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### (54) **Synthetic plate material and device for sealing up the ends of cavity channels of a cavity plate**

(57) A synthetic plate material comprises at least two substantially parallel synthetic-resin plates (2, 3) which are kept at a substantially constant distance from one another by means of strip-shaped spacers (4). The two plates (2, 3) and the spacers (4) together enclose a plurality of parallel, elongate cavity channels (5). The cavity channels (5) are sealed at their ends so that they are dustproof but transmit water and water vapour. This seal (6), according to the invention, comprises a foamed material with an open pore structure which is dustproof

but allows of a certain degree of ventilation, so that water and water vapour can pass through it.

A device for sealing up the ends of a cavity plate comprises a frame (10) with a practically flat base (12) provided with guiding means (13) for guiding the device along the cavity plate (1). The device further comprises a nozzle (14) for injecting a viscous foam substance into the ends of the cavity plate (1) and driving means (19) for conducting the device along the cavity plate (1) at a substantially constant speed.

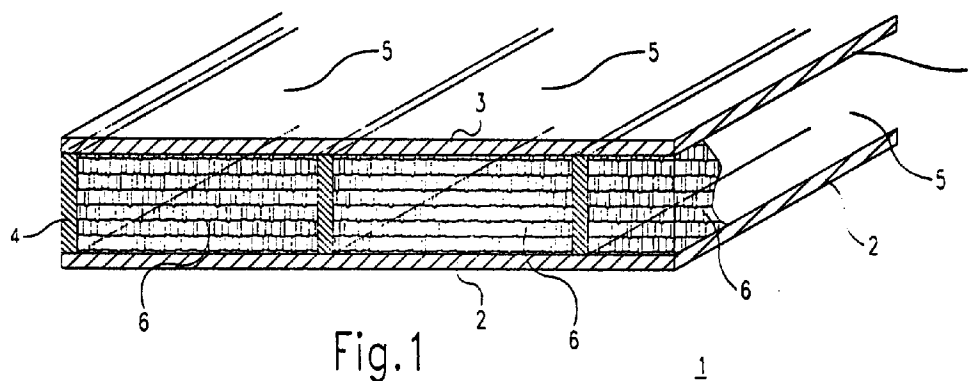


Fig.1

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## Description

The invention relates to a synthetic plate material comprising at least two substantially parallel synthetic plates which are kept at an at least substantially constant distance from one another by strip-shaped spacers and which enclose a number of elongate channels which are sealed up at their ends so as to be impermeable to dust but permeable to water and water vapour. The invention further relates to a device for sealing up cavity channels in a cavity plate comprising at least two substantially parallel plates which are interconnected by mutually parallel elongate spacers.

Plate material of the kind mentioned in the opening paragraph is used, for example in light-transmitting roof coverings and the like. In such a case a transparent, possibly coloured synthetic resin is used such as a suitable acrylate or polycarbonate, for example those known under the trade names Lexan and Macrolon. The covering usually comprises two plates of such material which are kept at a substantially fixed distance from one another by mutually parallel strip-shaped spacers. Between the spacers there are cavity channels, generally of a polygonal cross-section, in particular triangular or quadrangular.

To prevent dust and small organisms, such as insects, from entering the channels, the ends of the cavity channels are sealed up in a dustproof manner. The simplest solution here is to seal the end faces absolutely hermetically. Since most synthetic resins, among them those mentioned above, are to a certain degree permeable to water vapour, however, such a hermetic seal would inevitably lead to a persistent condensation in the cavity of the plate material. This is unpleasant enough in itself, but it also forms a breeding ground for fungi, algae and other microorganisms which are inevitably present in the air, in the long run leading to highly unattractive deposits and adversely affecting the light transmission of the plate. In addition, the insulation value of the plate is diminished by (condensed) moisture and dirt present in the cavity thereof. The latter aspect is not only of importance for transparent plate material, but also plays a part in opaque plates. The seals of the end faces should accordingly be dustproof but permeable to water and water vapour. In that case any condensation can always be removed through the ends of the cavity channels.

A synthetic plate material of the kind mentioned in the opening paragraph with the cavity channel ends sealed up in the manner described is known from a Netherlands Patent Application laid open to public inspection under no. 8803195. The plate material described therein is closed off at the edges with an adhesive tape comprising a first foil of non-woven material which on the one hand is dustproof but on the other hand admits of the desired ventilation and water (vapour) removal, and a second foil of a considerably stronger material provided over the first and having openings which leave the first foil locally exposed at the end faces of the cavity channels.

It is a disadvantage of the known plate material that the openings in the adhesive tape are of substantially smaller dimensions than the ends of the cavity channels. As a result of this, condensation water trickling in a cavity channel towards an end thereof will inevitably collect below an opening of the adhesive tape, which will still lead to stains and deposits eventually. This disadvantage is the more serious if the plate material is used at only a small angle, such as is frequently the case, for example, in a sun lounge.

The present invention has for its object inter alia to provide a synthetic plate material of the kind mentioned in the opening paragraph in which this disadvantage is counteracted.

The invention is based on the recognition that such a build-up of condensation is avoided in a plate material in which the ends of the cavity channels are permeable to water (vapour) over their entire thickness.

According to the invention, a plate material of the kind mentioned in the opening paragraph is for this purpose characterized in that the seals of the channels comprise a foam substance with an open pore system which is impermeable to dust but permeable to water and water vapour. The sealing foam is preferably injected into the cavity channels in this case by means of a special device according to the invention designed for this purpose, after which it adheres permanently to the inner walls of the channels. This connection was found to be sufficiently secure in practice for accommodating the shrinkage and expansion behaviour of the plate material. The open cell or pore system of the foamed seal provides the desired permeability to water and water vapour, while the labyrinth of pores formed thereby is sufficiently dustproof. The fact that the cavity channels are made permeable to water (vapour) over their entire end surface areas prevents small quantities of condensed water from collecting at the ends and eventually giving rise to unpleasant deposits there.

A special embodiment of the plate material according to the invention is characterized in that the seals of the cavity channels comprise a foam based on a material from a group of polyurethane, polythene, and polyester. These materials were found to be sufficiently weather-resistant and durable in practice also for outdoor use and, provided they are correctly applied in a manner known per se to those skilled in the art, are suitable for use in a foamed form with the required open pore structure. If so desired, the foam may be treated with a fungicide and/or algicide in order to inhibit the growth of fungi and algae in the foam.

In a very specific embodiment of the plate material according to the invention, the foam substance with which the cavity channels are sealed up has a minimum permeability to moisture of approximately 1 litre per square metre per minute and, on either side, to water vapour of approximately 15 litres per square metre per minute under atmospheric pressure. Such a permeability of the foam to condensed water and water vapour ensures a sufficient discharge of any moisture which may

have penetrated the cavity channels also for very small installation angles of the plate material.

The foam substance need not be absolutely impermeable to particles, though. It suffices in practice for attaining the dustproofness required for the purposes of the invention that the foam is at least substantially impermeable to organic and inorganic particles larger than approximately 25  $\mu\text{m}$ . Smaller particles are in fact so small that they are invisible to the naked eye, also in larger numbers, and do not cause stains and brightness losses in the plate material used.

The invention further relates to a device for sealing up the ends of a cavity plate having at least two substantially parallel plates interconnected by mutually parallel elongate spacers, which device according to the invention is characterized in that the device comprises a frame with an at least substantially flat base provided with guiding means for guiding the device along the cavity plate, in that the device comprises a nozzle which is coupled to feeding means for a viscous foam substance, and in that the device is provided with driving means for conducting the device along the cavity plate at a substantially constant speed.

In a preferred embodiment of the device according to the invention, the nozzle is provided with dispensing means for regulating the supply of the foam substance, while the dispensing means and the driving means are mutually coupled by means of an electronic control unit such that during operation the driving speed of the device and the feed rate of the foam substance from the nozzle are continually attuned to one another. Any fluctuations in the driving speed or foam supply may thus be compensated, which contributes to an optimum degree of filling of the cavity channels.

To accommodate any variations in the thickness of the cavity plate, a special embodiment of the device according to the invention is characterized in that the guiding means are guide rollers which are arranged in pairs on either side of an injection space in front of the cavity plate and which exert forces on the cavity plate, at least during operation, which are directed towards one another. The guide rollers thus press against the plate material at all times and follow its thickness. To ensure an adequate driving speed during this at the same time, the driving means in a further embodiment comprise at least two drive wheels which are arranged on either side of the cavity plate and, at least during operation, also exert mutually opposed forces on the plate material.

The invention will now be explained in more detail with reference to an embodiment and an accompanying drawing, in which:

Fig. 1 shows an embodiment of the plate material according to the invention in perspective view;

Fig. 2 is a first cross-section of an embodiment of the device according to the invention for sealing up double-walled plate material; and

Fig. 3 is a second cross-section of the device of Fig. 2.

The Figures are purely diagrammatic and not true to scale. Some dimensions have been particularly exaggerated for the sake of clarity. Corresponding parts have been given the same reference numerals as much as possible in the Figures.

The plate material 1 of Fig. 1 comprises two substantially parallel transparent outer plates 2, 3 made from a polycarbonate which is commercially available under the brand name Lexan, Macrolan, or Perspex, or some other suitable synthetic resin material. The two plates are interconnected by means of a number of strip-shaped spacers 4 and are thus kept at a substantially fixed distance from one another. The two plates 2, 3 and the spacers 4 thus enclose a plurality of elongate cavity channels 5 which issue at both ends of the plate material. To prevent dust particles and microorganisms from entering the cavity channels, the latter have been provided with at least substantially dustproof seals 6 at their end faces.

Since the synthetic resins used are to a certain degree permeable to water vapour, there will inevitably be a risk of condensation in the cavity channels 5. The seal 6 of each cavity channel 5 is so constructed as to be permeable to water and water vapour, so that this moisture can be removed. According to the invention, the seal for this purpose comprises a foam substance with an open pore structure which on the one hand is permeable to water and water vapour, but on the other hand is at least substantially dustproof. Polyurethane foam is used for the seal in the present embodiment, which is applied in a manner known to those skilled in the art such that the desired open pore or cell structure is obtained. Alternative materials capable of such foam formation may indeed be used for the seal as well within the scope of the invention, for example, polythene and polyester. The latter two materials are non-decomposing and sufficiently weather-resistant and durable for outdoor use, as is the polyurethane used here. With this in view, the foam 6 in the present embodiment is in addition provided with a fungicide and an algicide for counteracting the excessive growth of fungi and algae.

The pores or cells of the foam exhibit an open structure, i.e. the pores are in communication with one another. As a result the foam admits of a certain, low degree of ventilation so that water and water vapour can pass through the foam. The labyrinth of pores, however, is practically impermeable to dust particles and microorganisms such as insects. In the present example the foam has a permeability to water of at least approximately 1 litre per square metre per minute (16.7  $\text{ml/m}^2\cdot\text{s}$ ) and to water vapour of at least 15 litres per square metre per minute (250  $\text{ml/m}^2\cdot\text{s}$ ) on either side and at atmospheric pressure. Condensation removal and ventilation in the cavity channels 5 are amply sufficient with such values, even at very small installation angles of the plate material such as frequently occur in light-transmitting roofs and other coverings. The foam 6 is impermeable

to particles larger than approximately 25  $\mu\text{m}$ , however, and thus provides a sufficient barrier to dust particles and microorganisms for counteracting any stains and deposits caused thereby.

The foamed seal 6 is preferably provided by means of a device according to the invention which was specially designed for the purpose. An embodiment thereof is shown in Figs. 2 and 3 in cross-section. The device shown comprises a frame 10 which is provided with a handle 11 and a substantially flat base 12. Guiding means in the form of two sets of guide wheels 13 are fastened to the base for guiding the device along the cavity plate 1 during operation. The device further comprises a nozzle 14 which is coupled to feeding means for a viscous foam substance. The nozzle 14 issues against or even slightly inside the cavity plate 1 and injects the sealing foam into the cavity channels 5 during operation. The feeding means 15 for the foam substance in the present example comprise a feed hose which is connected at a first end to the nozzle 14, and furthermore dispensing means in the form of a volumetric pump 16 by which an opposite end of the feed hose 15 is coupled to a storage vessel or cartridge 17. To influence not only the dosage but also the issuing characteristics of the foam substance, a controllable needle 18 is included in the flow path of the foam.

The device is in addition provided with driving means in the form of a pair of drive wheels 19 mounted on either side of the plate 1 and covered with a suitable friction material, for example rubber, which are driven by an electric motor 20 so as to conduct the device along the cavity plate 1 at a substantially constant speed. The device is provided with a conventional electric supply connection 21 to obtain the electric power necessary for this.

The device is passed with its guide wheels 13 over the end faces of the cavity plate 1 until the drive wheels come into contact with the upper and lower sides 2, 3 of the cavity plate 1. This contact is registered and the drive wheels 19 are blocked. Since the drive wheels 19 are covered with friction material, the device is now fixed on the cavity plate 1. The device is subsequently started with a switch 22, whereby the nozzle 14 is opened and the drive wheels 19 start rotating. The foam substance 6 now flows from the nozzle 14 into a first cavity channel 4 and the nozzle is moved on slowly and thus passed along the ends of subsequent cavity channels. The driving speed and the quantity of foam injected are continually electronically attuned to one another by means of a central control unit (not shown) during this, which unit governs an interrelationship between the controllable pump 16 and the drive wheels 19. Any fluctuations in the driving speed or in the foam supply can thus be compensated, which contributes to an optimum degree of filling and sealing of the cavity channels.

To accommodate also variations in thickness of the cavity plate, the guide wheels 13 as well as the drive wheels 19 are electromagnetically attracted, so that they press firmly against the plate 1 during operation, exerting mutually opposed forces on the cavity plate. The guide

wheels 13 and the drive wheels 19 will accordingly follow any variation in thickness of the plate at all times, so that the drive and guidance of the device are not adversely affected by these variations. Alternatively, this may be achieved by means of a resilient suspension of the drive and guide wheels. Preferably, moreover, the drive wheels 19 are positioned at a certain angle to the plate material 5, whereby the plate material 5 will be continually urged against the guide wheels 13 and the nozzle 4 during operation.

The device described above was found to be particularly effective and appropriate for sealing up the ends of cavity plates and cavity plate material by means of foam. The foam then adheres permanently to the inner walls of the cavity channels. This adhesion is found to be sufficiently strong for accommodating the expansion and shrinkage behaviour of the cavity plate.

Although the invention was explained in detail with reference to only a single embodiment, it will be clear that the invention is by no means limited to the example given. On the contrary, many variations and modifications are possible to those skilled in the art within the scope of the invention. Thus the device for providing the foam seal may be not of a portable construction, as in the embodiment, but of a stationary construction, the plate material then being conducted along the nozzle.

The invention, furthermore, is not limited to double-walled plates and plate material, but may be equally well used for sealing the end faces of plate material consisting of more than two plates, two outer plates and one or more intermediate plates, which are fastened to one another by means of parallel, strip-shaped spacers.

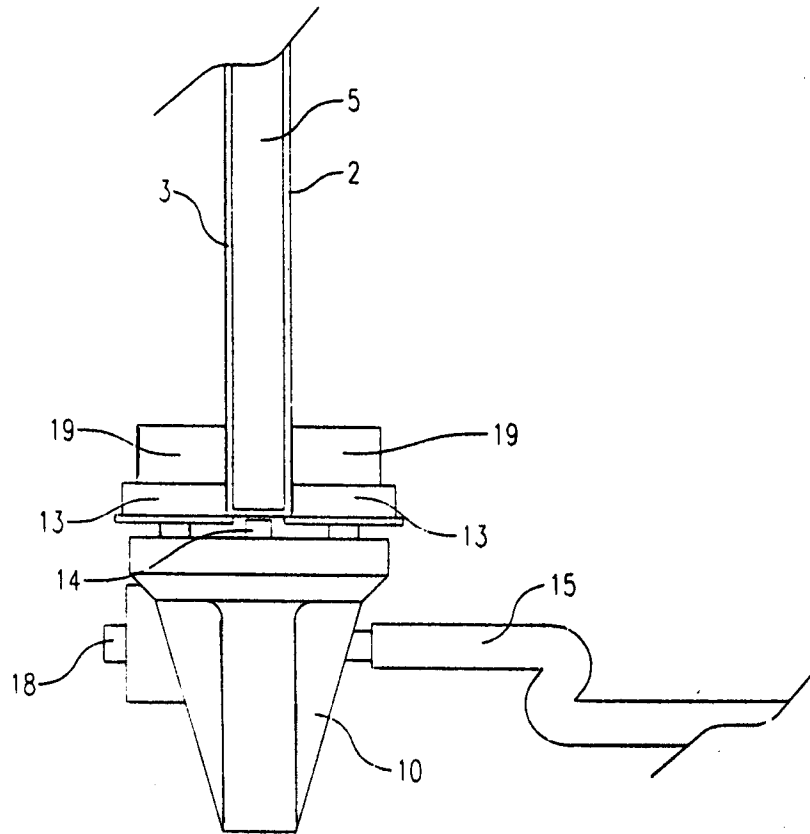
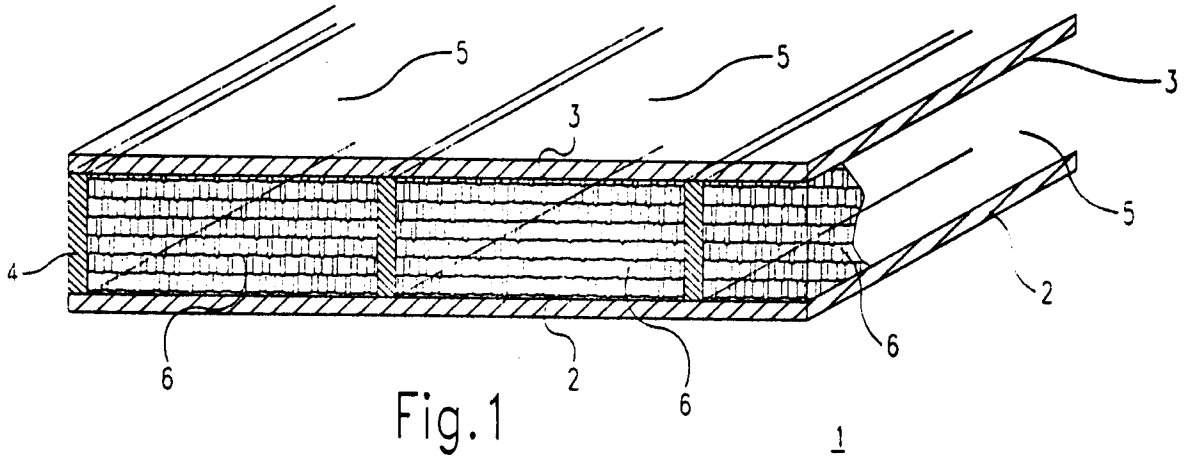
Generally speaking, the invention offers a particularly apt solution to the problem of how to seal up cavity channels in a dustproof manner while keeping them permeable to water and water vapour.

## Claims

1. A synthetic plate material comprising at least two substantially parallel synthetic plates which are kept at an at least substantially constant distance from one another by strip-shaped spacers and which enclose a number of elongate channels which are sealed up at their ends so as to be impermeable to dust but permeable to water and water vapour, characterized in that the seals of the channels comprise a foam substance with an open pore system which is impermeable to dust but permeable to water and water vapour.
2. A synthetic plate material as claimed in Claim 1, characterized in that the seals of the cavity channels comprise a foam based on a material from a group of polyurethane, polythene, and polyester.
3. A synthetic plate material as claimed in Claim 1 or 2, characterized in that the foam has been treated with a fungicide or algicide.

4. A synthetic plate material as claimed in any one of the Claims 1, 2 and 3, characterized in that the foam is permeable to water with a minimum permeability of 1 litre per square metre per minute. 5
  
5. A synthetic plate material as claimed in any one of the preceding Claims, characterized in that the foam is permeable to water vapour on either side with a minimum permeability of 15 litres per square metre per minute at a pressure of 1 at. 10
  
6. A synthetic plate material as claimed in any one of the preceding Claims, characterized in that the foam is at least substantially impermeable to organic and inorganic particles larger than approximately 25  $\mu\text{m}$ . 15
  
7. A device for sealing up ends of cavity channels in a cavity plate comprising at least two substantially parallel plates which are interconnected by mutually parallel elongate spacers, characterized in that the device comprises a frame with an at least substantially flat base provided with guiding means for guiding the device along the cavity plate, in that the device comprises a nozzle which is coupled to feeding means for a viscous foam substance, and in that the device is provided with driving means for conducting the device along the cavity plate at a substantially constant speed. 20  
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8. A device as claimed in Claim 7, characterized in that the nozzle is provided with dispensing means for regulating the supply of the foam substance, while the dispensing means and the driving means are mutually coupled by means of an electronic control unit such that during operation the driving speed of the device and the feed rate of the foam substance from the nozzle are attuned to one another. 30  
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9. A device as claimed in Claim 7 or 8, characterized in that the guiding means are guide rollers which are arranged in pairs on either side of an injection space in front of the cavity plate and which during operation exert mutually opposed forces on the cavity plate. 40
  
10. A device as claimed in Claim 7, 8 or 9, characterized in that the driving means comprise at least two drive wheels which are arranged on either side of the cavity plate and which, at least during operation, exert mutually opposed forces on the plate material. 45  
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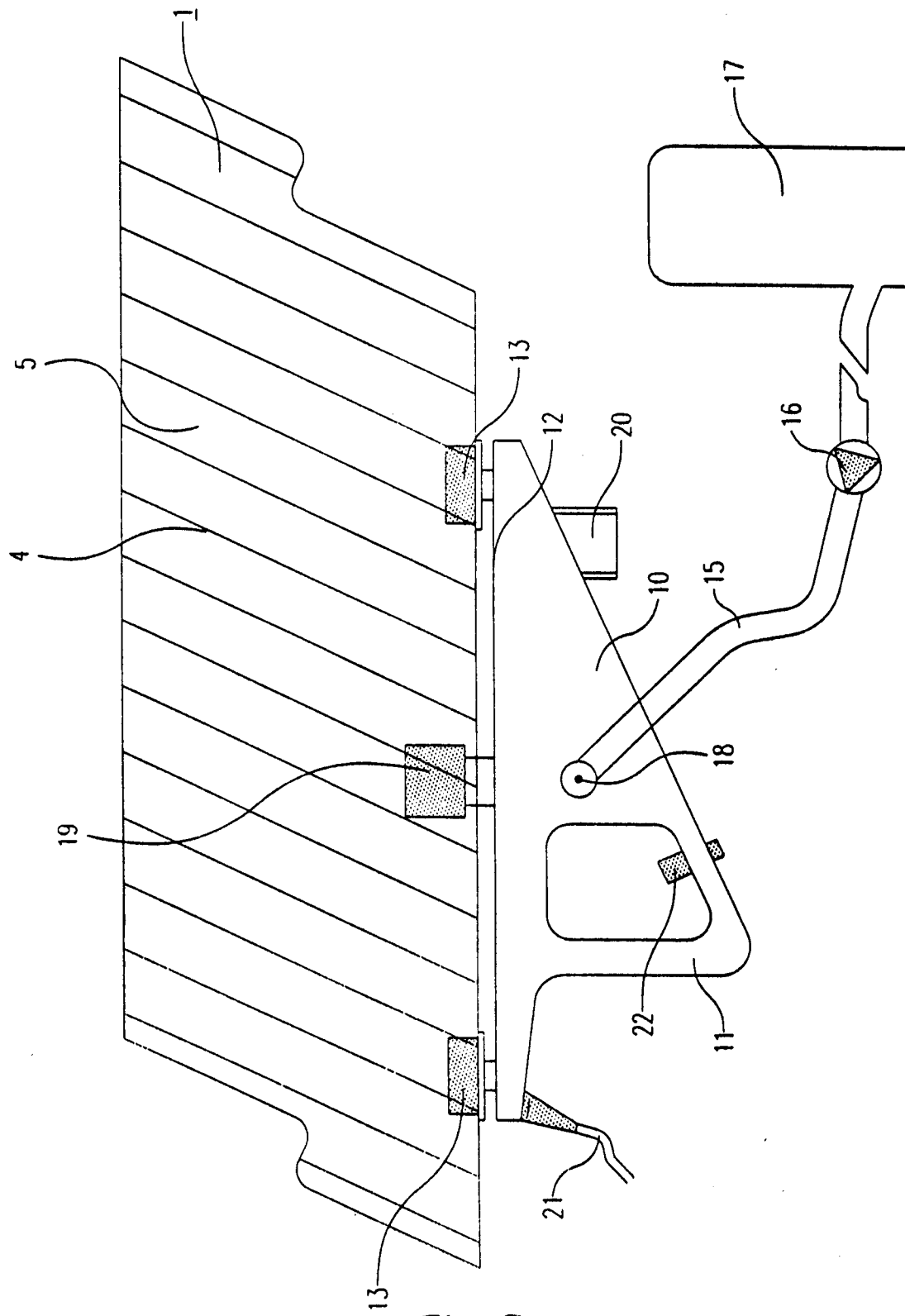


Fig.3



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## EUROPEAN SEARCH REPORT

Application Number  
EP 95 20 3017

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	DE-A-38 38 641 (POWER SYSTEME GESELL. FÜR TECHNISCHE GEBÄUDEAUSRÜSTUNG M.B.H.) 17 May 1990 * column 3, line 13 - line 35 * * figure 2 *	1,2,6	E04C2/36
A	US-A-1 664 867 (STRAND) 3 April 1928 * page 1, line 64 - line 70 * * page 1, line 82 - line 86 * * figures 1,2 *	1	
A	US-A-4 586 308 (JENNINGS) 6 May 1986 * figures 1-3 * * column 5, line 49 - line 55 *	1	
A	DE-A-26 32 040 (MENERINGHAUSEN) 19 January 1978 * claims 5-8; figures 5,6A,6B *	7	
A	DE-A-16 04 699 (REGEHR) 4 March 1971 * claims 1,2,6; figure 3 *	7	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			E04C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15 February 1996	Examiner Guthmuller, J
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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