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(54) **A bracket for connecting timber to concrete**

(57) A bracket for connecting timber to concrete, wherein the bracket is formed of metal and comprises a folded plate having: a first planar section having means to facilitate positive locking of the bracket to concrete; a second planar section having means for connection to timber; and a third section integrally joined to each of the first and second sections at non-zero angles; so that the bracket has a "Z" shape.

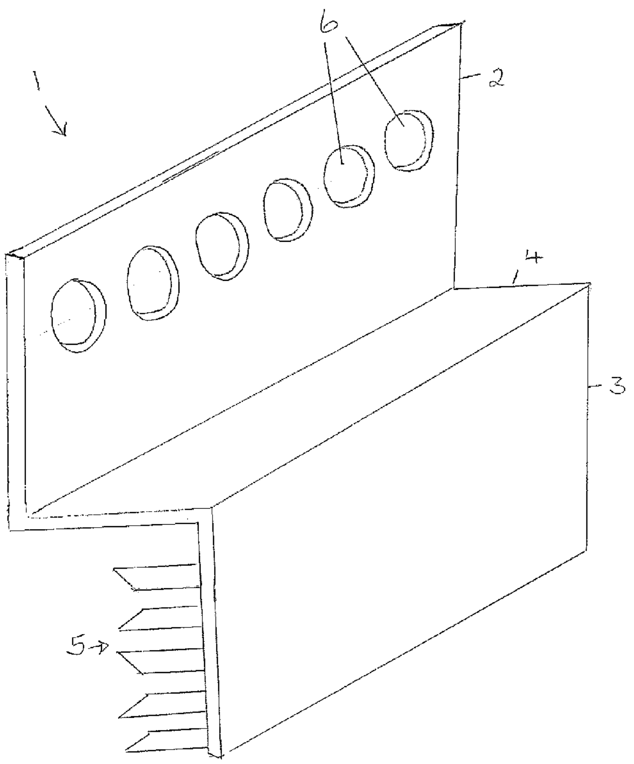

Figure 1

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Description

[0001] The present invention relates to a bracket for use as a connector in building construction.

Background

[0002] In the construction industry different materials are traditionally used for their particular properties in different applications. For example, materials handle load differently: wood is particularly suitable for tension and vertical loads, whereas concrete is better for shear and compression loads. It is thus advantageous to combine the use of wood and concrete in certain components of a building. However connecting different materials together, particularly in a load bearing way, can be difficult because of the different characteristics of the materials. For example, a minimum timber thickness of 80 mm is required for structural connection to concrete because of the need to embed a connector in the timber which is usually done by screwing, meshing or gluing it into a groove.

Summary of the Invention

[0003] According to a first aspect of the invention there is provided a bracket for connecting timber to concrete, wherein the bracket is formed of metal and comprises a first section having means to facilitate positive locking of the connector to concrete, a second section having means for connection to timber, and a third section to which the first and second sections are both integrally joined at non-zero angles, wherein the bracket has generally a "Z" shape and is structurally weaker than each of the timber or concrete to which it is to be connected.

[0004] According to a second aspect of the invention there is provided a bracket formed of metal comprising a folded plate having a first planar section comprising means to facilitate connection to concrete, and a second planar section comprising means for connection to timber, wherein the first and second sections are both connected to a third section and each subtend a non-zero angle with the third section and wherein the plate is weaker than each of the timber or concrete to which it is to be connected.

[0005] Preferably the means for connection to timber comprises a nail plate.

[0006] Advantageously the bracket is engineered to fail at the nail plate connection to the timber.

[0007] In one embodiment the means to facilitate bonding with concrete comprises a plurality of holes through with liquid concrete can flow.

[0008] Use of the bracket in construction assists in combining the advantages of timber with the advantages of concrete and thus optimises the strengths of the two materials. It enables an engineer to split the global load transfer so as to allocate different types of load to materials which are most suitable to deal with it. Ideally most shear and compression forces should be directed into the concrete whilst most tension and vertical loads are ideally directed into the timber.

[0009] In this way, the use of concrete can be targeted to where it is essential, and the amount of concrete in a particular structure can be minimized, with attendant savings in material, weight and cost of the entire structure. Hence the dead load of components can be minimised and the load transferred to the supporting structure can be optimised which has advantages throughout the building including in the foundations.

[0010] Use of the invention effectively strengthens timber components of a build because it enables the shear and compression loads to be transferred to concrete components.

[0011] Building components can be prefabricated to include the bracket of the invention using industrial manufacturing processes to reduce costs for improved quality and reliability, and this optimizes the onsite labour and time needed for the installation of a build. Savings of up to 50% in onsite assembly time can be achieved, particularly in installation of concrete ground or intermediate floors and also in installation of services, ducts and piping work in a floor.

[0012] The use of a "Z" shape for the bracket provides an eccentric load transfer but does not affect the efficiency of the load transfer. This unique shape transfers loads into the flange, i.e. the end face, of the timber rather than the side directly touching the concrete. This has the advantage of adding stiffness to the timber-concrete connection. The shape also facilitates the use of a loose layer of casing sheet between the concrete and the timber beam. Such a casing sheet can vary in thickness according to what is required to stay within the limits of the structurally allowed deflection of the casing sheet in concrete form work. However tests show that this thickness does not affect the load transferring capabilities of the bracket.

[0013] Another advantage of the "Z" shape of the bracket is that it is straightforward to place in the correct position on a timber beam because it is self placing at the outside flange of the timber beam and so no further jigs, grooves or placement supports are needed.

[0014] The shape and the size of the bracket define its load transferring characteristics and the predefined system of placement on a timber beam also aids in standardisation so as to more consistently define the structural robustness of the assembled timber-concrete beam or other component, and thus reduce errors caused by misplacement or wrong calculations.

[0015] The bracket also assists in the placement of a reinforced steel mesh which is usually part of a concrete building component and thus helps to ensure that a minimum coverage thickness of concrete on top of the steel reinforcement is achieved. Traditionally this minimum is 20 mm.

[0016] Forming a joist by fixing a timber beam to a shear stiff concrete panel or slab using the bracket in this way, effectively helps to lock the position of the joist and resist lateral buckling and tipping. It avoids the need to use permanent bracing of floor joists thus reducing costs.

[0017] The bracket can also be used to connect concrete slabs or panels to beams made of combinations of timber and metal, for example to an open web beam known as a Posi-Joist™ beam which is manufactured by the applicant. Such an open web joist comprises two parallel spaced beams of timber connected at intervals by metal webs.

Description of the Drawings

[0018] For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made to the accompanying drawings in which:

Figure 1 is a schematic perspective view of a bracket according to the invention;

Figure 2 is a view of the bracket of Figure 1 in an unfolded flat state;

Figure 3 is an elevational view of the bracket in a folded state;

Figure 4 is a cross-sectional view of the bracket of Figure 1 taken along the line A-A in Figure 3;

Figure 5 is a perspective view of a part of a building showing the bracket of Figure 1 in use;

Figure 6 is a cross-sectional view showing the bracket of Figure 1 in use generally as seen in Figure 5; and

Figure 7 is a cross-sectional view taken along the line B-B in Figure 6.

[0019] Figure 1 shows a general perspective view of the bracket 1 according to the invention. Figure 2 shows the bracket flattened out, i.e. unfolded, and Figures 3 and 4 show a front elevation view and a cross section A-A respectively. It is formed of metal, preferably steel, and comprises three planar sections, integrally connected to each other. A first section 2 and a second section 3 are both shown in a vertical configuration in the figures and will usually be vertical in use. They are both integrally joined to a third section 4 which is generally horizontal, generally to form a "Z" shape in cross section (as shown in Figure 4). Preferably the vertical sections 2 and 3 are joined to the horizontal section 4 substantially at right angles. However in certain applications it may be appropriate to use different angles at these junctions.

[0020] The actual and relative dimensions of sections of the bracket will depend on the application, for example the sizes of timber and concrete pieces to be connected and the loads to be borne. The bracket is chosen to be weaker than the pieces to which it is attached.

[0021] In the example shown, the two vertical sections 2 and 3 are of similar lengths to each other and are longer than the horizontal section 4. The lower vertical section 3 has a nail plate 5, formed on its side which is below the horizontal section 4, for embedding in the side i.e. flange of a timber beam. In use, the horizontal section 4 rests on top of the timber beam and it is thus relatively straightforward to fit the bracket because the horizontal section 4 can be placed on the beam and then the nail plate 5 driven into the flange of the beam by pressure exerted on the opposite side of the lower vertical section 3. This can also be accomplished in a manufacturing facility and supplied to a building site as an assembled component comprising a beam fitted with one or more brackets, to ensure consistency of quality and reduce errors on site, for example in using the wrong size bracket for the size of the beam.

[0022] The upper vertical section 2 of bracket 1 is perforated with a plurality of holes 6 of a suitable size and shape to allow unset concrete to flow through and thus to bond more effectively with the upper vertical section 2. In the example shown these holes are generally circular and in a line across the upper part of the section but it will be readily appreciated that a variety of shapes and sizes would be suitable.

[0023] In Figure 5, the bracket 1 is shown in use. It is attached to an upper chord 21 of a beam 10 by the nail plate 5 embedded in the side of the beam 10 so that the upper vertical section 2 of the bracket is upstanding on the top of the beam 10. The beam 10 may typically be a Posi-Joist™ beam as manufactured by the Applicant. As shown this comprises two parallel struts or chords 21, 22, joined by V shaped metal webs 20.

[0024] A plywood casing 11 rests on top of the beam 10. Alternatively the bracket 1 could be attached to the beam 10 by drilling screws or hammering nails through holes in the bracket into the timber. In this case the strength, stability and durability of the connection would be reduced and the mathematical model would be different.

[0025] A reinforced concrete beam or slab 12 is then formed on top of the timber beam 10 by conventional methods. The concrete flows through the holes 6 in the upper section 2 of the bracket 1 so as to bond to it securely and strongly. For illustrative purposes the concrete beam 12 is about 70 mm thick in this example.

[0026] The concrete is poured *in situ* after the timber beam 10 has been attached to a hanger 13 which is attached to a fixing on a ring beam casing 14, for a typical concrete ring beam 15 constructed on a brick or block wall 16. The concrete in ring beam 15 and in the concrete beam 12 is reinforced with and connected structurally by steel bars or rods 18. The steel bars or rods 18 are usually made of round solid steel bent at about 90° as shown. They serve to transfer the shear loads from the beam 12 into the ring beam 15 and further into the walls 16. The arrows H and V schematically illustrate how horizontal loads H are taken predominately by the concrete in the beam 12, and vertical loads V are taken predominantly by the timber beam 10.

[0027] Figures 6 and 7 show the bracket 1 in use in more detail to form a supporting structure comprising a sandwich of timber and concrete connected using the bracket of the invention. The nail plate 5 is engaged with the side of the timber of Posi-Joist beam 10 and the reinforced concrete beam 12 is bonded with the upper vertical section 2 of the bracket 1. Sandwiched between the timber beam 10 and the concrete beam 12 is a plywood casing sheet 11, and separating it from the concrete beam 12 is a plastic foil 17. The casing sheet 11 may alternatively be a particle board or OSB board. It prevents the wet concrete falling between the floor joists. Normally casing sheets would be removed when the concrete is hardened but in this application it is trapped between the concrete and the timber beam. This is known as a "lost casing system" and has the advantages of saving onsite labour and providing a visually aesthetic screen from the concrete floor and providing means for attaching lightweight items without having to drill the concrete.

[0028] The plastic foil 17 protects the casing sheet 11 from the moisture of the wet concrete and seals small gaps between the edges of the casing sheets.

[0029] A reinforcing steel mesh or net 19 is located in the concrete beam 12 just above the top of the bracket 1. This serves to take tension loads in the concrete beam 12. It can be seen that the presence of the bracket 1 acts as a guide to assist in locating this reinforcing net 19 in the correct position and horizontal orientation.

[0030] The bracket 1 is chosen so that it fails at the timber beam to nail plate junction before either the timber or the concrete fails, i.e. the size and strength of the bracket is matched to the application so that it is marginally weaker than the timber beam or concrete beam. The calculations to achieve this are well known to skilled persons working in the built environment and depend on the sizes and materials of the components and thus their strength. Mathematical models such as the "shear analogy" method and the "frame work" method are used and incorporated into proprietary software and for engineering tables and span tables. The "shear analogy" method is commonly used in steel and concrete construction. The "frame work" method is commonly used in timber constructions. Both are well known to structural engineers.

[0031] The exact dimensions, both relative and absolute, of the bracket to be used, will vary according to the application but one possible example is given below, referring to the letters in Figures 2, 5 and 6:

length of bracket 1:	a = 203 mm
height of first section 2:	b = 60 mm
height of second section 3:	c = 52 mm
depth of third section 4:	d = 23 mm
distance between holes 6:	e = 25.4 mm
diameter of holes 6:	f = 20 mm
distance of holes from top of bracket:	g = 18 mm
height of top chord 21 of beam 10:	h = 60 mm
width of top chord 21 of beam 10:	w = 120 mm
thickness of casing 11:	i = 14 mm
thickness of concrete 12:	j = 70 mm
distance of top of bracket 1 from top of concrete 12:	1 = 24 mm
distance of top of bracket 1 from bottom of concrete 12:	m = 46 mm

[0032] Typically brackets would be spaced about 600 mm apart along the beam, either on one side or parallel on both sides - particularly at or toward the ends (bearings) of the beam or joist where most of the critical shear loads appear. The spacing of the brackets 1 is also determined by the distribution of the metal webs 20 since the brackets 1 sit between the webs 20 and do not overlap them. Alternatively, or in addition, the brackets would be spaced closer together for example about 300 mm apart toward the ends of the beam. In the illustrated embodiment the bracket would be about 250 mm from the end of the beam but this spacing might be shorter or two parallel brackets could be used because this is the zone of maximum shear loads and of transfer into the bearing (i.e. the ring beam 15). This depends on the engineering requirements.

[0033] In the open web beam system shown in figure 5, brackets are generally positioned on the beam 10 between each of the webs 20 which connect the two timber struts 21 forming the beam 10, although only one bracket 1 is shown in figure 5.

[0034] The bracket of the invention would work equally well for beams which are used in non-horizontal orientations. For example it could be used in walls or at any angle and orientation such as in a sloped roof or a round domed roof or a vertical facade panel. In general the bracket of the invention has the advantage of being a versatile and reliable means of connecting timber and concrete to form a single sandwich component. It will work with any shape of beam provided that in section it has a corner of the same shape as the bracket so that the nail plate on the bracket can fully engage with the beam flange. Preferably this is a right angle and the beam will usually be rectilinear or square in cross section, but other angles and shapes can be envisaged for specialist applications.

Claims

1. A bracket (1) for connecting timber (10) to concrete (12), wherein the bracket (1) is formed of metal and comprises a folded plate having:

    a first planar section (2) having means to facilitate positive locking of the bracket to concrete;
    a second planar section (3) having means for connection to timber; and
    a third section (4) integrally joined to each of the first and second sections at non-zero angles;
    so that the bracket (1) generally has a "Z" shape.

2. A bracket according to claim 1 wherein the means for connection to timber comprises a nail plate.

3. A bracket according to claim 1 or claim 2 wherein the means to facilitate bonding with concrete comprises a plurality of holes through which liquid concrete can flow.

4. A bracket according to claim 1, 2 or 3 wherein at least one of the non-zero angles is approximately a right angle.

5. A bracket according to any one of the preceding claims wherein the means for connection to timber is adapted to connect to a flange of the timber.

6. A bracket according to any one of claims 1 to 5 wherein the bracket is engineered to fail at the nail plate connection to the timber.

7. A supporting structure for the built environment comprising:

    a timber beam; and
    a concrete panel;
    joined by a metal bracket which is structurally weaker than each of the timber beam or concrete panel to which it is connected.

8. A supporting structure according to claim 7 wherein the timber beam comprises an open web beam having two timber struts connected by a plurality of "V" shaped metal webs, and a plurality of the metal brackets are connected to one strut at positions corresponding to the middle of the "V".

9. A method of connecting a timber beam to a concrete panel, the method comprising using a bracket according to any one of claims 1 to 6 selected to be structurally weaker than either the timber beam or the concrete panel.

10. A method according to claim 9 wherein a plurality of the brackets are used.

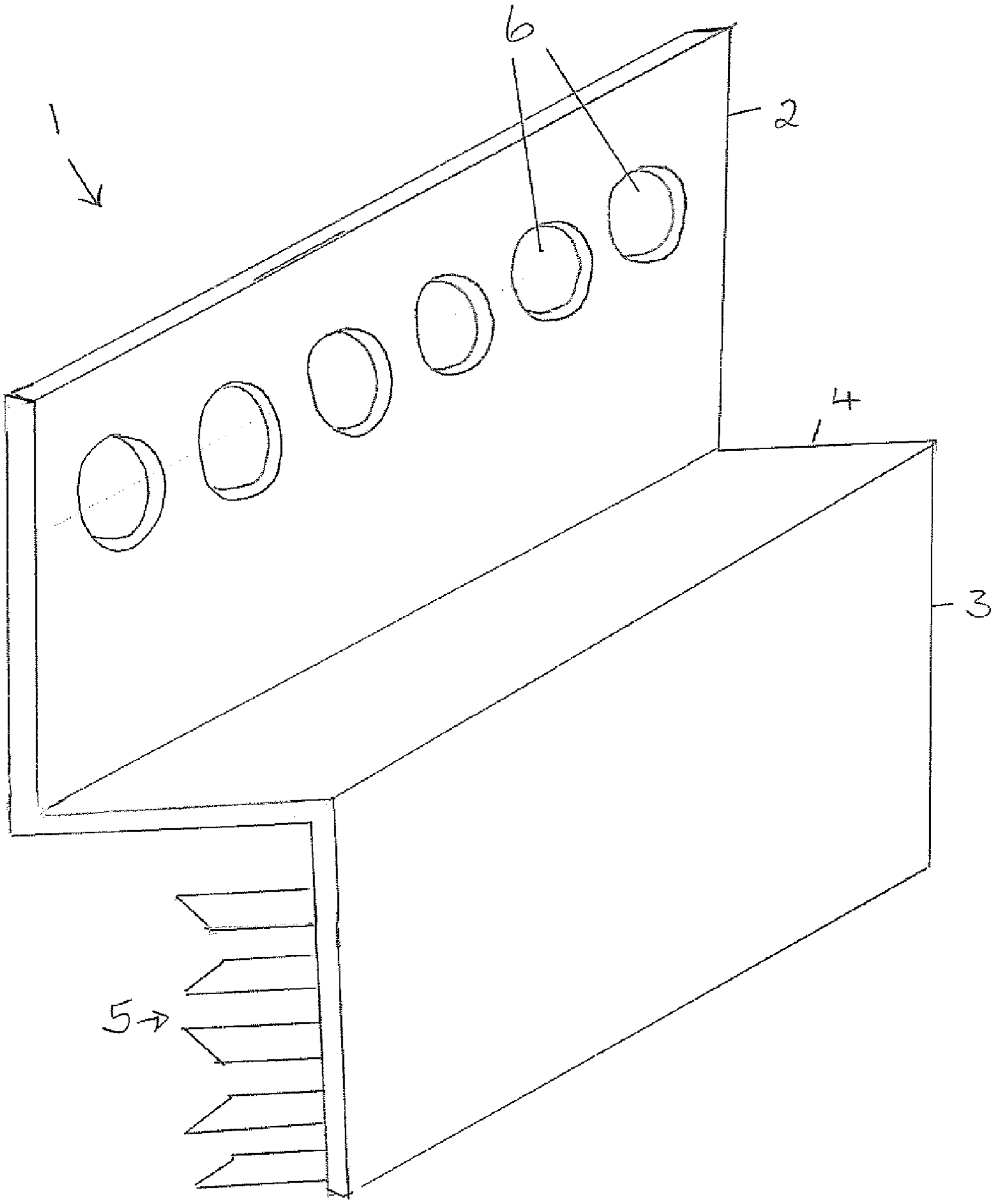

Figure 1

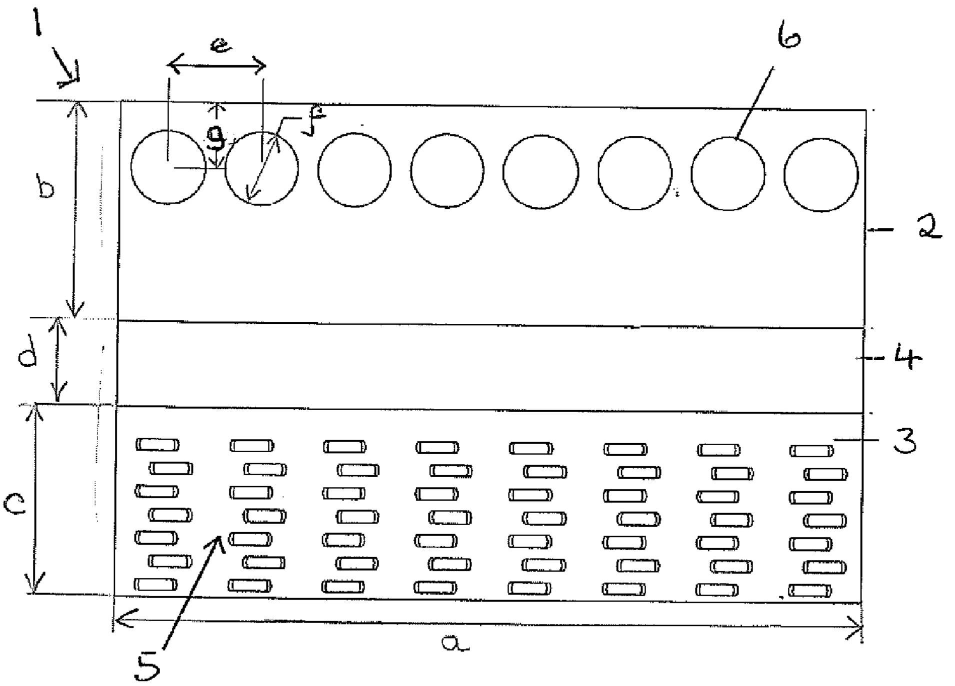

Figure 2

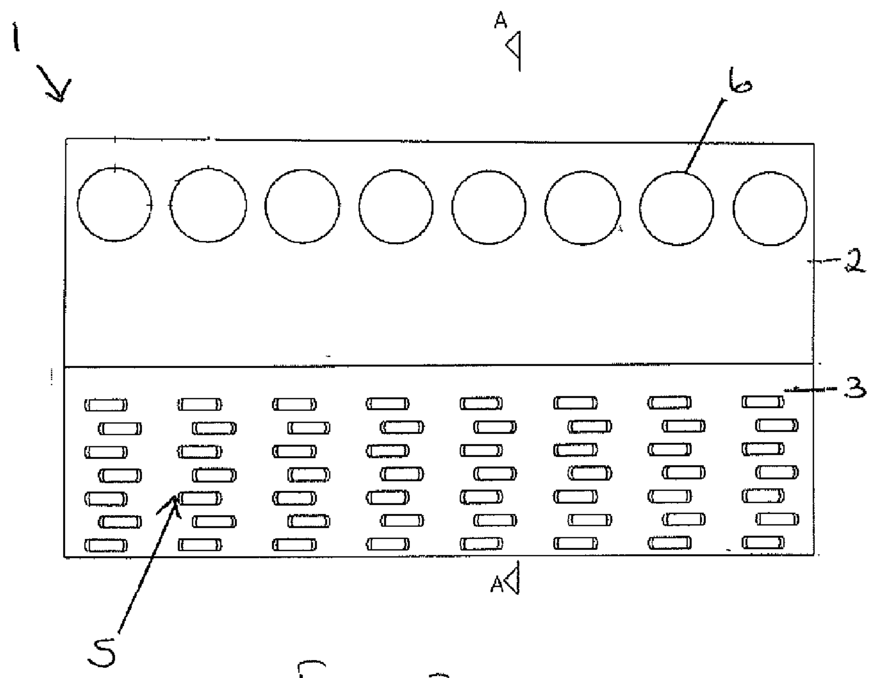

Figure 3

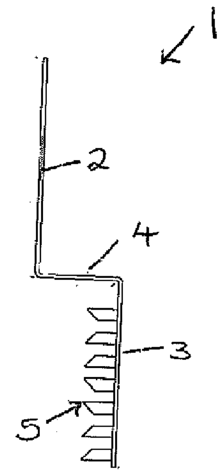

Figure 4

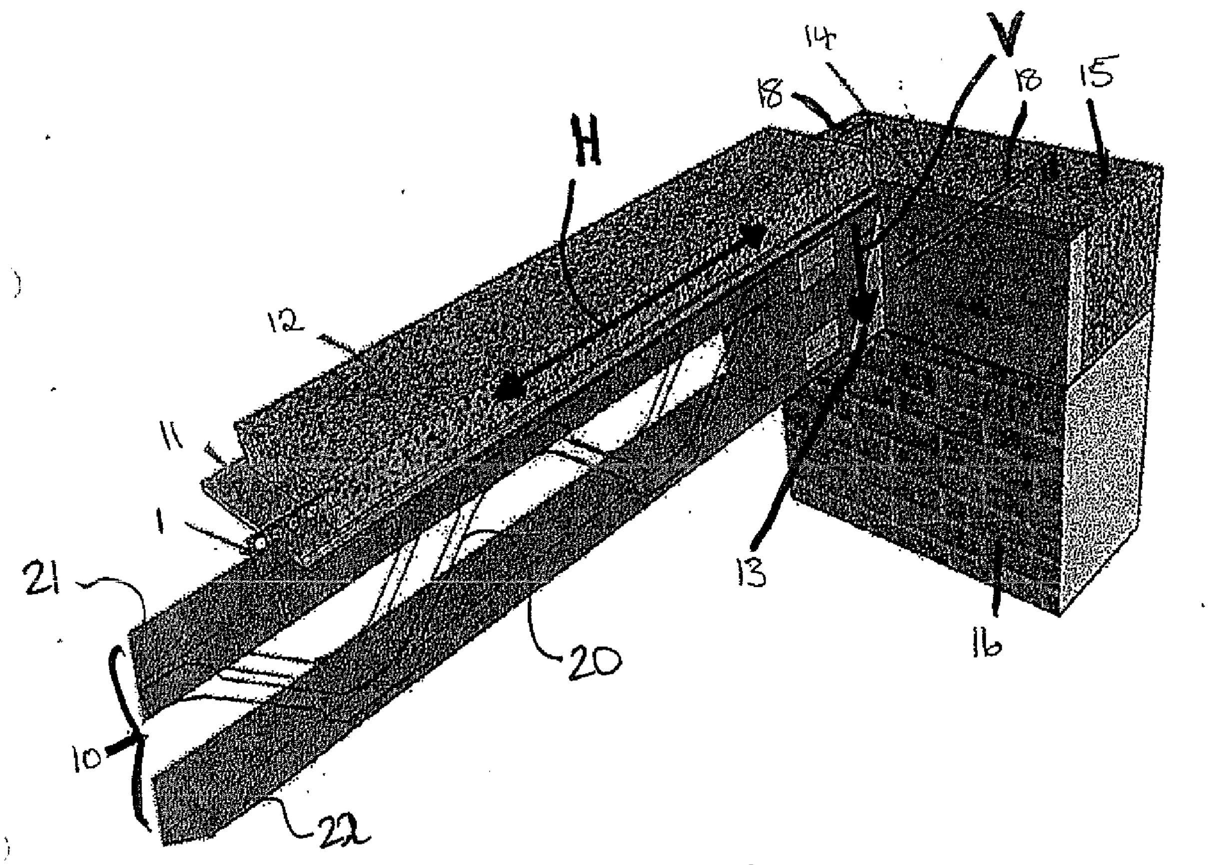

figure 5

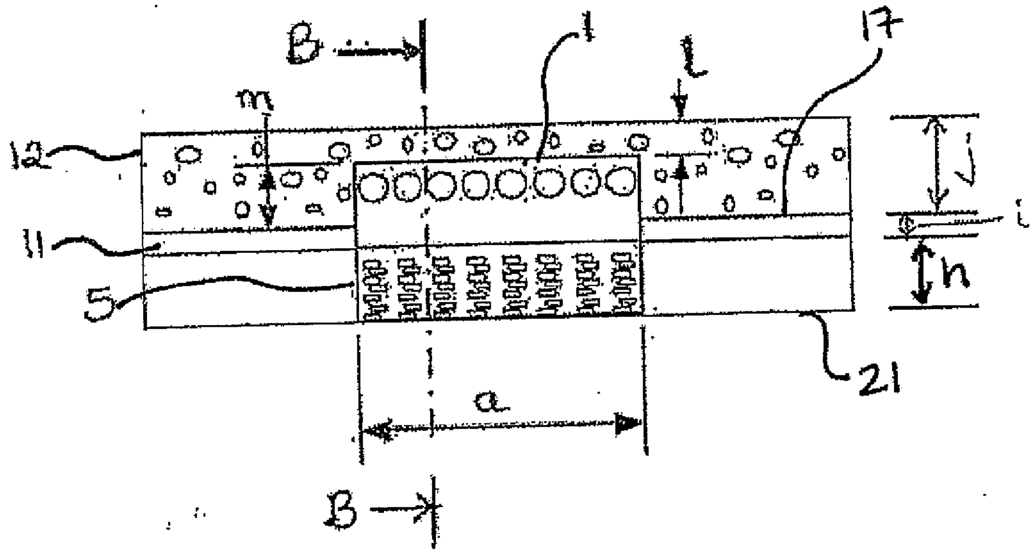

Figure 6

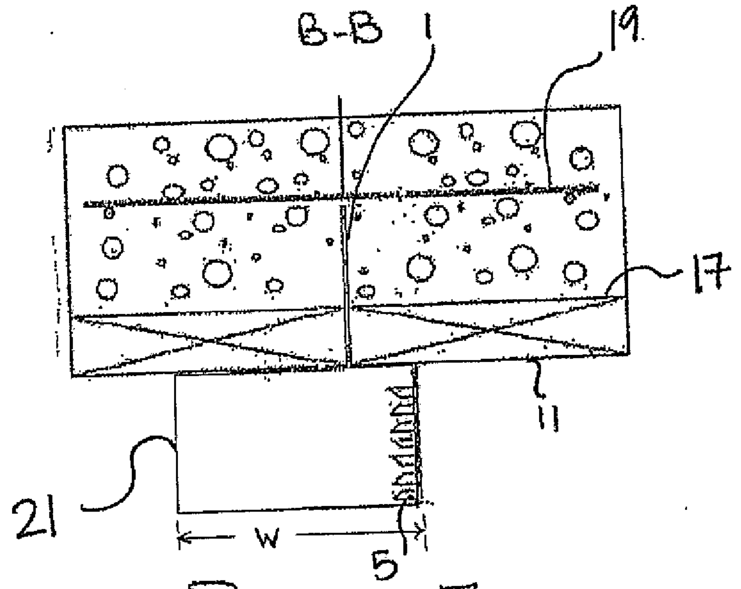

Figure 7

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EUROPEAN SEARCH REPORT

Application Number
EP 11 17 7028

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 January 2012	Stern, Claudio

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X : particularly relevant if taken alone
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