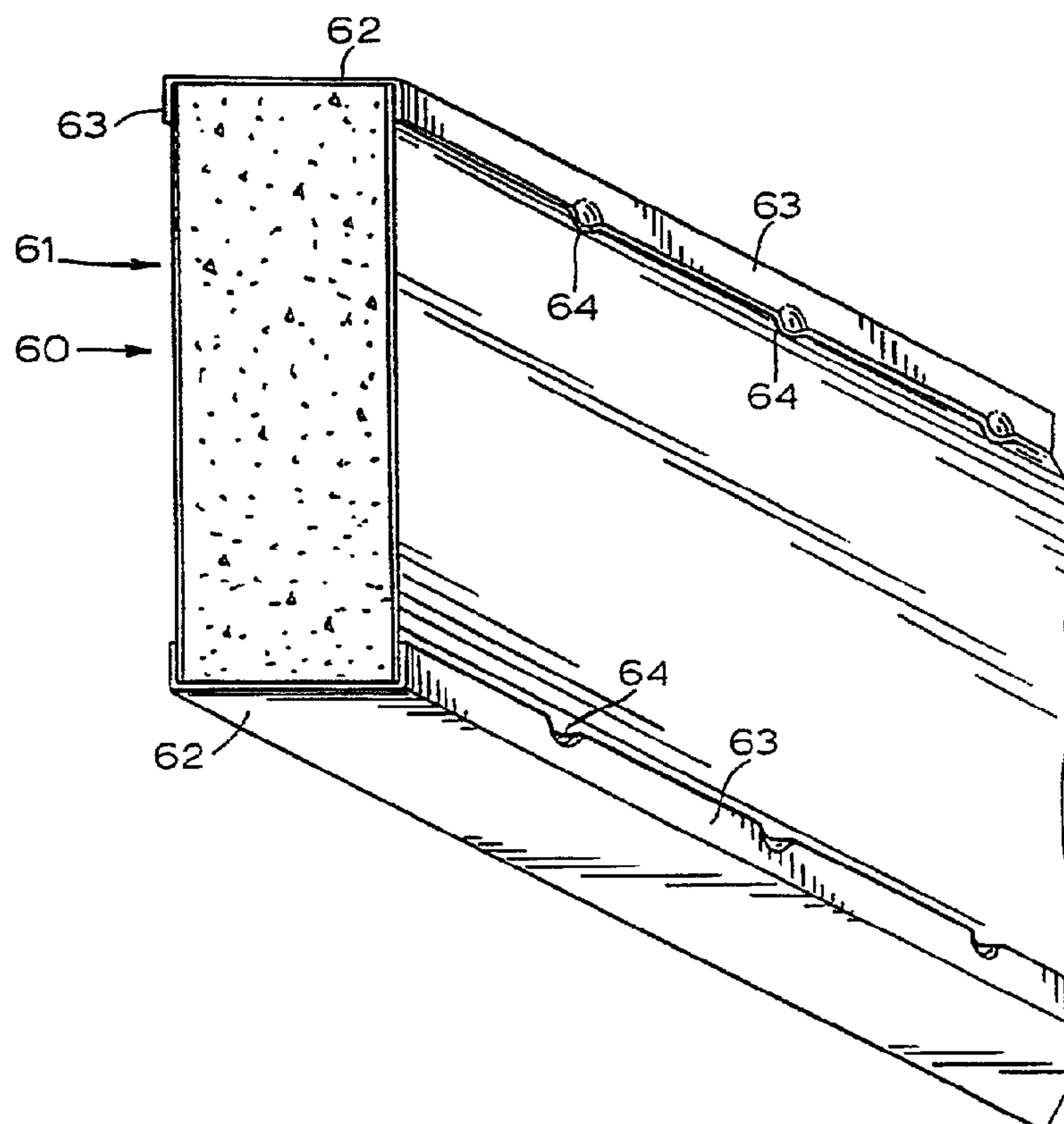




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(54) Title: COMPOSITE STRUCTURAL MEMBER



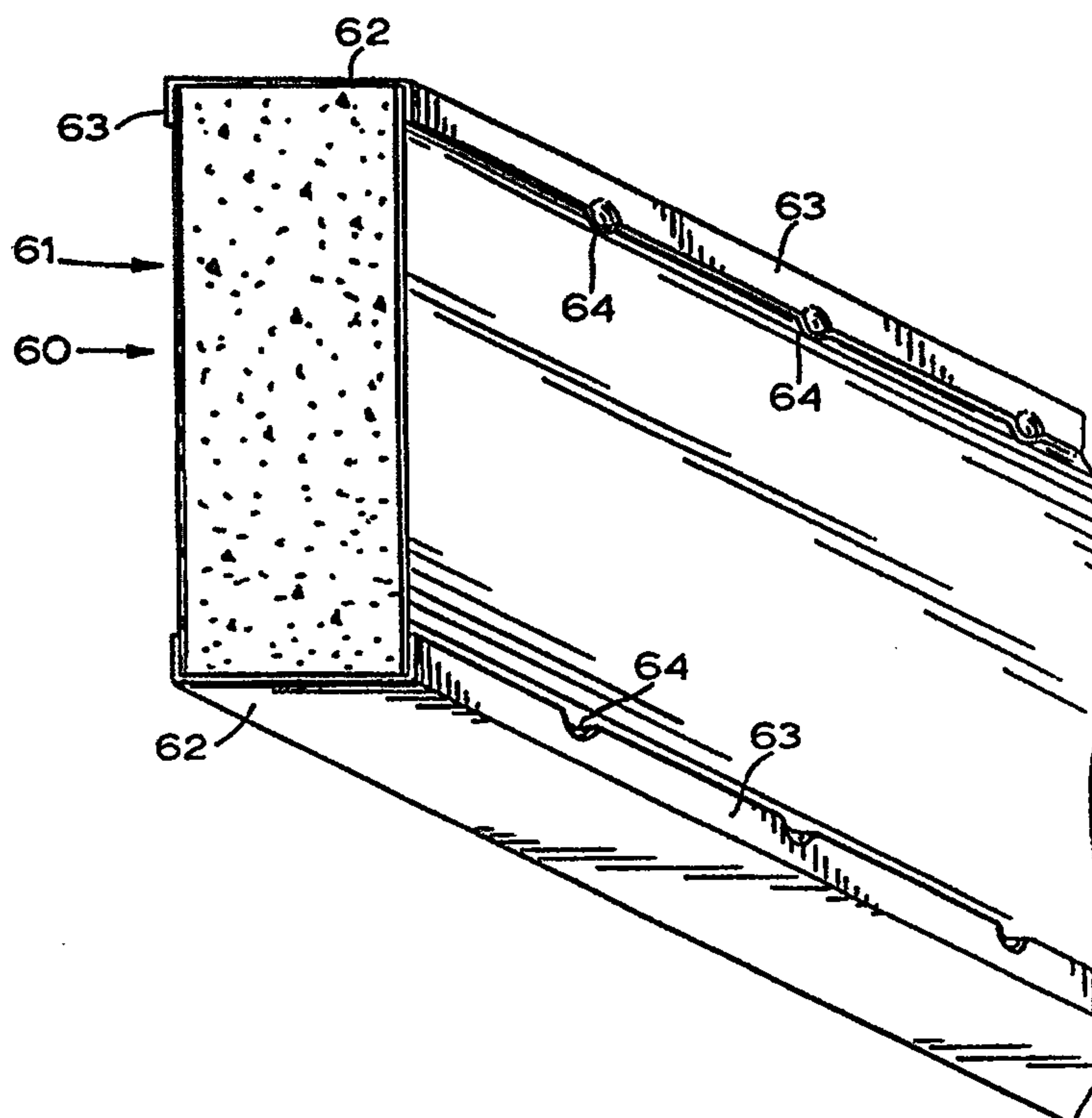
(57) Abrégé/Abstract:

This disclosure relates to a composite structural member (60) comprising a body part (61) and multiple rigid strips (62) which are attached to and separated by the body part (61). The body part (61) is formed by a core having substantially flat parallel sides and opposed edges, and the opposed edges are covered by the rigid strips (62). As an example, the core is made of gypsum, and the strips are made of sheet metal. The rigid strips (62) enable screw fasteners to be secured to the structural member. The sides of the core are preferably covered by backing sheets.

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(54) Title: COMPOSITE STRUCTURAL MEMBER (57) Abstract This disclosure relates to a composite structural member (60) comprising a body part (61) and multiple rigid strips (62) which are attached to and separated by the body part (61). The body part (61) is formed by a core having substantially flat parallel sides and opposed edges, and the opposed edges are covered by the rigid strips (62). As an example, the core is made of gypsum, and the strips are made of sheet metal. The rigid strips (62) enable screw fasteners to be secured to the structural member. The sides of the core are preferably covered by backing sheets.		



COMPOSITE STRUCTURAL MEMBERField and Background of the Invention

5 This invention relates to structural members for use primarily in the construction of houses and other buildings.

10 A typical building, such as a house, includes a variety of different structural or framing members. Examples are wall studs, floor and ceiling joists, roof rafters, partition wall studs, etc. These members have traditionally been made of wood, although in recent years sheet metal studs have found increasing use.

15 While wood performs well, it has drawbacks such as increasing scarcity and the resulting higher cost, and it is susceptible to damage from fire, insects and rot. On the other hand, sheet metal structural members conduct
20 heat (or cold) through a wall, and some metal structural members tend to buckle when exposed to high temperatures. Further, many builders are not familiar with the techniques required to build with metal.

25 It is a general object of the present invention to avoid the foregoing disadvantages by providing a composite structural member having a wood stud-type feel, reduced cost, reduced susceptibility to heat conductivity.

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Summary of the Invention

5 A composite structural member constructed in accordance with this invention comprises a body part and multiple rigid strips which are attached to and separated by the body part. The body part is formed by a core having substantially flat parallel sides and opposed edges, and the opposed edges are covered by the rigid strips. As an example, the core is made of gypsum and the strips are
10 made of sheet metal. Backing sheets of paper may be secured to the sides.

Brief Description of the Drawings

15 This invention will be better understood from the following detailed description taken in conjunction with the accompanying figures of the drawings, wherein:

20 Fig. 1 is a fragmentary perspective view of a wall including structural members constructed in accordance with the present invention;

Fig. 2 is an end view of the wall shown in Fig. 1;

25 Fig. 3 is an enlarged fragmentary sectional view taken on the line 3-3 of Fig. 2;

Fig. 4 is a further enlarged sectional view illustrating a structural member shown in Fig. 3;

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Fig. 5 is a view similar to Fig. 4 but illustrating an alternative construction;

Fig. 6 is a perspective view further illustrating the structural member shown in Fig. 4;

Figs. 7, 8 and 9 are fragmentary sectional views showing alternative constructions of the structural member;

Fig. 10 is a fragmentary sectional view showing still another form of the invention;

Fig. 11 is a view illustrating the manufacture of the member shown in Fig. 10;

Figs. 12 and 13 are views similar to Figs. 10 and 11 but illustrating still another alternative form of the invention;

Figs. 14 and 15 are views illustrating the manufacture of still another embodiment of the invention;

Fig. 16 is a view illustrating another embodiment of the invention;

Figs. 17, 18 and 19 illustrate steps in the manufacture of another embodiment of the invention;

Fig. 20 is a view of a part of the structural member shown in Figs. 17 through 19;

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Fig. 21 is a view of another embodiment of the invention;

5 Fig. 22 is a sectional view of still another embodiment of the invention;

Fig. 23 is a diagram of a building including structural members in accordance with the invention;

10 Fig. 24 is a view of a truss constructed in accordance with the invention;

15 Fig. 25 is a sectional view of another building including structural members in accordance with the invention; and

Fig. 26 is a view of another structural member in accordance with this invention.

20 Detailed Description

25 With reference first to Figs. 1 through 3, there is illustrated a wall 30 which may be a partition wall, for example, of a house or other type of building. The wall 30 includes a plurality of vertically extending composite studs 31 constructed in accordance with the present invention which are spaced apart in the horizontal direction. In the present instance, the studs 31 are fastened at their lower ends through a C-shaped metal floor channel 32 and are fastened at their upper ends through a C-shaped metal ceiling channel 33. One side of the chan-

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- 5 -

nels and the studs 31 is covered by a board 34 and the other side is covered by a board 35, thereby forming a hollow wall since the studs 31 both separate and support the boards 34 and 35. In the present specific example of the invention, the two boards 34 and 35 are gypsum wall-boards.

With specific reference to Figs. 3 and 4 which show one of the studs 31, the stud 31 comprises a main body 41 and two rigid strips 42 and 43. The main body 41 includes a core 44 formed, for example, of gypsum and cover or backing sheets 45 and 46 secured to the two sides of the core 44. The main body 41 includes two edges 47 which are covered by the rigid edge strips 42 and 43. The two rigid strips 42 and 43 are preferably made of sheet metal, and in the embodiment of the invention illustrated in Figs. 1-4, the two strips 42 and 43 cover the edges 47 and each includes flanges 48 which fold or extend over the backing sheets 45 and 46. The strips 42 and 43 are firmly secured to the main body 41, and the boards 34 and 35 are secured to the members 31 by screw fasteners 49. The fasteners 49 extend through the boards 34 and 35 and self-thread through the rigid strips 42 and 43 and firmly secure the boards 34 and 35 to the strips. Since the strips are, in turn, secured to the main body 41, the boards 34 and 35 are separated by and secured to the studs 31.

As a specific example of the invention, the core 44 is made of gypsum and its sides are covered by backing sheets 45 and 46 of the type normally used to cover ordi-

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nary gypsum wallboard. The depth of the studs 31, or in other words the distance between the adjacent sides of the boards 34 and 35, is substantially equal to 3-5/8", and the thickness of the studs (the distance between the sheets 45 and 46) is substantially 1-1/4". These dimensions are the most common size for conventional wall studs. The strips 42 and 43 are made of sheet metal preferably having a minimum thickness of 0.0179 inch, and the flanges 48 have a length of approximately 1/4".

The stud 31 constructed in accordance with this invention has a number of advantages. Its cost may be substantially less than the cost of a comparable size wood or metal stud. The main body 41 is relatively fire-resistant and does not conduct heat readily between the two boards 34 and 35. The metal strips 42 and 43 cover and protect the end surfaces of the core 44 and they also form members to which screw fasteners may be firmly secured. The studs may have the size and feel of wood studs and may be handled with essentially the same construction techniques as wood studs.

The stud construction shown in Figs. 3 and 4 may include a main body formed by a single sheet of gypsum shaft liner, which is normally approximately 1" in thickness. With the addition of the flanges 48, such a stud will have an overall thickness of approximately 1-1/32". Instead, the stud shown in Figs. 3 and 4 may be formed of a single core having a standard stud size of a thickness of 1-1/4" and a width of 3-5/8".

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Fig. 5 illustrates a preferred construction wherein the main body of a stud 51 is formed by two layers 52 and 53 of 5/8" gypsum board. Each of the layers 52 and 53 is covered on both sides by backing sheets 54, and the edges are covered by rigid strips 55 which extend across both layers. The adjoining backing sheets 54 of the two layers 52 and 53 may be fastened together by an adhesive, and the strips 55 may be secured to the two layers 52 and 53 by an adhesive.

10

Figs. 6 through 13 illustrate different methods of securing the rigid strips to the main body. In each instance, the main body may be formed by a single layer of core material and backing sheets as shown in Fig. 4. or by two layers as illustrated in Fig. 5.

15

With reference first to Fig. 6, a structural member 60 is illustrated which includes a main body 61 and two edge strips 62. Each of the edge strips 62 includes flanges 63 as previously described, and the flanges 63 are secured to the main body 61 by crimps or indentations 64 at spaced locations along the length of the structural member 60. The crimps or indentations 64 are provided in place of or in addition to an adhesive between the strips and the core and the backing sheets of the main body 61.

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Fig. 7 illustrates a structural member including a main core 66 and edge strips 67 (only one shown), wherein flanges 68 of the edge strips 67 are secured to the main body 66 by staking as indicated by the numeral 69 at

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spaced locations along the length of the structural member.

Fig. 8 illustrates a structural member 71 similar to the member 60 shown in Fig. 6. However, it is formed by two layers 72 and 73 instead of a single layer, and by rigid edge strips 74. The edge strips 74 are secured to the two layers 72 and 73 by crimps 75 similar to the structure shown in Fig. 6. The two layers 72 and 73 are preferably glued together and they may be fastened by an adhesive to the edge strips 74.

Fig. 9 shows a structural member 77 including a main body 78 and two edge strips 79. Each edge strip 79 includes two flanges 80 which are pressed toward each other and into the sides 81 of the main body 78, thereby securing the edge strips to the main body.

With reference next to Figs. 10 and 11, two edge strips 82 (only one shown in Figs. 10 and 11) are secured to a main body 83. Each of the edge strips 82 has two flanges 84 and each of the flanges has preformed prongs 85 formed in them at spaced locations. The prongs 85 may be precut by a punching operation. As is shown in Fig. 11, to assemble an edge strip 82 with the main body 83, the center portion of an edge strip 82 is positioned against an edge of the main body and then the flanges 84 are bent downwardly and inwardly to drive the prongs 85 into the main body 83 and secure the edge strip to the main body 83.

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With reference to Figs. 12 and 13, the main body 88 has edge strips 89 attached to it. Each of the edge strips 89 includes flanges 90 and the flanges have edge portions which are bent inwardly to form flange lips 91. The main body 88 has grooves 92 formed along the sides 93 adjacent the edges of the main body, and the flanges 90 are bent inwardly as best shown in Fig. 13 to cause the flange lips 91 to fold into the grooves 92. Preferably the lips 91 extend at substantially a right angle to the adjacent portions of the flanges 90 and the grooves 92 are shaped to engage the lips 91. Thus, each of the grooves 92 has a surface 94 which is at a right angle to the side 93 and is engaged by the lip 91, and another surface 95 which is sloped or angled to provide clearance for the lip 91 when the flange 90 is bent inwardly.

Figs. 14 and 15 illustrate a construction wherein edge strips are secured to a main body by covering it with a sheet of backing material. A structural member 101 formed by two board layers 102, and each of the boards has backing sheets 103 on both sides. A flat strip 104 of rigid material is positioned against the edge 105 of the main body 101, and the width of the strip 104 is substantially equal to the overall width of the main body 101. A cover strip 106 is positioned over the strip 104, and the strip 106 is sufficiently wide that it folds over the edges of the strip 104 and onto the outer sides of the layers 102. The folded over portions 107 are securely fastened by an adhesive to the sheets 103 of backing material, thereby securing the edge strip 104 to the main body 101. As previously described, edge strips

- 10 -

104 and strips 106 are provided along each edge of the main body 101. The cover strips 106 may be made of backing paper or other sheet material.

5 Fig. 16 illustrates a structural member including a main body 111 and edge strips 112 secured to opposed edges of the main body. In this instance, two layers 112 of board are secured together to form the main body. Each edge strip 112 includes a downwardly bent flange 114
10 and layers 115 of adhesive secure the flanges 114 to the outer backing sheets of the layers 113. In this instance, the center portion of each edge strip (that is the portion of the edge strip between the two flanges 114) may not be secured to the main body 111.

15 In the foregoing described embodiments of the invention, the edge strips are secured to one or more layers of core material, after the core material has been formed. Normally the layers have been cut or formed into
20 long strips. In the embodiments shown in Figs. 17 through 22, the core material of the main body may be extruded or cast in place and secured to the backing sheets and to the edge strips before it has set. With reference first to Figs. 17 to 19, a structural member
25 120 is formed by a core 121, two backing sheets 122 and 123 and two rigid edge strips 124. The core 121 is made, for example, from gypsum and may be cast in place or extruded in the shape shown in Fig. 17. After the core 121 has been formed of a gypsum slurry but before the
30 gypsum has set by passing through a drying stage, the two rigid strips 124 are positioned against the edge surfaces

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126 and then the backing sheet 122 is folded over one side 127 of the core, over the two rigid strips 124, and then over at least part of the other side 128 of the core. The second backing sheet 123 is then positioned against the side 128 and overlies the folded edge portions of the sheet 122. After the parts have been assembled and are in the condition shown in Fig. 19, the assembly is moved through a drying kiln to produce the resulting structural member. The backing sheet 122 may be sufficiently wide that it completely envelopes the core 121, thereby eliminating the need for the second sheet 123.

With reference to Fig. 20, the rigid edge strips 124 preferably include a plurality of perforations 129 which extend through the strips. The perforations 129 permit the slurry, used in forming the core 121, to pass through and engage the backing sheet 122 and attain a better attachment with the backing sheet at the edges of the member.

Figs. 21 and 22 also show two embodiments where the backing sheets and the end strips are secured to the core and backing sheets before the core slurry has finally set. In Fig. 21, a core 135 of, for example, gypsum slurry is formed and a backing sheet 136 is folded around one side, the edges and over a portion of the opposite side. A second backing sheet 137 is then applied to the other side of the core. The backing sheets are, of course, similar to those shown in Fig. 17-19. Extending along the edges of the core are two rigid edge strips 141.

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which have flanges 142. The flanges 142 angle inwardly and they extend into indentations 143 in the core 135 and the backing sheet 136, thereby forming a firm connection between the edge strips 141 and the core 135. The flanges 142 may be initially angled inwardly as shown in Fig. 21 before the core slurry is poured into the backing paper, or the flanges may be bent inwardly and the indentations 143 formed after the core slurry has been poured. Instead of two sheets 136 and 137 of backing paper, a single sheet may be provided, having a width sufficiently wide that the edges overlap and form an envelope around the core.

Fig. 22 shows a structural member similar to that shown in Fig. 21 and includes a core 146 having backing sheets 147 along opposite sides, and edge strips 148 along the opposed edges. The structural member shown in Fig. 22 is, of course, similar to the member shown in Fig. 21 except that the backing sheets do not extend across the edges of the core and underneath the rigid strips.

Figs. 23, 24 and 25 illustrate additional structural members incorporating the present invention. With regard to Fig. 23, a cutaway view of a house 153 mounted on a foundation 154 is illustrated. The house includes load carrying floor joists 156, ceiling joists 157, wall studs 158, roof rafters 159, and studs 160 forming an interior partition. All of the members 156-160 may be formed by composite structural members in accordance with the present invention. The floor and ceiling joists and the roof

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rafters 159 preferably have increased cross-sectional dimensions sufficient to withstand the structural forces imposed on them.

5 Fig. 24 illustrates a truss 166 which may be particularly useful in a manufactured home, for example. The truss 166 is formed by a single panel forming a main body 167 shown in Fig. 3. The peripheral edges of the main body 167 have rigid edge strips 168 secured to them, so
10 that other parts of the structure may be secured by screw fasteners to the truss 166. While the main body 167 as illustrated is imperforate, it may include openings for utilities such as conduits and wires. It should be noted that the wall studs and other structural members de-
15 scribed herein may have openings preformed through the main body to receive wires, etc.

 Fig. 25 illustrates a section of a rather large building including vertical columns 171 and horizontal
20 floor and ceiling slabs 172 and 173. Curtain walls 174 are mounted at the exterior of the building. Reference numerals 175 and 176 indicate partition walls including wall studs 177 constructed in accordance with the present invention. Since the walls 175 and 176 function to di-
25 vide or separate the interior space on a floor of the building and are not load bearing, the core of the structural members may be formed of a relatively lightweight material such as lightweight gypsum. Load bearing refers to a load parallel to the long length of a stud; such a
30 stud will normally bear a transverse load, that is, a load which is substantially perpendicular to the long

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length of the stud. The curtain wall 174 is also not load bearing and may be structured in accordance with this invention.

5 In the previously described embodiments of the invention, the main body of the structural members includes a core at least partially covered by at least one backing sheet. Fig. 26 illustrates an embodiment of the invention wherein the core 181 forming the main body has sufficient structural integrity that exterior backing sheets
10 are not needed. For example, the core 181 may be made of a gypsum-cement composition, or it may be made of gypsum with a fiber filler or binder. In Fig. 26, the number 182 indicates the strands of a fiber such as the paper
15 fiber normally used in the above described backing sheets. In such an instance, backing sheets are included in the main body but are incorporated in the core material. The core 181 is secured to edge strips 183 made, for example, of sheet metal. The strips 183 include inwardly
20 angled flanges 184. The member shown in Fig. 26 is preferably constructed by casting the core 181 in place between the flanges 184.

25 Structural members incorporating the present invention may have cores made from a variety of different materials, such as gypsum, gypsum-cement compositions. For example, standard weight or lightweight gypsum, or recycled gypsum, or a moisture-resistant gypsum core, may be used. Various fillers, such as wood chips and/or
30 volcanic material, may also be included. The backing sheets may also be made of a variety of different materi-

- 15 -

als, so long as the material has good shear resistance, such as paper, or paper treated for moisture resistance, sheets of woven fiber, etc. The edge strips do not necessarily have to be made of metal but could, for example, be made of a strong plastic, so long as they are able to facilitate the attachment of fasteners to the structural member.

A structural member in accordance with this invention has numerous advantages. In addition to a lower cost as compared with wood and all metal parts, the structural members have good resistance to heat or cold transfer. While the edge strips may be made of metal which are good heat conductors, the strips on opposite sides of a member are separated by a low heat conducting core material, and therefore reduced heat or cold is transferred from one side to another. In addition, the core acts as a heat sink (it absorbs heat), and heat drives moisture out of a core material such as gypsum and thus dissipates the heat. Screw fasteners used to secure boards 34 and 35 to the studs are buried in the core materials of the boards and the studs and thus are protected against overheating.

The structural member is made sufficiently strong and rigid by the combination of the core material, the backing sheets and the rigid strips. The core serves to hold the backing sheets in straight parallel planes, and the backing sheets give the member strength and stiffness. The edge strips add further rigidity and strength. The backing sheets provide needed strength against a

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transverse force (that is, a force perpendicular to the plane of the backing sheet).

5 Since the backing sheets and the rigid strips provide strength, the core may be made of a less costly material, such as lightweight gypsum, recycled gypsum, or a composition including inexpensive fillers.

10 Since the structural member is relatively stiff and may be secured using screw fasteners, it may be handled similarly to wood products.

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What is claimed is:

1. A structural member for supporting at least one board comprising a nonheat conducting core member, said core member comprising a substrate material
5 and further having first and second spaced apart sides and first and second spaced apart edge surfaces and non-metallic first and second edge strips, the improvement comprising:

said core being susceptible to deflection in
10 response to a load applied to one of said first and second edge surfaces, said first and second edge strips engage and cover said first and second edge surfaces, respectively, said edge strips being separated and spaced apart by said core member, said edge strips being
15 susceptible to deflection in response to the load applied to a surface of said edge strips, said edge strips covering a respective one of the first and second edge surfaces and said edge strips in cooperation with said core impeding bending of the structural member in
20 response to the load applied to the edge surfaces when the structural member is attached to the at least one board.

2. The structural member as set forth in
25 Claim 1, wherein said core member comprises a composition including gypsum.

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3. The structural member as set forth in Claim 1, wherein said core member comprises a composition including gypsum and a filler material.

5

4. The structural member as set forth in Claim 3, wherein said filler material comprises at least one material selected from the group of materials including paper fibers, synthetic fibers, wood chips and volcanic material.

10

5. The structural member as set forth in Claim 1, wherein said edge strips comprise cover sheets, said cover sheets having first and second portions that overlap and cover a portion of said first and second sides, respectively.

15

6. The structural member as set forth in Claim 1, wherein at least one of said cover sheets substantially covers said first side, overlaps each of said first and second edges, and has portions disposed on said second side.

20

7. The structural member as set forth in Claim 1, wherein said edge strips are formed of a

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nonwoven material, a plastic material or a paper material.

8. The structural member as set forth in
5 Claim 7, wherein said nonwoven material is a paper composition.

9. The structural member as set forth in
Claim 1, wherein said edge strips are formed integral
10 with a cover sheet.

10. The structural member as set forth in
Claim 1, further comprising first and second
reinforcement members, said first and second
15 reinforcement members being disposed between said first edge and said first edge strip and between said second edge and said second edge strip, respectively.

11. The structural member as set forth in
20 Claim 1, wherein said core member comprises at least one gypsum board formed by a gypsum core and backing sheets.

12. The structural member as set forth in
Claim 1, wherein said core member comprises at least two
25 gypsum boards which are secured together.

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13. The structural member as set forth in Claim 1, wherein said structural member is sized to form a wall stud.

5 14. The structural member as set forth in Claim 1, wherein said structural member is sized to form a joist, a roof rafter, or a truss.

10 15. The structural member as set forth in Claim 1, wherein said core member is made from a cementitious composition comprising gypsum and said edge strips are made from paper.

15 16. The structural member as set forth in Claim 1, wherein each edge strip has perforations formed therein.

20 17. The structural member as set forth in Claim 1, wherein said edge strips are adapted to securely retain a screw fastener.

25 18. The structural member as set forth in Claim 1, wherein said edge strips include extension portions which extend beyond the first and second end surfaces of the core member.

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19. A wall structure comprising two
substantially parallel wall panels, said panels being
spaced apart to form a wall space therebetween and said
panels being made of gypsum board, and at least one stud
5 located in said wall space, said stud being formed in
accordance with any of claims 1-18.

FIG. 2

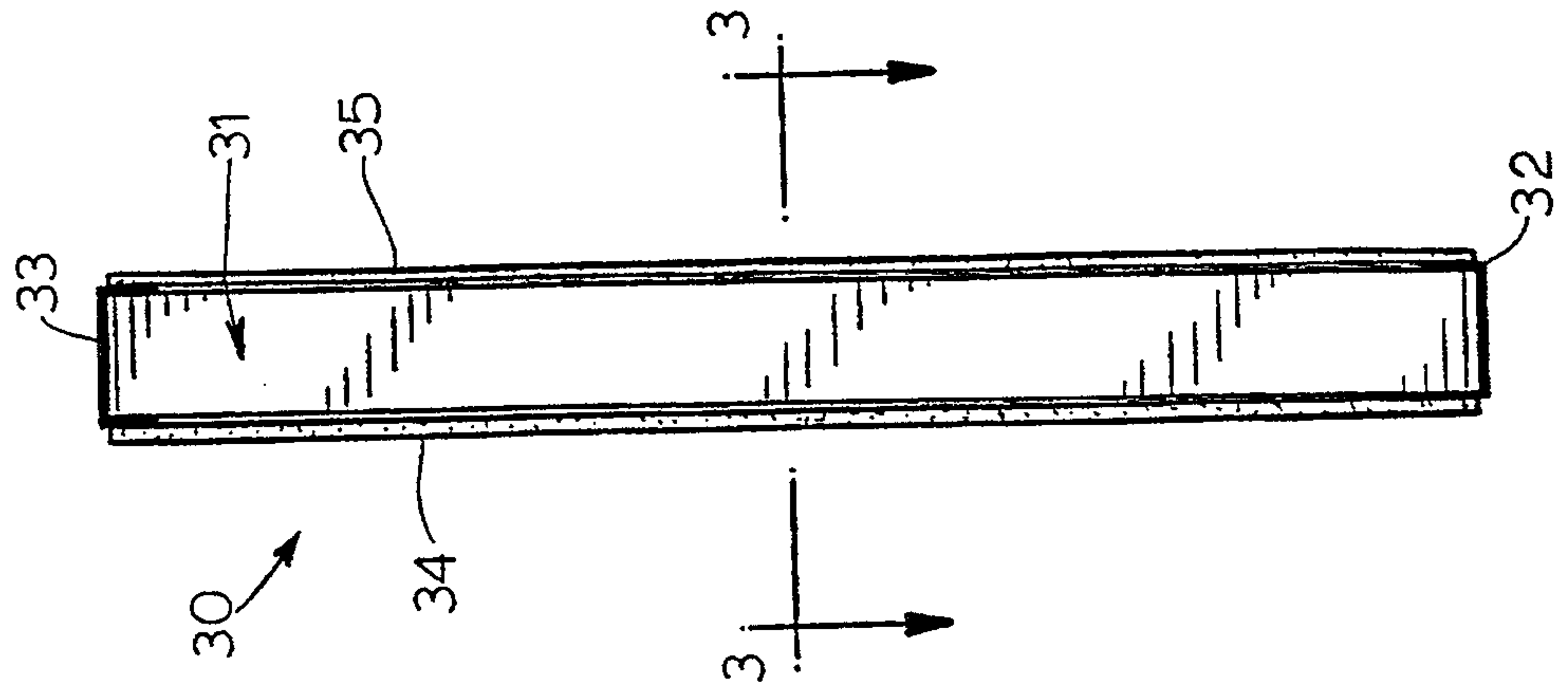


FIG. 1

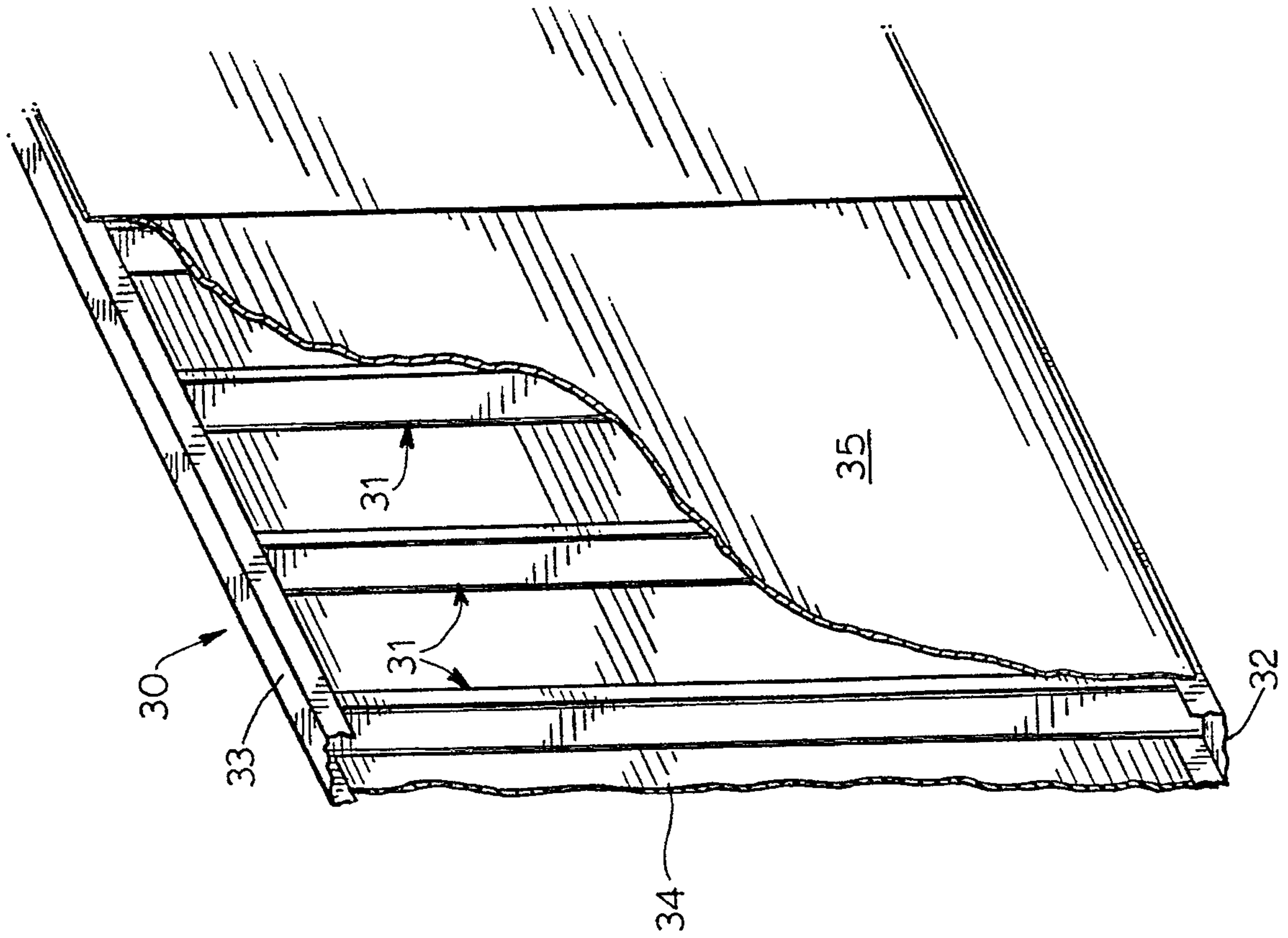


FIG. 6

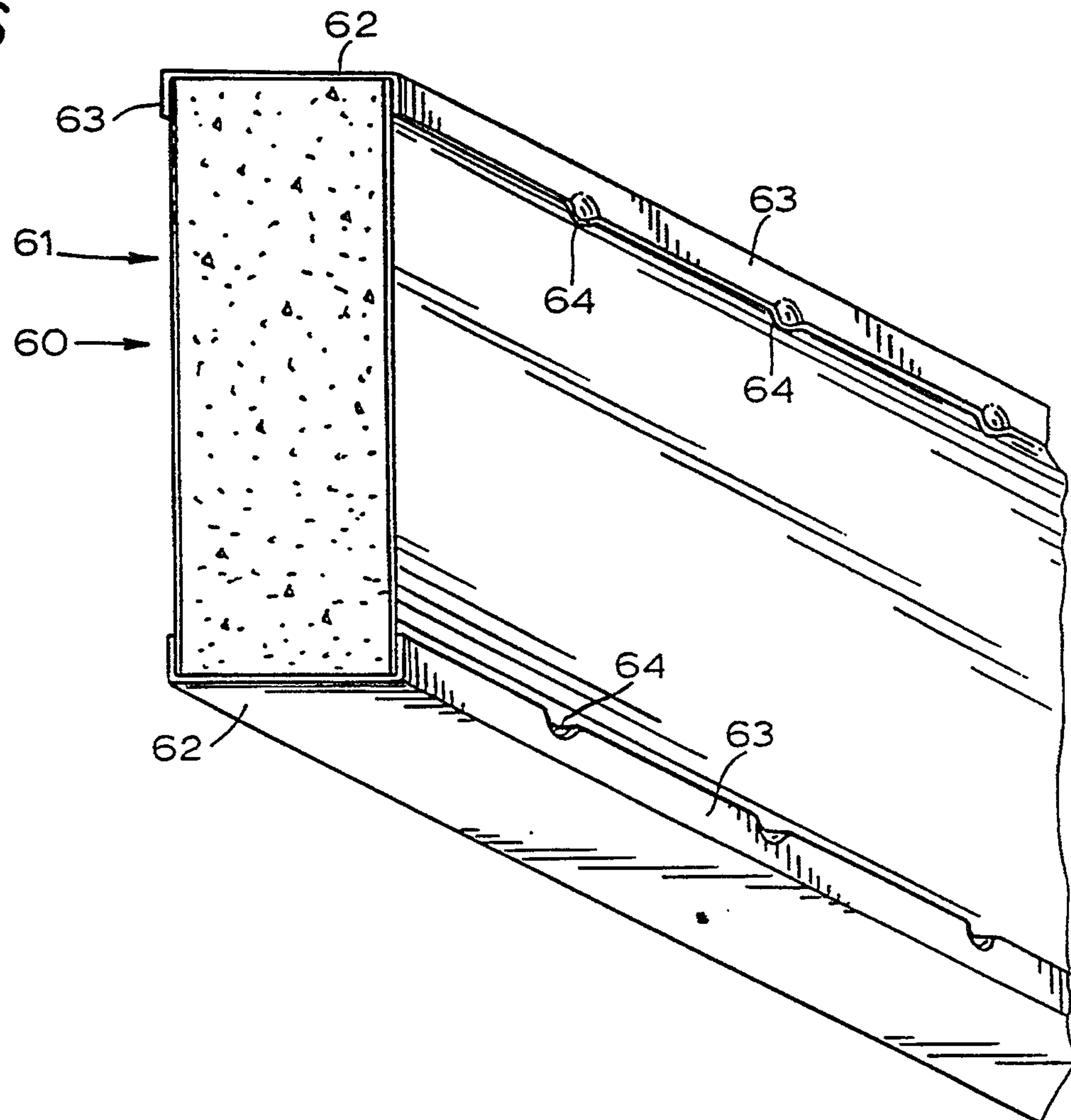


FIG. 3

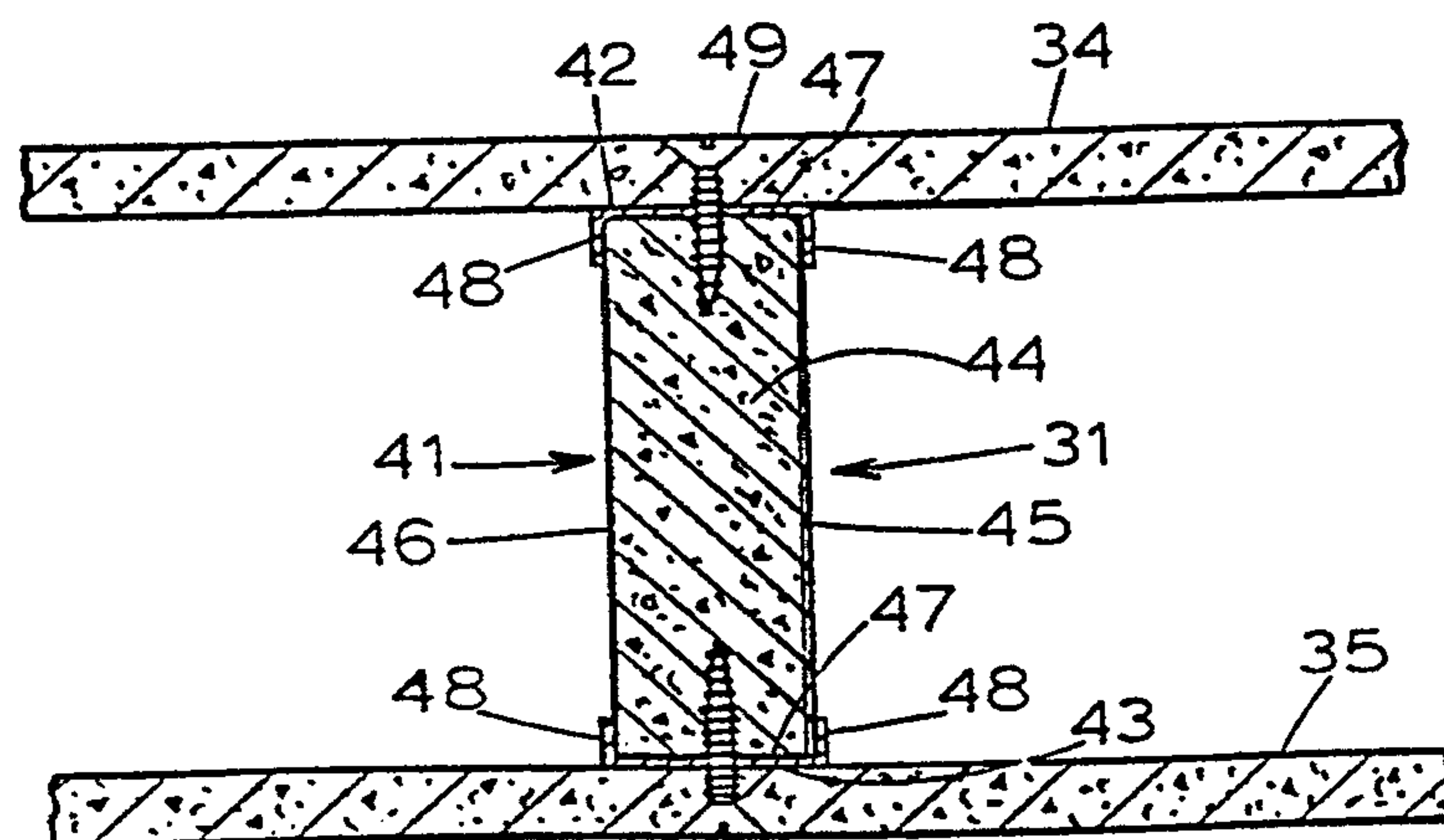


FIG. 4

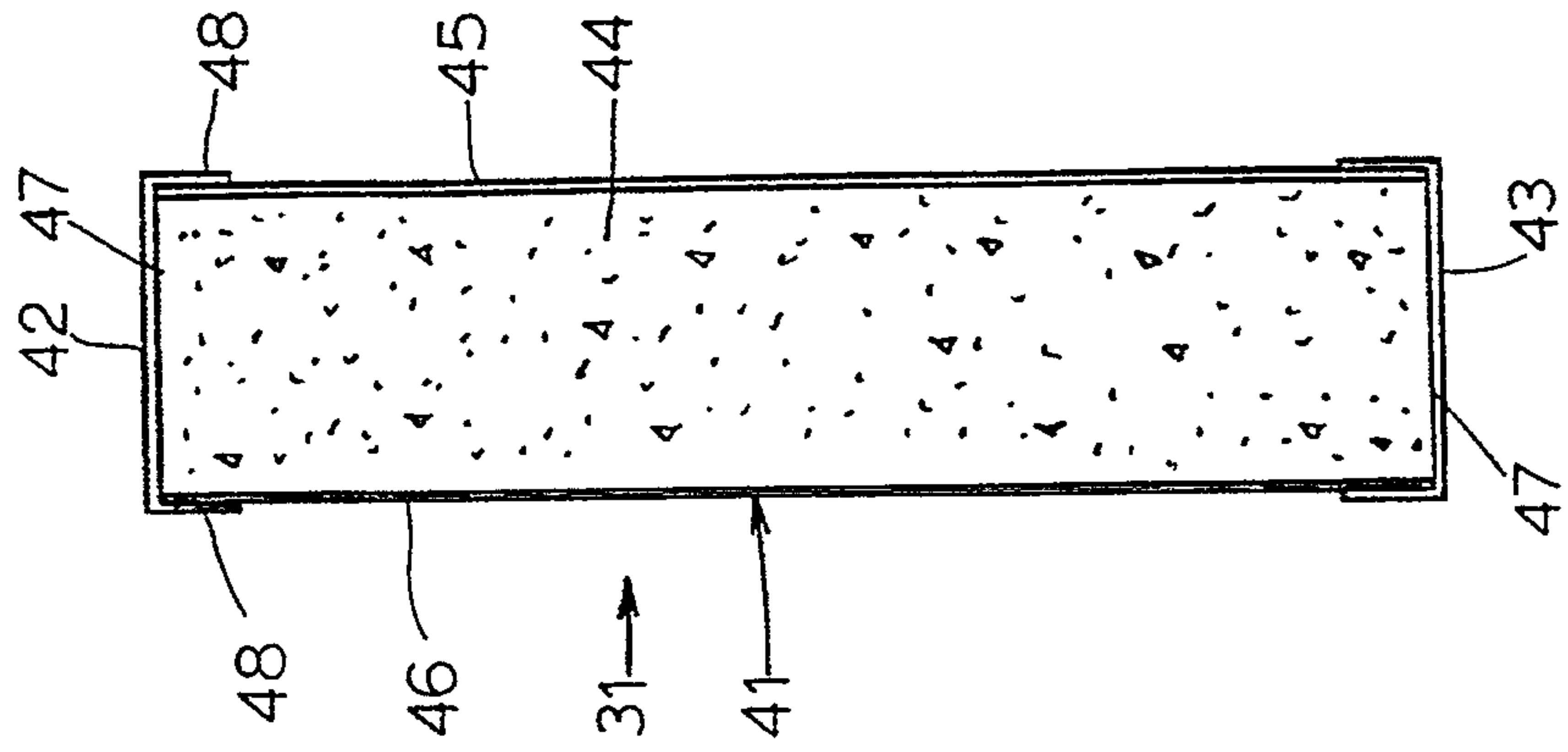
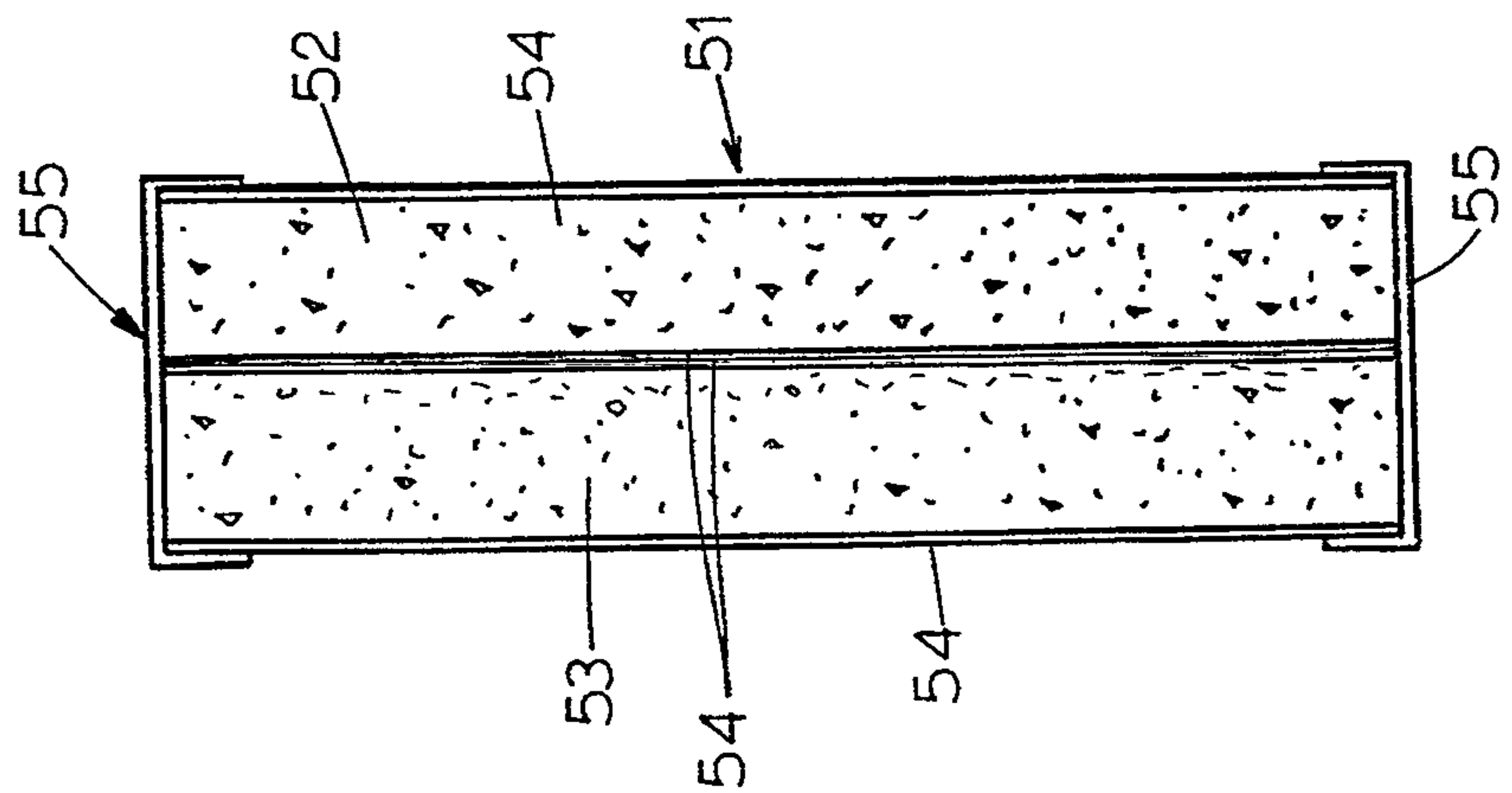


FIG. 5



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FIG. 7

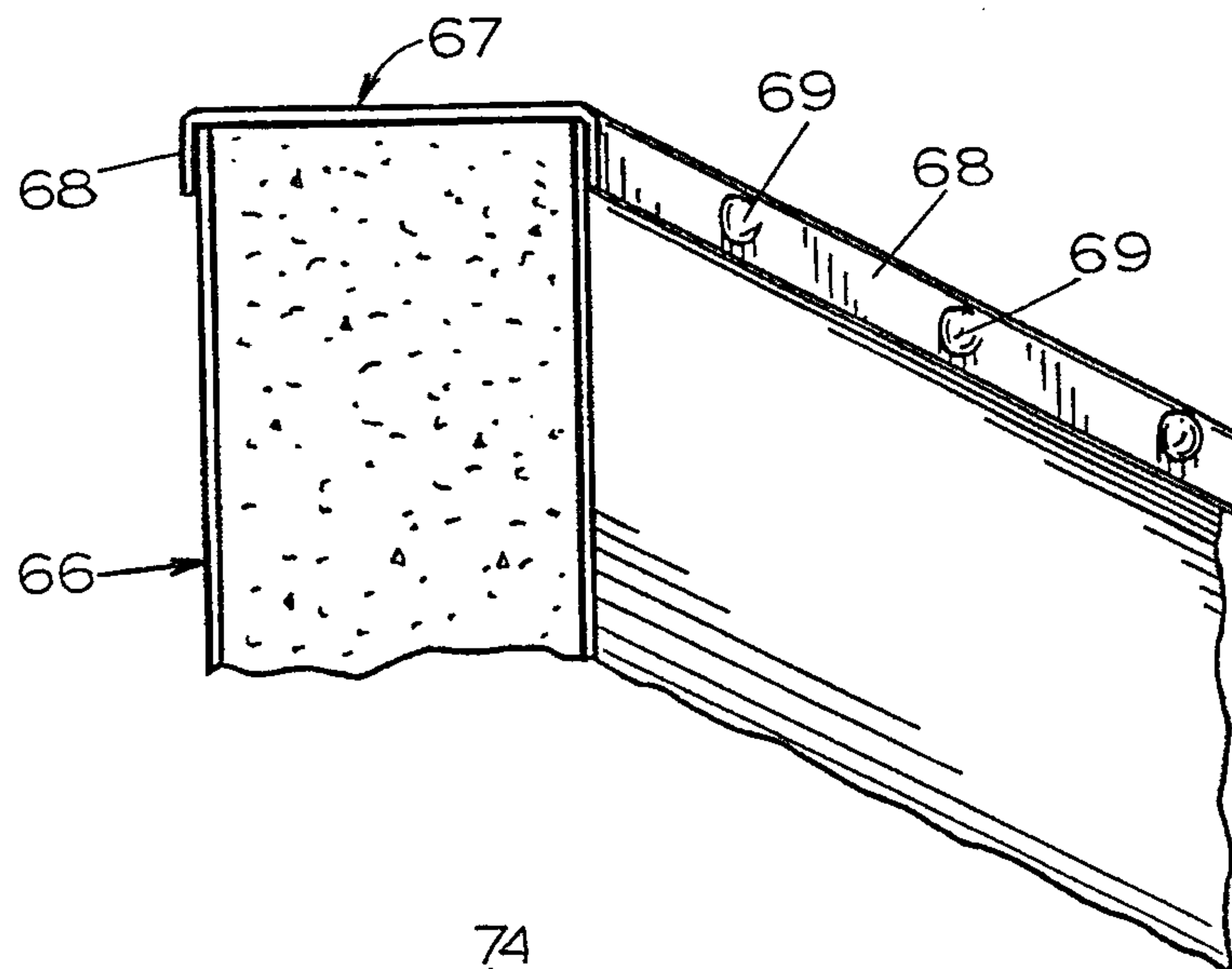


FIG. 8

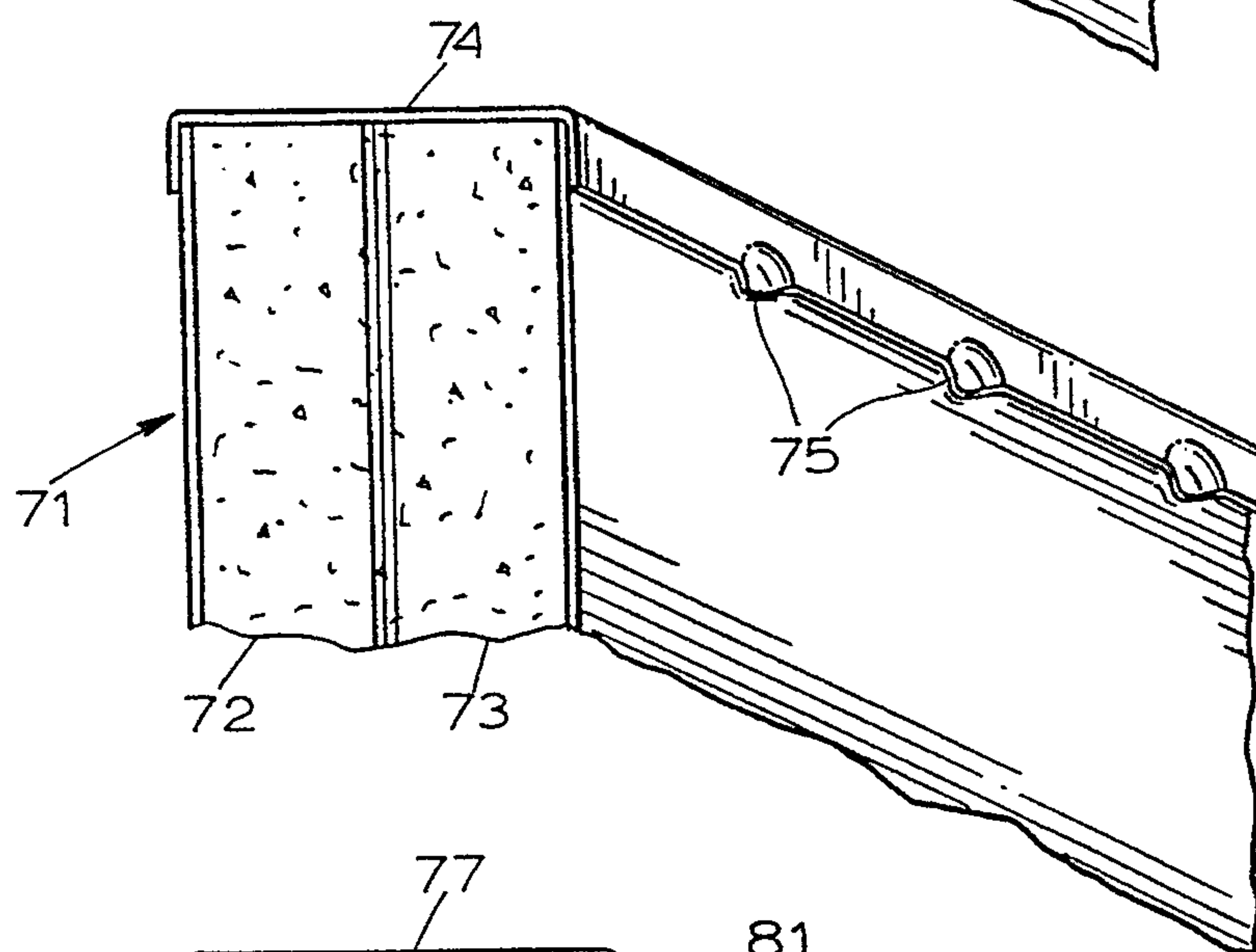
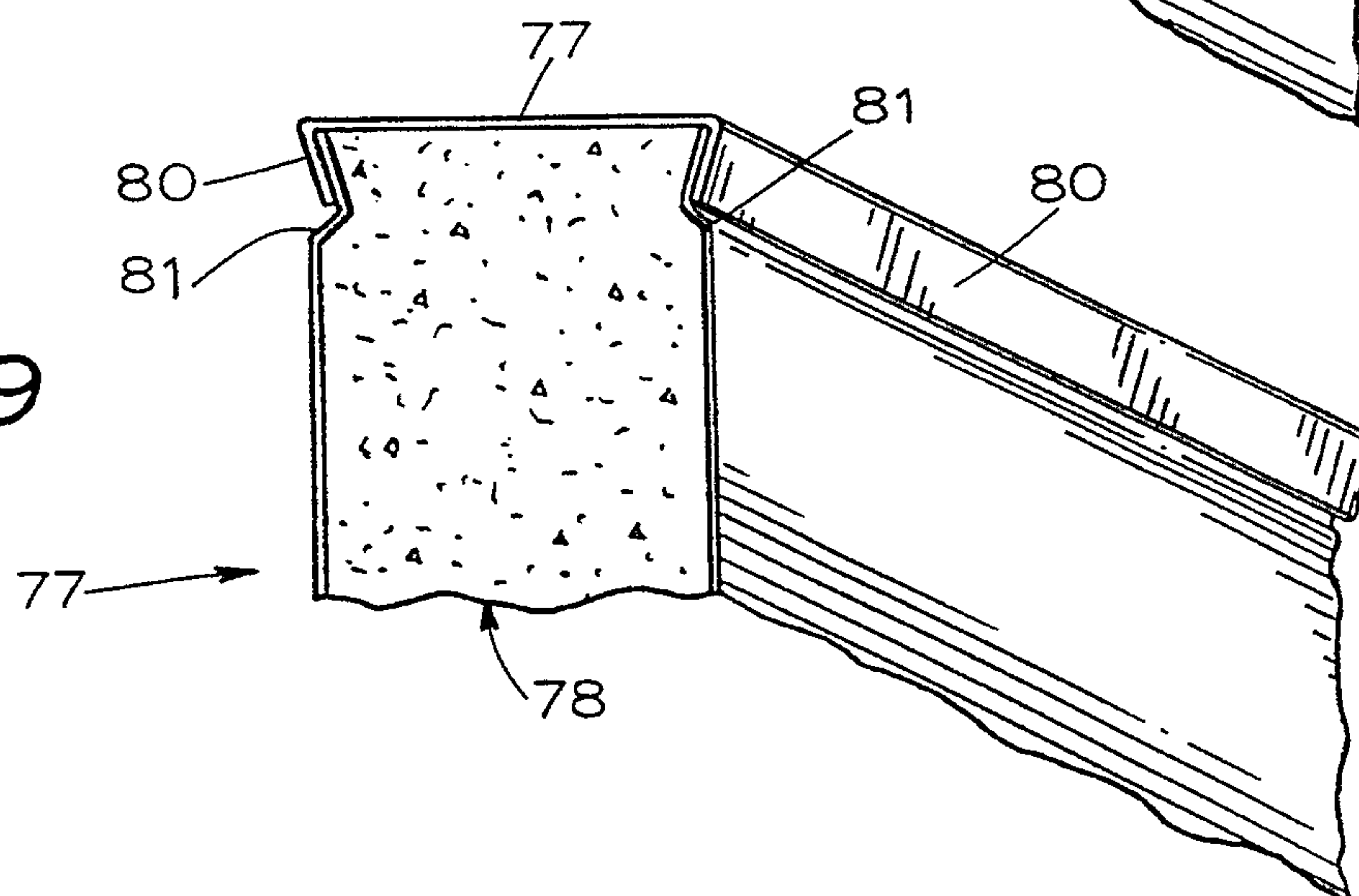


FIG. 9



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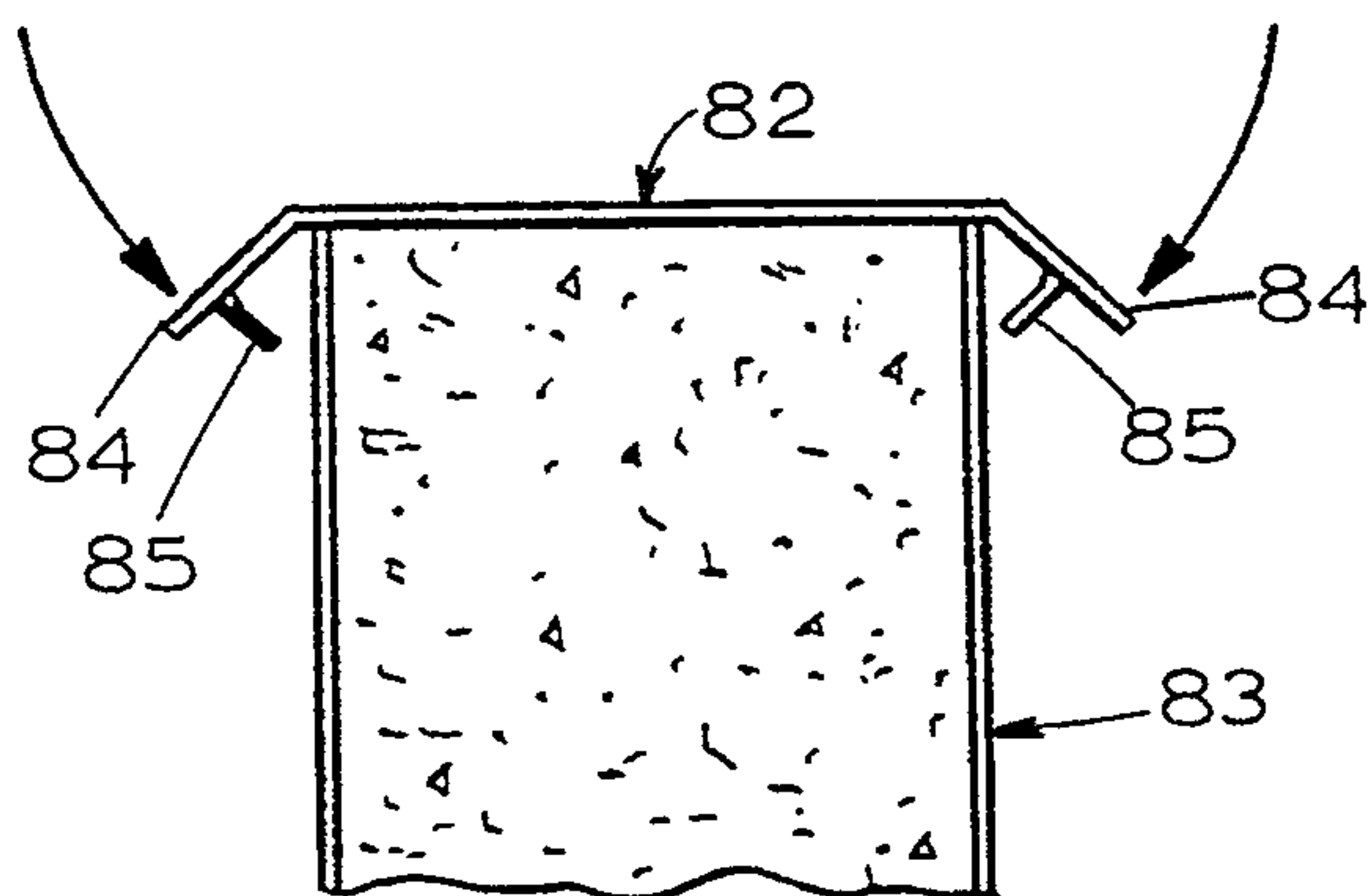
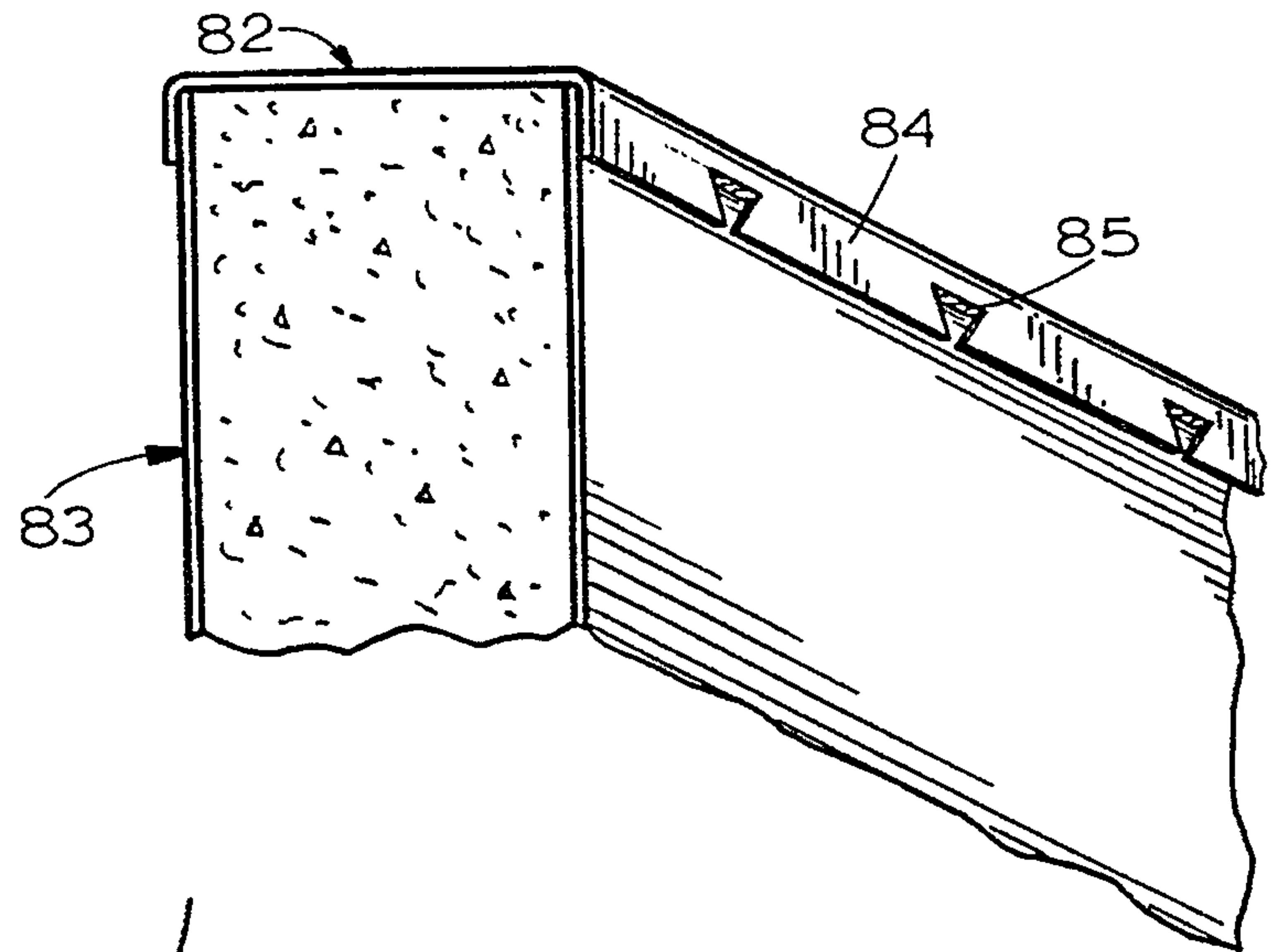
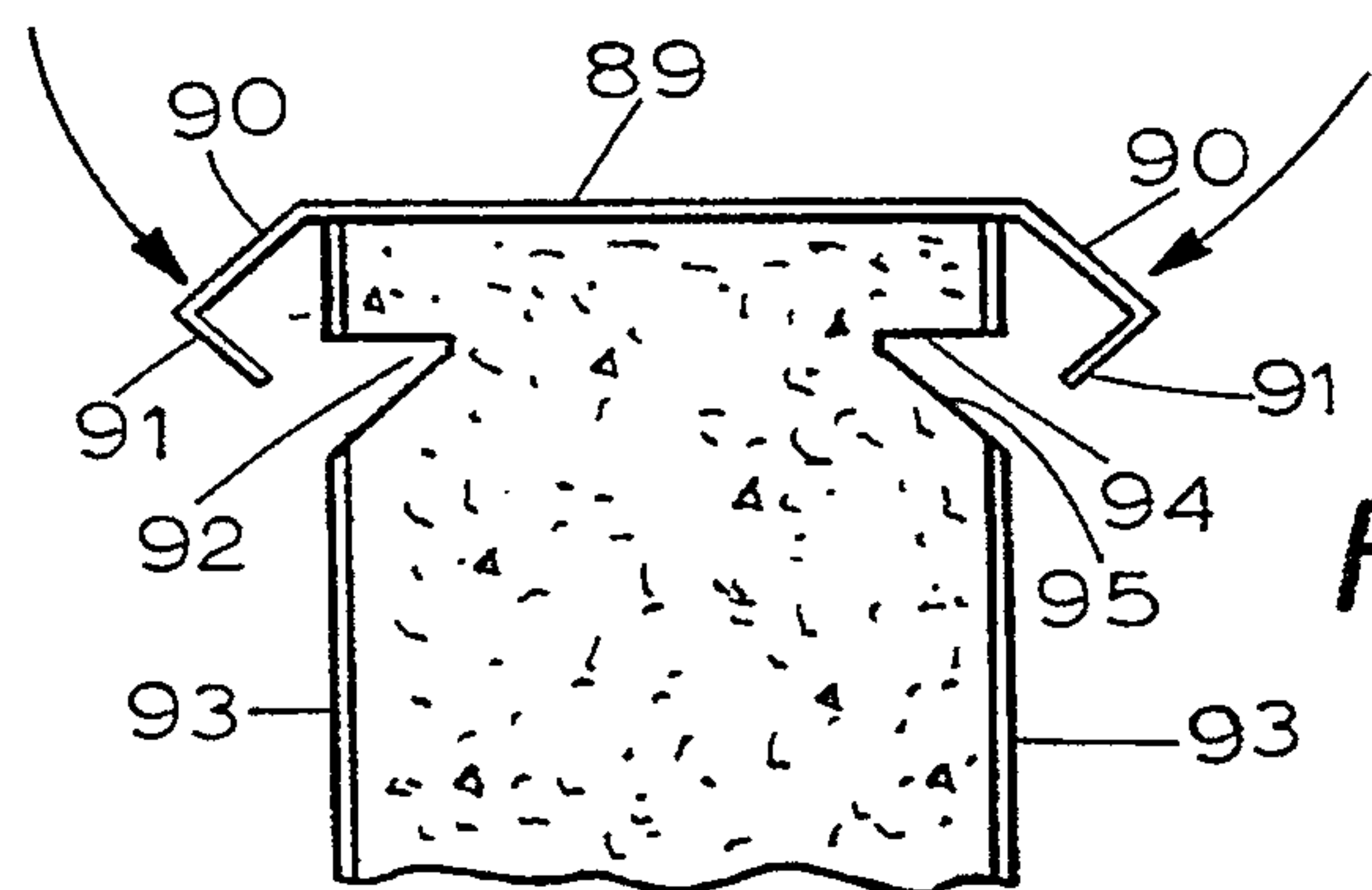
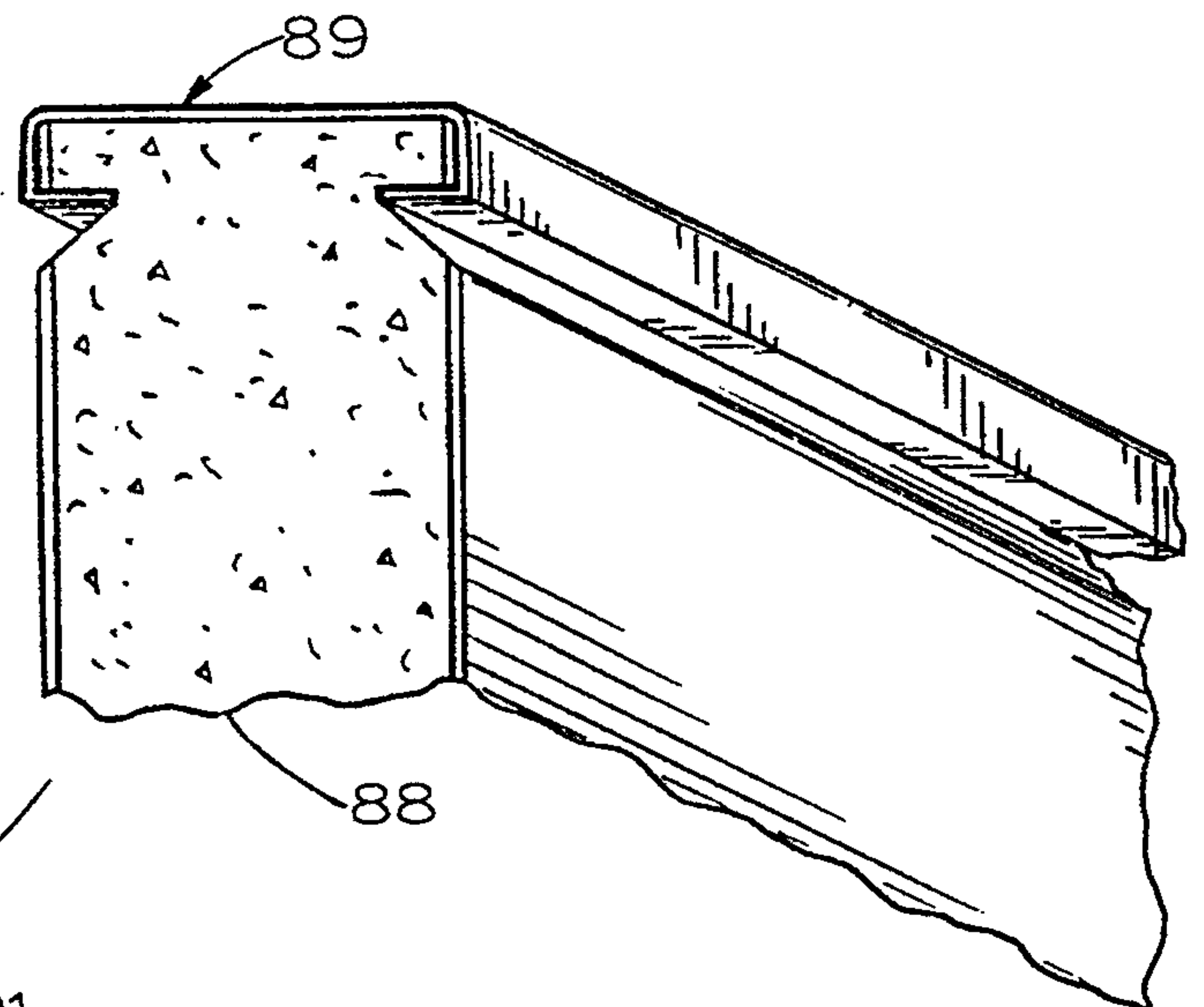
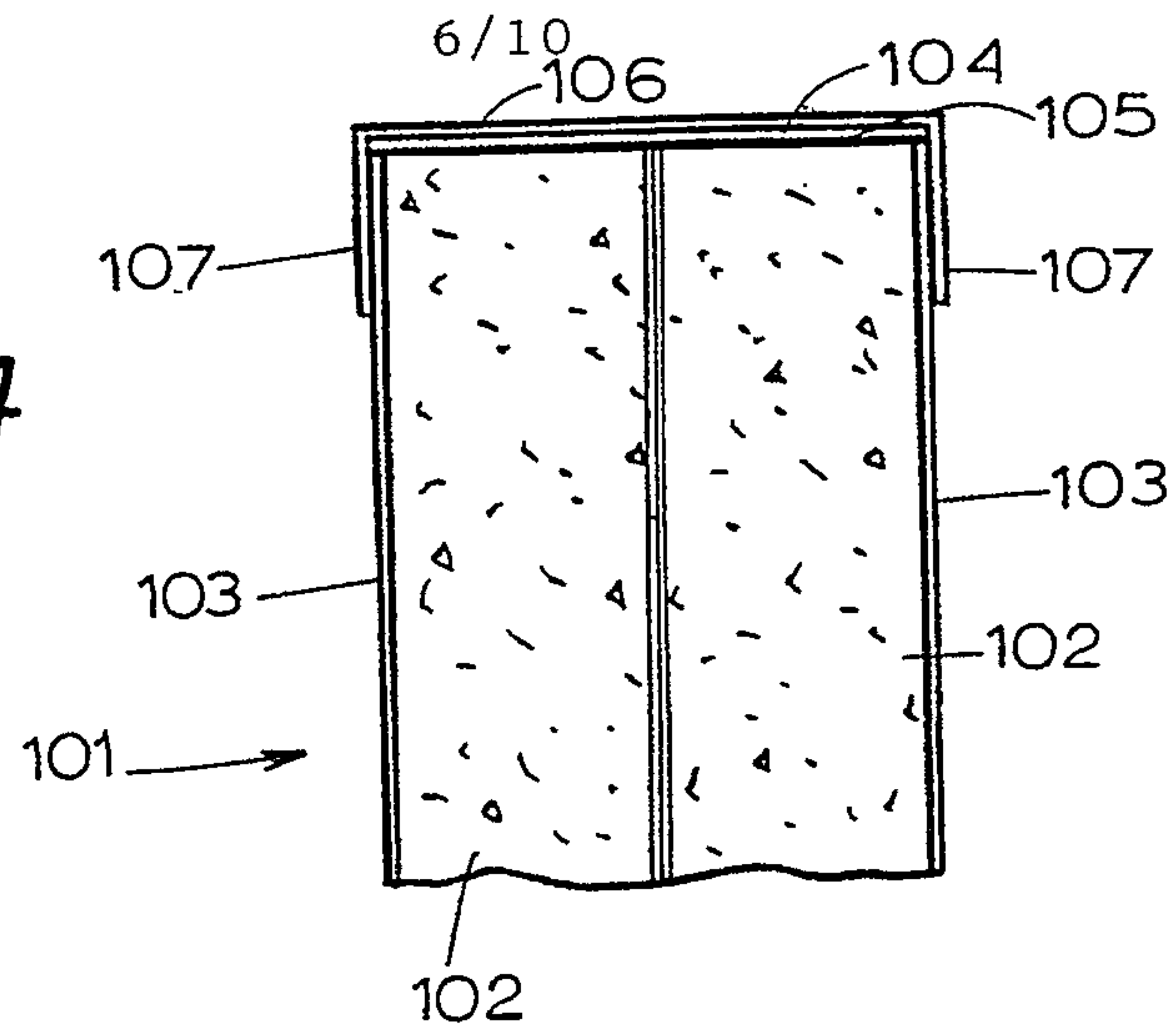
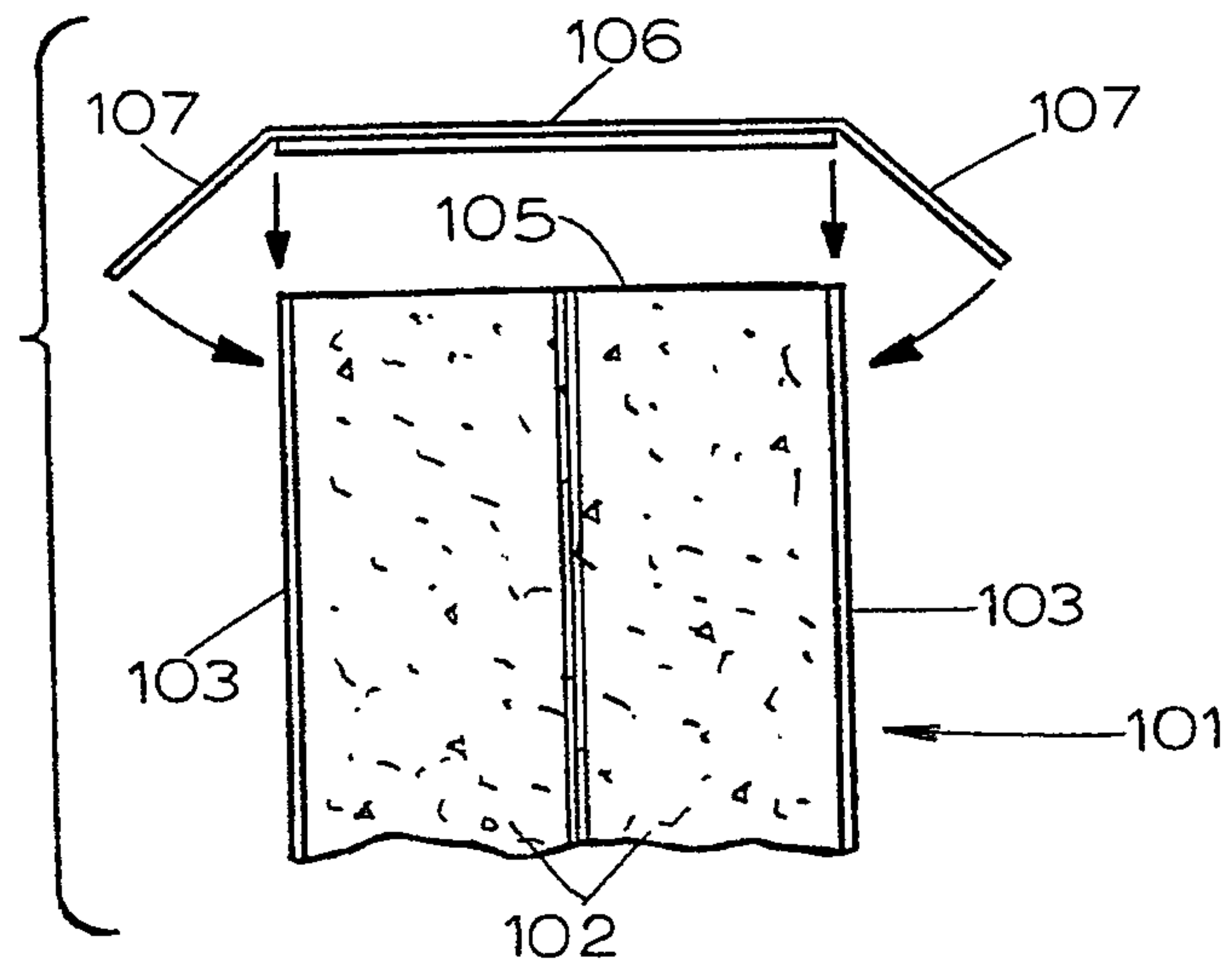
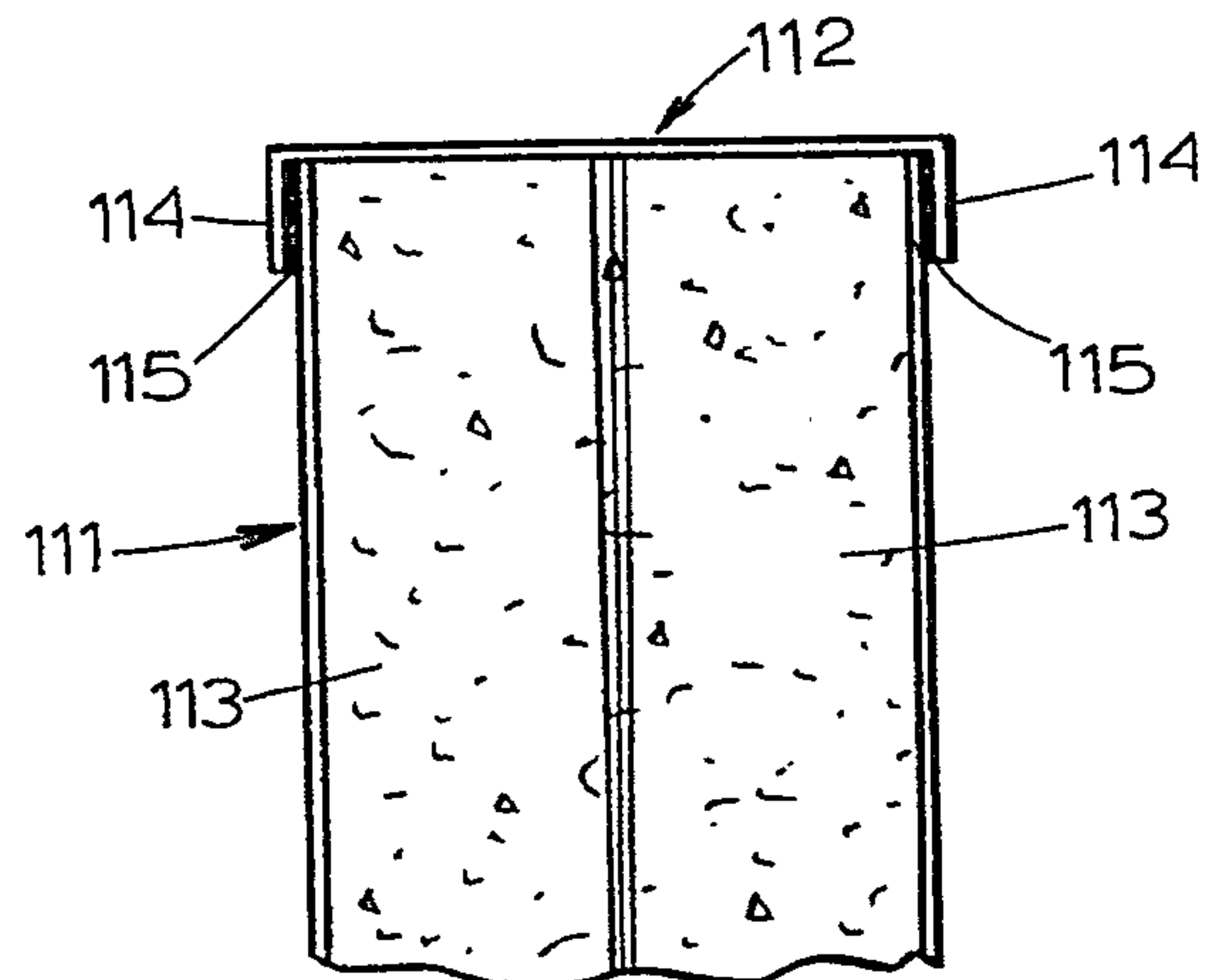
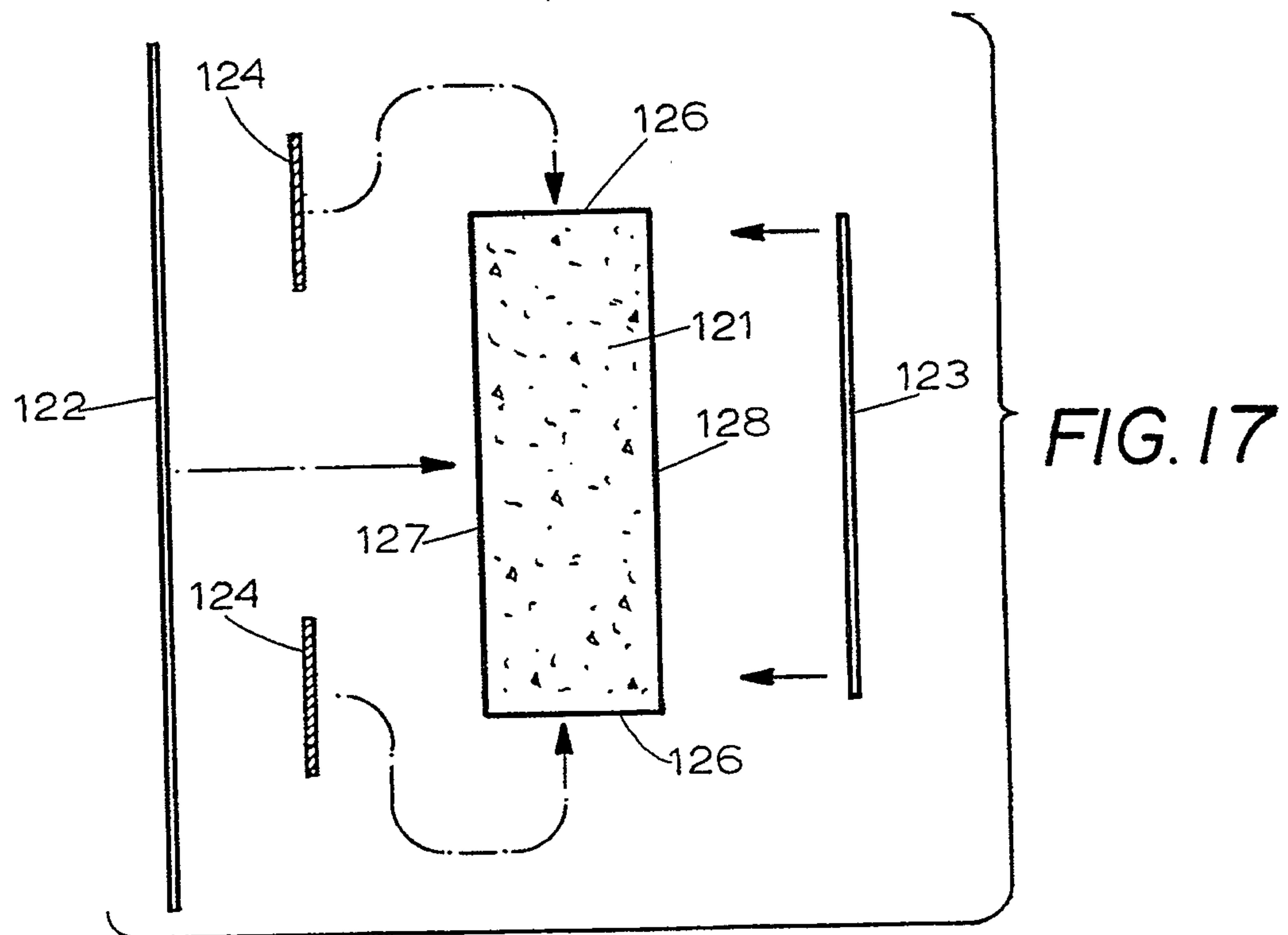
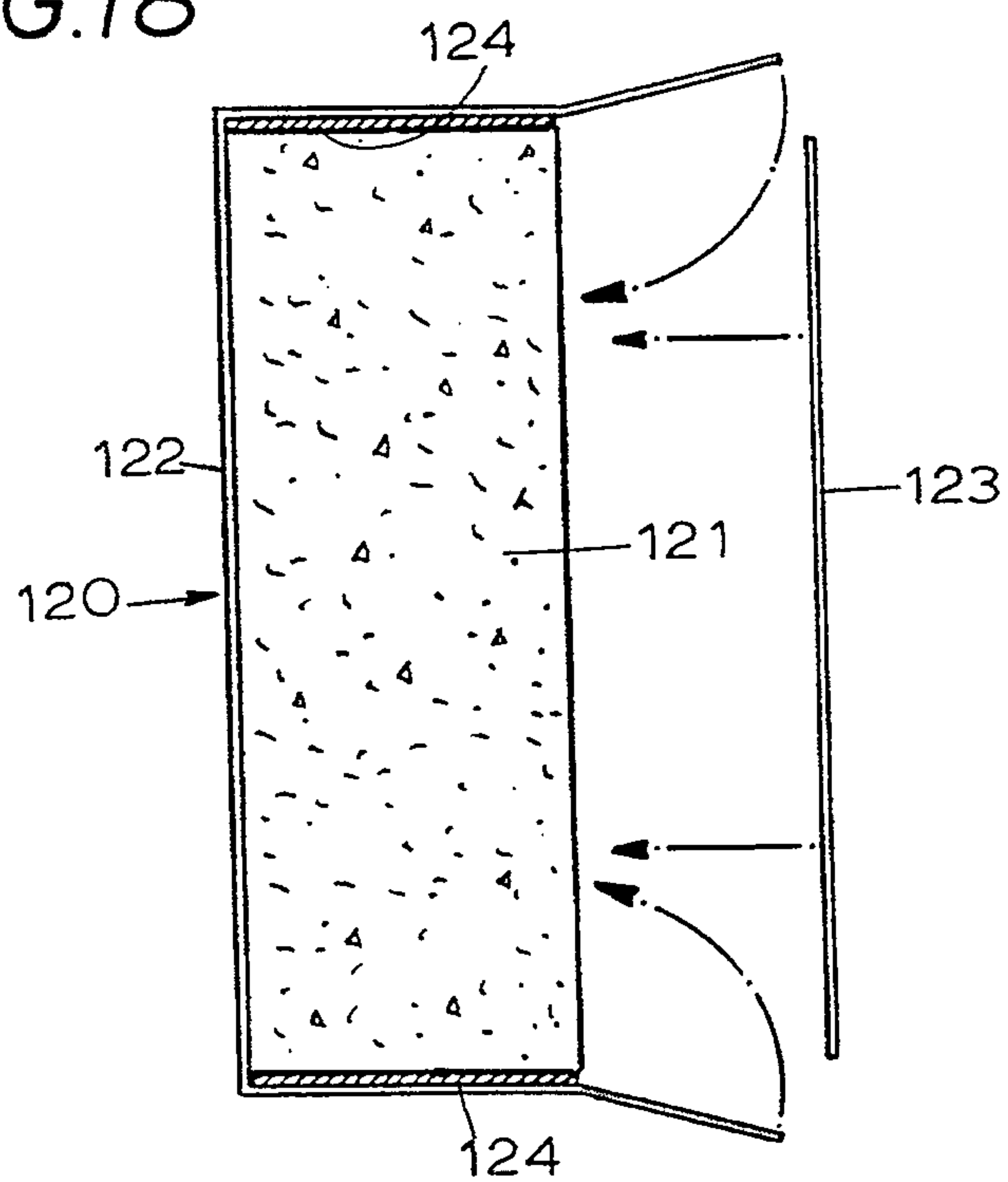
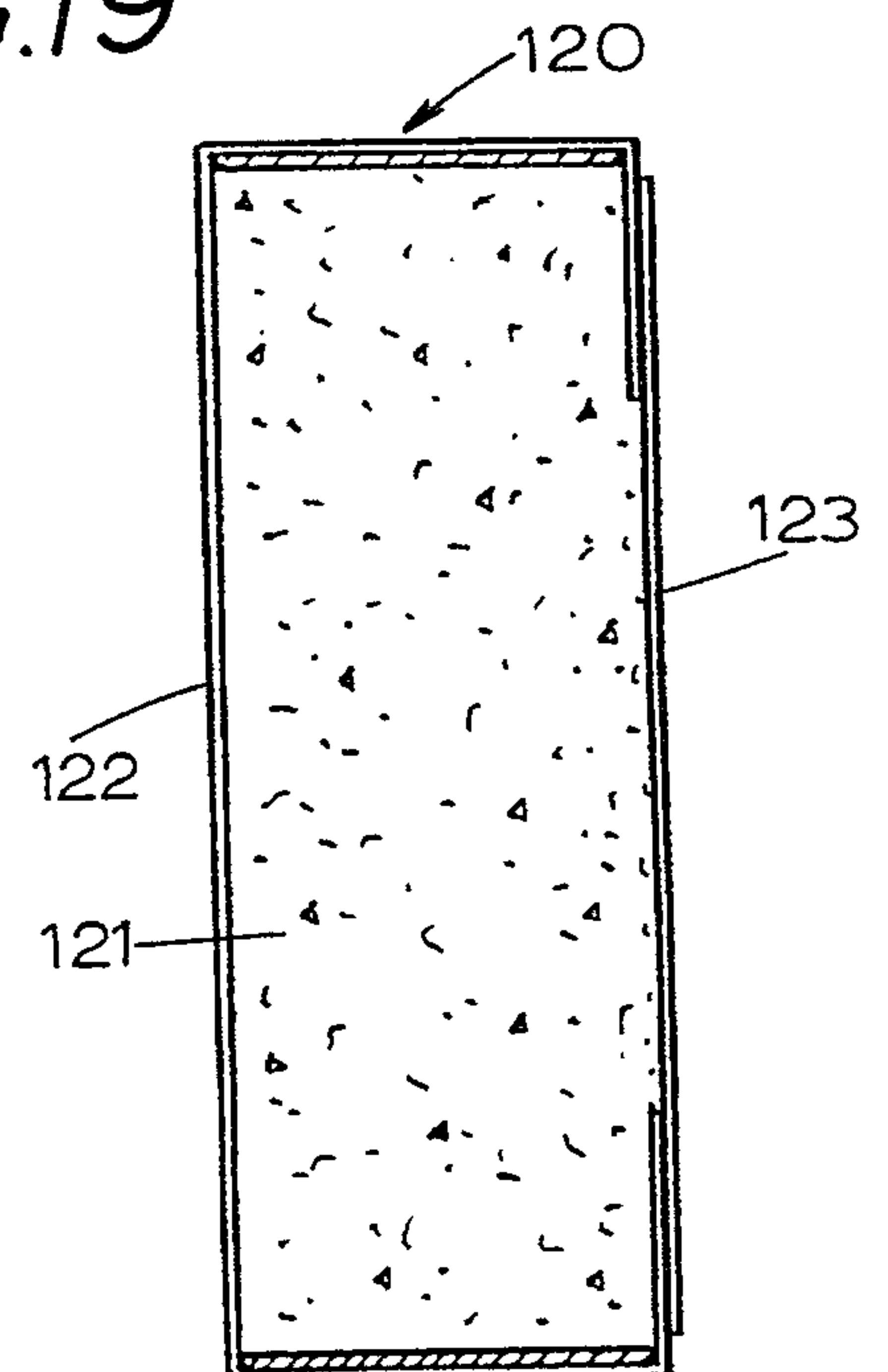
FIG. 10*FIG. 11**FIG. 12**FIG. 13*

FIG. 14**FIG. 15****FIG. 16**

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**FIG. 18****FIG. 19**

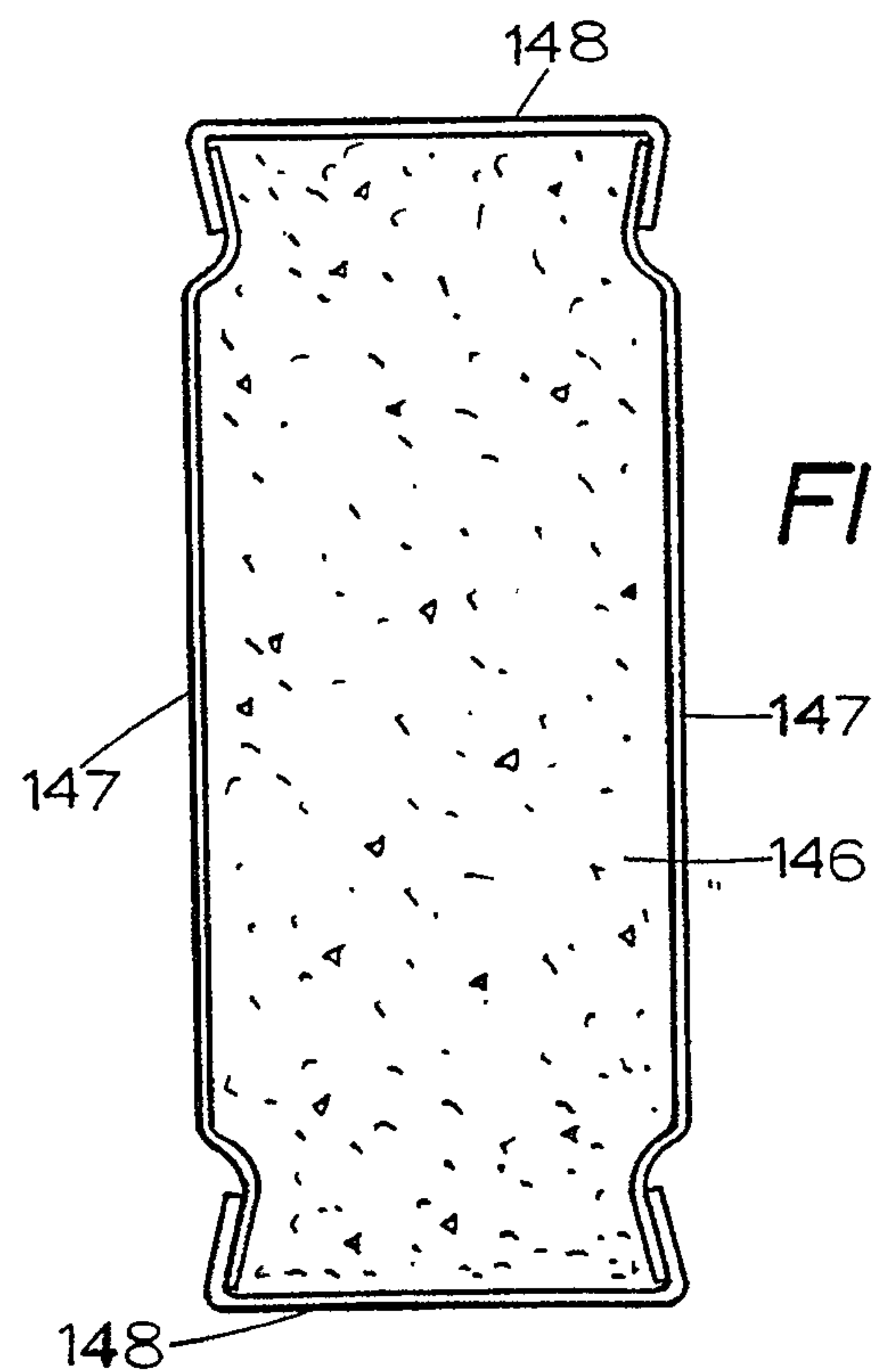
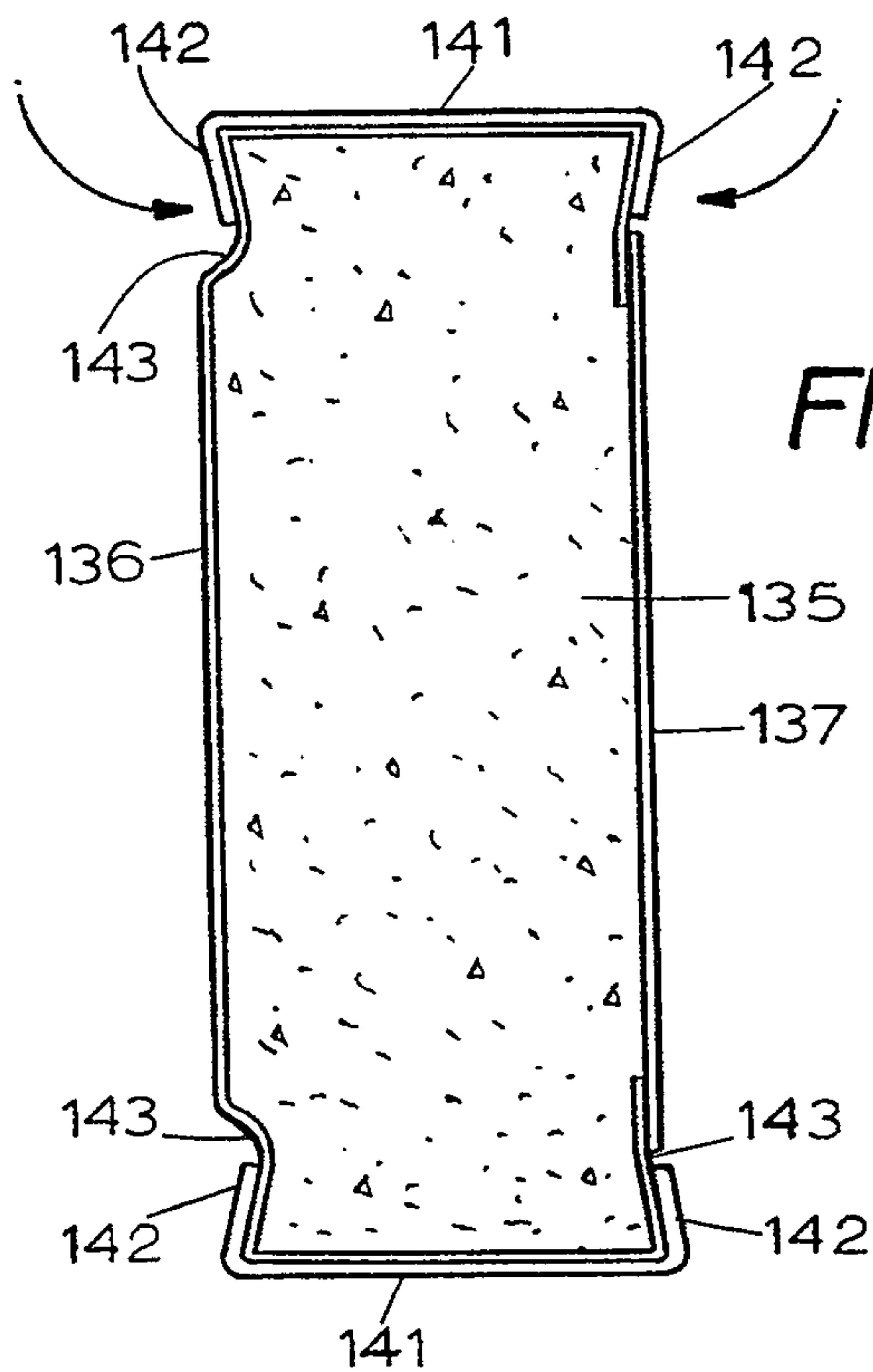
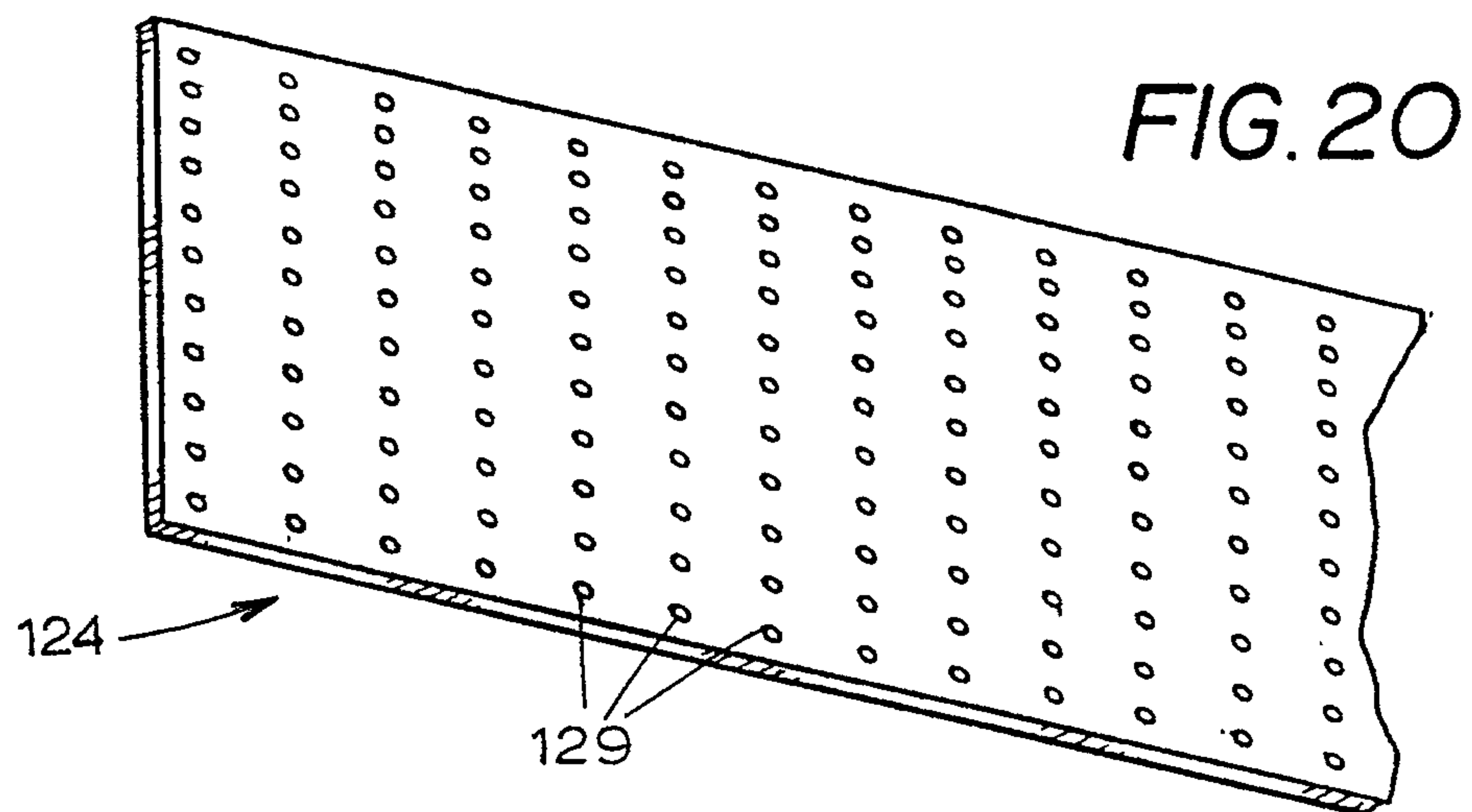


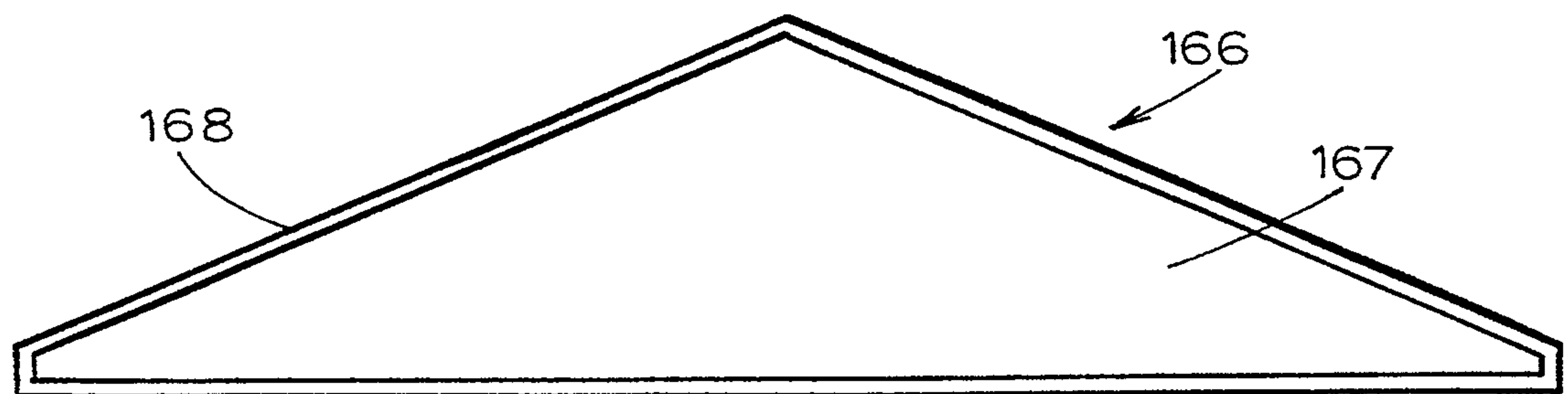
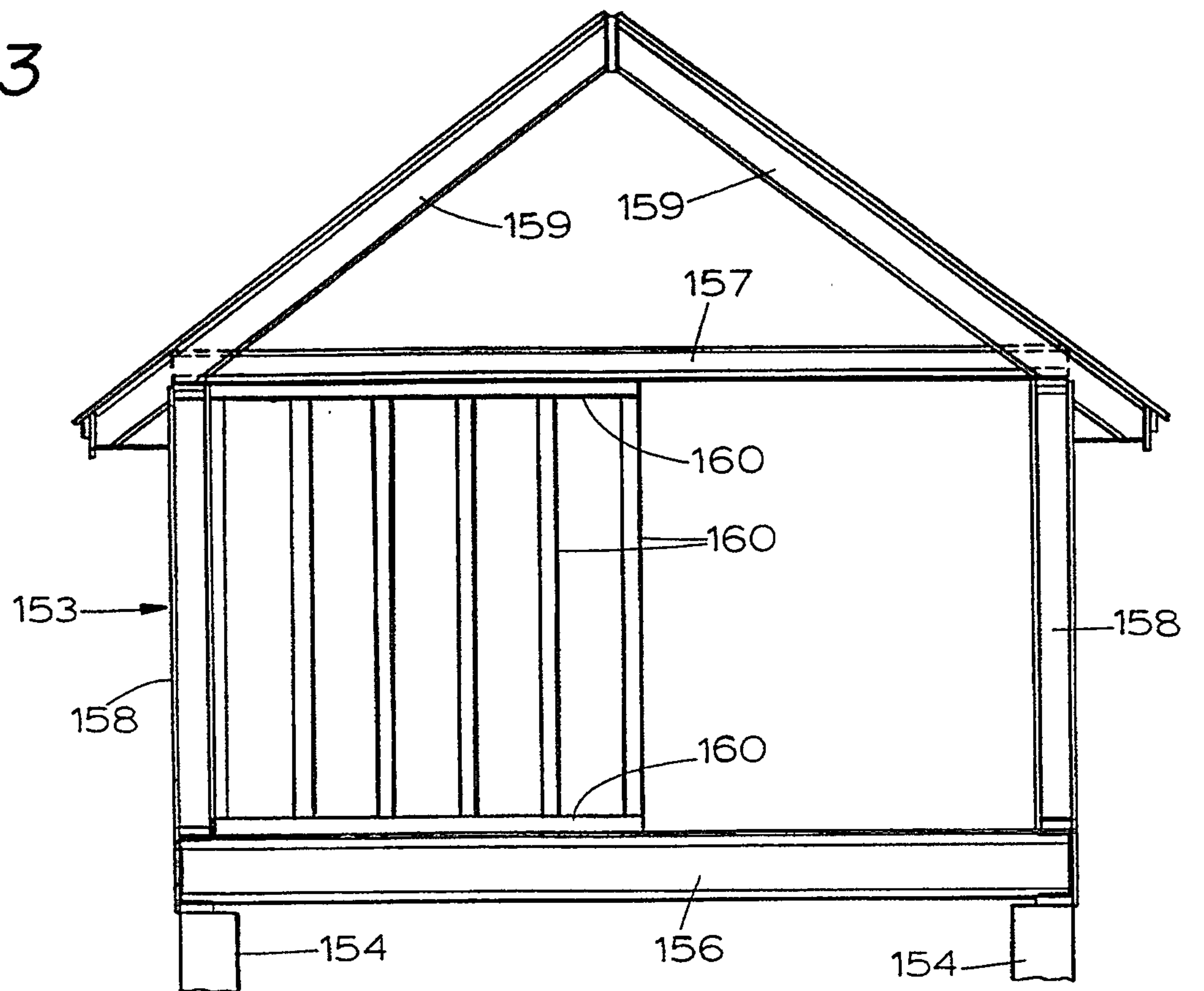
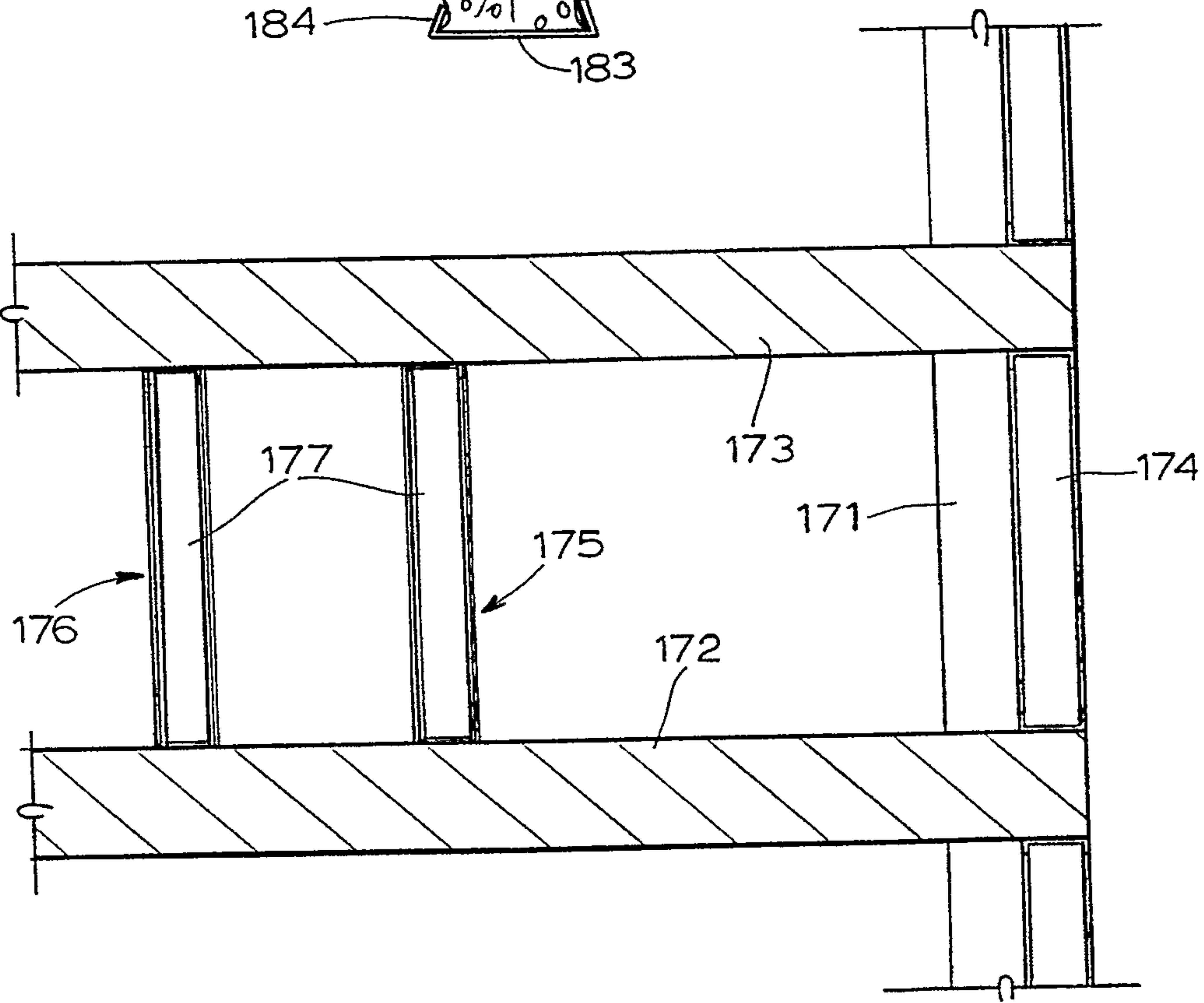
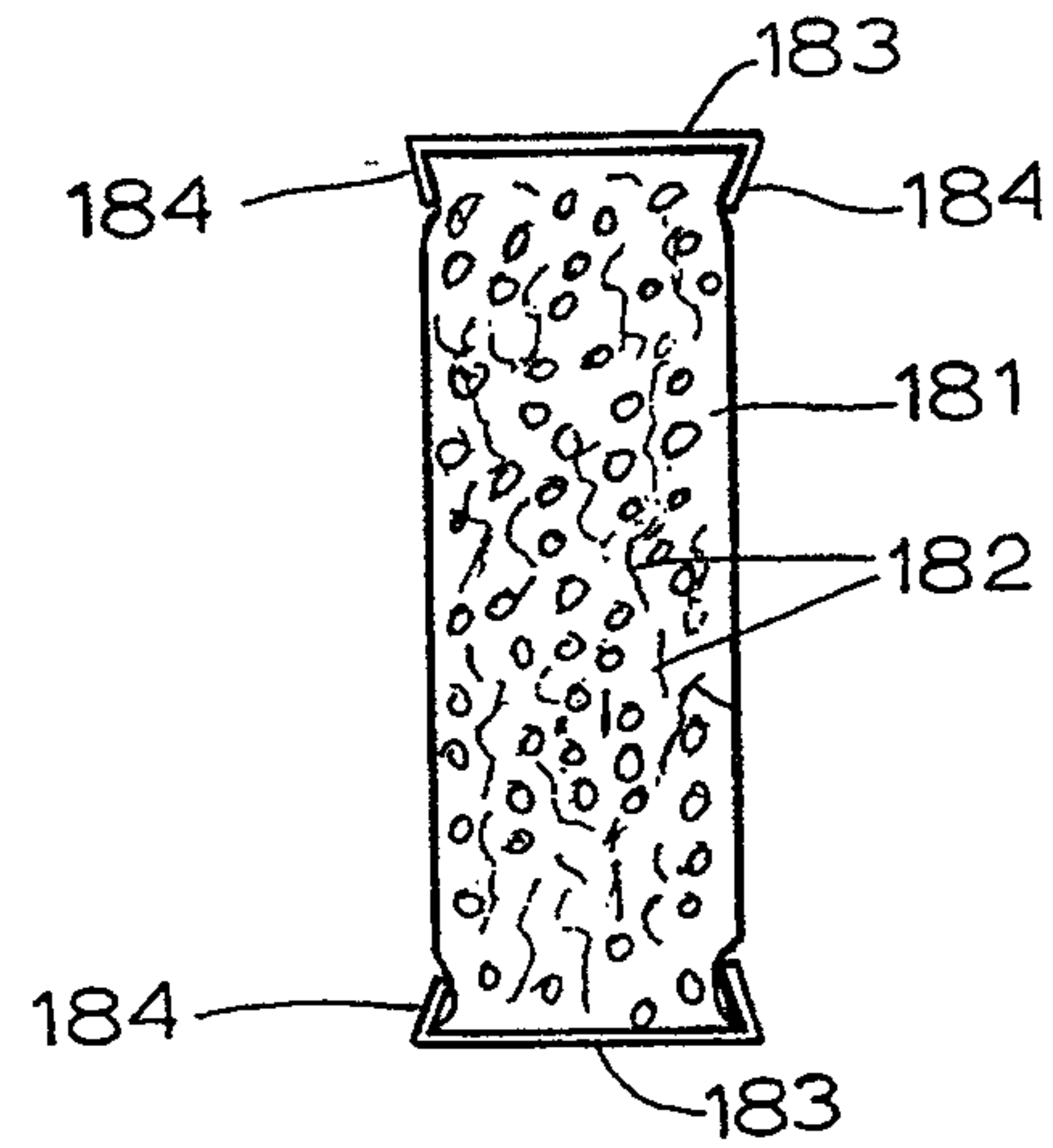
FIG. 23*FIG. 24*

FIG. 26**FIG. 25**

