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(54) **Glued laminated beam**

Geleimter und beschichteter Holzbaken

Poutre de bois stratifié collé

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**EP-B- 1 586 430 WO-A-2004/018798**  
**NL-A- 7 904 258 US-A- 5 755 068**  
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**EP 2 090 413 B1**

## Description

**[0001]** The invention is concerned with a glued laminated timber beam, according to the preamble of claim 1. Such a beam is known from US 20020015819 A.

**[0002]** EP 1 586 430 discloses a structural member constructed of a plurality of wood strips glued together wherein a layer of adhesive is provided between every two adjacent wood strips. The advantage of the said glued laminated timber beams or in short glulam beams is the improvement of the load-bearing behavior of such a structural beam.

**[0003]** However, it has to be noted that the advantage of such an improved load-bearing behavior necessitates some preparation work to prepare a beam comprising 8 to 20 of such glued wood strips.

**[0004]** From EP 1 721 714 a beam structure is known. However, the structure of D1 does not enhance the load bearing capacities of such a beam significantly.

## Summary of the invention

**[0005]** Based on such prior art, it is an object of the present invention to provide a simpler and more economic glulam beam which shows the desired improved load-bearing behavior.

**[0006]** Additionally it is a further object of the invention to provide an improved method for repairing or strengthening beams which may show structural damage as e.g. disclosed in "Glulam beam repair reinforcement" by Gary W. Gray and Paul C. Gilham in "Structure Magazine", September 2006, pages 11 to 15.

**[0007]** It is a further object of the invention to provide an improved load-bearing behaviour for continuous beams with two or more spans.

**[0008]** Based on the structural beam as disclosed in the preamble of claim 1 a solution is provided comprising the features of claim 1 or claim 5.

## Short description of the drawings

**[0009]** The invention is now described with reference to the enclosed drawings. These drawings show:

- Fig. 1 a schematic elevation of a simply supported beam according to the prior art.
- Fig. 2 a schematic cross section of a beam according to the prior art.
- Fig. 3 a second beam according to the prior art
- Fig. 4 a schematic elevation of a two-span beam according to the invention,
- Fig. 5 a perspective view of an embodiment similar to Fig. 4 showing a continuous slab according to the invention, and
- Fig. 6 a schematic view of a slab on columns according to a further embodiment of the invention.

## Detailed description of preferred embodiments

**[0010]** Fig. 1 shows according to the prior art a schematic elevation of the arrangement of a beam 10 according to the invention over two spans. The beam 10 comprises two parts 11 and 12 which are shown with their specific dimensions in Fig. 2. Beam 10 has a length allowing its use on two columns or walls 20 having a predetermined distance. Such a distance can be chosen between e.g. 5 and 25 meters. As known in prior art the beam 10 is arranged on the upper section of the wall or column 20. Beam 10 may extend beyond the wall 20 but is not supported in said section. In other words, only the portions shown in Fig. 1 are used for the simply supported beam.

**[0011]** Reference signs in Fig. 2 according to the prior art relate to the dimensions of the beam 10. The width  $b$  of the beam 10 is e.g. between 5 and 30 centimeters. The height of the beam 10 has received the reference sign  $h$  and can especially be chosen between 10 and 100 centimeters. In exceptional cases heights of over 1 meter may be possible. Said beam 10 comprises a lower thinner strip 12 and an upper major strip 11. The height of the lower strip is  $h_1$ .

**[0012]** It is possible to obtain an improvement in bending resistance of the beam of about 20% if the beam 10 is made out of two wood strips wherein a thinner wood strip comprises a height  $h_1$  being chosen between 10 and 25% of the overall height  $h$  of the beam 10.

**[0013]** It has been found that an improvement of load can be improved by 20% if  $h_1$  is 17.5% of the height  $h$  of the beam 10. The calculation of the bending resistance of such a glued laminated timber shows that said property is always greater than 118% of a single beam if the height  $h_1$  is between 15 and 25% of the height  $h$  of the entire beam 10.

**[0014]** The two wood strips 11 and 12, i.e. the main beam portion 11 and the thinner wood strip 12, are joined using an adhesive having the properties of the adhesive disclosed and used in EP 1 586 430. The adhesive for the adhesive interface 13 is preferably an adhesive showing a specific stiffness  $k/b$ , i.e. the stiffness  $k$  [N/mm<sup>2</sup>] in relation to the width of the beam being covered by the adhesive  $b$  [e.g. 100 mm], depending on the relation  $L/h$ , i.e. free span length  $L$  of the beam 10 over the height  $h$  of the beam,  $L/h$  being usually between 15 and 25. Thus a preferred value of  $k/b$  is 0.3 for a value of  $L/h$  of around 20. A specific preferred shear modulus of the adhesive is between 40 and 80 N/mm, especially between 50 and 70 N/mm and one embodiment was tested with an adhesive having a shear modulus of 60 N/mm.

**[0015]** Fig. 3 shows a different beam according to the prior art wherein the lower beam portion 12 is made out of two separate wood strips 21 and 22. The height of the two strips is  $h_1$  and  $h_2$ , respectively. The sum of  $h_1$  and  $h_2$  is according to preferred embodiment almost equivalent to the height  $h_1$  of the single wood strip of the embodiment according to Fig. 2. The adhesive interfaces

13 are identical to the single adhesive interface 13 of Fig. 1.

**[0016]** It is also possible to use other adhesives from prior art, but an adhesive showing an extensive gliding under heavy loads is preferred.

**[0017]** The said improvement of about 20% of the bending resistance behavior may result in a loss of rigidity of about 20% as compared to conventional glulam. Thus in comparison to conventional glulam, this product fails at a deformation increase of about 50%. Said results allows to use such an improved beam where a greater charge has to be accepted and in cases where a greater deformability is desired. Such beams are therefore especially suitable for the construction of bridges and/or constructions of roofs of all kind of halls. This is especially true for constructions in earthquake endangered areas.

**[0018]** The invention is related to a beam according to Fig. 4, showing a schematic side view of a two-span beam according to the invention.

**[0019]** The glued laminated timber beam 10 of Fig. 4 comprises one beam body 11 and one (or two) adjacent strip (s) 31, separated by different sections of an adhesive interface 32 and 33 as explained below, wherein the height of the adjacent strip(s) 31 is between 15 and 25% of the height of the entire beam 10.

**[0020]** The beam according to Fig. 4 is intended to be used in connection with a continuous beam of two or more spans, i.e. using side walls or columns 20 and one or more intermediate supporting portions 25. Fig. 4 only shows one intermediate supporting portion 25, but the beam 10 can also be supported at two or more intermediate positions and this has an influence on the adhesive interfaces 32 and 33.

**[0021]** Fig. 4 shows a schematic view of these interfaces 32 and 33. The beam 10 is positioned with its main body 11 on the supporting elements 20 and 25. The additional wood strip 31 is provided on the opposite side. At every supporting position the additional wood strip 31 is glued on the main body according to the same principles as shown in connection with the embodiments of Fig. 1 to 3, i.e. using an adhesive interface 33 allowing for a gliding connection, and, possibly, use of a so called elastic adhesive with a shear modulus between 40 and 80 N/mm. The length of the interface 33 stretches over an area between 1/10 and 1/3 of the span on both sides of the intermediate columns 25: thus each stretch has a total length of 2/10 - 2/3 of the span. The remainder of the adhesive interface 32 is a conventional rigid interface, especially using a rigid adhesive or a thinner glue layer. This is represented by the dotted line. As such a rigid adhesive Mirapur 9521 from Geistlich Ligamenta can be used, being an adhesive on polyurethane prepolymer basis.

**[0022]** Beside use of a different, more rigid, adhesive in the areas 32 in comparison to the areas 33, it is also possible to provide a recess of e.g. 0.5 to 1 millimeter within the body 11 to create room for a thicker glue layer in comparison to the interfaces 32, thus realizing the

shear modulus as requested for.

**[0023]** Said reinforcement of the beam body 11 on the upper side reflects the different loading of a two-span beam construction, which suffers smaller shear stresses at midspan, whereas the greater shear stresses are concentrated in the areas directly over the supports.

**[0024]** Fig. 5 shows a perspective view of an embodiment similar to Fig. 4 showing a continuous slab 100 according to the invention. The slab 100 comprises a lower sheet 11 and a cover sheet 31 (not distinguished in Fig. 5), wherein the adhesive interface 33 is provided and schematically shown between said elements 11 and 31 in a region over the intermediate wall 25. The width of the adhesive interface 33 is preferably three to seven times the width of the intermediate wall 25.

**[0025]** Fig. 6 shows a schematic view of a slab 100 on columns 125 according to a further embodiment of the invention. The nine columns 125 are provided under the slab 100, which is positioned in a way that the adhesive surface 133 is centered on the columns. Preferably the adhesive surface 133 is circular or square and has a width between covers an area of between 1/10 to 1/3 of the span on both or all of the supporting columns 25.

**[0026]** The adhesive surface 133 corresponds to the areas 33 of the embodiment of Fig. 4 and 5, e.g. either provided within a recess of e.g. 0.5 to 1 millimeter within the body 11 of the slab 100 to create a room for a thicker glue layer in comparison to the interfaces 32, thus realizing the shear modulus as requested for. The surfaces beside the illustrated surfaces 133 are the conventional rigid adhesive interface areas.

**[0027]** Beside using the so called elastic adhesive having a shear modulus, preferably, between 40 and 80 N/mm, it is also possible to use a ductile adhesive as mentioned in EP 1 586 430, having an initial shear modulus of about 500 to 1000 N/mm for a range up to e.g. 0.1 to 0.3 millimeters. Said length provides a threshold value. For lengths beyond said threshold value the shear modulus becomes very small, e.g. changes to a value below 10 N/mm. Therefore an almost constant force between e.g. 100 and 200 N is available for additional lengths, i.e. it is possible to use an adhesive showing the properties according to Fig. 4 of EP 1 586 430.

**[0028]** Either approach results to an increase of the bending resistance in comparison to a conventional glulam beam by up to approx. 20%. Such a beam also exhibits 50% more deformability before failure, which is advantageous for constructions in regions with important risks of earthquake activity.

#### Reference signs

#### **[0029]**

10	beam
11	first part
12	second part
13	adhesive interface

20 wall / column  
 21 lower second part  
 22 upper second part  
 25 intermediate support  
 31 first portion  
 32 outer adhesive interface  
 33 supported adhesive interface  
 35 non-supported region  
 100 slab  
 125 column  
 133 column supported adhesive interface

adhesive interface (33, 133) is arrangeable opposite to any intermediate supporting element (25, 125) has a width covering an area of between 1/10 to 1/3 of the span on both or all of the supporting columns (25, 125).

8. Beam (100) according to one of claims 6 to 8, wherein the adhesive interface (33, 133) is arrangeable opposite to any intermediate supporting element (25, 125) is provided within a recess, especially within a recess of 0.5 to 1 millimeters depth within the body of the beam (100).

9. Beam (100) according to one of claims 6 to 9, wherein outside the adhesive interface (33, 133) a thinner glue layer of the same adhesive as within the adhesive interface (33, 133) is provided.

## Claims

1. Glued laminated timber beam (10), comprising one beam body (11) and one or two adjacent strips (12), each separated by an adhesive interface (13), **characterized in that** the height of the adjacent strip(s) (31) is between 15 and 25% of the height (h) of the beam (10) **in that** the strip or strips (31) have the same width (b) as the beam body (11) and **in that** the adjacent strip (31) is glued on the main body using an adhesive interface (33) allowing for a gliding connection and of an adhesive interface (32) using a rigid adhesive.
2. Beam (10) according to claim 1, wherein the adjacent strip(s) (12; 21, 22) are made from the same wood as the beam body (11).
3. Beam (10) according to claim 1 or 2, wherein the shear modulus of the adhesive allowing the gliding connection is between 40 and 80 N/mm, especially between 50 and 70 N/mm.
4. Beam (10) according to claim 1 or 2, wherein the shear modulus of the adhesive allowing the gliding connection starts with a value between 500 to 1000 N/mm for a range up to a threshold value of between 0.1 to 0.3 millimeters, then essentially changing to a value below 10 N/mm for length beyond said threshold value.
5. Beam (100) according to one of claims 1 to 4 for use as a multi-span, especially two-span, beam, wherein the beam can be positioned with its strip (31) on the opposite side of supporting elements (20), especially of intermediate supporting element(s) (25, 125).
6. Beam (100) according to one of claims 1 to 4 and 6, wherein the adhesive interface (33, 133) is arrangeable opposite to any intermediate supporting element (25, 125) uses an adhesive comprising a shear modulus between 40 and 80 N/mm, especially between 50 and 70 N/mm.
7. Beam (100) according to claim 6 or 7, wherein the

## Patentansprüche

1. Geklebter laminierter Holzbalken (10), umfassend ein Balkenkörper (11) und einer oder zwei benachbarte Streifen (12), wobei jeder durch eine geklebte Schnittstelle (13) getrennt ist, **dadurch gekennzeichnet, dass** die Höhe des/der benachbarten Streifen (31) zwischen 15 und 25% der Höhe (h) des Balkens (10) ist, dass der Streifen oder die Streifen (31) die gleiche Breite (b) als der Balkenkörper (11) haben, und dass die benachbarten Streifen (31) auf den Hauptkörper unter Verwendung der geklebten Schnittstelle (33) geklebt ist, wobei eine gleitende Verbindung erlaubt wird, und einer geklebten Schnittstelle (32) unter Verwendung eines steifen Klebstoffes.
2. Balken (10) gemäss Anspruch 1, wobei die benachbarten Streifen (12; 21, 22) aus dem gleichen Holz wie der Balkenkörper (11) sind.
3. Balken (10) gemäss Anspruch 1 oder 2, wobei der Gleitmodul des Klebstoffes, der die gleitende Verbindung erlaubt, zwischen 40 und 80 N/mm, insbesondere zwischen 50 und 70 N/mm, ist.
4. Balken (10) gemäss Anspruch 1 oder 2, wobei der Gleitmodul des Klebstoffes, der die gleitende Verbindung erlaubt, mit einem Wert von zwischen 500 bis 1000 N/mm bis zu einem Bereich eines Grenzwertes von zwischen 0,1 bis 0,3 Millimeter beginnt, wobei er dann im Wesentlichen auf einen Wert unter 10 N/mm für Längen über diesem Grenzwert verändert wird.
5. Balken (100) gemäss einem der Ansprüche 1 bis 4 zur Verwendung als Mehrfach-Spannweitenbalken, insbesondere als Zweifach-Spannweitenbalken, wobei der Balken mit seinen Streifen (31) auf der

gegenüberliegenden Seite von Stützelementen (20) positioniert werden kann, insbesondere auf dazwischen angeordneten Stützelementen (25, 125).

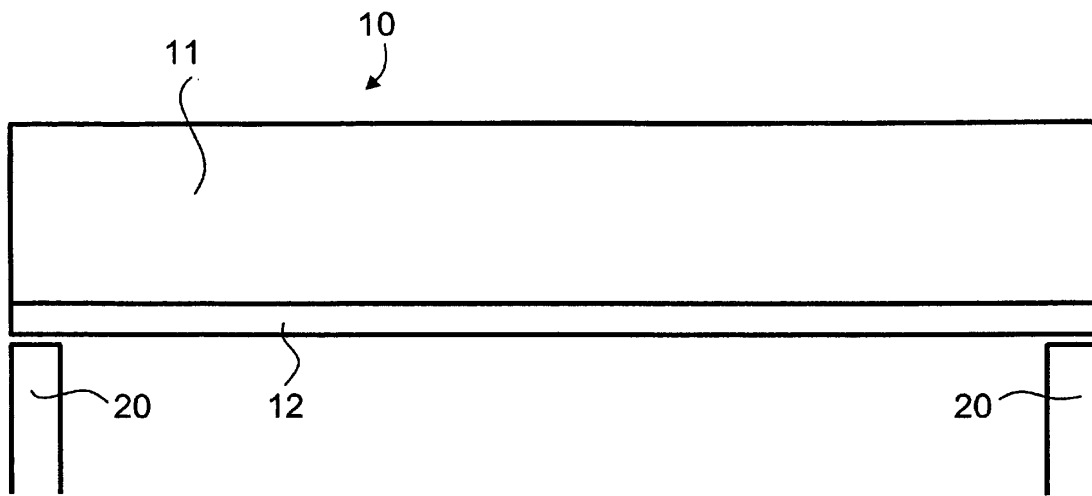
6. Balken (100) gemäss einem der Ansprüche 1 bis 4 und 6, wobei die geklebte Schnittstelle (33, 133) gegenüber jedem dazwischenliegenden Stützelement (25, 125) anordbar ist, wobei ein Klebstoff umfassend ein Gleitmodul zwischen 40 und 80 N/mm, insbesondere zwischen 50 und 70 N/mm, eingesetzt wird.
7. Balken (100) gemäss einem der Ansprüche 6 oder 7, wobei die geklebte Schnittstelle (33, 133) gegenüber jedem der dazwischen liegenden Stützelemente (25, 125) anordbar ist, wobei die geklebte Schnittstelle eine Breite hat, welche eine Fläche von zwischen 1/10 bis 1/3 der Spannweite von beiden oder allen der Stützsäulen (25, 125) aufweist.
8. Balken (100) gemäss einem der Ansprüche 6 bis 8, wobei die geklebte Schnittstelle (30, 133) gegenüber jedem Stützelement (25, 125) anordbar ist, wobei die geklebte Schnittstelle mit einer Ausnehmung bereitgestellt ist, insbesondere mit einer Ausnehmung von 0,5 bis 1 mm Tiefe innerhalb des Körpers des Balkens (100).
9. Balken (100) gemäss einem der Ansprüche 6 bis 9, wobei ausserhalb der geklebten Schnittstelle (33, 133) eine dünnere Klebeschicht des gleichen Klebstoffes wie innerhalb der geklebten Schnittstelle (30, 133), bereitgestellt ist.

## Revendications

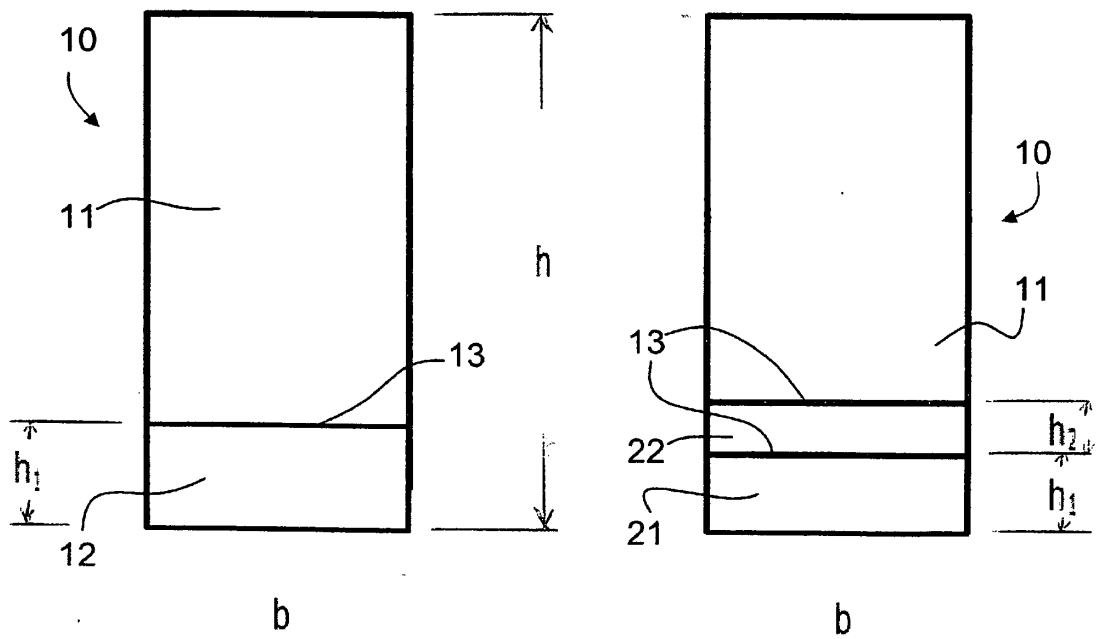
1. Poutre (10) en bois laminé collé, comprenant un corps de poutre (11) et une ou deux bandes (12) adjacentes, chacune séparée par une interface adhésive (13),  
**caractérisée en ce que** la hauteur de la ou des bandes (31) est comprise entre 15 et 25 % de la hauteur (h) de la poutre (10),  
**en ce que** la bande ou les bandes (31) présentent la même largeur (b) que le corps de poutre (11) et  
**en ce que** la bande adjacente (31) est collée sur le corps principal en utilisant une interface adhésive (33) permettant un raccordement de glissement et une interface adhésive (32) utilisant un adhésif rigide.
2. Poutre (10) selon la revendication 1, dans laquelle la ou les bandes adjacentes (12 ; 21, 22) sont constituées du même bois que le corps de poutre (11).
3. Poutre (10) selon la revendication 1 ou 2, dans laquelle le module de cisaillement de l'adhésif permet-

tant le raccordement de glissement est compris entre 40 et 80 N/mm et plus particulièrement entre 50 et 70 N/mm.

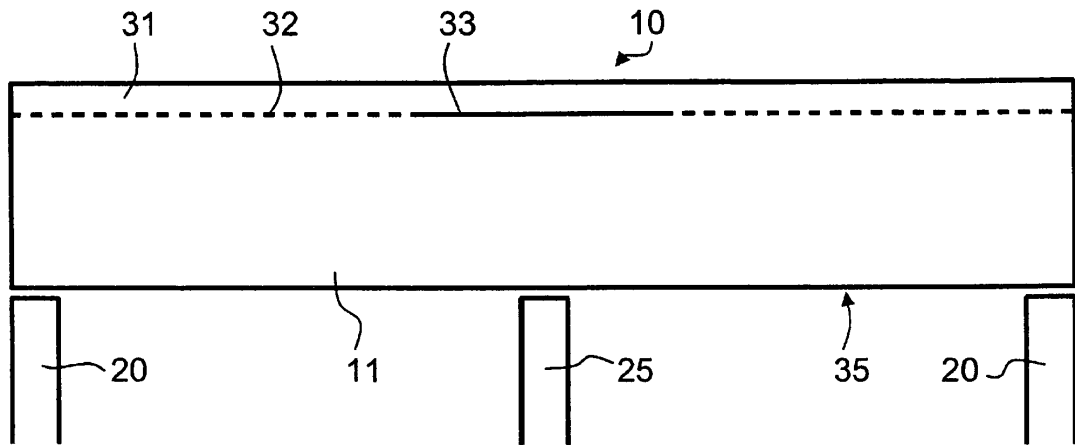
4. Poutre (10) selon la revendication 1 ou 2, dans laquelle le module de cisaillement de l'adhésif permettant le raccordement de glissement présente une valeur comprise entre 500 et 1 000 N/mm dans une plage allant jusqu'à une valeur de seuil comprise entre 0,1 et 0,3 millimètres et passe ensuite essentiellement à une valeur inférieure à 10 N/mm pour une longueur supérieure à ladite valeur de seuil.
5. Poutre (100) selon l'une quelconque des revendications 1 à 4, destinée à être utilisée en tant que travée multiple et spécialement en tant que poutre à double travée, dans laquelle la poutre peut être positionnée avec sa bande (31) située sur le côté opposé des éléments (20) de support et en particulier du ou des éléments (25, 125) de support intermédiaires.
6. Poutre (100) selon l'une quelconque des revendications 1 à 4 et selon la revendication 6, dans laquelle l'interface adhésive (33, 133) qui peut être placée face à tout élément (25, 125) de support intermédiaire utilise un adhésif dont le module de cisaillement est compris entre 40 et 80 N/mm et plus particulièrement entre 50 et 70 N/mm.
7. Poutre (100) selon la revendication 6 ou 7, dans laquelle la largeur de l'interface adhésive (33, 133) qui peut être placée face à tout élément (25, 125) de support intermédiaire couvre une surface comprise entre 1/10 et 1/3 de la portée sur les deux ou sur toutes les colonnes (25, 125) de support.
8. Poutre (100) selon l'une quelconque des revendications 6 à 8, dans laquelle l'interface adhésive (33, 133) qui peut être placée face à tout élément (25, 125) de support intermédiaire est placée dans un creux, plus particulièrement dans un creux profond de 0,5 à 1 millimètre agencé dans le corps de la poutre (100).
9. Poutre (100) selon l'une quelconque des revendications 6 à 9, dans laquelle on prévoit à l'extérieur de la surface adhésive (33, 133) une couche de colle plus fluide constituée du même adhésif que dans l'interface adhésive (33, 133).



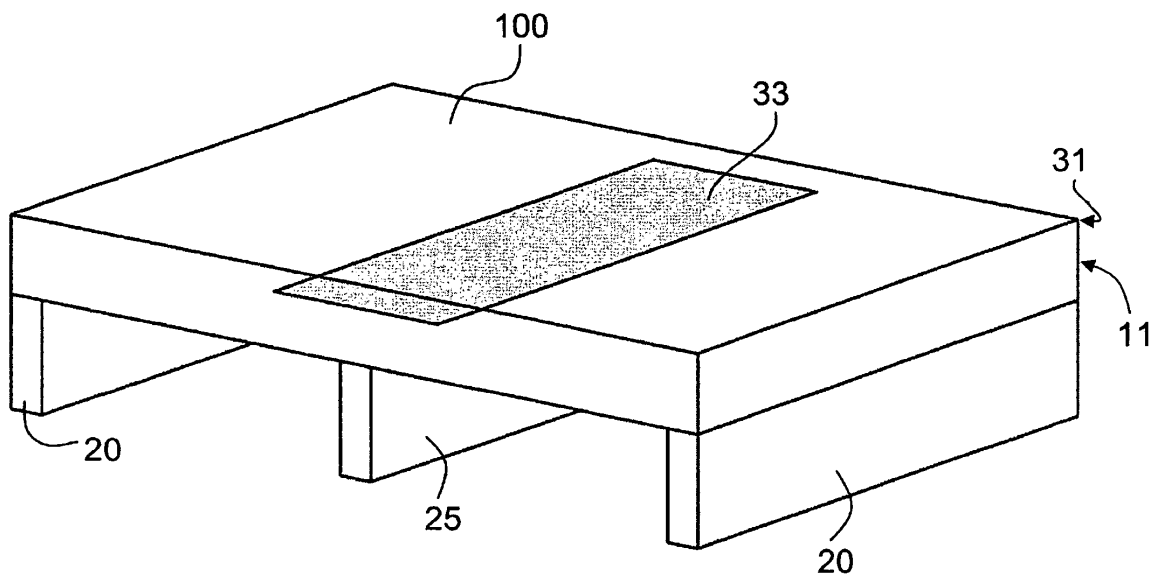
**FIG. 1**



**FIG. 2**



**FIG. 4**



**FIG. 5**

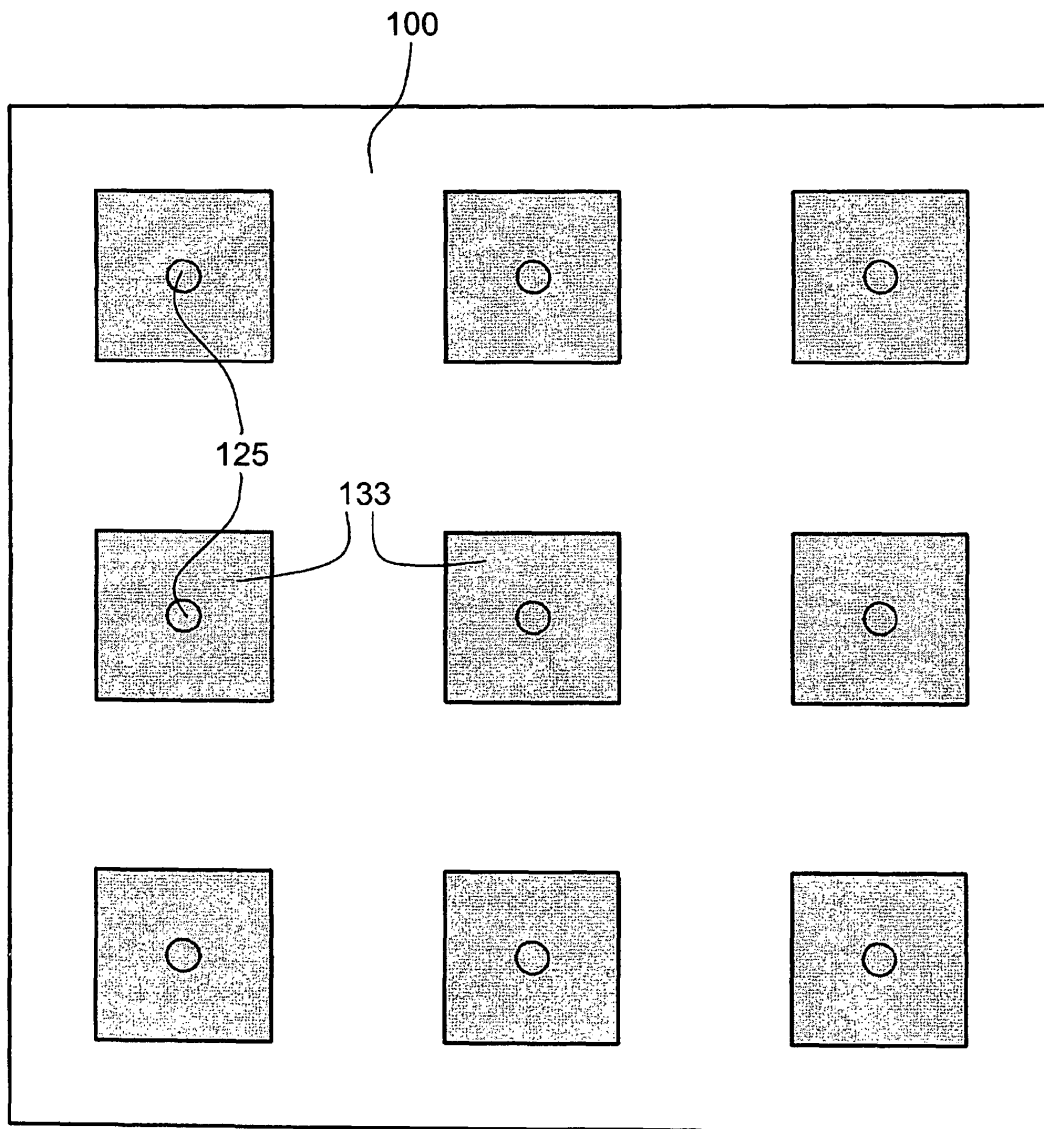


FIG. 6

**REFERENCES CITED IN THE DESCRIPTION**

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