bars supporting a soft iron distributory reinforcement 4 adjacent to the contemplated upper surface of the beam. An anchor 5 having a threaded bore is welded (at 6) to the reinforcement 4. The bore is closed by a plastic cap 7 to

prevent the penetration of concrete during moulding.

In Fig. 2, the beam 8 has been moulded and cured, and the shuttering 1 has been removed. Lengths of membrane cloth 9 have been rolled out, and holes 10 have been cut in the cloths above the anchors 5 so that the cloth can now lie smoothly on top of the beam. The lengths of cloth are heat-sealed together along their edges to form a continuous sheet in the whole width of the beam.

In Fig. 3, the caps 7 have been removed, and concrete blocks 11 have been fastened to the anchors by means of steel screws 15. The blocks 11 may alternatively consist of any other suitable material having the required mechanical strength and may e.g. be of a circular, oval or rectangular configuration in horizontal plane. Hoods 16 of the membrane material have been placed on and around the blocks 11, and their collars 17 have been sealed to the cloth 9 by hot air-blast and pressure.

Now, as illustrated in Fig. 4, mats 18 of a draining hygrophilic material are placed on top of the membrane 9, and a layer of draining concrete 23 is moulded, whereby recesses are formed which fit around the hood-clad blocks 11. As an intermediary step, a reinforcement ring 19 connected by stays 21 to an upper ring 20 may first be placed around each block 11, and a body of expanding mortar 22 may be moulded to ensure a particularly firm and permanent grip around the blocks 11.

As a last step, as illustrated in Fig. 5, a top layer 24 of asphalt is laid out in adhesive engagement with the concrete layer 23.

Fig. 6 illustrates a manner of efficiently draining off water from the hygrophilic layer 18 to a gutter 26.

Claims

1. A building structure comprising an upper part (23, 24) having an exposed upper surface and consisting of liquid-pervious building materials suitable for the intended use of the structure, a lower part (2,3,4,8) forming a structural support of the upper part, a liquid-impervious membrane (9) interposed between the lower part (2,3,4,8) and the upper part (23,24) for the purpose of preventing the penetration of liquid through the upper part (23,24) to the lower part (2,3,4,8), and force transfer means (5,11,15) anchored in the lower part (2,3,4,8) and extending upwards into the body of the upper part (23,24) for the purpose of transferring surface-parallel forces directly from the upper part (23,24) to the lower part (2,3,4,8), **characterized in** that said force transfer means consist of distributed block-like elements (11) projecting upwards from the upper surface of the lower part (2,3,4,8) and fitting tightly in hood portions of the membrane (16), which again fit tightly in recesses formed in the upper part (23,24), and that the membrane consists of a non-adhesive material and has practically zero friction at least towards the areas of the upper part (23,24) with which it is in contact.
2. A building structure as in claim 1, **characterized in** that the block-like elements (11) are constructed with flank portions which are perpendicular to the upper surface of the upper part (23,24) and have a sufficient size to enable the totality of block-like elements (11) to take up the maximum forces in any surface-parallel direction, for which the building structure is designed, without exceeding the permissible pressure on the membrane material of the hood portions surrounding the block-like elements (11).
3. A method of making a building structure as in claim 1, **comprising the steps of**
 - (1) providing a lower part (2,3,4,8) having the required supporting capacity and having a substantially flat surface,
 - (2) applying a non-adhesive, liquid-impervious sheet material (9) to said substantially flat surface in such a manner as to form a continuous covering of the entire area of that surface,
 - (3) fastening block-like elements (11) on top of said sheet material by fastening means (5,15) extending through holes cut in the sheet material (10) into said lower part (2,3,4,8) and mechanically secured therein,
 - (4) pulling a hood (16) made from the same sheet material down around each of said block-like elements (11), said hood (16) having a configuration closely fitting around that of the element (11),
 - (5) sealingly connecting a lower marginal portion (17) of each hood (16) with the flat sheet material in the area immediately surrounding the respective block-like element (11) by a welding or sealing process appropriate for establishing a permanent liquid proof seal,
 - (6) applying liquid-pervious building materials (23,24) to form an upper part of the building structure on top of said liquid-impervious membrane (9) and up to a level above the top of said hood-clad block-like elements (11,16).
4. A method as in claim 3 for making a building structure as in claim 1 having a lower part in the form of a reinforced concrete beam (2,3,4,8), **characterized in** that before pouring the concrete to form the beam, anchors (5) are fastened to an upper portion of the pre-paratorily set-up reinforcement iron structure (4), e.g. by welding (6) in horizontal positions corresponding to the con-

templated positions of the block-like elements and in a vertical position such as to be firmly embedded in the concrete of the beam (8), when poured, and to extend upwards approximately to the contemplated upper level of the reinforced concrete beam, and that after concrete has been poured up to that level and has hardened, steps (2)-(6) of claim 3 are carried out, said anchors (5) having threaded bores to receive screws or bolts (15) constituting the fastening means of step (3).

5. A method as in claim 4, **characterized in that** before carrying out step (6) of claim 3 a body of expanding mortar (22) is moulded around each hood-clad block-like element (11,16) such as to embed a reinforcement ring (19) held in position to encircle the block-like element (11,16) at some distance therefrom.

Patentansprüche

1. Baustruktur, umfassend einen Oberteil (23,24), die eine freie Oberfläche hat und aus flüssigkeitsdurchlässigen Materialien, die für die beabsichtigte Verwendung der Struktur geeignet sind, einen Unterteil (2,3,4,8), der als bauliche Unterstützung des Oberteils dient, eine zwischen dem Unterteil (2,3,4,8) und dem Oberteil vorgesehene flüssigkeitsundurchlässige Membrane (9) zur Verhinderung des Durchdringens von Flüssigkeit durch den Oberteil (23,24) in den Unterteil (2,3,4,8) hinein, und Kraftübertragungsmittel (5,11,15), die im Unterteil (2,3,4,8) verankert sind und sich nach oben in den Körper des Oberteils (23,24) hinein erstrecken und dazu dienen, oberflächenparallele Kräfte direkt vom Oberteil (23,24) auf den Unterteil (2,3,4,8) zu übertragen, dadurch gekennzeichnet, dass die genannten Kraftübertragungsmittel aus verteilt angeordneten blockartigen Elementen (11) bestehen, die sich von der Oberfläche des Unterteils (2,3,4,8) nach oben erstrecken und von haubenförmigen Teilen der Membrane (16) eng umschlossen sind, die wiederum von Höhlen des Oberteils (2,3,4,8) eng umschlossen sind, und dass die Membrane aus einem nicht klebenden Material besteht und wenigstens gegenüber den Bereichen des Oberteils (23,24), mit denen sie in Berührung gelangt, praktisch reibungslos ist.
2. Baustruktur gemäss Anspruch 1, dadurch gekennzeichnet, dass die blockartigen Elemente (11) mit Flankenteilen ausgebildet sind, die zur Oberfläche des Oberteils (23,24) senkrecht sind und eine ausreichende Grösse haben, damit die Gesamtheit der blockartigen Elemente (11) die maximalen Kräfte in einer beliebigen oberflä-

chenparallelen Richtung, für die die Baustruktur dimensioniert ist, aufnehmen kann, ohne den zulässigen Druck auf das Membranmaterial der die blockartigen Elemente (11) umschliessenden Haubenteile zu überschreiten.

3. Verfahren zur Herstellung einer Baustruktur gemäss Anspruch 1, gekennzeichnet durch die folgenden Verfahrensschritte:

- (1) ein Unterteil (2,3,4,8) mit der erforderlichen Tragfähigkeit und mit im wesentlichen flacher Oberfläche wird zustandegebracht,
- (2) ein nicht klebendes, flüssigkeitsundurchlässiges Folienmaterial (9) wird auf die genannte im wesentlichen flache Oberfläche aufgelegt, u.zw. so, dass es eine kontinuierliche Abdeckung der ganzen Oberfläche bildet,
- (3) blockartige Elemente (11) werden durch Befestigungsmittel (5,15), die sich durch Löcher, die in dem Folienmaterial geschnitten werden, in den Unterteil (2,3,4,8) hinein erstrecken und darin mechanisch befestigt werden, auf der Oberfläche des Folienmaterials befestigt,
- (4) eine Haube aus dem gleichen Folienmaterial wird von oben auf jedes der blockartigen Elemente (11) eingeschoben, wobei die Haube (16) so gestaltet ist, dass sie das Element (11) eng umschliesst,
- (5) ein unterer Randteil jeder Haube (16) wird mit dem flachen Folienmaterial in dem das jeweilige blockartige Element (11) unmittelbar umgebenden Bereich durch ein Schweiss- oder Schmelzverfahren verbunden, das geeignet ist, eine dauerhafte, flüssigkeitsundurchlässige Naht zu erzeugen,
- (6) flüssigkeitsdurchlässige Baumaterialien (23,24) werden zur Bildung des Oberteils der Baustruktur auf die Oberfläche der genannten flüssigkeitsundurchlässigen Membrane bis zu einer Höhe oberhalb der Oberfläche der genannten haubenbekleideten blockartigen Elemente (11,16) aufgetragen.

4. Verfahren gemäss Anspruch 3 zur Herstellung einer Baustruktur gemäss Anspruch 1 mit einem Unterteil in der Form eines armierten Betonbalkens (2,3,4,8), dadurch gekennzeichnet, dass bevor dem Aufgiessen des den Balken zu bildenden Betons, Anker (5) an einem oberen Teil der im voraus hergestellten Armierungseisengerüsts (4), z.B. durch Schweissen, befestigt werden, u.zw. in Positionen, die waagrecht gesehen den Positionen der beabsichtigten Positionen der blockartigen Elemente entsprechen, und senkrecht gesehen in einer solchen Höhe liegen, dass sie in das später aufgegossene Beton des

Balkens (8) fest eingelagert werden, wobei die Anker sich ungefähr bis zur beabsichtigten Höhenlage der Oberfläche des armierten Betonbalkens erstrecken, und dass nachdem das Beton bis zu dieser Höhenlage aufgegossen und abgehärtet ist, die Verfahrensschritte (2)-(6) vom Anspruch 3 durchgeführt werden, indem die Anker (5) Gewindebohrungen zur Aufnahme von Schrauben oder Bolzen (15) haben, die die Befestigungsmittel des Verfahrensschrittes (3) bilden.

5. Verfahren gemäss Anspruch 4, dadurch gekennzeichnet, dass vor der Ausführung des Verfahrensschrittes (6) vom Anspruch 3 ein Körper von expandierenden Mörtel (22) um jedes haubenbekleideten blockartigen Element (11,16) herum gegossen wird, worin ein Armierungsring (19) eingelagert wird, der in einer Lage gehalten wird, wo er das blockartige Element (11,16) in einem gewissen Abstand davon umschliesst.

Revendications

1. Structure de construction comprenant: une partie supérieure (23, 24) ayant une surface supérieure exposée et composée de matériaux de construction perméables aux substances liquides et conformes à l'usage auquel est destinée la structure; une partie inférieure (2, 3, 4, 8) constituant l'élément porteur de la partie supérieure; une membrane imperméable aux substances liquides (9) interposée entre la partie inférieure (2, 3, 4, 8) et la partie supérieure (23, 24) de manière à empêcher la pénétration dans la partie inférieure (2, 3, 4, 8) des infiltrations de la partie supérieure (32, 24); des éléments de transfert des forces (5,11,15) ancrés dans la partie inférieure (2, 3, 4, 8) et pénétrant dans le corps de la partie supérieure (23, 24) de manière à transmettre directement à la partie inférieure (2, 3, 4, 8) les forces horizontales s'exerçant sur la partie supérieure (23, 24); cette structure de construction a les **caractéristiques** suivantes: les éléments de transfert des forces précités consistent en blocs cubiformes (11) disposés sur la face supérieure de la partie inférieure et engainés étroitement par des coiffes de même matériau que la membrane (16), qui sont à leur tour étroitement insérées dans des cavités prévues dans la partie supérieure (23, 24); la membrane est en matériau non-adhésif, à coefficient de friction pratiquement nul, du moins par rapport aux surfaces de la partie supérieure (23, 24) avec lesquelles elle est en contact.
2. Structure de construction similaire à celle décrite dans la revendication 1 et ayant les **caractéristi-**

ques suivantes: les blocs cubiformes (11) sont construits de manière à ce que leurs flancs soient perpendiculaires à la surface de la partie supérieure (23, 24) et sont de taille suffisante pour que la totalité de ces blocs (11) absorbe les forces maximales agissant dans n'importe quelle direction horizontale calculée dans la construction de la structure, sans excéder la charge tolérable s'exerçant sur les coiffes couvrant les blocs (11).

3. Méthode de réalisation d'une structure de construction correspondant à la revendication 1, **comprenant les phases suivantes**:
 - (1) mise en place d'une partie inférieure (2, 3, 4, 8) ayant la capacité de charge requise et une surface bien plane;
 - (2) pose sur la surface plane précitée de feuilles de revêtement en matériau (9) non adhésif et imperméable aux liquides, de manière à former une nappe continue couvrant la totalité de cette surface;
 - (3) fixation des blocs cubiformes (11) sur les feuilles précitées, à l'aide de pièces d'assujettissement (5, 15), de manière que les blocs, au travers d'orifices (10) découpés dans les feuilles de revêtement, pénètrent dans la partie inférieure susmentionnée (2, 3, 4, 8), à laquelle ils sont assujettis mécaniquement;
 - (4) gainage des blocs cubiformes (11) susmentionnés à l'aide de coiffes (16) de même matériau que les feuilles de revêtement, et dont la forme permet de gagner étroitement les blocs cubiformes (11);
 - (5) Raccordement étanche de chaque coiffe (16), par sa base (17), à la surface de la feuille sous-jacente située sur la bordure immédiate du bloc cubiforme (11) correspondant, par un procédé de soudage ou d'étanchéage propre à la réalisation d'une jointure étanche aux substances liquides;
 - (6) Pose de matériaux de construction perméables (23, 24) formant la partie supérieure de la structure de construction reposant sur la membrane imperméable précitée (9) et sur une épaisseur dépassant le sommet des blocs cubiformes recouverts de leurs coiffes (11, 16).
4. Méthode, similaire à la méthode objet de la revendication 3 concernant la réalisation d'une structure de construction similaire à l'objet de la revendication 1, comportant une partie inférieure se présentant sous la forme d'une poutre en béton armé (2, 3, 4, 8), et ayant les **caractéristiques** suivantes: d'une part le coulage du béton dans le coffrage de la poutre de béton est précédé de la fixation de pièces d'ancrage (5) sur la

partie supérieure de l'armature métallique du béton (4), par exemple par soudure de ces pièces horizontalement sur les positions correspondant aux points de positionnement prévus pour les blocs cubiformes, verticalement de manière telle qu'elles s'encastrant fermement dans le béton de la poutre (8) et affleurent approximativement au niveau de la face supérieure des poutres projetées; d'autre part le coulage du béton à cette hauteur est suivi de la réalisation des phases (2) à (6) définies dans la revendication 3, les pièces d'ancrage (5) ayant chacune une section creuse taraudée recevant les vis ou boulons constituant les moyens de réalisation de l'opération de fixation correspondant à la phase (3).

5. Méthode similaire à la méthode objet de la revendication 4, ayant les **caractéristiques** suivantes: avant l'exécution de la phase (6) de la revendication 3, un tablier en mortier expansif (22) est moulé autour de chaque bloc cubiforme recouvert de sa coiffe de gainage (11,16), et comporte un anneau de renforcement encastré (9) encerclant le bloc cubiforme (11, 16) avec une certaine distance entre le bloc et l'anneau.

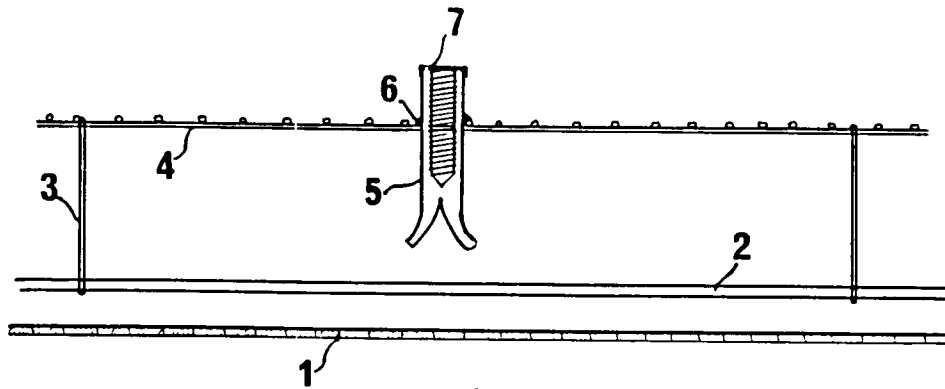


Fig. 1

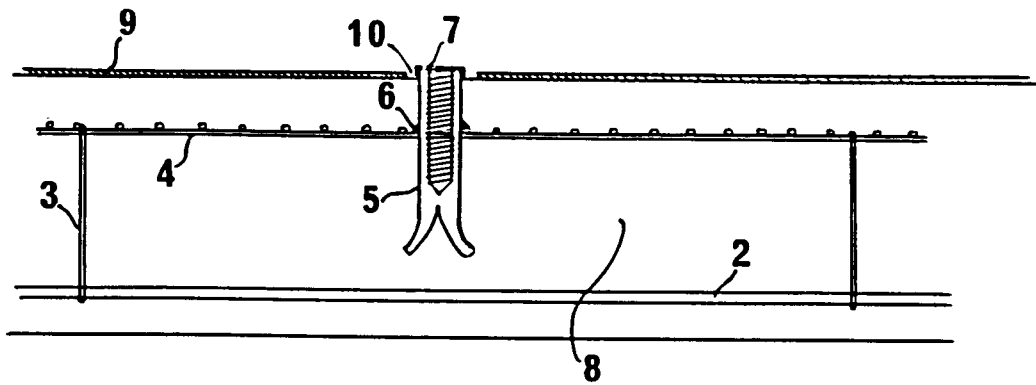


Fig. 2

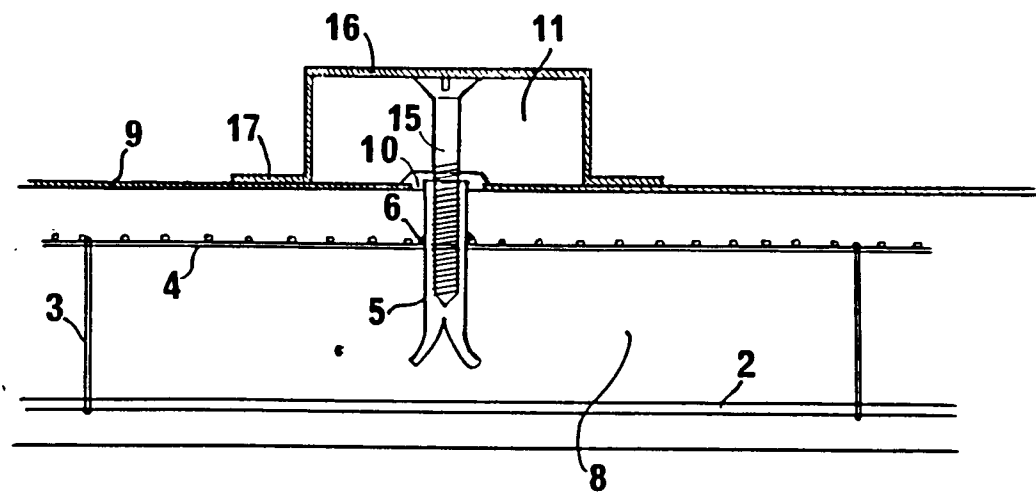


Fig. 3

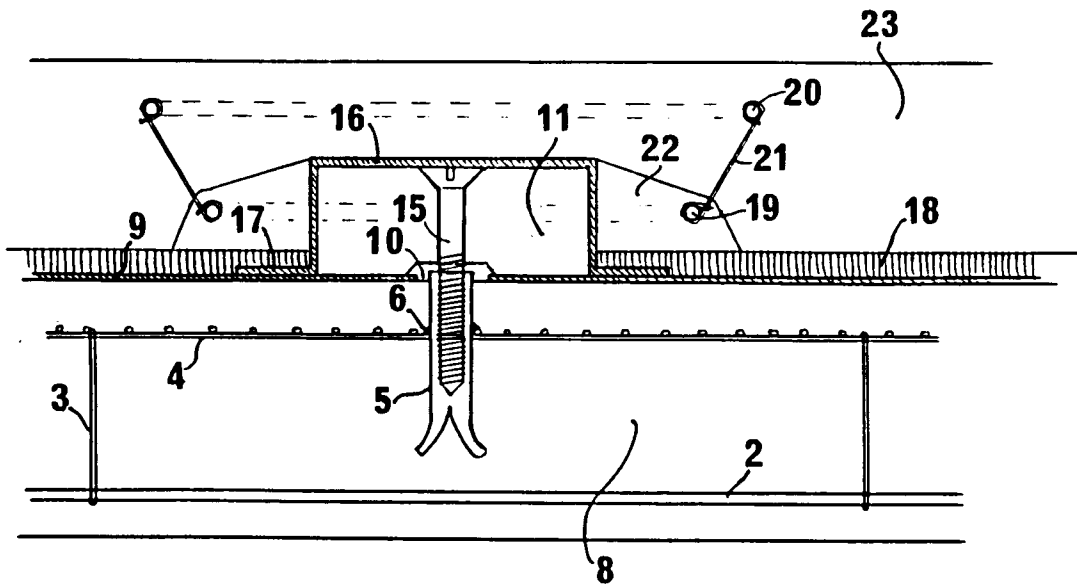


Fig. 4

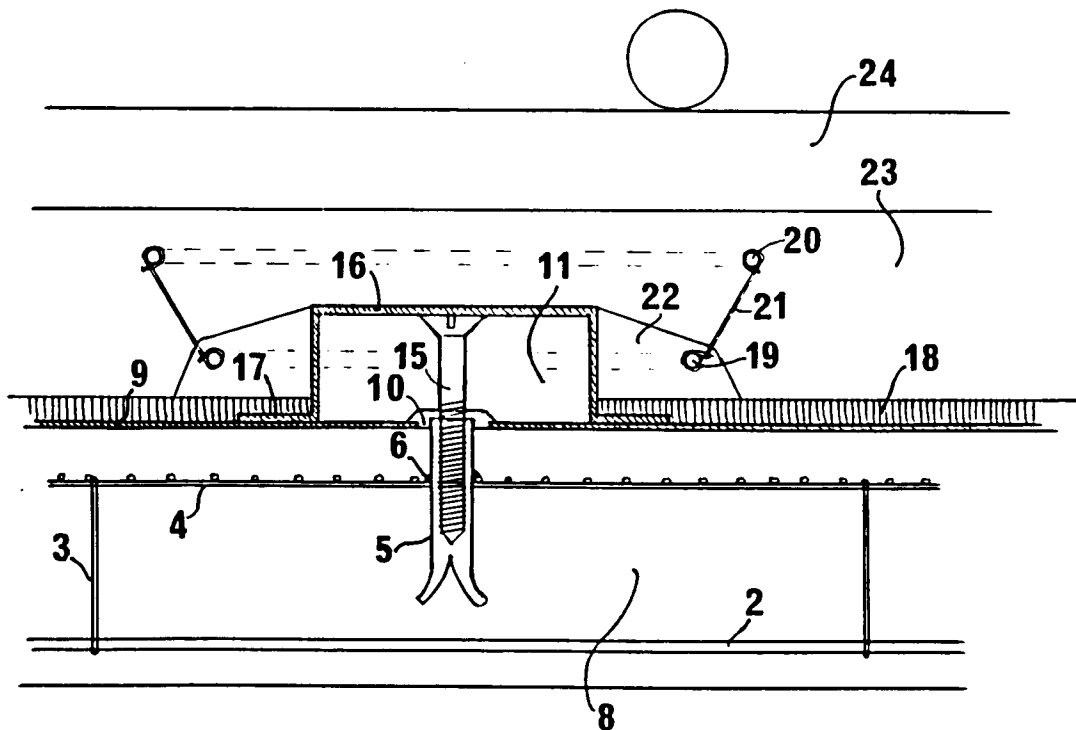


Fig. 5

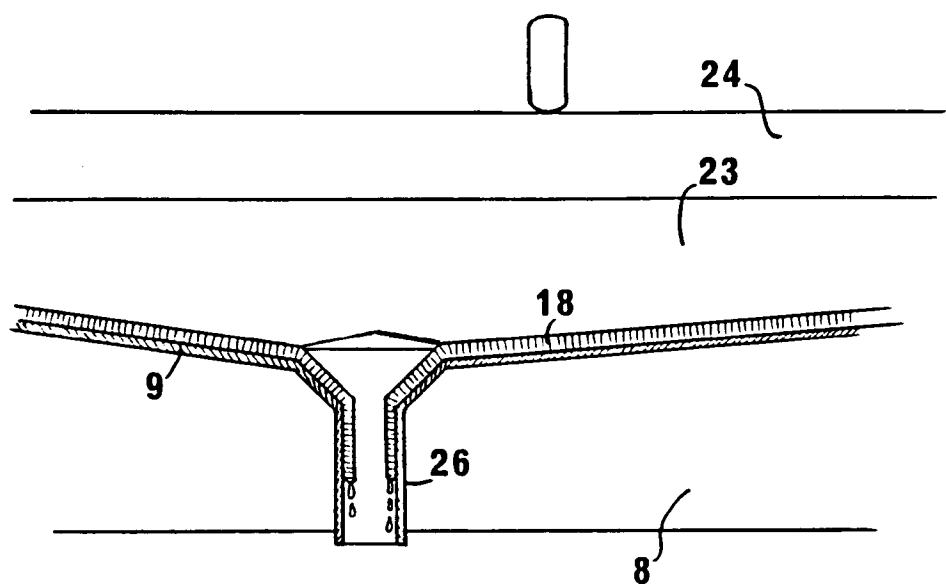


Fig. 6