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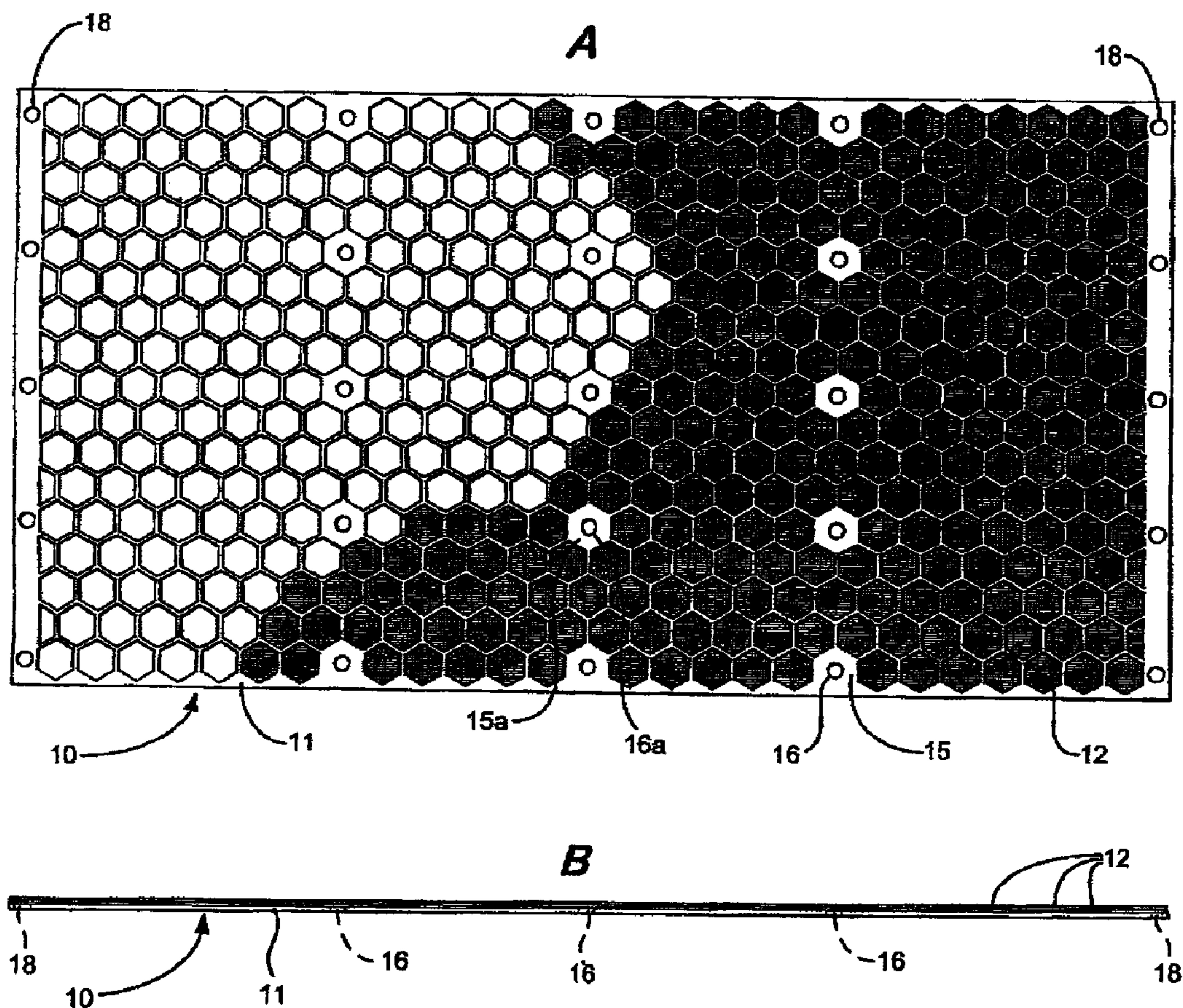
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(57) Abrégé/Abstract:

A method for mounting a screen assembly in a shale shaker, the shale shaker comprises a mounting structure for receiving the screen assembly. The screen assembly comprises at least one layer of screening material tensioned over a screen support,



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characterized in that the method comprises the steps of aligning the screen assembly with the mounting structure using at least one hole located in at least one of the screen support and the mounting structure and inserting a corresponding pin of the other of the screen support and mounting structure into said at least one hole.

ABSTRACT

A method for mounting a screen assembly in a shale shaker, the shale shaker comprises a mounting structure for receiving the screen assembly. The screen assembly comprises at least one layer of screening material tensioned over a screen support, characterized in that the method comprises the steps of aligning the screen assembly with the mounting structure using at least one hole located in at least one of the screen support and the mounting structure and inserting a corresponding pin of the other of the screen support and mounting structure into said at least one hole.

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APPARATUS FOR SEPARATING MATERIAL

This is a division of Canadian Patent Application Serial No. 2,472,692, filed January 16, 2003.

5 The present invention relates to an apparatus for separating material, particularly, but not exclusively, solids from used drilling mud. The present invention also relates to a shale shaker, a screen assembly and a wear strip.

10 In the drilling of a borehole in the construction of an oil or gas well, a drill bit is arranged on the end of a drill string and is rotated to bore the borehole. A drilling fluid known as "drilling mud" is pumped through the drill string to the drill bit to lubricate the drill bit. The drilling mud is also used to carry the cuttings produced by the drill bit and
15 other solids to the surface through an annulus formed between the drill string and the borehole. The drilling mud contains expensive synthetic oil-based lubricants and it is normal therefore to recover and re-use the used drilling mud, but this requires the solids to be removed from the drilling mud. This
20 is achieved by processing the drilling fluid. The first part of the process is to separate the solids from the solids laden drilling mud. This is at least partly achieved with a vibratory separator, such as those shale shakers disclosed in US 5,265,730, WO 96/33792 and WO 98/16328.

25 Shale shakers generally comprise an open bottomed basket having one open discharge end and a solid walled feed end. A number of rectangular screens are arranged in the basket, which are held in C-channel rails located on the basket walls, such as those disclosed in GB-A-2,176,424. The basket is arranged on
30 springs above a receptor for receiving recovered drilling mud. A skip or ditch is provided beneath the open discharge end of the basket. A motor is fixed to the basket, which has a drive rotor provided with an offset clump weight. In use, the motor rotates the rotor and the offset clump weight,

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which causes the basket and the screens fixed thereto to shake. Solids laden mud is introduced at the feed end of the basket on to the screens. The shaking motion induces the solids to move along the screens towards the open
5 discharge end. The recovered drilling mud is received in the receptor for further processing and the solids pass over the discharge end of the basket into the ditch or skip.

The prior art discloses a variety of mounting
10 systems and apparatuses for releasably mounting a screen assembly to a shale shaker. These include drawbar and hookstrip apparatuses; inflatable device systems (as described above); wedge systems; for example, the systems described in US-A-6,179,128 issued Jan 30, 2001; US-A-
15 5,392,925 issued Feb. 28, 1995; US-A-4,882,054 issued Nov. 21, 1989; US-A-4,582,597 issued Apr. 15, 1986; and in the prior art referred to in each of these references.

A prior art shale shaker is shown in Figure 5. The shale shaker 1 has a screen 2 (with screen or screening
20 cloth or mesh as desired) mounted on vibratable screen mounting apparatus or "basket" 3. The screen 2 may be any known screen or screens. The basket 3 is mounted on springs 4 (only two shown; two as shown are on the opposite side) which are supported from a frame 6. The
25 basket 3 is vibrated by a motor 5 and interconnected vibrating apparatus 8 which is mounted on the basket 3 for vibrating the basket and the screens. Elevator apparatus 7 provides for raising and lowering of the basket end.

30 Figure 6 discloses an example of a prior art shaker system (for example as shown in US-A-5,190,645).

The system A has a shale shaker K having a screen or screens S. The screen(s) S are mounted in a typical shaker basket B and one or more vibrators V (any known
35 suitable shaker

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vibrator) vibrate the basket B and hence the screen(s) S. The other components of the system A are as described in US-A-5,190,645.

5 The screens are generally of one of two types: hook-strip; and pre-tensioned.

10 The hook-strip type of screen comprises several rectangular layers of mesh in a sandwich, usually comprising one or two layers of fine grade mesh and a supporting mesh having larger mesh holes and heavier gauge wire. The layers of mesh are joined at each side edge by a strip which is in the form of an elongate hook. In use, the elongate hook is hooked on to a tensioning device arranged along each side of a shale shaker. The shale shaker further comprises a crowned set of
15 supporting members, which run along the length of the basket of the shaker, over which the layers of mesh are tensioned. An example of this type of screen is disclosed in GB-A-1,526,663. The supporting mesh may be provided with or replaced by a panel having apertures therein.

20 The pre-tensioned type of screen comprises several rectangular layers of mesh, usually comprising one or two layers of fine grade mesh and a supporting mesh having larger mesh holes and heavier gauge wire. The layers of mesh are pre-tensioned on a rigid support comprising a
25 rectangular angle iron frame and adhered thereto. The screen is then inserted into C-channel rails arranged in a basket of a shale shaker. An example of this type of screen is disclosed in GB-A-1,578,948.

30 A further example of a known rigid support is disclosed in PCT Publication No. WO 01/76719, which discloses, amongst other things, a flat panel like portion having apertures therein and wing portions which are folded to form a support structure, which may be made from a single sheet of material. This rigid support has
35 been assigned the Trade Mark "UNIBODY" by the applicants.

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The layers of mesh in the screens wears out frequently and therefore needs to be easily replaceable. Shale shakers are generally in the order of 5ft wide and 10ft long. A screen of
5 dimensions 4ft wide by 10ft long is difficult to handle, replace and transport. It is known to use two, three, four or more screens in a single shale shaker. A standard size of screen currently used is of the order of 4ft by 3ft.

There is a need, recognized by the present inventors, for
10 an efficient and effective screen mounting structure and method for screen assemblies for shale shakers. There is a need, recognized by the present inventors, for an efficient and stable mounting of screens to a shale shaker.

In accordance with an embodiment of the present invention
15 there is provided a method for mounting a screen assembly in a shale shaker, the shale shaker comprising a mounting structure for receiving the screen assembly, the screen assembly comprising at least one layer of screening material tensioned over a screen support, characterized in that the method
20 comprises the steps of aligning the screen assembly with the mounting structure using at least one hole located in at least one of the screen support and the mounting structure and inserting a corresponding pin of the other of the screen support and mounting structure into the at least one hole.

Also disclosed is an apparatus for separating material,
25 the apparatus comprising a shale shaker and a screen assembly, the shale shaker having a mounting structure on to which the screen assembly is releasably mountable, wherein one of the mounting structure and the screen assembly has projecting member
30 sized and configured so it is receivable in a corresponding hole or recess in the other of said mounting structure and said screen assembly.

The projecting member may take the form of a pin, stud, or a finger. The mounting structure may comprise a mounting tray,
35 bed, or deck. The projecting member provides for correct emplacement and positioning of the screen assembly (or

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assemblies) in the mounting structure of the shale shaker during operation of the shale shaker. The mounting structure may be
5 located in a basket of the shale shaker. The projecting member or members may be formed integrally with a screen support and/or they may be releasably attached to or connected to the support, preferably incorporating a wear strip,

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which may be replaceable.

Preferably, the screen assembly has a perimeter and the projecting member and the hole or recess are located within the perimeter.

5 Advantageously, the apparatus further comprises at least one further projecting member and a hole or recess for each of the further projecting members.

Preferably, the projecting member is substantially vertical.

10 Advantageously, the mounting structure has a body located underneath the screen assembly, the body comprising open areas, which in use allows separated material flowing through the screen assembly to pass the mounting structure. Preferably, one of the projecting member and
15 the hole is located on the body. Advantageously, the body comprises a plurality of spaced-apart interconnected members between which the part of the separated material is flowable. Preferably, one of the projecting member and the hole or recess is located on or in one of the
20 interconnected members and one of a further projecting member and the hole is located on or in a different member of the plurality of spaced-apart interconnected members. Advantageously, the body comprises a deck of the shale shaker. Preferably, the projecting member projects
25 upwardly substantially perpendicular from the body. Advantageously, the projecting member projects from the body at an angle other than a right angle to the body.

Preferably, the apparatus further comprises a projecting member located on the other of the mounting
30 structure and the screen assembly sized and configured so it is receivable in a corresponding hole or recess located in the other of the mounting structure and the screen assembly.

Advantageously, the mounting structure has an outer
35 periphery corresponding with at least part of the outer

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periphery of the screen assembly and one of the projecting member and the hole or recess arranged at the outer periphery.

5 Preferably, the screen assembly comprises at least one layer of screening material secured to a frame, the frame having at least one of the projecting member and the hole therein or thereon. Advantageously, the frame comprises at least one cross-member, at least one of the projecting member and the hole
10 therein or thereon.

 Preferably, the projecting member tapers from a base with a base largest dimension to a top with a top largest dimension, the base largest dimension larger than the top largest dimension.

15 Advantageously, the projecting member has a shape viewed from above from the group consisting of: circle; square; rectangle; triangle; oval; ellipse; pentagon; and hexagon.

 Preferably, the mounting structure comprises a wear strip, the wear strip comprising at least one of the projecting member
20 and the hole or recess. Advantageously, upon emplacement on the mounting structure beneath a screen assembly, the wear strip is positioned so that the wear strip provides an upward force on the screen assembly. Preferably, the wear strip is bowed, such that the wear strip has a spring force, which provides an upward
25 force on to the screen assembly.

 Advantageously, the screen assembly comprises a wear strip, the wear strip comprising at least one of the projecting member and the hole or recess.

 Also disclosed is a shale shaker of the apparatus of the
30 invention.

 A screen of the apparatus of the invention is also disclosed. Preferably, the screen assembly comprises a support comprising at least one of a: frame; strip support; perforated plate; and unibody structure. Preferably, the screen assembly
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further comprises at least two fine layers of screening mesh.

5 One or three layers of fine screening material may be used. Advantageously, the screen assembly further comprises a supporting mesh underlying the at least two fine layers of screening mesh. Preferably, the fine layers of screening mesh are glued together using lines of glue.

10 The screen assembly may be of the hookstrip type and comprise at least one layer of fine mesh arranged on a lower supporting mesh and/or a perforate plate and a hookstrip arranged on two opposing sides of the mesh. The upstanding members or holes arranged in said perforate plate/supporting
15 mesh between said hookstrips. The layers of mesh may be glued together.

A screen assembly may be any known shale shaker screen or screen assembly to which the pin(s), stud(s), and/or finger(s) are added.

20 Also disclosed is a wear strip of the apparatus.

Wear strips that are made in an originally upwardly bowed configuration can provide such an upward force or an initially flat wear strip that is installed so that it bows slightly upwardly can provide such a force.

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For a better understanding of the present invention, reference will now be made, by way of example, to the accompanying drawings, in which:

5 Figure 1A is a top plan view of a screen assembly in accordance with the present invention with a screen support in accordance with the present invention;

Figure 1B is a side view of the screen assembly of Figure 1A.

10 Figures 2A is a side view in cross-section of fastener system for use in releasably connecting a screen assembly in accordance with the present invention to a shale shaker;

Fig 2B shows the fastener of Figure 2A in position connecting a screen assembly to a shale shaker;

15 Figure 3A is a side view in cross-section of fastener system for use in releasably connecting a screen assembly in accordance with the present invention to a shale shaker;

20 Fig 3B shows the fastener of Figure 3A in position following activation connecting a screen assembly to a shale shaker;

Figure 4 is a side view in cross-section of a fastener system releasably connecting a screen assembly according to the present invention to a shale shaker;

25 Figure 5 is a perspective view of a shale shaker;

Figure 6 is a schematic view of a prior art system for processing drilling mud including a shale shaker;

Figures 7 to 9 are perspective views of shale shakers in accordance with the present invention;

30 Figure 10A is a schematic view of a system in accordance with the present invention;

Figure 10B shows a shale shaker of the system of Figure 10A;

35 Figures 11, 12 and 15 are top plan views of screen assemblies in accordance with the present invention, with

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parts of layers of screening material cut-away.

Figure 13 is a top plan view of a frame in accordance with the present invention;

5 Figure 14A is a top view of a plastic grid in accordance with the present invention;

Figure 14B is a perspective view of a plastic grid in accordance with the present invention;

Figure 16 is a cross-sectional view of a screen assembly in accordance with the present invention;

10 Figure 17 is a perspective view of a frame support for a screen assembly in accordance with the present invention;

Figure 18A is a top plan view of a screen assembly in accordance with the present invention;

15 Figure 18B is an underneath view of the screen assembly of Figure 18A;

Figure 18C is a view of one end of the screen assembly of Figure 18A, the opposing end identical to the end shown;

20 Figure 18D is a side view of one side of the screen assembly of Figure 18A, the opposing side identical to the side shown;

25 Figure 18E is a perspective view of part of the screen assembly shown in Figure 18A showing part of the underneath, one side and one end of the screen assembly;

Figure 18F is a perspective view of part of the screen assembly of Figure 18A, showing a central part of the underneath of the screen assembly.

30 Figure 19 is a perspective view of a screen assembly mounting structure for a shale shaker in accordance with the present invention;

35 Figure 20A is a top plan view of a screen assembly in accordance with the present invention; Figure 20B is an end view, Figure 20C is a side view and Figure 20D is an underneath view of the screen assembly of Figure 20A;

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Figure 20E is a top view of possible hole shapes in accordance with the present invention for the screen assembly of Figure 20A.

5 Figure 21 is a perspective view of a screen assembly mounting structure for a shale shaker in accordance with the present invention;

Figure 22 is a perspective view of a screen assembly mounting structure for a shale shaker in accordance with the present invention;

10 Figure 23A is a top view of a screen assembly in accordance with the present invention; Figure 23B is an end view, Figure 23C is a side view and Figure 23D is a bottom view of the screen assembly of Figure 23A;

15 Figure 24 is a perspective view of a screen assembly mounting structure for a shale shaker in accordance with the present invention;

Figures 25A to 25F and 25H are side schematic views of shale shakers in accordance with the present invention;

20 Figure 25G is a side view of a screen assembly for the shale shaker of Figure 25H;

Figure 26 is a perspective view of a shale shaker in accordance with the present invention;

25 Figure 27 is a perspective view of a shale shaker in accordance with the present invention;

Figure 28 is a top plan view of a wear strip in accordance with the present invention;

30 Figure 29A is a top plan view of a wear strip in accordance with the present invention; Figure 29B is a side view of the wear strip of Figure 29A;

Figure 30A is a top plan view of a wear strip in accordance with the present invention; Figure 30B is a side view of the wear strip of Figure 30A;

35 Figure 31A is a top plan view of a wear strip in accordance with the present invention; Figure 31B is a

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side view of the wear strip of Figure 31A;

Figure 32A is a top plan view of a wear strip in accordance with the present invention; Figure 32B is a side view of the wear strip of Figure 32A; Figure 32C
5 is a side view of an alternative embodiment of the wear strip of Figure 32A; Figures 32D and 32E are top plan views of wear strips in accordance with the present invention;

Figure 33 is a perspective view of a screen assembly
10 mounting structure for a shale shaker in accordance with the present invention;

Figure 34A is a top plan view of a wear strip in accordance with the present invention; Figure 34B is a side view of the wear strip of Figure 34A;

15 Figure 35A is a top plan view of a wear strip in accordance with the present invention; Figure 35B is a side view of the wear strip of Figure 35A;

Figure 36A is a top plan view of a wear strip in accordance with the present invention; Figure 36B is a
20 side view of the wear strip of Figure 36A;

Figure 37A is a top plan view of a wear strip in accordance with the present invention; Figure 37B is a side view of the wear strip of Figure 37A;

Figure 38A is a top plan view of a wear strip in
25 accordance with the present invention; Figure 38B is a side view of the wear strip of Figure 38A;

Figure 39A is a top plan view of a wear strip in accordance with the present invention; Figure 39B is a side view of the wear strip of Figure 39A;

30 Figure 40A is a top plan view of a wear strip in accordance with the present invention. Figure 40B is a side view of the wear strip of Figure 40A.

Figure 41A is a top plan view of a wear strip in accordance with the present invention; Figure 41B is a
35 side view of the wear strip of Figure 41A;

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Figure 42 is a perspective view of a screen assembly mounting structure for a shale shaker in accordance with the present invention;

5 Figure 43 is a perspective view of a screen assembly mounting structure for a shale shaker in accordance with the present invention;

Figure 44 is an underneath view of a wear strip of Figure 43;

10 Figure 45 is a perspective view of a screen assembly mounting structure for a shale shaker in accordance with the present invention, shown with exploded parts;

Figure 46 is a perspective view of a screen assembly mounting structure for a shale shaker in accordance with the present invention;

15 Figure 47 is a perspective view of a screen assembly mounting structure for a shale shaker in accordance with the present invention;

Figure 48 is an underneath view of a screen assembly in accordance with the present invention;

20 Figure 49A is a perspective view of an upstanding member suitable for any of the embodiment of the present invention disclosed herein;

Figure 49B is a perspective view of a hole for receiving the upstanding member shown in Figure 49A;

25 Figure 50A is a top view of a screen assembly in accordance with the present invention; Figure 50B is a side cross-section view of the screen assembly of Figure 50A;

30 Figure 50C is a top view of a screen assembly in accordance with the present invention; Figure 50D is a side cross-section view of the screen assembly of Figure 50C;

35 Figure 50E is a top view of a screen assembly in accordance with the present invention; and Figure 50F is a side cross-section view of the screen assembly of

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Figure 50E.

Figure 50G is a top view of a screen assembly in accordance with the present invention.

Figure 51 is a side view of a wear strip in accordance with the present invention.

Figures 1A and 1B show a screen assembly 10 in accordance with the present invention which has a perforated plate 11 on which is mounted three layers 12 of mesh or screening material. One, two, four, or more layers of screening material may be used. The plate 11 has a plurality of side holes 18 on each of two of its sides for receiving releasable fasteners for mounting the screen 10 in a suitable shale shaker. Optionally, the screen assembly's plate 11 may also have inner portions 15 with holes 16 therethrough and/or inner portions 15a with interior holes 16a therethrough which holes are also for receiving releasable fasteners for releasably connecting the screen assembly to the shale shaker. To insert the fasteners through the holes 16, 16a and 18 into holes in a deck or bed below a screen assembly, corresponding and appropriate holes or openings are made in the screening material. Although the entire inner portions 15a are revealed in Figure 1A, in an actual screen assembly, prior to making holes in screening material, the holes 16a and inner portions 15a are covered by screening material.

Figure 2A shows a fastener system 20 in accordance with the present invention which has a top member 21 with a lower portion 22 that is received within a bottom member 23 which has a plurality of spaced-apart fingers 24. The lower portion 22 upon insertion into the bottom member 23 forces the fingers 24 apart for a tight friction fit of the lower portion 22 within the bottom member 23. An upper shoulder 25 of the bottom member 23 abuts the top surface of a screen assembly SC which may

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be any screen assembly according to the present invention. A shale shaker deck 26 has a hole 27 corresponding to a hole 27a through the screen assembly SC through which is mounted the bottom member 23. Any
5 fastener hole in any screen assembly or part thereof in accordance with the present invention and/or any corresponding hole through a shaker deck according to the present invention may have any desired opening shape as viewed from above, including, but not limited to,
10 rectangular, triangular, elliptical, oval, pentagonal, circular, and hexagonal.

Figure 2B shows the fastener system 20 releasably holding the screen assembly SC to the shaker deck 26. Spaced apart shoulders 28 and 29 of the top member 21
15 provide an abutment against the screen assembly SC (the bottom shoulder 28) and a structure (the top shoulder 29) to grasp or contact to facilitate removal of the fastener.

Figures 3A and 3B show another embodiment of a
20 fastener system in accordance with the present invention for releasably connecting a screen assembly to a shale shaker. A system 30 has a fastener 31 with a body 32 and a lower inflatable member 33. A stop shoulder 39 on the body 32 abuts the top of a screen assembly SC (like
25 that of Figure 2A). Following insertion of the body 32 through a hole 34 in the screen assembly SC (see Figure 3A), the inflatable member 33 is inflated through valve apparatus 35 to hold the fastener (and thus the screen assembly) in place. To release the fastener, the valve
30 apparatus is activated to allow air to escape from the inflated inflatable member 33. The inflatable member 33 is sized and positioned so that, upon inflation, it abuts an underside of the deck 36 (like the deck 26, Figure 2A) of a shale shaker.

35 Figure 4 shows a fastener 40 for releasably

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connecting a screen assembly SC (like that of Figure 2A) to a shale shaker with a deck 46 (like the deck 26, Figure 2A). The fastener 40 has a body 41 that is inserted through a hole 42 in the screen assembly SC.

5 Optional threads 43 on the fastener body 41 mate with corresponding threads 44 on the deck 46 to releasably hold the fastener, and thus the screen assembly, in place. Any fastener in accordance with the present invention and any deck in accordance with the present
10 invention may have such threads. Optionally, the threads are deleted and the fastener is held in place with a friction fit; and/or, glue, epoxy, or an adhesive is used to hold the fastener in position (as may be done, optionally, with any other fastener disclosed herein); or
15 a non-threaded locking fastener is used with required holes and/or surfaces on the shaker deck or bed. Any suitable screw or bolt may be used for the body 41. Optionally, the fastener 40 has a top head 45 that facilitates turning of and removal of the fastener 40.
20 Any fastener in Figures 2A - 4 may be used with any screen assembly disclosed herein.

It is within the scope of this invention for the screen assembly SC to have one, two, three or more layers of screening material, i.e., screen, mesh, and/or
25 cloth made, for example, of stainless steel wire and/or plastic. Any such layer or combination of layers may be bonded together (glued, welded, and/or sintered) in any known manner and/or bonded to the plate 11 in any known manner. Any such layer or layers of screening material
30 may be substantially flat or may be undulating (with a series of alternating ridges and valleys) as is well known in the art. In accordance with the present invention any known support, plate, strip support, or frame for supporting a shale shaker screen and/or for
35 mounting thereto of one or more layers of screening

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material, mesh, and/or cloth may have one or more holes for receiving one or more fasteners according to the present invention for releasably connecting a screen assembly to a shale shaker.

5 Figure 7 shows a shale shaker 70 in accordance with the present invention which is like a shaker disclosed in US-A-5,641,070 co-owned with the present invention;

but the shaker 70 has a basket 71 with screen mounting decks 72

10 and 73. Supports 72a of the deck 72 and supports 73a and 73b of deck 73, have holes 72b, 72c, 72d and 72e therethrough (in deck 72) and 73c, 73d, 73e (in deck 73). As desired such holes may be provided on all sides and/or on all cross-members of either or both decks.
15 These holes are sized and positioned to correspond to holes in a screen support (and, optionally, holes through screening mesh and/or cloth) of screen assemblies (not shown) to be mounted in the basket 71. Springs 75 (two shown; four, six or more may be used) support the basket
20 in a shaker body 76 and one or more vibrators 77 connected to the basket 71 vibrate the basket 71. Holes as in either or both decks 72, 73 may be provided for the deck(s) of any known multi-deck shale shaker so that screen assemblies in accordance with the present
25 invention with holes according to the present invention may be releasably fastened thereto.

 Figure 8 shows a shale shaker 80 in accordance with the present invention with screen assemblies 81, 82 in accordance with the present invention mounted in a basket
30 83 to decks 86, 87 with fasteners 84, 85 which may be any screen assembly disclosed herein according to the present invention. The fasteners 84, 85 extend through holes (not shown) in the screen assemblies into holes (not shown) in the decks 86, 87. The basket 83 is
35 mounted on spring mounts 88 (three shown; four used in

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this embodiment) and is vibrated by a vibrator 89.

Referring now to Figure 9, a shale shaker 90 in accordance with the present invention has a screen deck 92 in accordance with the present invention in a basket 91. The deck 92 has holes 93 therearound into which are releasably inserted fasteners (not shown; including, but not limited to, fasteners as disclosed herein and/or fasteners in accordance with the present invention) to releasably secure one or more screen assemblies (not shown) to the deck 92. Any screen in accordance with the present invention may be used on the deck 92. The basket 91 is mounted on springs 94 (only two shown; two as shown are on the opposite side) which are supported from a frame 96. The basket 91 is vibrated by a motor 99 and interconnected vibrating apparatus 98 which is mounted on the basket 91 for vibrating the basket and the screens. Optional elevator apparatus 97 provides for raising and lowering of the basket end.

Referring now to Figures 10A and 10B a well 111 is being drilled by a bit 112 carried on a string of drill pipe 114. Drilling mud is pumped by a pump 118 into the drill pipe 114 and out through nozzles in the bit 112. The mud cools and cleans the cutters of the bit and then passes up through a well annulus 116 flushing cuttings out with it.

After the mud is removed from the well annulus 116, it is treated before being pumped back into the pipe 114. First, the mud enters the shale shaker 110 where relatively large cuttings are removed. The mud then enters a degasser 124 where gas can be removed if necessary. Degasser 124 may be automatically turned on and off, as needed, in response to an electric or other suitable signal produced by a computer 124 and communicated to degasser 124 as indicated by line 125. The computer 1344 produces the signal as a function of

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data from a sensor assembly 136 associated with shale shaker 110 and described more fully below. The data from sensor assembly 136 is communicated to computer 134 by line 182. The mud then passes to a desander and (or a desilter), jointly represented by station 126, for removal of smaller solids picked up in the well.

The mud next passes to a treating station 128 where, if necessary, conditioning media, such as barite, may be added from source 130. As shown, suitable flow control means, indicated in a simplified form by valve 132, controls flow of media from source 130 to station 128. Valve 132, in turn, may be automatically operated by an electric or other suitable signal produced by computer 134 as a function of the data from sensor assembly 136, such signal being communicated to valve 132 as indicated by line 131.

From the station 128, the mud is directed to tank 140, from which pump 118 takes suction, to be re-cycled through the well. Any shale shaker disclosed herein may be substituted for the shale shaker 110. The system 100 is like the systems disclosed in U.S. Patent 5,190,645, but the system 100 has a shake shaker in accordance with the present invention.

The shale shaker 110 as shown in detail in Figure 10B has a basket 121 in which a screen mounting deck 122 (shown schematically in Figure 10B). A screen assembly 123 in accordance with the present invention (shown schematically) is releasably secured to the deck 122 by a plurality of spaced-apart fasteners 133 which extend through holes 135 in the screen assembly 123 and through corresponding holes 137 in the deck 122. Vibrator apparatus 139 vibrates the basket 121 which is mounted on mounts 127. Material flows through exit structure 141 into a collection receptacle 143.

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The screen assembly 123 may be any (one, two, three or more) screen assembly in accordance with the present invention and the fasteners 133 may be any fastener in accordance with the present invention.

5 Figure 11 shows a screen assembly 190 in accordance with the present invention which has a lower tubular frame support 191 to which is connected and/or welded a perforated plate 192 (including, but not limited to a perforated plate like that disclosed in US-A-4,575,421;
10 but with holes in accordance with the present invention for receiving fasteners in accordance with the present invention to releasably connect the screen assembly 190 to a shale shaker).

15 The perforated plate 191 of the screen assembly 190 has a plurality of peripheral holes 193 and a plurality of interior holes 194 (either holes 193 or holes 194 may be deleted - as is the case for any support, plate, or frame in accordance with the present invention). A
20 plurality of fasteners 195 (two shown; one through each hole 193, 194) connect the plate 192 to the tubular frame support 191. The fasteners' lower ends are received in holes 196 of the tubular frame support 191 whose position corresponds to that of the holes 193, 194.

25 As shown in Figure 11 there are three layers 197a, 197b, 197c of screening material on the plate 192. Any one or two of these layers may be deleted; any known combination of layers may be used; and the layers may or may not be connected and/or bonded together at their
30 edges and/or across their surfaces in any known manner with any known material and/or process. Any known suitable tubular members may be used to make the tubular frame support 191 with its outer members 191a and its cross-members 191b.

35 Figure 12 shows a screen assembly 210 in accordance

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with the present invention with a unibody structure 220 in accordance with the present invention. The screen assembly 210 has, optionally, three 211, 212, 213 of screening material (shown partially; extending over the entire open area of the unibody structure 220) bonded to a top surface 222 of the unibody structure 220. Preferably, the layers 211, 212, 213 are also bonded together over substantially their entire surface area. A plurality of fasteners 240 extend through holes 241 in the unibody structure 220 to releasably connect the screen assembly 210 to a screen mounting deck 242 of a shale shaker (not shown in its entirety). Optionally, one or more fasteners 243 (one shown) may extend through the layers of screening material on the screen assembly 210 and into the deck 242.

A plurality of openings 224 through the unibody structure 220 define a plurality of support members 226. To the underside of the unibody structure 220 are, optionally, connected a plurality of spaced-apart ribs 228 which, in one aspect are welded to a metal unibody structure 220. In this particular embodiment the ribs 228 are positioned along a substantial majority of their length directly beneath one of the support members 226 that extend across a major portion of the unibody structure 220; but it is within the scope of this invention to use no such ribs or to position them anywhere on the underside of the unibody structure 220. The unibody structure 220 has spaced-apart sides 236, 238. The screen assembly 210 has an end 214 and a ledge end 216. The ledge end has an upper ledge portion that rests on a shoulder of an end of an adjacent screen. Thus one screen end seals against another screen end when such screens are used end-to-end (as described in U.S. Patent 6,283, 302 co-owned with the present invention.

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Figure 13 shows a screen strip support 250, in accordance with the present invention with a plurality of spaced-apart strips 252 (made of any suitable metal or metal-like material) secured to and between spaced-apart sides 254. The screen strip support 250 is like the strip support of Figure 51A, US-A- 6,290,068 (co-owned with the present invention); but the screen strip support 250 has outer holes 267 and inner holes 268 through which may be inserted any fastener disclosed herein for releasably connecting the support 250 (and any screen assembly of which it is a part) to a shale shaker deck. Either holes 267 or holes 268 may be deleted. Any known strip support may be provided, in accordance with the present invention, with holes 267 and/or holes 268. Each end 256 of each strip 252 is received and held in a recess 264 in a side 254. The recess 264 corresponds in shape to the shape of the end 256 and a shoulder 266 of each strip 252 abuts a side 254. The end 256 may be inserted into the recess 254 from the side or from above or below. The top and bottom strips 252 each has two humps or ridges 253 which are located, sized, and configured to be received in corresponding corrugations of a corrugated plate and/or corrugated screen assembly. it is within the scope of this invention for each strip to have one, two, or a plurality of multiple humps or ridges. In one aspect there is one hump or ridge for each corrugation on a superimposed plate and/or screen assembly. It is within the scope of this invention to delete the humps and/or ridges so that the strips 252 are flat for use with flat mesh and/or screen(s).

Figures 14A and 14B show plastic grids 270, 271, respectively, each with a body 270d, 271d respectively with a plurality of openings 270a, 270b, 271b respectively, therethrough. Although only certain of

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the openings 271b are shown, it is to be understood they extend across the entire surface of the body 271d. The plastic grids 270, 271 are like plastic grids disclosed in U.S. Patents 5,417,859; 5,958,236; 5,783,077; and
5 6,053,332; but the grids 270, 271 each have a plurality of spaced-apart holes 270c, 271c, respectively therethrough for accommodating fasteners according to the present invention which extend through a screen
10 assembly in accordance with the present invention to releasably connect a screen assembly to a shale shaker. Any grid disclosed in the patents cited above and any known plastic grid or piece used in a screen assembly for a shale shaker may have holes as shown in Figures 14A
15 and 14B (and/or any holes disclosed herein for any perforated plate or support disclosed herein); and any screen or screen assembly disclosed in the patents cited above may have any such grid or piece. Any such grid or piece in accordance with the present invention may have
20 holes corresponding to any fastener holes as described herein. In one aspect the holes in the grid or piece are made, in accordance with the present invention, prior to the final formation or assembly of a screen or screen assembly (as may also be the case with any perforated
25 plate or strip support in accordance with the present invention); while in another aspect the holes are made through the plastic grid (and/or through other parts, pieces and/or layers of the screen or screen assembly) following final formation or assembly thereof (as may
30 also be the case with any perforated plate, frame or strip support in accordance with the present invention). It is to be understood that it is within the scope of the present invention to have a plastic layer or a mass of fusing plastic fusing together layers of screening
35 material, the layer or mass optionally provided

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initially by a plastic grid, the plastic layer or mass having holes for fasteners corresponding to holes in a screening material support.

Figure 15 shows a screen assembly 280 in accordance with the present invention with a lower supporting perforated plate 281 according to the present invention. The screen assembly 280 is like those disclosed, for example, in US-A-4,575,421; but without hookstrip mounting apparatus and with a plurality of peripheral
10 holes 282 and one or more interior holes 284 for receiving fasteners 283 to releasably connect the screen assembly 280 to a shale shaker (not shown) whose deck or mounting structure has corresponding holes for releasably
15 receiving a portion of the fasteners 283 (as is the case for a shale shaker and fasteners through any screen or screen assembly in accordance with the present invention). In certain preferred aspects holes 282 and/or 284 are simply added to a perforated plate as
20 shown in US-A- 4,575,421; while in other aspects the plate is initially made so that plate portions 288 have only a hole 282 or a hole 284. In one particular aspect (as is true for any perforated plate in accordance with the present invention) an area like the areas 288
25 (and/or like the areas 15, Figure 1A and/or like the areas around the holes 193, 194, Figure 11 and for any plastic grid or piece in accordance with the present invention) are at least as large (viewed from above) as one of the openings or perforations through the plate
30 and in another preferred aspect are at least twice as large (viewed from above) as such an opening or perforation.

One, two, or three (or more) layers of mesh and/or screening material may, in accordance with the present
35 invention, be used on a perforated plate 280 (or on any

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perforated plate in accordance with the present invention); for example, as shown in Figure 15, three layers 285, 286, and 287 are used on the plate 281. Although these layers are shown partially, it is to be understood they substantially cover the plate 281.

The prior art discloses a variety of non-flat screens and screen assemblies sometimes referred to as "3D" or "Three Dimensional" screens (for example, but not limited to, as disclosed in US-A-s 5,417,793; 5,417,858; 5,417,859; 6,053,332; 5,598,236; 5,783,077; 6,283,302; 6,290,068. Figure 16 illustrates

that, in accordance with the present invention, non-flat screen assemblies may be fastened with releasable fasteners passing through holes therethrough to a shale shaker. A screen assembly 290 (shown partially) has a lower perforated plate 291 (which, optionally, may be any support plate, frame, or strip support) with a plurality of spaced-apart openings 292 therethrough (see, for example, but not limited to, Figure 13, U.S. Patent 5,417,858; and Figure 3, US-A- 5,417,859 regarding possible plates and screening material). A plurality of fasteners 295 passing through holes 296 (in screening material 294), holes 297 (in the plate 291) and into (and, optionally, through) holes 298 (in a shaker deck 293).

As shown in Figure 16, it is also within the scope of this invention to employ one or more fasteners 299 which extend through a portion of the screening material 294 that is not directly adjacent the plate 291 but which is spaced-apart therefrom. As shown a fastener 299 passes through a highest (with respect to the plate 291 as viewed in Figure 16) portion of the screening material 294 and through holes 299a, and 299b, in the plate 291 and deck 293, respectively, and through a hole 299c in the material 294; but it is within the scope of

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this invention to have one or more fasteners 299 (or 295) pass through any part or portion of the screening material 294. As may be the case with any fastener in accordance with the present invention and any fastener used with a screen assembly in accordance with the present invention, any suitable desired washer(s) and/or sleeve(s) may be used with the fastener(s) 295, 299 at any interface and/or for any hole.

It is within the scope of the present invention to provide holes for fasteners as disclosed herein in any known prior art frame used as a support for screening material for a screen assembly for a shale shaker. Figure 17 illustrates a frame 300 in accordance with the present invention which is like a frame as disclosed in US-A- 5,417,858, Figure 8; but which has a series of outer holes 301 through tubular frame members 302 and, optionally, (or instead of the holes 301) holes 303 through interior tubular members 304. Any holes described herein for releasably fastening a screen assembly to a shale shaker may be used in the frame 300 or in any frame support for a shale shaker screen assembly. Any layer or layers of mesh or screening material described or referred to herein or known in the prior art may be used on the frame 300 or on any frame in accordance with the present invention.

With screen assemblies in accordance with the present invention (for example as in Figure 1A) which employ no lower support frame, any opening through the lower support can receive a common plug to replace torn screening material above the opening and no frame member blocks any of the openings which could require a customized plug.

Figures 18A - 18F show a screen assembly 340 in accordance with the present invention which has a tubular frame 342 with ends 344 and interconnected sides 345. A

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screening material combination 350 is secured with cured epoxy to the tubular frame 342. A crossmember 341 (of a plurality of spaced-apart crossmembers 343 that extend between and have ends connected to the sides 345) has two
5 notches 346, either of which is for receiving a portion of an upstanding member of a shale shaker deck.

In certain shale shakers in which screen assemblies without crossmembers such as the crossmember 341 are used, one or more upstanding members are located so that
10 they do not push up on a screen assembly above them and such upstanding members are often used for proper screen assembly positioning, for preventing unwanted screen movement with respect to a shaker deck, or for stabilizing screen assemblies in position. Rather than
15 removing such upstanding member(s) when a screen assembly is used that does have one or more crossmembers that would undesirably abut the top of an upstanding member (preventing correct screen assembly emplacement on a deck), a screen assembly in accordance with the
20 present invention may be installed on such a shaker deck so that a portion of the upstanding member (which is perpendicular to the crossmember 41 as viewed from above or below) is received in and projects into one (or more) of the notches 346. With a screen assembly 340 as
25 shown, the crossmembers 343 on either side of the crossmember 341 are sufficiently spaced-apart from the crossmember 341 that the upstanding member does not contact the adjacent crossmembers 343. Although only one notch 346 can accommodate an upstanding member, by
30 using two notches 346, proper emplacement of the screen assembly 340 over the upstanding member is made "fool proof" - i.e. whichever side of the screen assembly is placed nearest the shaker's exit end (or fluid introduction end) one of the notches will be above the
35 upstanding member. Of course it is within the scope of

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the present invention to place aligned notches on adjacent crossmembers to accommodate an upstanding member of such dimensions that it extends beyond the distance separating two, three, four or more crossmembers. The screen assembly 340 as shown has a multi-layer combination 350 of layers of screening material glued together with moisture curing hot melt glue in a glue pattern 362. The multi-layer glued-together combination 360 is secured to the tubular frame 342 with cured epoxy.

Figure 19 shows a mounting structure (or "tray") 400 for a shale shaker on which is releasably securable one or more screen assemblies. As shown a screen assembly mounts on and covers tray 400, but it is within the scope of this invention to have a larger tray on which two, three or more screen assemblies are secured or to have multiple trays 400 on a single shale shaker (as is true for any tray or mounting structure in accordance with the present invention disclosed herein). Although a particular tray is shown in Figure 19, it is to be understood that, in accordance with the present invention, the teachings of the various holes and projecting members for trays (for example, as in Figures 19-49) are applicable to known screen mounting structures for shale shakers in which and on which the holes and upstanding members may be used; and similarly for the screen assemblies shown in Figures 20A - 48 the various holes and projecting members may be used with any suitable known screen assembly.

The tray 400 has two spaced-apart outer ends 402, 404 which are spaced-apart by sides 406. The entire tray 400 is positioned in and connected to a basket or other suitable enclosure or housing of a shale shaker. Crossmembers 408 extend from end to end of the tray 400 and crossmembers 410, 412 extend between crossmembers 408

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and sides 406. A support member 409 extends beneath one of the crossmembers 408 (and such a support may be under any crossmember). Wear strips 414 are connected to tops of the sides 406 and wear strips 416 are on tops of some of the interior crossmembers. An upstanding member 420 projects upwardly from each end 402, 404 of the tray 400. Each upstanding member 420 is located, sized, and configured for receipt within a corresponding hole of a screen assembly placed on the tray 400. Fluid to be treated by a shale shaker with a tray as in Figure 19 (or any tray disclosed herein) may flow across a screen assembly placed on the tray in any desired direction; and one such direction is indicated by the arrows AA and BB in Figure 19.

Figures 20A to 20D show a screen assembly 430 in accordance with the present invention which has a lower support frame 432 (which may be any known screen assembly support frame or which may, alternatively, be any known screen assembly support such as a strip support, perforated plate, or unibody structure). Screening material 434 (shown partially, but covering the frame 432) is on the top of the frame 432 and may be any known screening material used in screen assemblies for shale shakers, including, but not limited to, multi-layer screen meshes and/or flat or 3-D materials. A lower bar 436 is connected to or formed integrally of the frame 432 at each of its ends. Each end of the screen assembly 430 has a hole 438 for receiving a member projecting upwardly from a shale shaker's screen mounting structure, for example, but not limited to, like the upstanding members 420, Figure 19. The holes 438 do not extend through the top of the frame 432. The lower support frame 432 is rigid enough to inhibit the screening material from curling and maintains the screening material in substantially one flat plane. The

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support frame 432 is light and easy to handle. The support frame 432 is preferably rigid enough to allow the screening material 434 to be tensioned thereover and glued or otherwise secured thereto and most preferably
5 rigid enough to be held at either end, whereupon the screen assembly will not sag.

Figure 20E shows possible shapes 439a, b, c, d, e, f, g, h, i and j as viewed from above, for any upstanding member or upwardly projecting member in
10 accordance with the present invention, and also for holes corresponding to such upstanding or upwardly projecting members.

Figure 21 shows a tray 440 in accordance with the present invention which is like the tray 400 (and like
15 parts are designated with the same numerals), Figure 19; but which has three upstanding members 420 at each of its ends, each for receipt within corresponding holes of a screen assembly to be emplaced on the tray 400. Tray ends or sides in accordance with the present invention
20 may have any desired number of upstanding or upwardly projecting members for receipt within corresponding holes of a screen assembly.

Figure 22 shows a tray 450 like the tray 400 (and like parts are designated with the same numerals); but
25 without any upstanding members 420 and with a hole 452 in each of its ends. The holes 452 are located, sized, and configured for receiving corresponding downwardly projecting members of a screen assembly emplaced on the tray 450.

Figures 23A to 23D show a screen assembly 460 in accordance with the present invention like the screen assembly 430, Figure 20A, and like numerals designate like parts. Instead of holes 438, however, the screen assembly 460 has downwardly projecting members 468 on
30 each of its ends. The downwardly projecting members 468
35

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are located, sized, and configured for receipt within corresponding holes in a shale shaker's screen mounting structure, for example, but not limited to, such as the holes 452 in the support frame 432 shown in Figure 22.

5 Figure 24 shows a tray 470 in accordance with the present invention like the trays 400 (Figure 19) and 450 (Figure 22); but with two upstanding members 472 at each of its ends and a hole 474 in each of its ends. Each upstanding member 472 is located, sized and configured
10 for receipt within a corresponding hole of a screen assembly and the hole 474 is located, sized and configured for receiving a corresponding downwardly projecting member of a screen assembly. Either one or both of the upstanding members 472 may be deleted; there
15 may be three or more upstanding members 472; the hole 474 may be deleted; and/or there may be two, three or more holes 474 - as is true for any tray in accordance with the present invention.

 Figures 25A to 25H show schematically shale shakers
20 in accordance with the present invention with shale shaker decks (screen mounting structures) in accordance with the present invention. The shale shakers of Figures 25A to 25H are like the shale shaker of Figure 10B and like numerals designate the same parts. It is
25 within the scope of the present invention to employ any of the holes or upstanding members in Figures 25A to 25H on any shale shaker mounting structure disclosed herein. Also, any screen assembly disclosed herein can have the hole(s) and/or downwardly projecting members of the
30 screen assembly of Figure 25G. It is to be understood that although the drawings of Figures 25A to 25H show upstanding members or holes at only one side of a deck, the other side (not shown) of the deck may have the same structure, or it may have none of the structure shown.

35 A shale shaker 480 shown in Figure 25A has a

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plurality of spaced-apart holes 481, each hole for receiving a corresponding downwardly projecting member of a screen assembly placed on the shale shaker's deck. The holes 481 extend down substantially perpendicularly into the deck 122. Any number of holes 481 may be used (one to four or more).

5 A shale shaker 482 shown in Figure 25B has a plurality of spaced-apart holes 483, each hole for receiving a corresponding downwardly projecting member of a screen assembly placed on the shale shaker's deck. 10 The holes 483 extend down at an angle (toward the left) into the deck 122. Any number of holes 483 may be used (one to four or more) and they may extend into the deck 122 at any desired angle, including, but not limited to, 15 angled toward or away from a fluid introduction end or fluid exit end.

A shale shaker 484 shown in Figure 25C has a plurality of spaced-apart holes 485, each hole for receiving a corresponding downwardly projecting member of a screen assembly placed on the shale shaker's deck. 20 The holes 485 extend down at an angle into the deck 122. Any number of holes 485 may be used (one to four or more) and they may be angled at any desired angle in any desired direction.

25 A shale shaker 486 shown in Figure 25D has a plurality of spaced-apart upstanding members 487, each hole for receipt within a corresponding hole of a screen assembly placed on the shale shaker's deck. The upstanding members 487 extend up substantially perpendicularly to the deck 122. Any number of members 30 487 may be used (one to four or more).

A shale shaker 488 shown in Figure 25E has a plurality of spaced-apart upstanding members 489, each for receipt within a corresponding hole of a screen assembly placed on the shale shaker's deck. The 35

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upstanding members 489 extend up at an angle to the deck 122. Any number of members 489 may be used (one - four or more) and they may project from the deck at any desired angle in any desired direction.

5 A shale shaker 489 shown in Figure 25F has a plurality of spaced-apart upstanding members 491, each for receipt within a corresponding hole of a screen assembly placed on the shale shaker's deck. The upstanding members 491 extend up at an angle to the deck
10 122. Any number of upstanding members 491 may be used (one - four or more) and they may be at any desired angle in any desired direction.

 A shale shaker 492 shown in Figure 25H has a plurality of spaced-apart holes 493, each hole for
15 receiving a corresponding downwardly projecting member of a screen assembly placed on the shale shaker's deck and a plurality of spaced-apart upstanding members 494 projecting up from the deck 122. The holes 493 extend down substantially perpendicularly into the deck 122 (but
20 may be at any angle at any direction) and the upstanding members 494 project up substantially perpendicularly to the deck 122, but may be at any angle in any direction. Any number of holes and/or upstanding members may be used (one - four or more).

25 Figure 25G shows schematically a screen assembly 495 in accordance with the present invention, useful on a shale shaker, which has a body or support 496 with two spaced-apart downwardly projecting members 497 and two spaced-apart holes 498. The downwardly projecting
30 members 497 are for receipt within corresponding holes (for example but not limited to, such as the holes 493, Figure 25H) in a shale shaker screen assembly mounting structure; and the holes 498 are for receiving corresponding upwardly projecting members of a shale
35 shaker mounting structure (for example, but not limited

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to, such as the upstanding members 494, Figure 25H).

Figure 26 shows a shale shaker 500 like the shale shaker of Figure 9 (like numerals indicate the same parts); but with a plurality of spaced-apart upwardly projecting members 502 projecting up from the deck 92. It is to be understood, although not shown, that as desired, upstanding members 502 may be provided spaced-apart on both sides or around the entire periphery of the deck 92 (or of any shaker deck). Optionally, the holes 93 may be deleted or they may be sized for receiving downwardly projecting members of a screen assembly.

Figure 27 shows a shale shaker 504 like that of Figure 27 but with a plurality of spaced-apart upwardly projecting members 506 at the sides of the screen assembly mounting structures of the shale shaker. Optionally, the holes (or some of them) 72 and 73 may be deleted or they may be sized to receive a downwardly projecting member of a screen assembly.

Figure 28 shows a wear strip 510 in accordance with the present invention which has a body 511 and an upstanding member 512 for receipt within a corresponding hole of a screen assembly. Using openings 513 at either end of the body 511, the wear strip 510 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 513 has, optionally, a bevelled edge 514 for ease of installation, for example, but not limited to with fasteners, bolts, screws, pins, and/or around upstanding connectors on a shale shaker mounting structure. In certain aspects the openings 513 are located so that the wear strip 510 is slipped onto corresponding upstanding members of a shale shaker mounting structure (for example as in Figure 33). The wear strip (and any wear strip herein) 510 may be made of any suitable material,

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for example, but not limited to fiberglass, rubber, zinc, zinc alloy, urethane, BUNA-N, aluminum, aluminum alloy, steel, stainless steel, wood, iron or plastic as may be the upstanding member 512 (as may be any wear strip or mounting structure disclosed herein).

Figure 29A and 29B show a wear strip 520 in accordance with the present invention which has a body 521 and an upstanding member 522 for receipt within a corresponding hole of a screen assembly. Using openings 523 at either end of the body 521, the wear strip 520 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 523 has, optionally, a bevelled edge 524 for ease of installation, for example, but not limited to with fasteners, bolts, screws, pins, and/or around upstanding connectors on a shale shaker mounting structure. In certain aspects the openings 523 are located so that the wear strip 520 is slipped onto corresponding upstanding members of a shale shaker mounting structure (for example as in Figure 33). The wear strip (and any wear strip herein) 520 may be made of any suitable material, for example, but not limited to fiberglass, rubber, steel, stainless steel, wood, iron or plastic as may be the upstanding member 522.

Figure 30A and 30B show a wear strip 530 in accordance with the present invention which has a body 531 and an upstanding member 532 for receipt within a corresponding hole of a screen assembly. Using openings 533 at either end of the body 531, the wear strip 530 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 533 has, optionally, a bevelled edge 534 for ease of installation, for example, but not limited to with fasteners, bolts, screws, pins, and/or around upstanding connectors on a shale shaker mounting

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structure. In certain aspects the openings 533 are located so that the wear strip 530 is slipped onto corresponding upstanding members of a shale shaker mounting structure (for example as in Figure 33). The wear strip (and any wear strip herein) 530 may be made of any suitable material, for example, but not limited to fiberglass, rubber, steel, stainless steel, wood, iron or plastic as may be the upstanding member 532. As with any of the wear strips in Figures 28 to 32A, any desired number of upstanding members of any desired shape may be used. Also, any such upstanding member may be formed integrally of or connected to a wear strip in accordance with the present invention.

Figure 31A and 31B show a wear strip 540 in accordance with the present invention which has a body 541 and an upstanding member 542 for receipt within a corresponding hole of a screen assembly. Using openings 543 at either end of the body 541, the wear strip 540 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 543 has, optionally, a bevelled edge 544 for ease of installation, for example, but not limited to with fasteners, bolts, screws, pins, and/or around upstanding connectors on a shale shaker mounting structure. In certain aspects the openings 543 are located so that the wear strip 540 is slipped onto corresponding upstanding members of a shale shaker mounting structure (for example as in Figure 33). The wear strip (and any wear strip herein) 540 may be made of any suitable material, for example, but not limited to fiberglass, rubber, steel, stainless steel, wood, iron or plastic as may be the upstanding member 542.

Figure 32A to 32C shows a wear strip 550 in accordance with the present invention which has a body 551 and an upstanding member 552 (Figure 32B) or 557

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(Figure 32C) for receipt within a corresponding hole of a screen assembly. Using openings 553 at either end of the body 551, the wear strip 550 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 553 has, optionally, a bevelled edge 554. Any upstanding member in any embodiment of the present invention may have a rounded surface as does the upstanding member 557. Figures 32D and 32E show wear strips with a hole at one end and an opening at the other end. Figure 32D shows a wear strip 550a like the wear strip 550, Figure 32A. The wear strip 550a has a body 551a, like the body 551 described above, with an opening 553a, like the opening 553 described above and with an upstanding member 557a, like the upstanding member 557 described above. The wear strip 550a also has a hole 573a, like the hole 573 described below. Figure 32E shows a wear strip 550b like the wear strip 550, Figure 32A. The wear strip 550b has a body 551b, like the body 551 described above, with an opening 613a, like the opening 613 described below and with an upstanding member 557b, like the upstanding member 557 described above. The wear strip 550b also has a hole 573b, like the hole 573 described below. The wear strips of Figures 32D and 32E are emplaceable on a tray with their end hole receiving an upstanding connector of the tray and with their other end opening encompassing another upstanding connector.

Figure 33 discloses a tray 560 like the tray 400, Figure 21 and like numerals indicate the same parts. Each end 402, 404 of the tray 560 has two spaced-apart upstanding connectors 562 useful for releasably attaching wear strips with appropriate openings (for example, but not limited to, wear strips as in Figures 28 to 32C and 38A to 41A, with appropriately sized openings) to the tray 560. Each connector 562 has a top

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564 larger than a base 565 so that, for example, upon sliding an opening (for example, but not limited to an opening 513 of the wear strip 510, Figure 28) around a connector 562, the top 564 abuts a top surface of the wear strip (which is made with an appropriate thickness) thereby holding the wear strip in position. One, three or more such connectors 562 may be used (with a corresponding opening or openings in a wear strip).

10 Figures 34A and 34B show a wear strip 570 in accordance with the present invention with a body 571 and an upstanding member 572. Holes 573 at each end of the body 571 may be used for fasteners, bolts, screws, or pins to releasably secure the wear strip to a side of a shale shaker mounting structure which has corresponding
15 holes for the fasteners, etc. Holes 573 (and any hole in Figures 35A - 37A) may be bevelled as shown.

Figures 35A and 35B show a wear strip 580 in accordance with the present invention with a body 581 and an upstanding member 582. Holes 583 at each end of the
20 body 581 may be used for fasteners, bolts, screws, or pins to releasably secure the wear strip to a side of a shale shaker mounting structure which has corresponding holes for the fasteners, etc.

Figures 36A and 36B show a wear strip 590 in accordance with the present invention with a body 591 and an upstanding member 592. Holes 593 at each end of the
25 body 591 may be used for fasteners, bolts, screws, or pins to releasably secure the wear strip to a side of a shale shaker mounting structure which has corresponding
30 holes for the fasteners, etc.

Figures 37A and 37B show a wear strip 600 in accordance with the present invention with a body 601 and an upstanding member 602. Holes 603 at each end of the
body 601 may be used for fasteners, bolts, screws, or
35 pins to releasably secure the wear strip to a side of a

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shale shaker mounting structure which has corresponding holes for the fasteners, etc.

Figures 38A and 38B show a wear strip 610 in accordance with the present invention which has a body 611 and an upstanding member 612 for receipt within a corresponding hole of a screen assembly. Using holes 613 at either end of the body 611, the wear strip 610 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 613 has, optionally, a bevelled edge portion 614 for ease of installation. A connector on a shaker tray can be inserted through a generally round part 615 of the openings 613 and then the wear strip is moved (to the left in Figure 38A) to secure the wear strip in place with the connectors.

Figures 39A and 39B show a wear strip 620 in accordance with the present invention which has a body 621 and an upstanding member 622 for receipt within a corresponding hole of a screen assembly. Using holes 623 at either end of the body 621, the wear strip 620 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 623 has, optionally, a bevelled edge portion 624 for ease of installation. A connector on a shaker tray can be inserted through a generally round part 625 of the openings 623 and then the wear strip is moved (to the left in Figure 39A) to secure the wear strip in place with the connectors.

Figures 40A and 40B show a wear strip 630 in accordance with the present invention which has a body 631 and an upstanding member 632 for receipt within a corresponding hole of a screen assembly. Using holes 633 at either end of the body 631, the wear strip 630 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each

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opening 633 has, optionally, a bevelled edge portion 634 for ease of installation. A connector on a shaker tray can be inserted through a generally round part 635 of the openings 633 and then the wear strip is moved (to
5 the left in Figure 40A) to secure the wear strip in place with the connectors.

Figures 41A and 41B show a wear strip 640 in accordance with the present invention which has a body 641 and an upstanding member 642 for receipt within a
10 corresponding hole of a screen assembly. Using holes 643 at either end of the body 641, the wear strip 640 is connectible to an end or side or crossmember of a shale shaker's screen assembly mounting structure. Each opening 643 has, optionally, a bevelled edge portion 644
15 for ease of installation. A connector on a shaker tray can be inserted through a generally round part 645 of the openings 643 and then the wear strip is moved (to the left in Figure 41A) to secure the wear strip in place with the connectors.

20 Figure 42 shows a tray 650 in accordance with the present invention for a screen assembly mounting structure of a shale shaker like the tray 400, Figure 19, and like numerals indicate the same parts. The tray 650 has three holes 652 in each of its ends 402, 404.
25 (Note that fluid flow over a screen assembly on the tray 650, and on any similar tray, may be from the top side 406 in Figure 42 to the bottom side 406 in Figure 42; or alternatively from end 402 to end 404). The holes 652 may be located, sized and configured for receipt therein
30 of corresponding downwardly projecting members of a screen assembly or they may be used for releasably connecting a wear strip in accordance with the present invention to the tray 65 (or they may be used for receiving fasteners that pass through a screen assembly,
35 as may be any hole in any tray in accordance with the

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present invention).

Figure 43 shows a tray 660 in accordance with the present invention like the tray 400 of Figure 19 and like numerals indicate the same parts. Each end 402, 404 has on its top surface an amount 662 of releasably cooperating hook-and-loop connection material and each of two wear strips 664 has a corresponding amount 665 (see for example Figure 44) of such releasably cooperating hook-and-loop connection material (for example but not limited to VELCRO[®] material (for releasably connecting the wear strips 664 to the tops of the ends of tray 660. Each wear strip has an upstanding member 667 (like the upstanding member 420, Figure 19). The wear strips 664 are shown above the tray 400 over the positions on the tray 664 at which they are connected in use (as is true for the wear strips shown above the tray in Figure 45).

Figure 45 shows a tray 670 in accordance with the present invention like the tray 400 of Figure 19 and like numerals indicate the same parts. Each end 402, 404 has on its top surface an amount 672 of two-sided adhesive tape for adhesively and releasably securing each of two wear strips 674 to the tops of the ends of tray 670. Each wear strip 674 has an upstanding member 677 (like the upstanding member 420, Figure 19).

Figure 46 shows a tray 680 in accordance with the present invention like the tray 400, Figure 19, and like numerals indicate the same parts. A wear strip 684 is secured on crossmembers 410, 412 as shown with any suitable securement, fastener, adhesive, and/or welding. It is within the scope of this invention to have a wear strip in accordance with the present invention on any crossmember or crossmembers of a shale shaker's screen assembly mounting structure.

Figure 47 shows a tray 690 in accordance with the

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present invention like the tray 400, Figure 19, and like numerals indicate the same parts. A crossmember 412 has an upstanding member 692 for receipt within a corresponding hole of a screen assembly emplaced on the tray 690. Another crossmember 412a has a hole 693 for receiving a downwardly projecting member of a screen assembly emplaced on the tray 690. Any number of holes 693 on any of the crossmembers may be used in accordance with the present invention; and/or any number of upstanding members 692 may be used on any of the crossmembers. The hole 693 and upstanding member 692 may have any shape for holes and upstanding members, respectively, disclosed herein.

Figure 48 shows a screen assembly 700 like the screen assembly 430, Figure 20A, and like numerals indicate the same parts. One crossmember 432a of the frame 432 has a hole 703 sized, located and configured for receiving a corresponding upstanding member of a screen mounting structure of a shale shaker. A crossmember 432b of the frame 432 has a projecting member 702 for receipt within a corresponding hole in a screen mounting structure of a shale shaker. Any number of holes 703 may, in accordance with the present invention, be used on a crossmember or crossmembers of the frame 432; and/or any number of projecting members 702 may, according to the present invention, be used on a crossmember or crossmembers of the frame 432.

Figure 49A shows a projecting member 710 in accordance with the present invention which may be used for any upstanding or upwardly projecting member or downwardly projecting member disclosed herein. The projecting member 710 has a base 712 larger than a top 714.

Figure 49B shows a hole 720 in material 722 which has a top opening 724 larger than a hole bottom 726.

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Such a hole may be used for any hole in any embodiment of the present invention. The base 712 and top 714 (and the top opening 724 and hole bottom 726) may be any desired size, and the distance between them may be any desired length; and the shape of the top 714 and base 712 (and of the top openings 724 and hole bottom 726) may be any shape disclosed herein for an upstanding or upwardly projecting member.

Figures 50A and 50B show a screen assembly 730 in accordance with the present invention which has a plurality of glued-together layers of screening material 731, 732, 733 with a plate 734 attached at one end and secured to the lower layer 733 of screening material. Holes 735 extend through the screening material layers and through the plate 734. The plate 734 may be adhesively secured to the screening material and/or any suitable fastener and/or clamp apparatus may be used for such securement. The holes 735 may be used (as may the holes 743, Figure 50C) as holes for receiving an upstanding member of a screen assembly mounting structure of a shale shaker; or fasteners may be inserted through the holes to releasably secure the screen assembly to a shale shaker screen assembly mounting structure. As with the glued-together layers of the screen assemblies of Figures 50C, 50E and 50G the screen assembly 730 may be any combination of two, three or more layers of screening material and/or mesh as disclosed in U.S. Patent No.

6,669,985 issued December 30, 2003.

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Optionally, the screen assembly 730 has holes 736 through the screening material and through plates 737a, 737b; and, optionally, holes 738 through a plate 739. It is within the scope of the present invention to provide a hole or holes on the outer periphery of the screen assembly 730 or to provide one or more holes with a corresponding lower plate (made of any suitable material including materials disclosed herein for wear strips and projecting members, rigid or flexible) at an inner area of the screen assembly 730 (and as may be provided in the screen assemblies of Figures 50C and 50E).

Figures 50C and 50D show a screen assembly 740 in accordance with the present invention which has a plurality of glued-together layers of screening material 742 (like the layers 731 - 733, Figure 50B) and holes 743 through a plate 741 (like the plate 734, Figure 50B). Optionally, a flexible seal flap 744 is provided along an end (or side) of the screen assembly and it is within the scope of the present invention to provide such a flexible seal flap on the opposite side or end (or on any side or end of any known screen assembly) for sealing a screen-assembly-basket-wall interface when the screen assembly is in position in a shale shaker basket. A hook apparatus 745 is connected to one end (or side) of the screen assembly 740 and provides a hook structure that can be engaged by known screen mounting apparatuses. With pins or fasteners extending through the holes 743 to releasably connect the screen assembly 740 at one side of a screen basket, tension can be applied to the screen assembly 740 through the hook apparatus 745 for efficient tensioning and positioning of the screen assembly on a shale shaker.

Figures 50E and 50F show a screen assembly 750 in accordance with the present invention which has a

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plurality of glued-together layers of screening material 752 with plates 753, 754 on either side of the screen assembly 750. Downwardly projecting members 755 (which may be like any downwardly projecting members disclosed herein) project down from the plates 753, 754 and are sized, located, and configured for receipt in corresponding holes of a screen assembly mounting structure of a shale shaker.

Figure 50G shows a screen assembly 760 in accordance with the present invention which has a plurality of glued-together layers of screening material 762 (like the layers 731 - 732, 742, and 752 disclosed above). An outer peripheral layer 763 of glue, adhesive, and/or epoxy surrounds the screen assembly 760 and a plurality of spaced-apart holes 765 extend through the layer 763 and through the layers of screening material. (Alternatively the layers 763 and/or 764 may be made of material like that of any plate in Figures 50A - 50F.) Optionally a layer 764 like the layer 763 is provided on the bottom of the screen assembly 760. Any one, two, or three sides of either layer 763, 764 may be deleted, for example if holes are desired on less than all sides of the screen assembly. A plate or plates (rigid or flexible) may be positioned above layers of screening material above any plate in Figures 50A - 50F.

Figure 51 shows a wear strip 770 (which may be any wear strip in accordance with the present invention) which is made in a bowed shape as shown in Figure 51 so that it will exert an upward force on a screen assembly mounted above it in a shale shaker. Alternatively, any wear strip in accordance with the present invention which is flexible may be connected to a shale shaker screen assembly mounting structure so that it is bowed upwardly. It is within the scope of the present invention to employ an initially-bowed wear strip in a

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flattened position so that in such flattened position it exerts an upward force on a screen assembly above it. This can be useful when wedges or other screen holding items are used which are made of a material such as rubber or urethane which can shrink or lose some of its resiliency in use thereby loosening the mounting of a screen assembly in a shale shaker.

10 The present invention, therefore, in some and not necessarily all embodiments, provides mounting structure for a shale shaker to which is releasably mountable a screen assembly, the mounting structure having a body over which a screen assembly is positionable, part of
15 material to be treated by the shale shaker flowable through the body, at least one upwardly projecting member projecting upwardly from the body, the at least one upwardly projecting member sized and configured so it is receivable in a corresponding hole in the screen
20 assembly.

 The present invention, therefore, in some and not necessarily all embodiments, provides mounting structure for a shale shaker to which is releasably mountable a screen assembly, the mounting structure having a body
25 over which a screen assembly is positionable, part of fluid to be treated by the shale shaker flowable through the body, at least one hole in the body projecting down into the body, the at least one hole sized and configured for receiving a corresponding downwardly projecting
30 member of the screen assembly.

 The present invention, therefore, in some and not necessarily all embodiments, provides a wear strip (any screen assembly mounting structure may have one, two, three, four or more of them - for example, on two
35 opposite ends, on two opposite sides, and/or on one or

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more crossmembers) for attachment to a mounting structure of a shale shaker to which is releasably mountable a screen assembly, the wear strip having a body, at least one upwardly projecting member projecting upwardly from the body member, the at least one upwardly projecting member sized, located and configured so it is receivable in a corresponding hole in the screen assembly.

The present invention, therefore, in some and not necessarily all embodiments, provides a screen assembly for releasable mounting to a mounting structure of a shale shaker, the screen assembly having one or more screen holes as described herein and/or one or more projecting members as described herein for mating with corresponding hole(s) and/or projecting member(s) of a screen mounting structure and/or a wear strip or wear strips thereof of a shale shaker.

The present invention, therefore, in some and not necessarily all embodiments, provides a shale shaker with: one, two, three or more screen assembly mounting structures as described herein; one, two, three, four or more wear strips as described herein; and/or one, two, three or more screen assemblies as described herein; and methods for their use.

The present invention, therefore, in some and not necessarily all embodiments, provides a screen assembly with a hole or holes in a surface of a support of a screen assembly, for example, but not limited to in part of a tubular frame of a screen assembly, and a projecting member or members are moved into such hole or holes (for example, a projecting member on a screen assembly holding member or structure or on an air bladder that is inflated above or below a screen assembly to secure it in place on a shaker deck, bed or tray). In certain such aspects the screen assemblies shown in the drawings and described herein have the hole

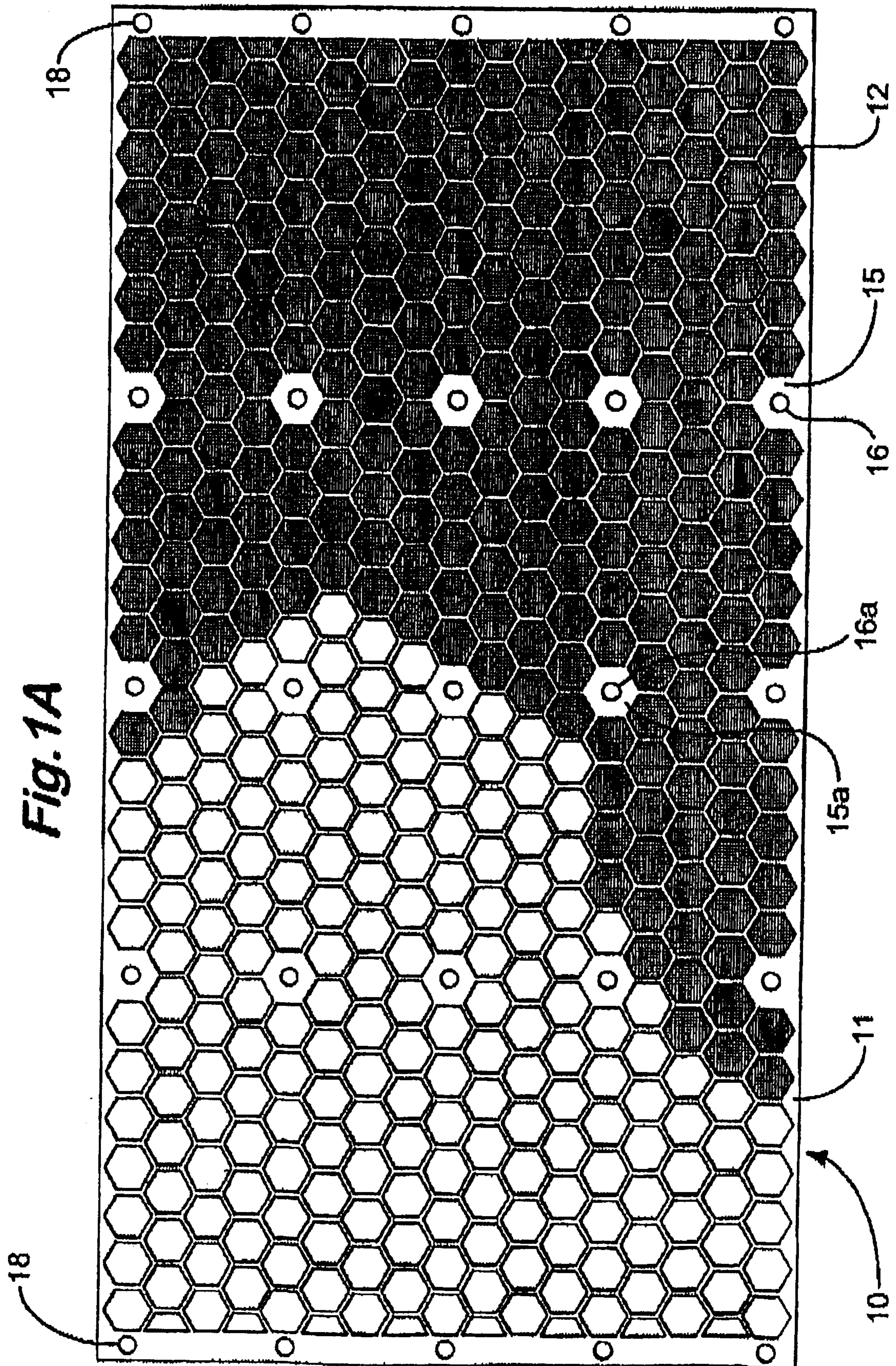
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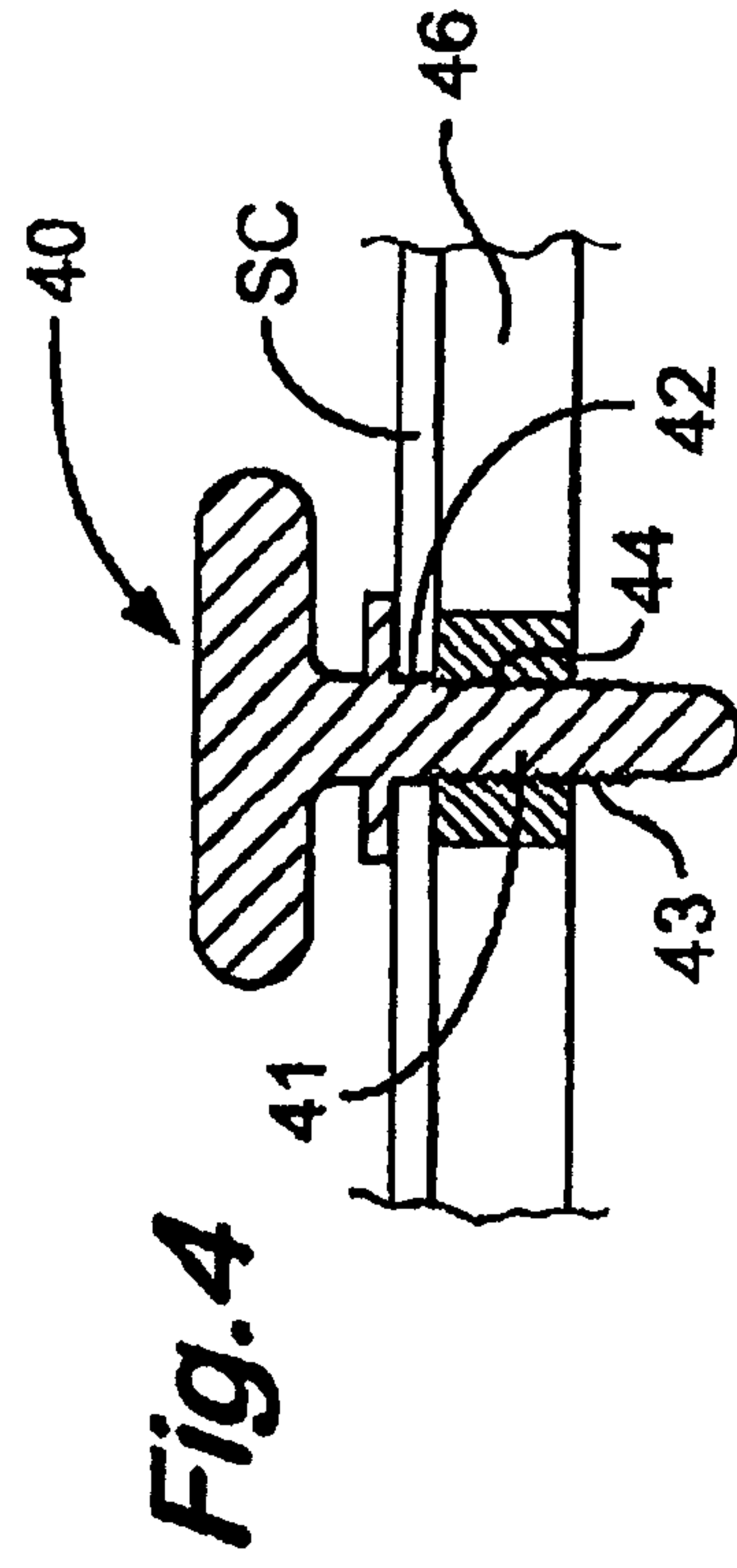
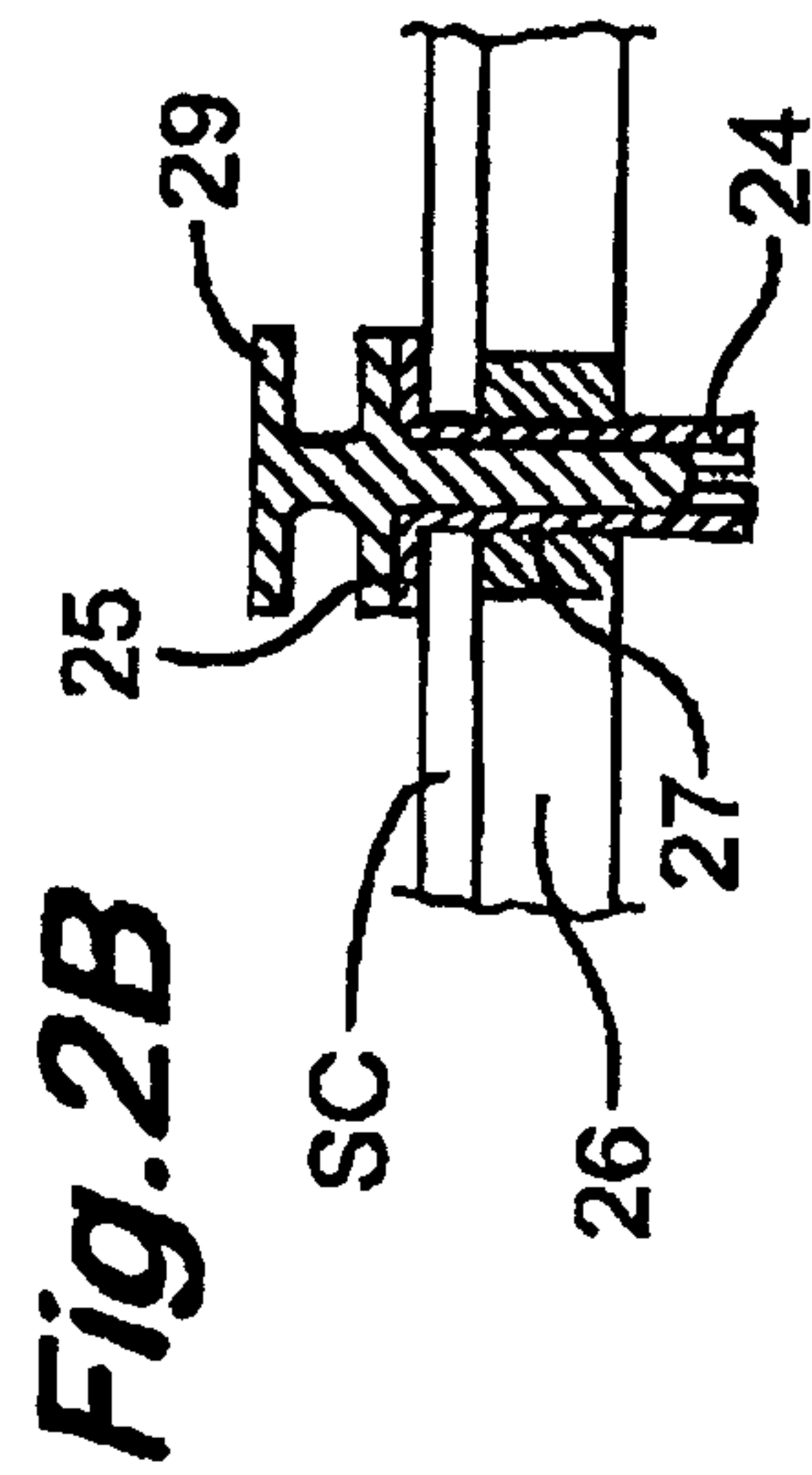
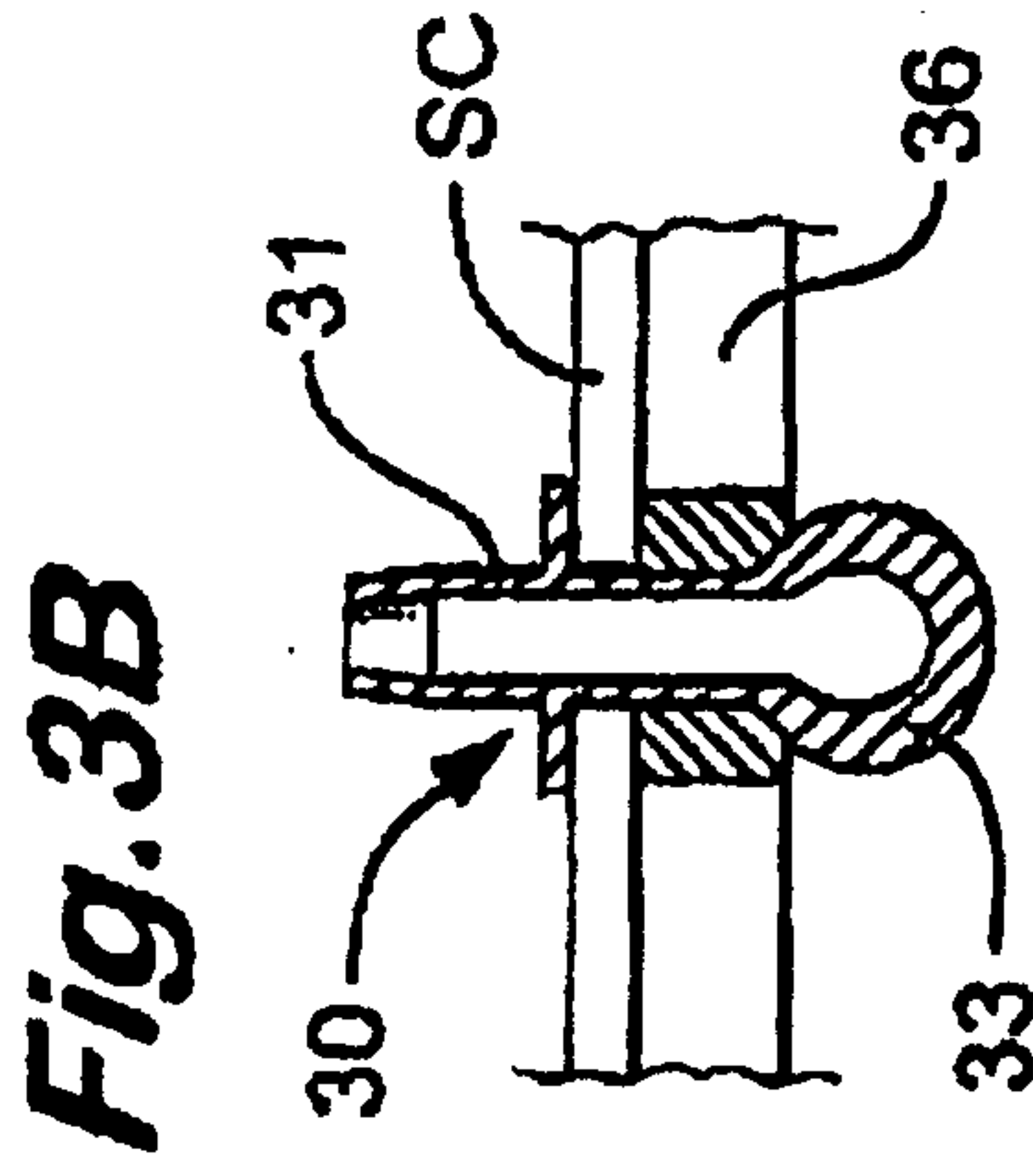
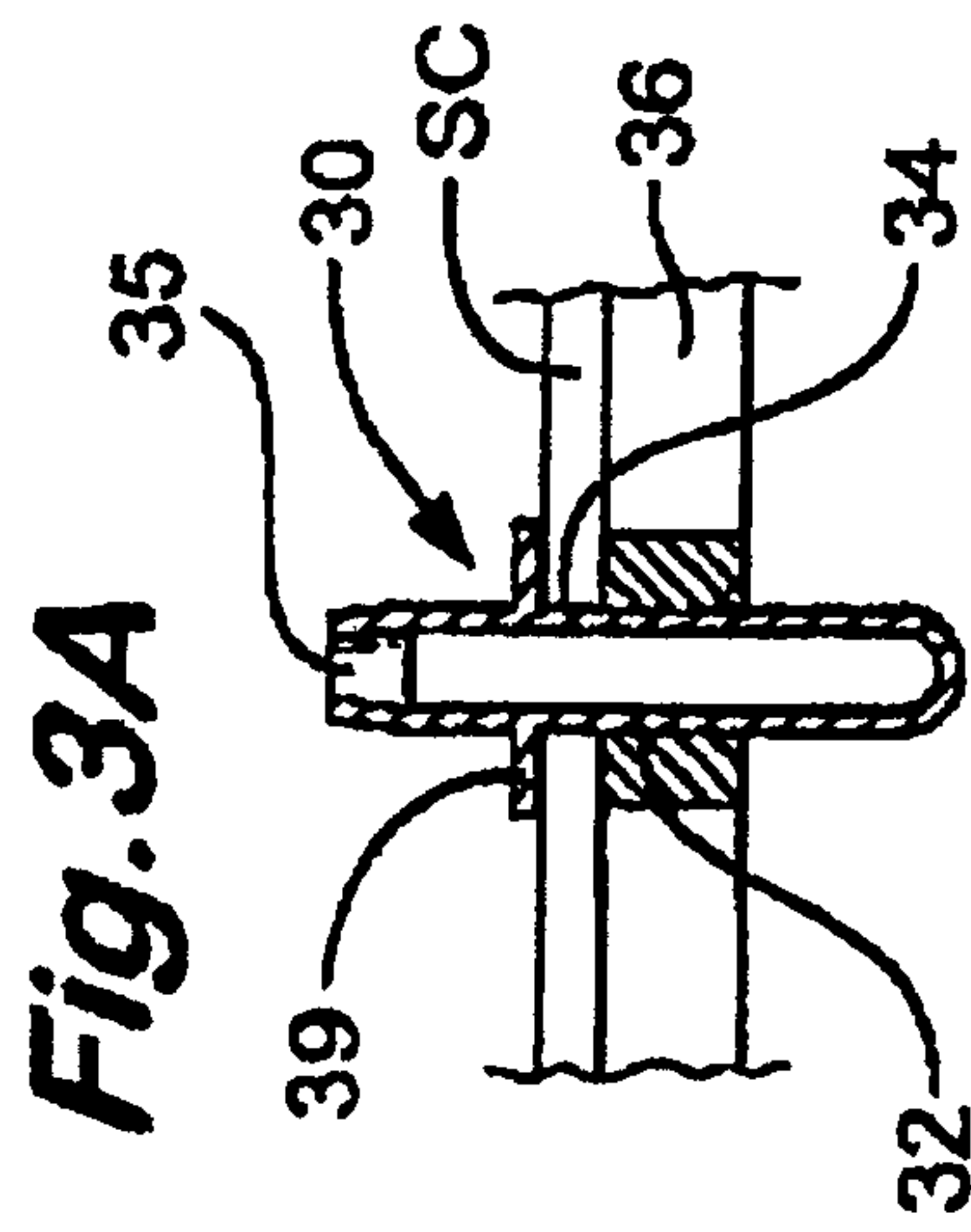
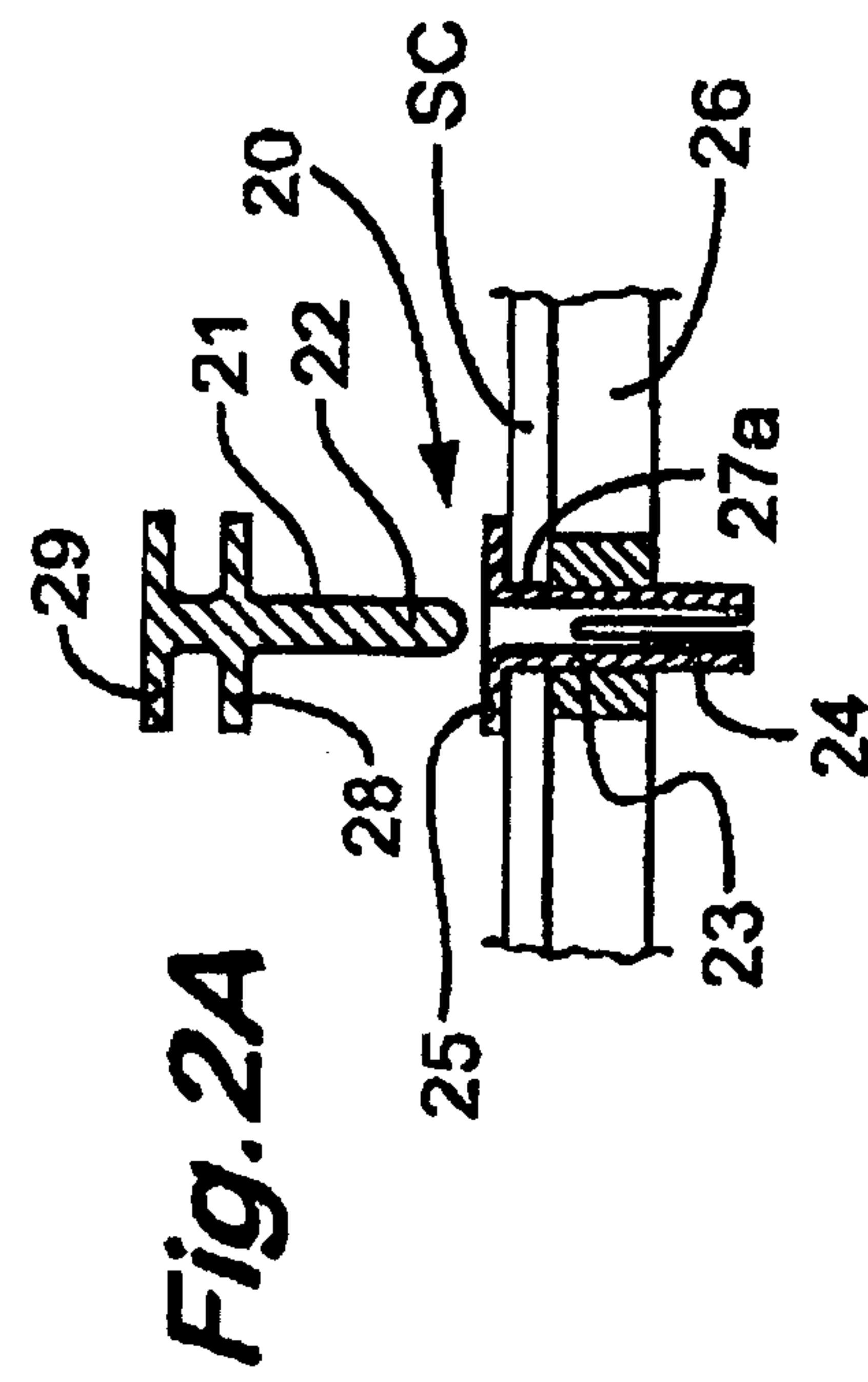
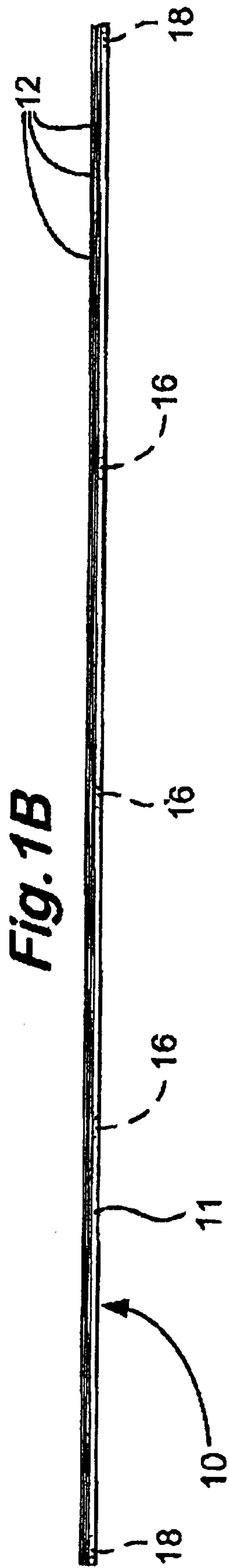
or holes in the topmost surface of a screen frame or tubular support or in the bottom thereof.

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CLAIMS:

1. A method for mounting a screen assembly in a shale shaker, the shale shaker comprising a mounting structure for receiving the screen assembly, the screen assembly comprising at least one layer of screening material tensioned over a screen support, characterized in that the method comprises the steps of aligning said screen assembly with said mounting structure using at least one hole located in at least one of the screen support and the mounting structure and inserting a corresponding pin of the other of the screen support and mounting structure into said at least one hole.
2. The method in accordance with claim 1, wherein the pin is fixed to, and projects from one of said screen support and mounting structure and the at least one hole is located in the other of said screen support and mounting structure, the method comprising the step of locating the pin with the hole of the other of said screen support and mounting structure.
3. The method in accordance with claim 1 or 2, wherein both of the screen support and the mounting structure comprise at least one hole, the method comprising the steps of aligning said holes and placing the pin through the at least one hole on the screen support and into the at least one hole in the mounting structure.
4. The method in accordance with claim 1 or 2, wherein a further hole is located in at least one of the screen support and the mounting structure and the method further comprises the step of locating a further pin in the further hole.
5. The method in accordance with claim 3, wherein a further hole is located in at least one of the screen support and the mounting structure and the method further comprises the step of locating a further pin in the further hole.





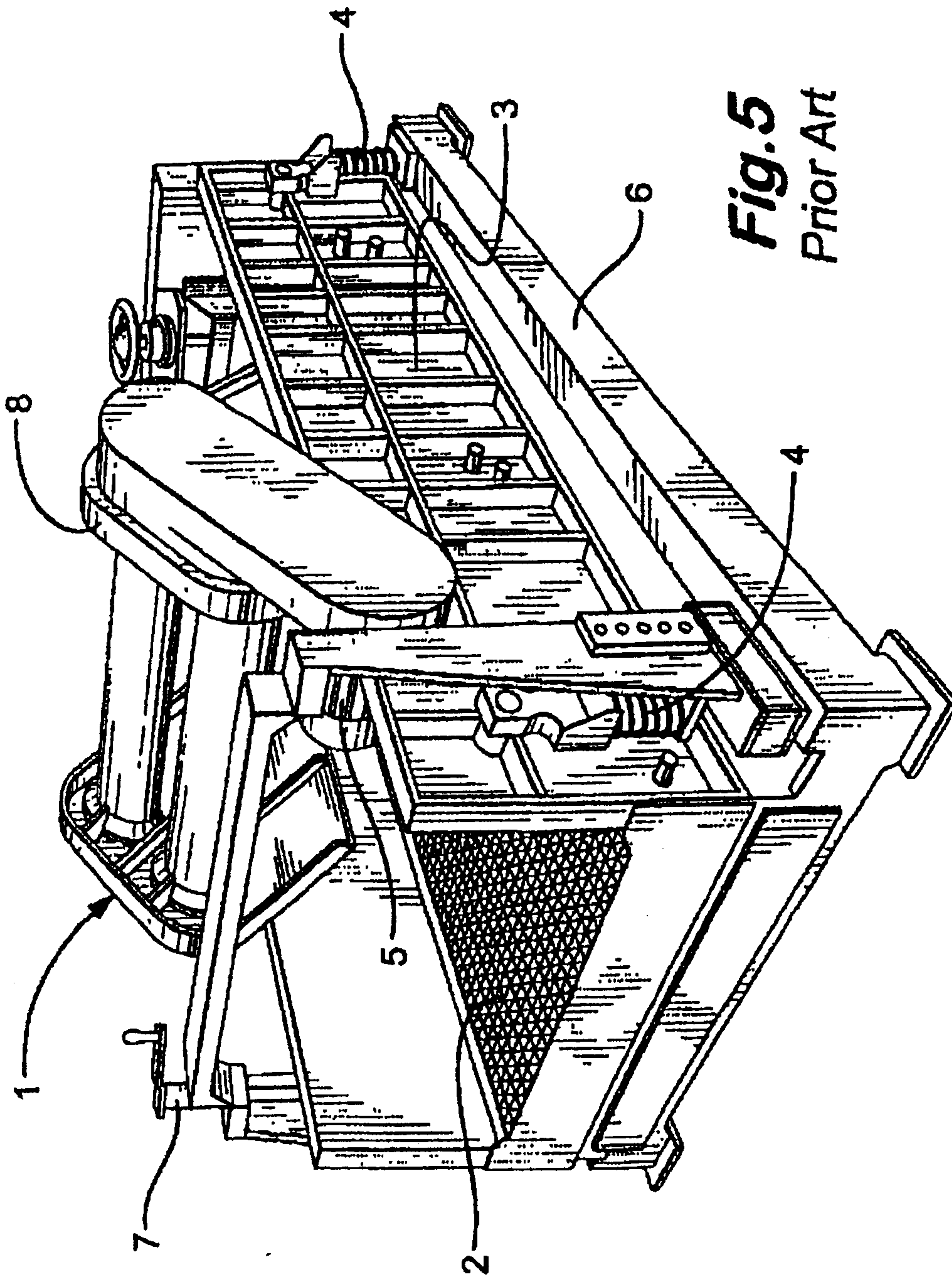
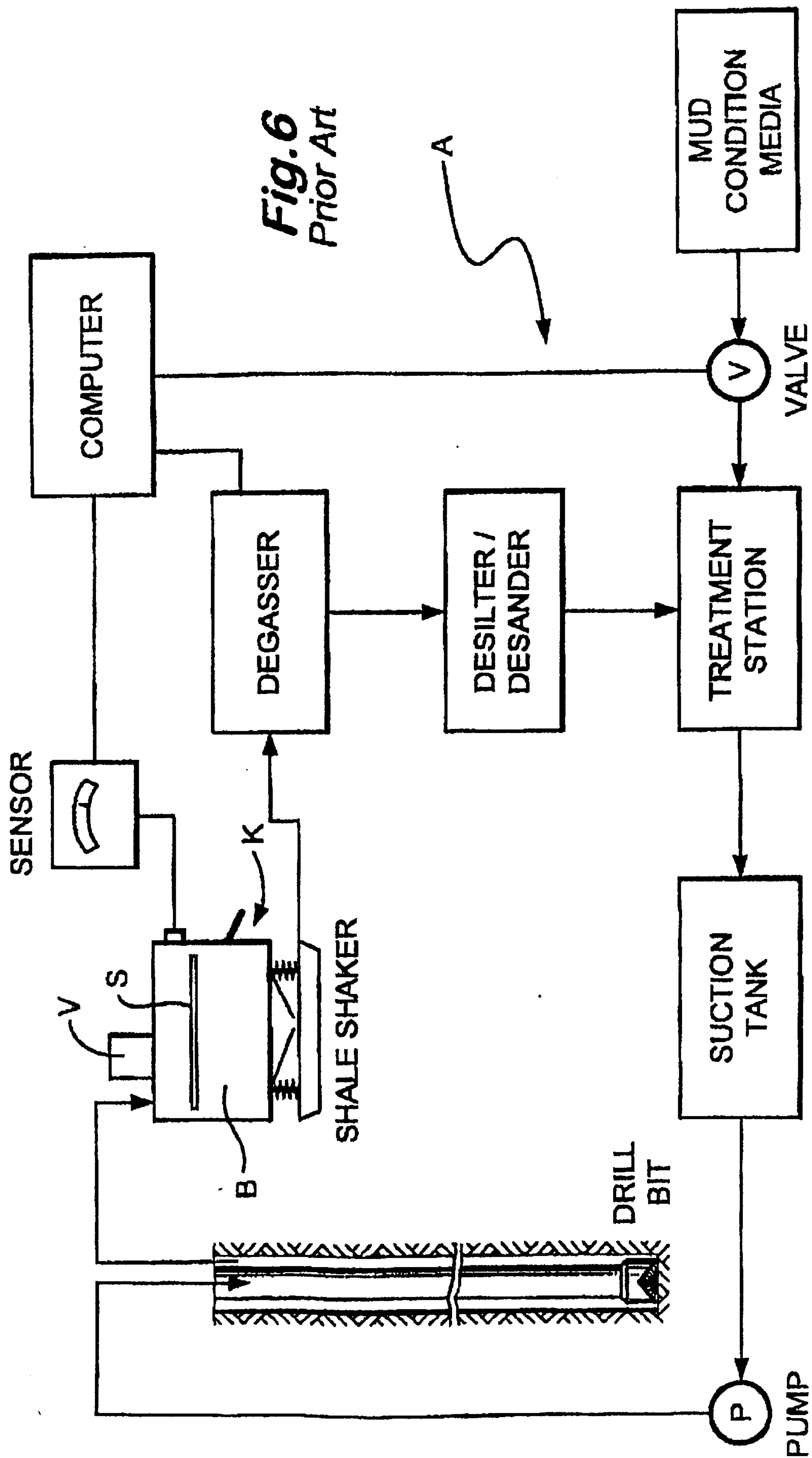
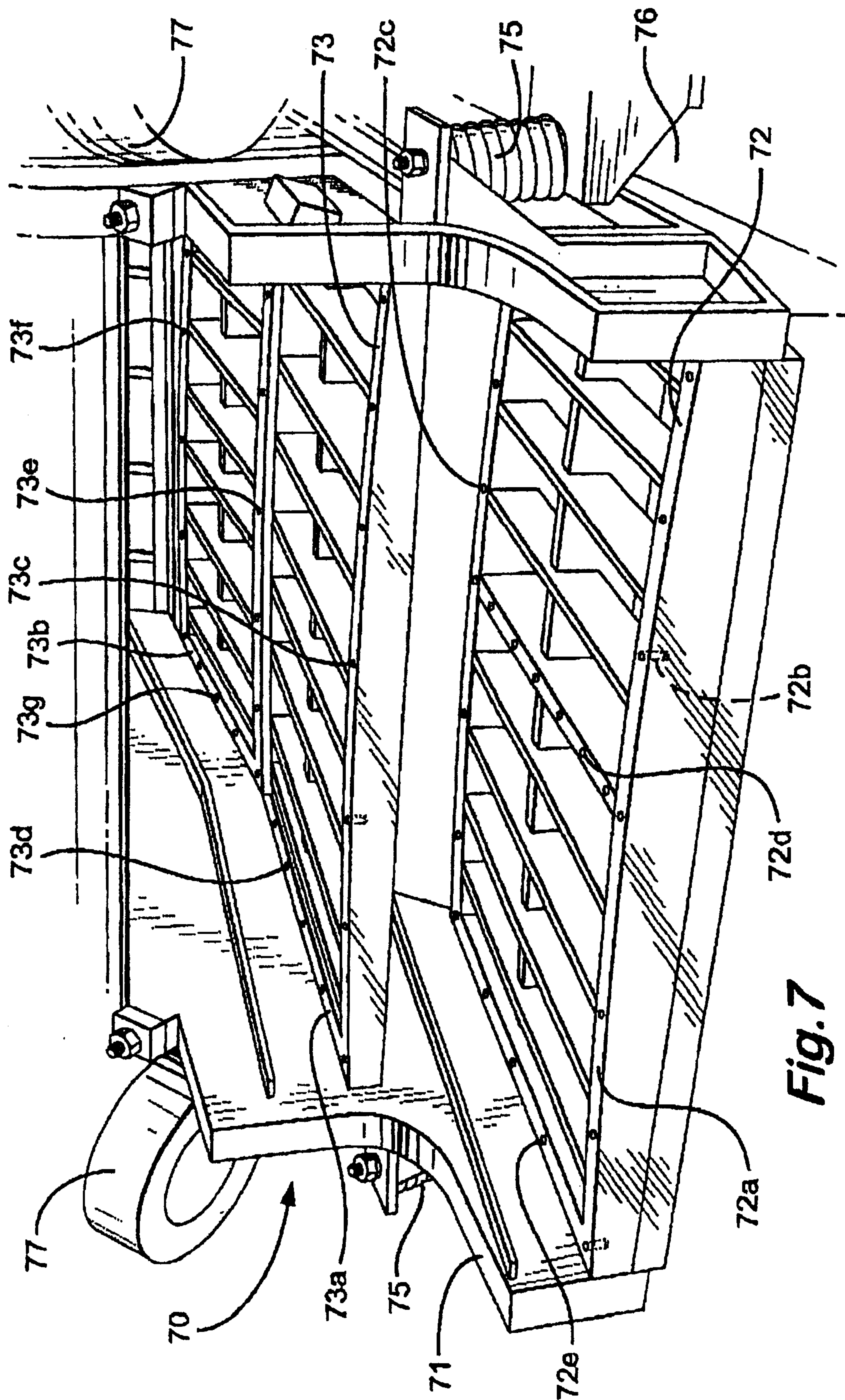


Fig. 5
Prior Art

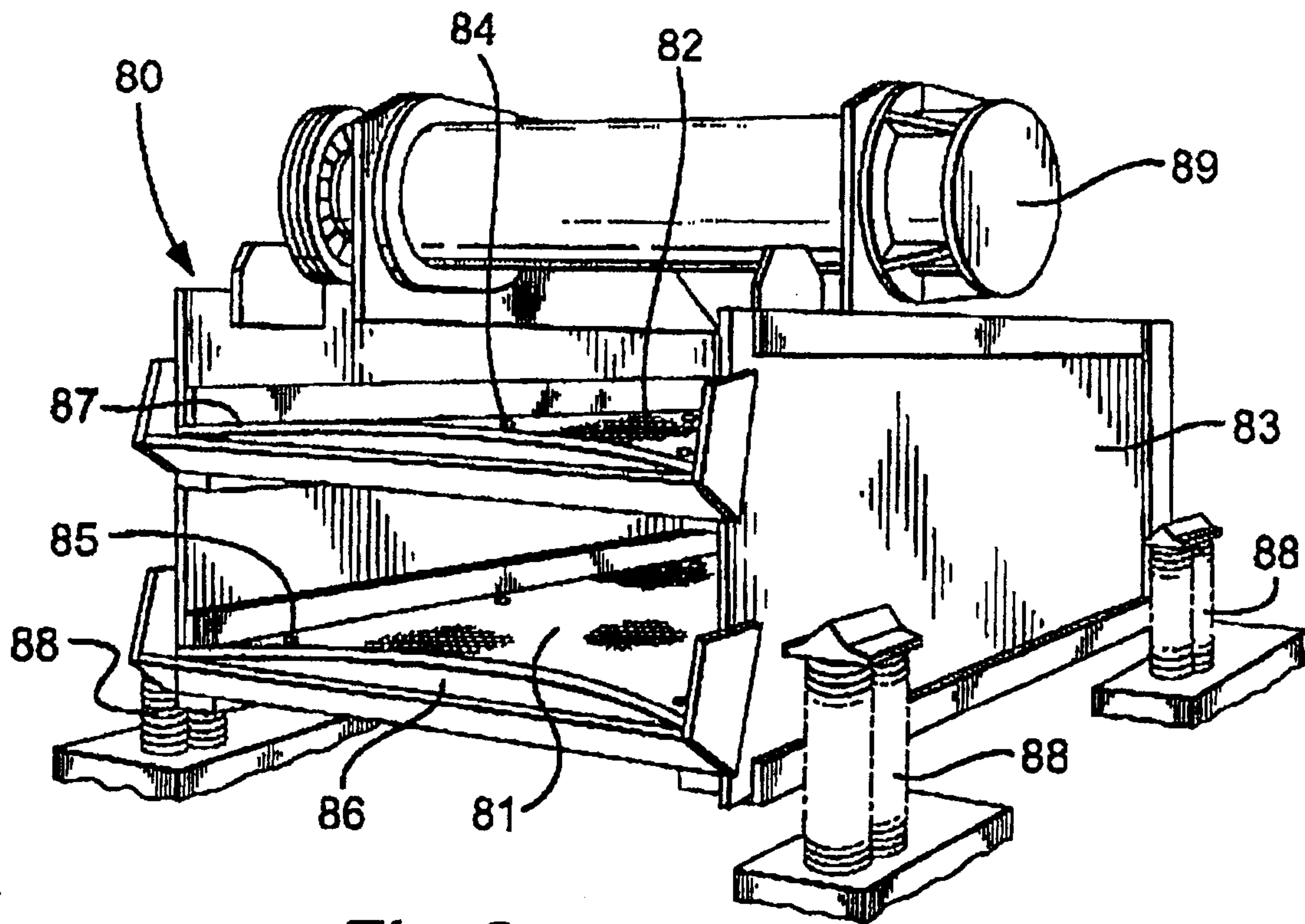
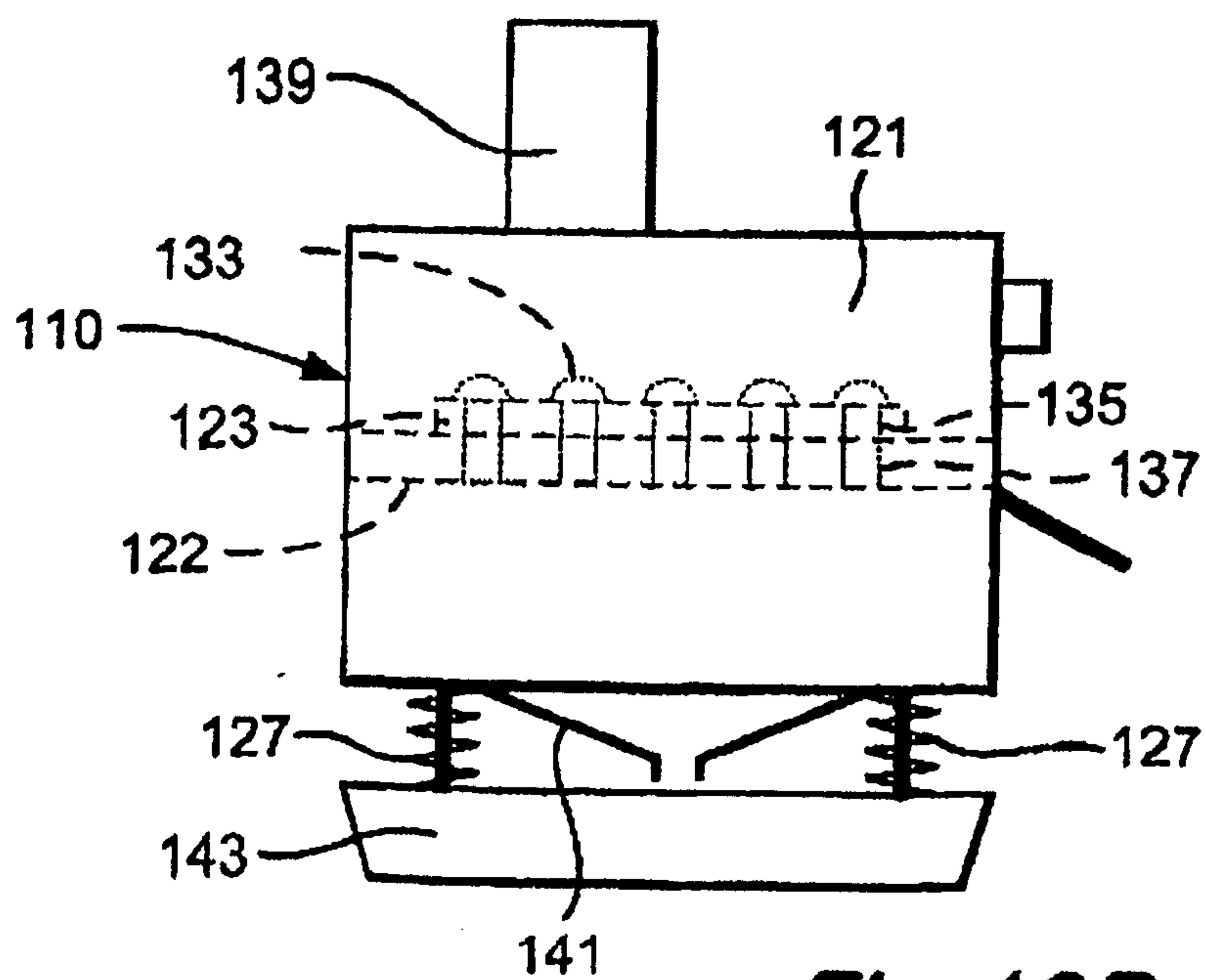
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**Fig. 8****Fig. 10B**

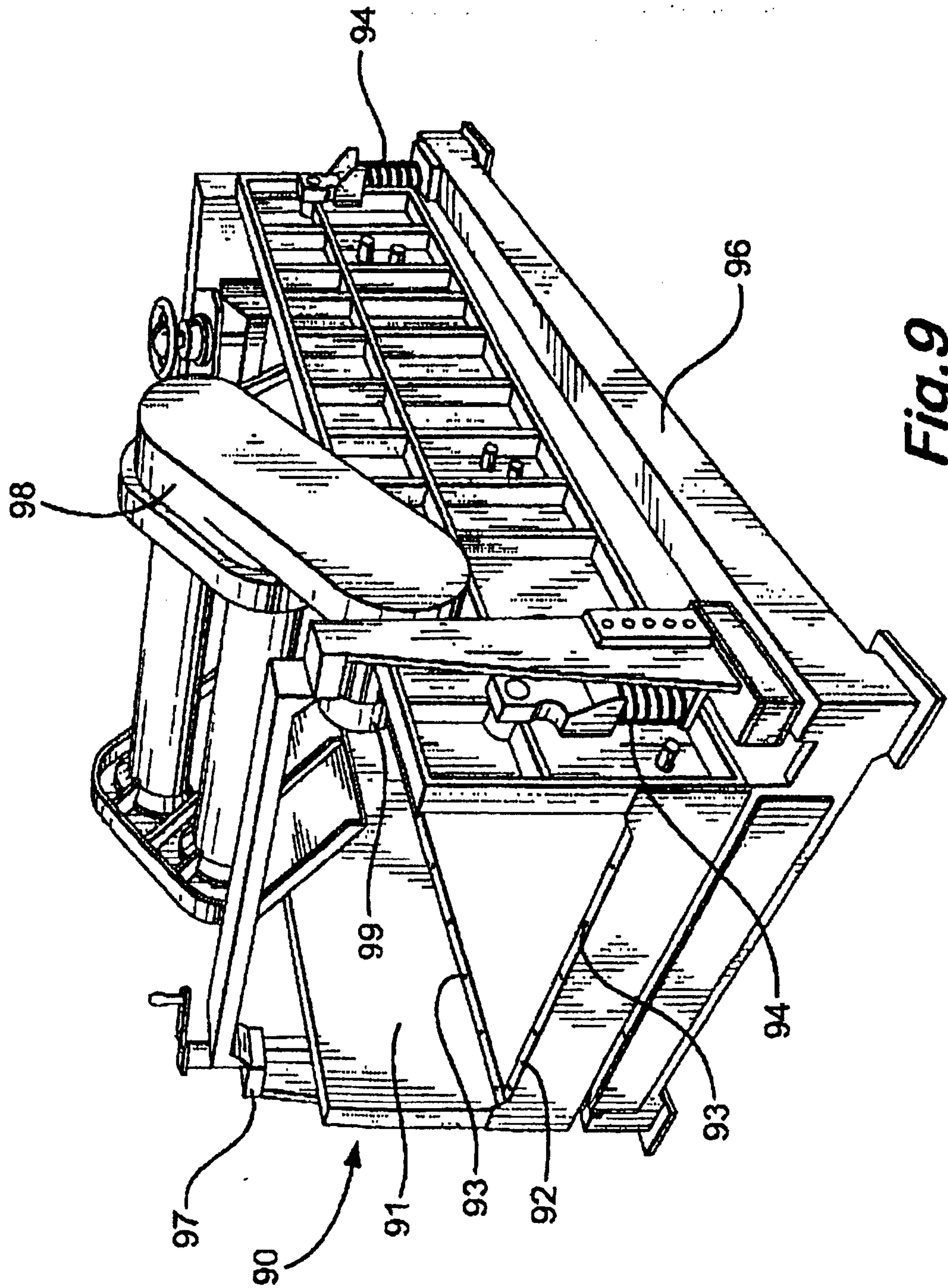


Fig. 9

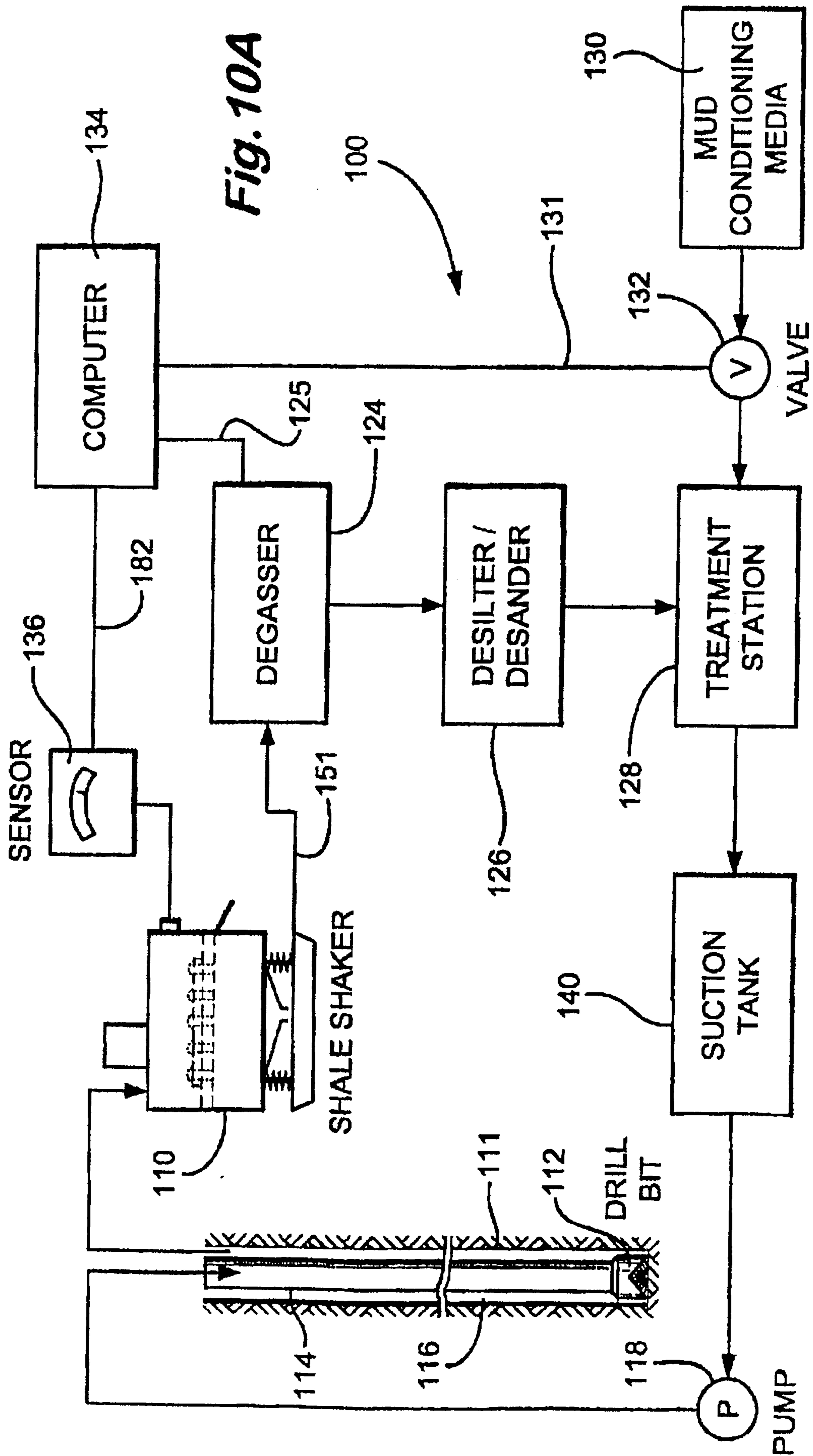


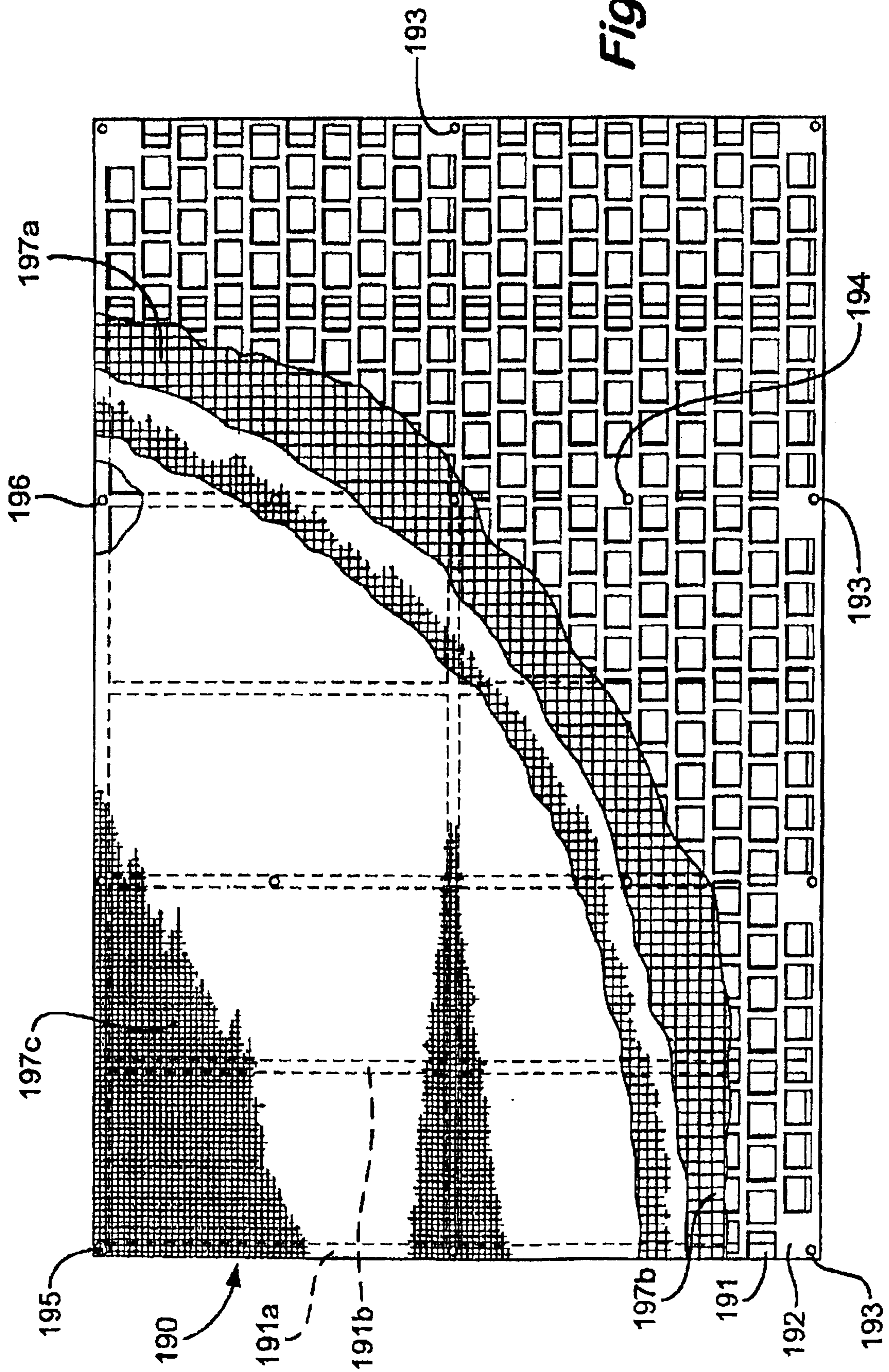
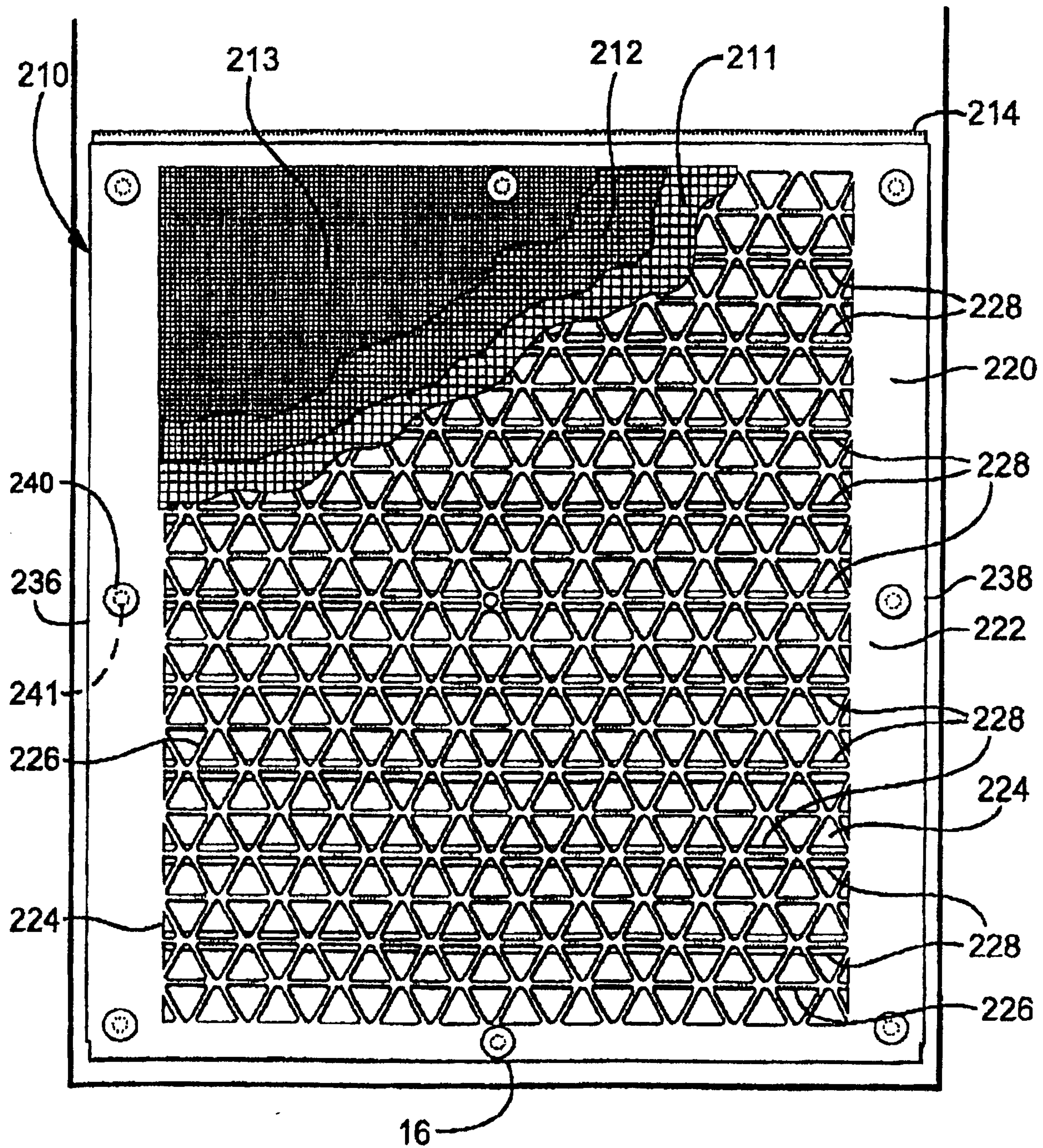
Fig. 11

Fig. 12

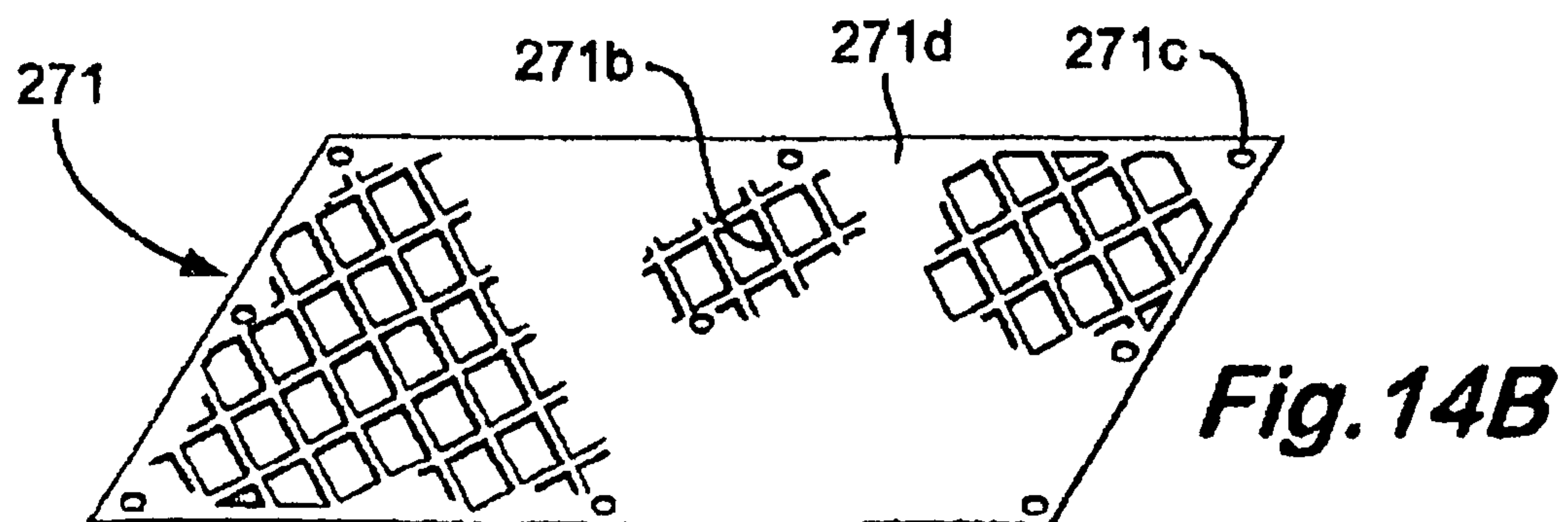
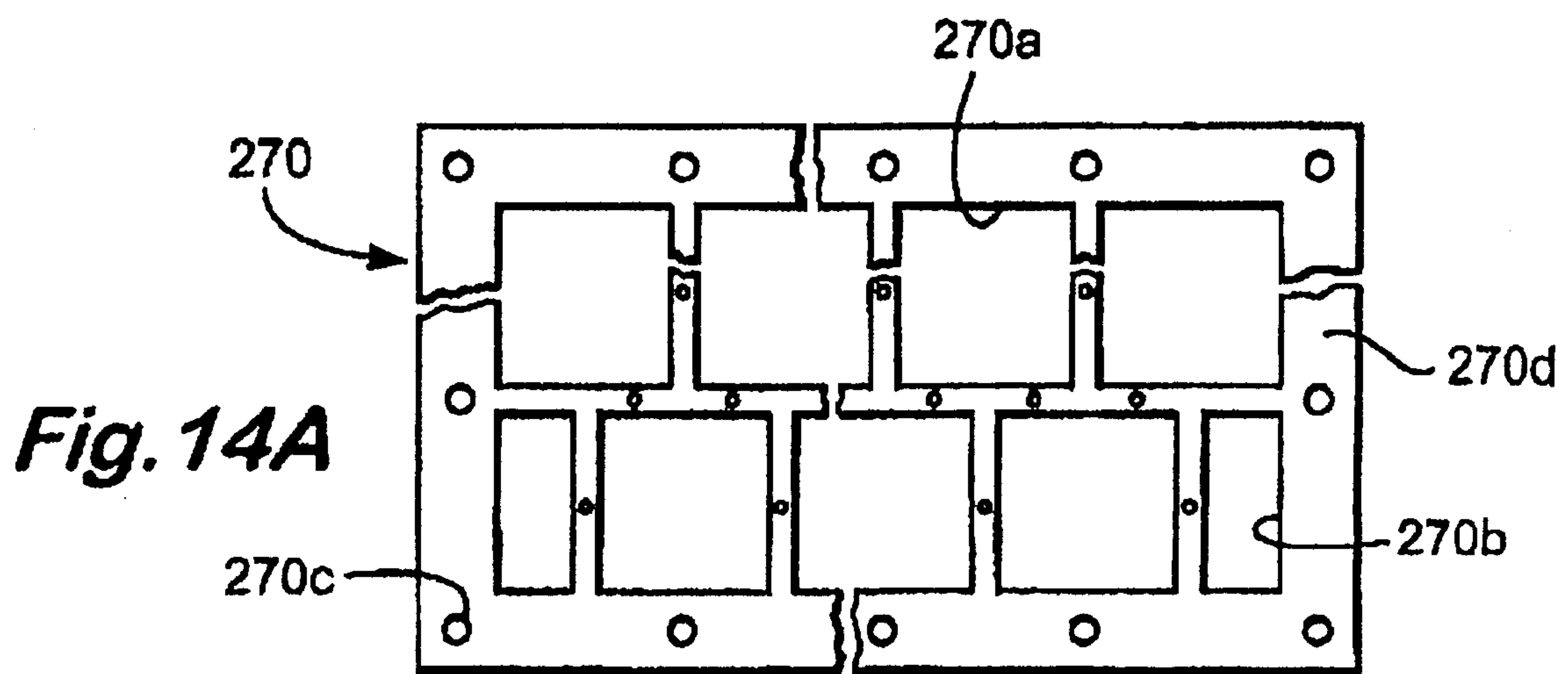
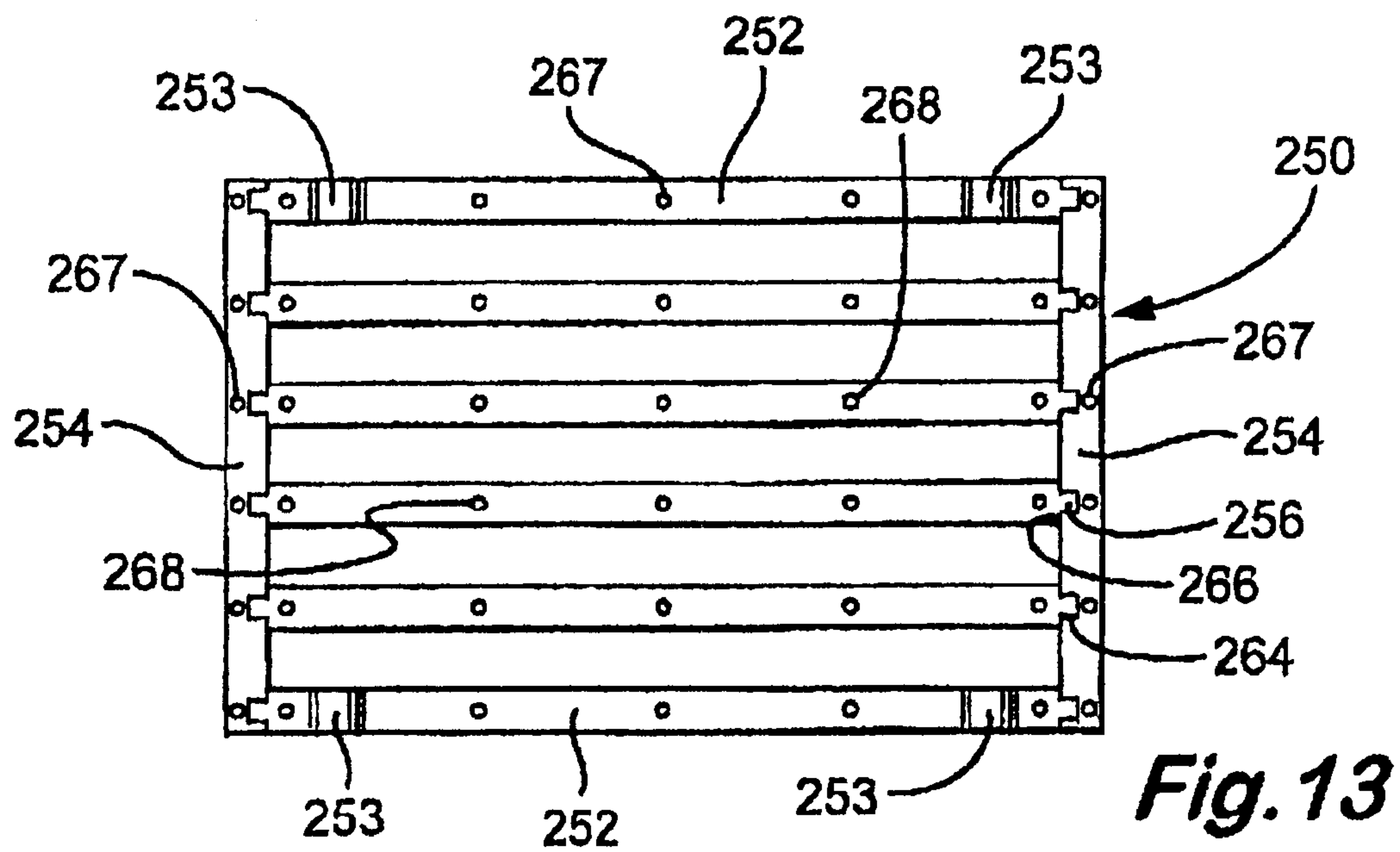
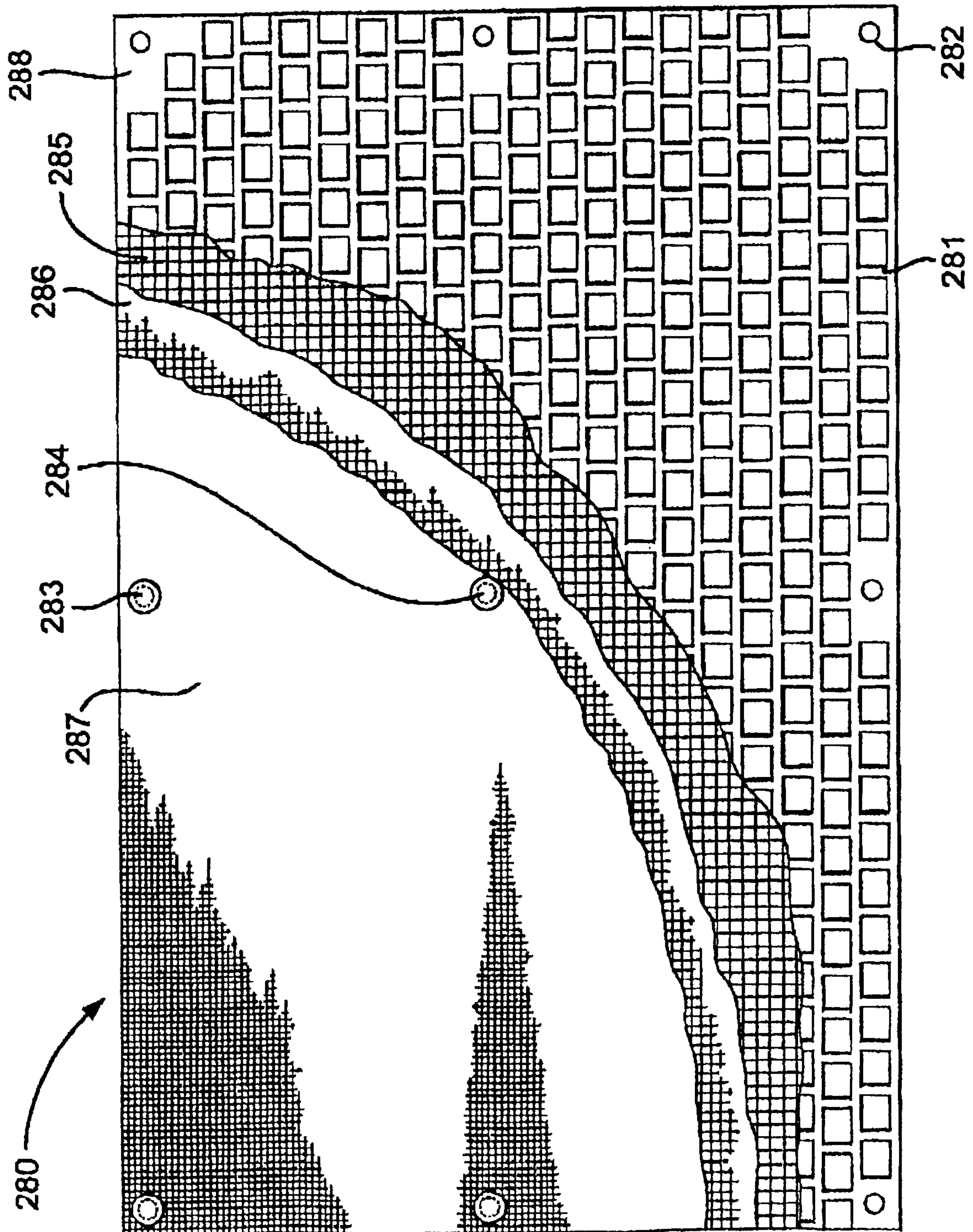
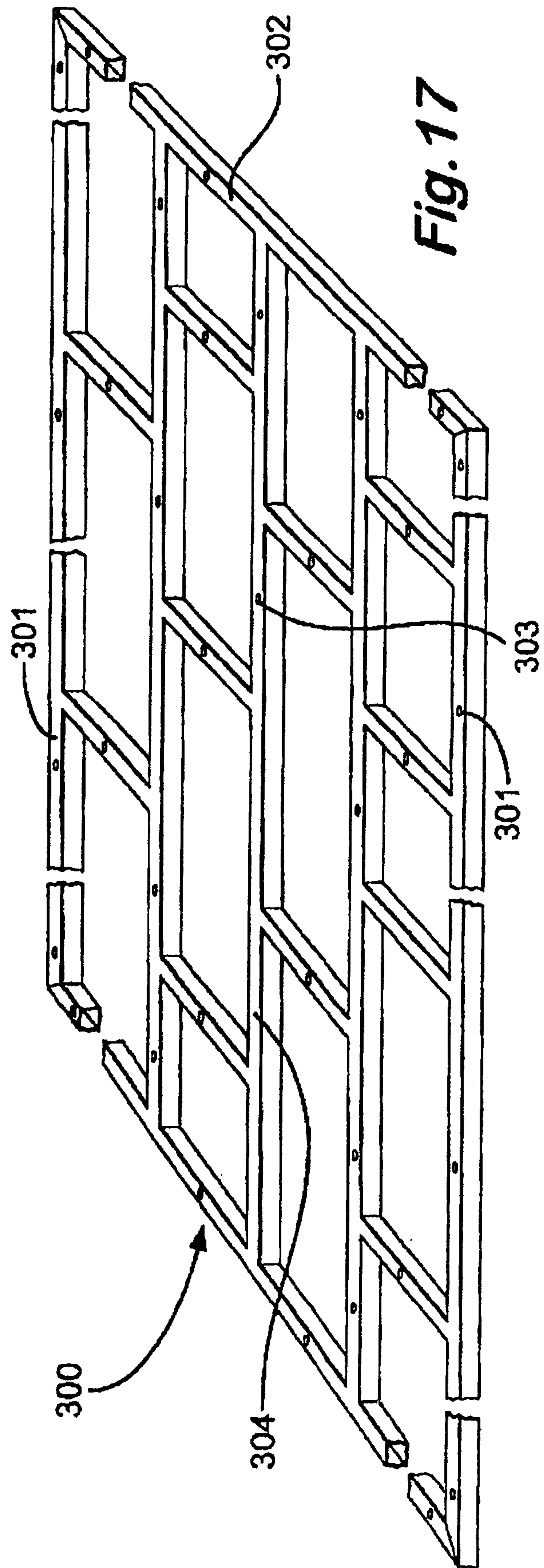
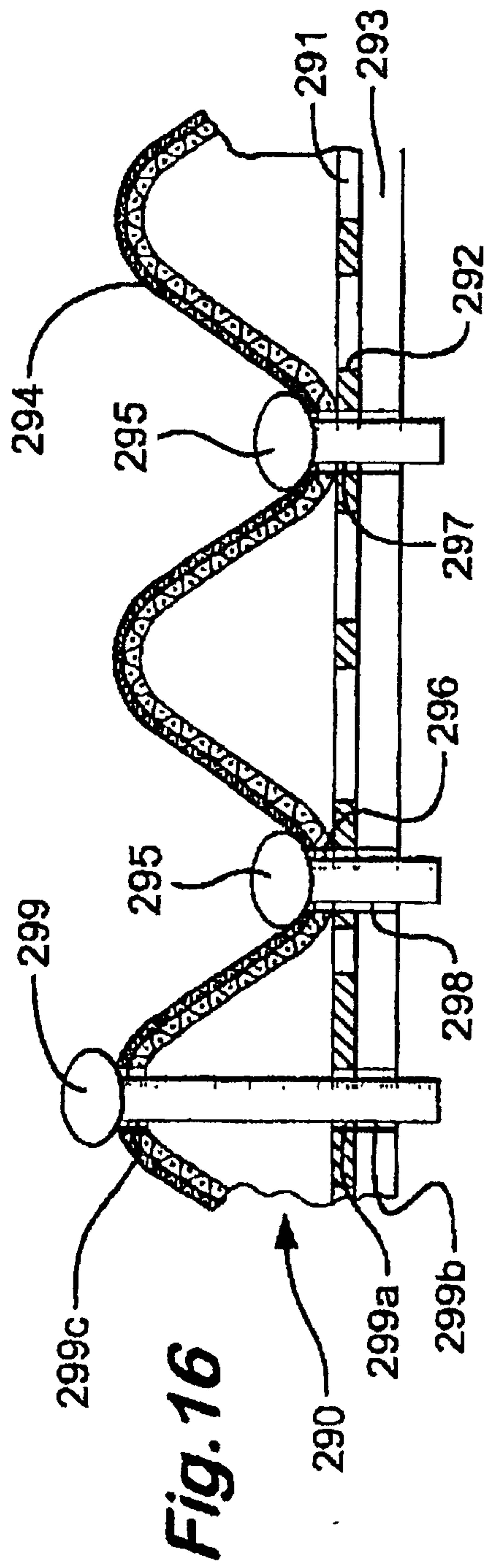
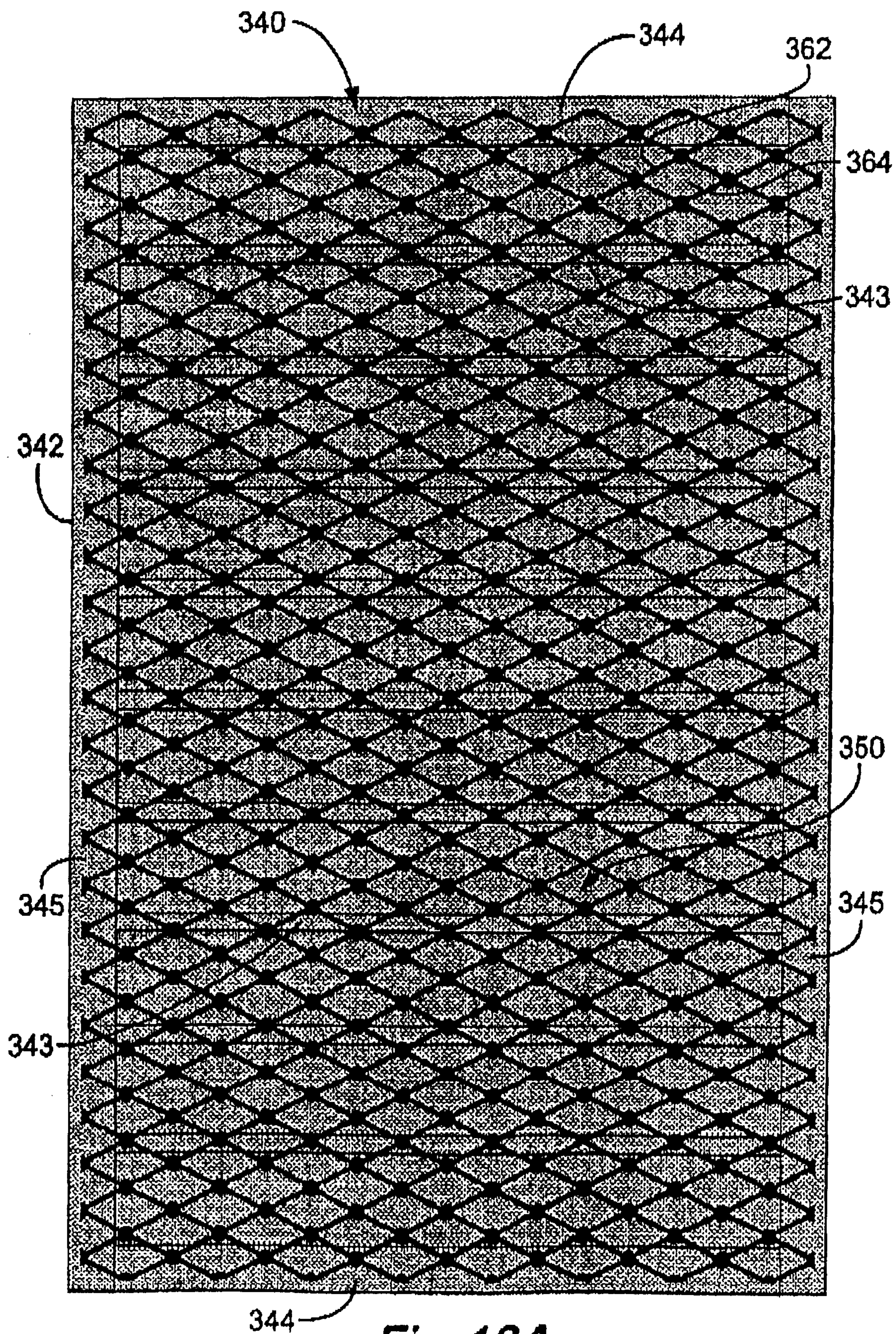


Fig. 15





**Fig. 18A**

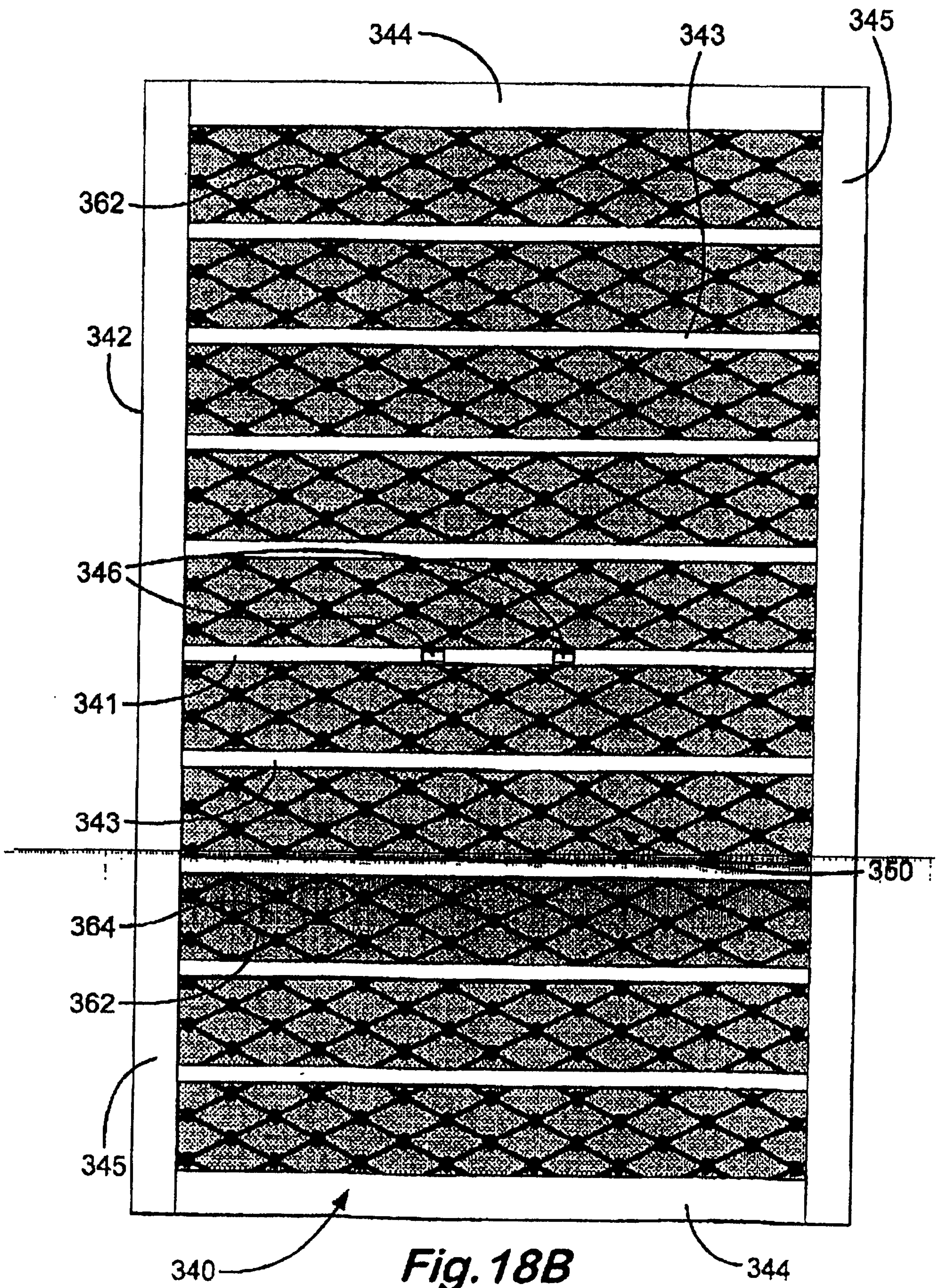


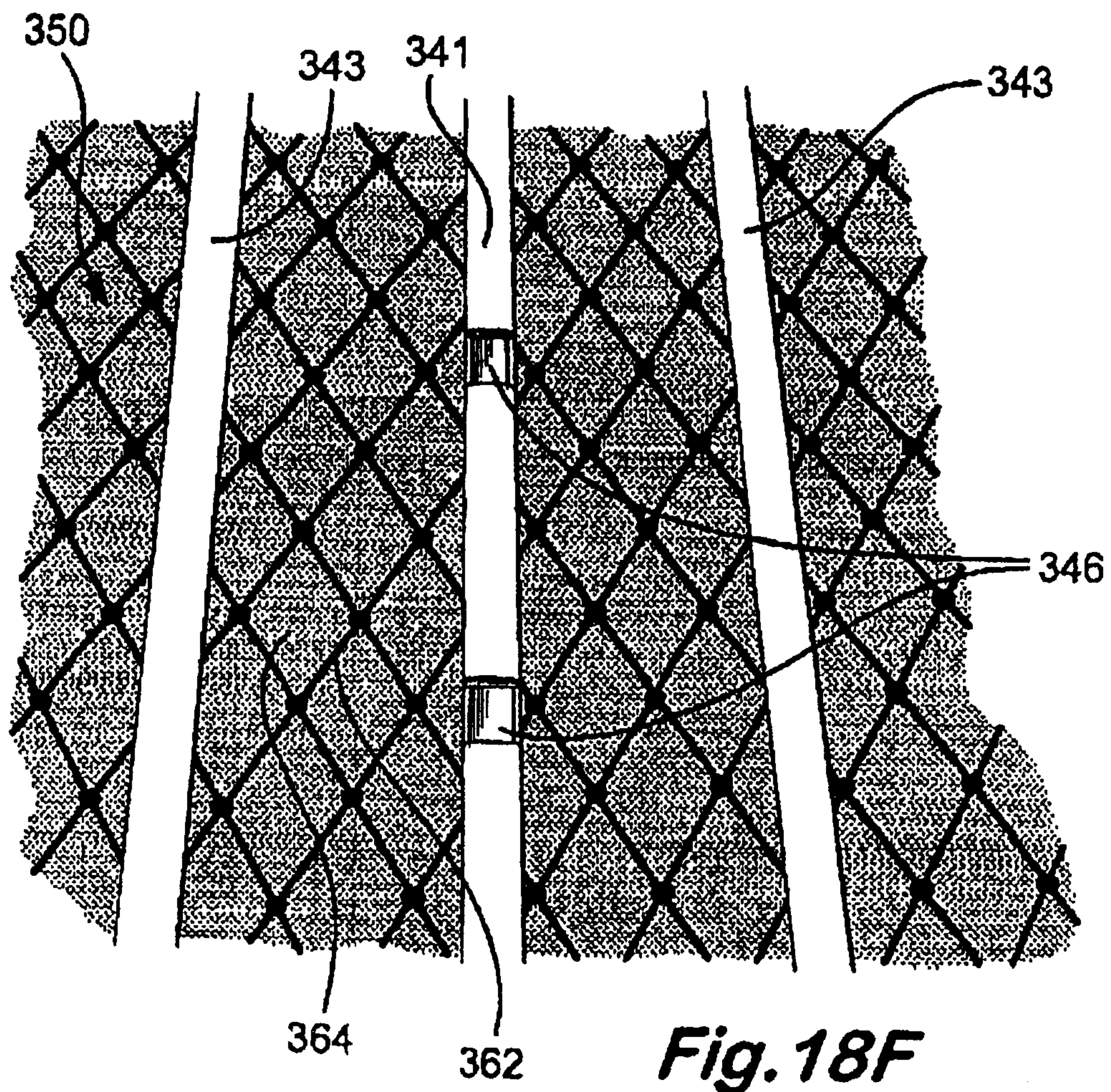
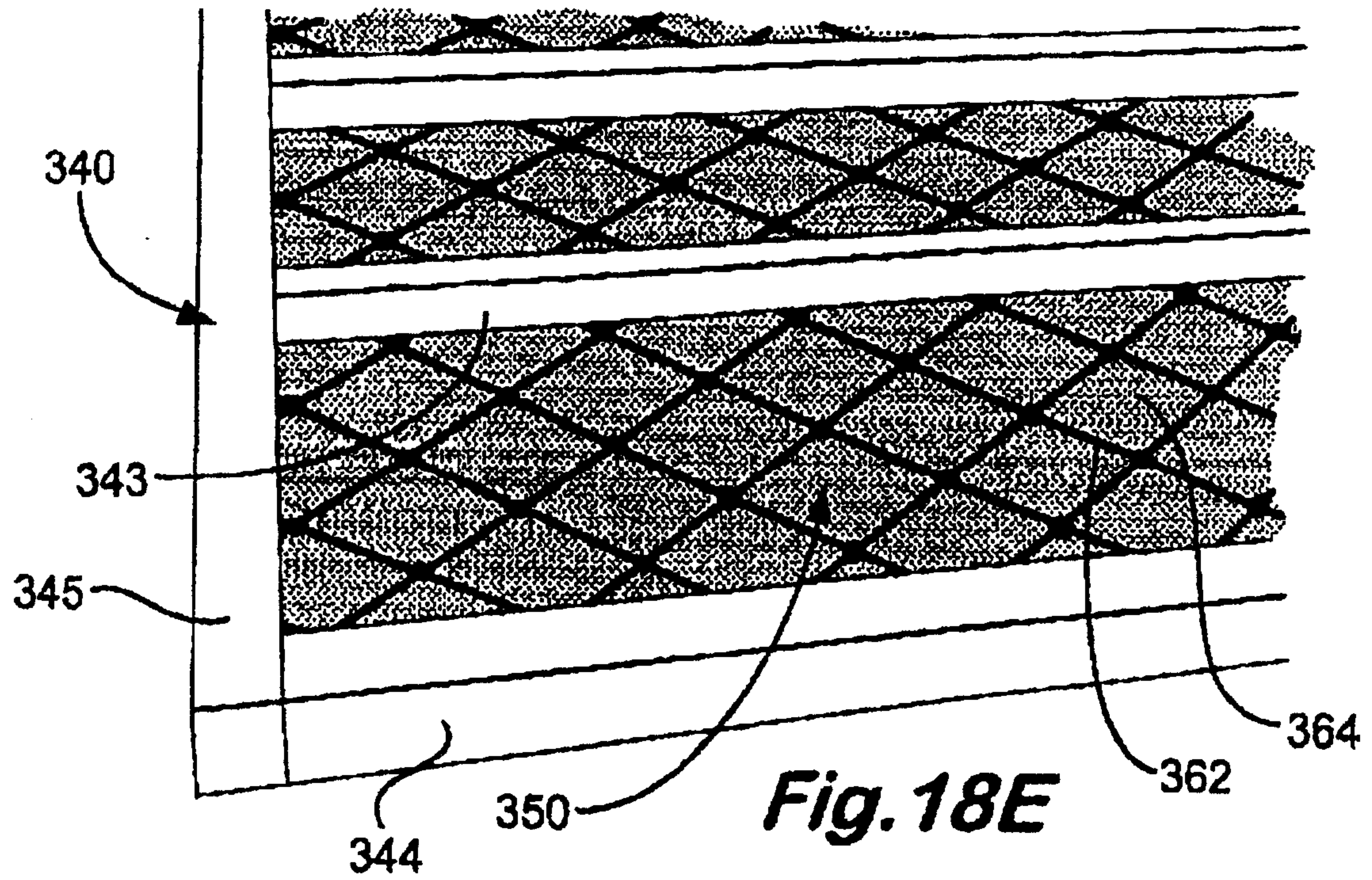


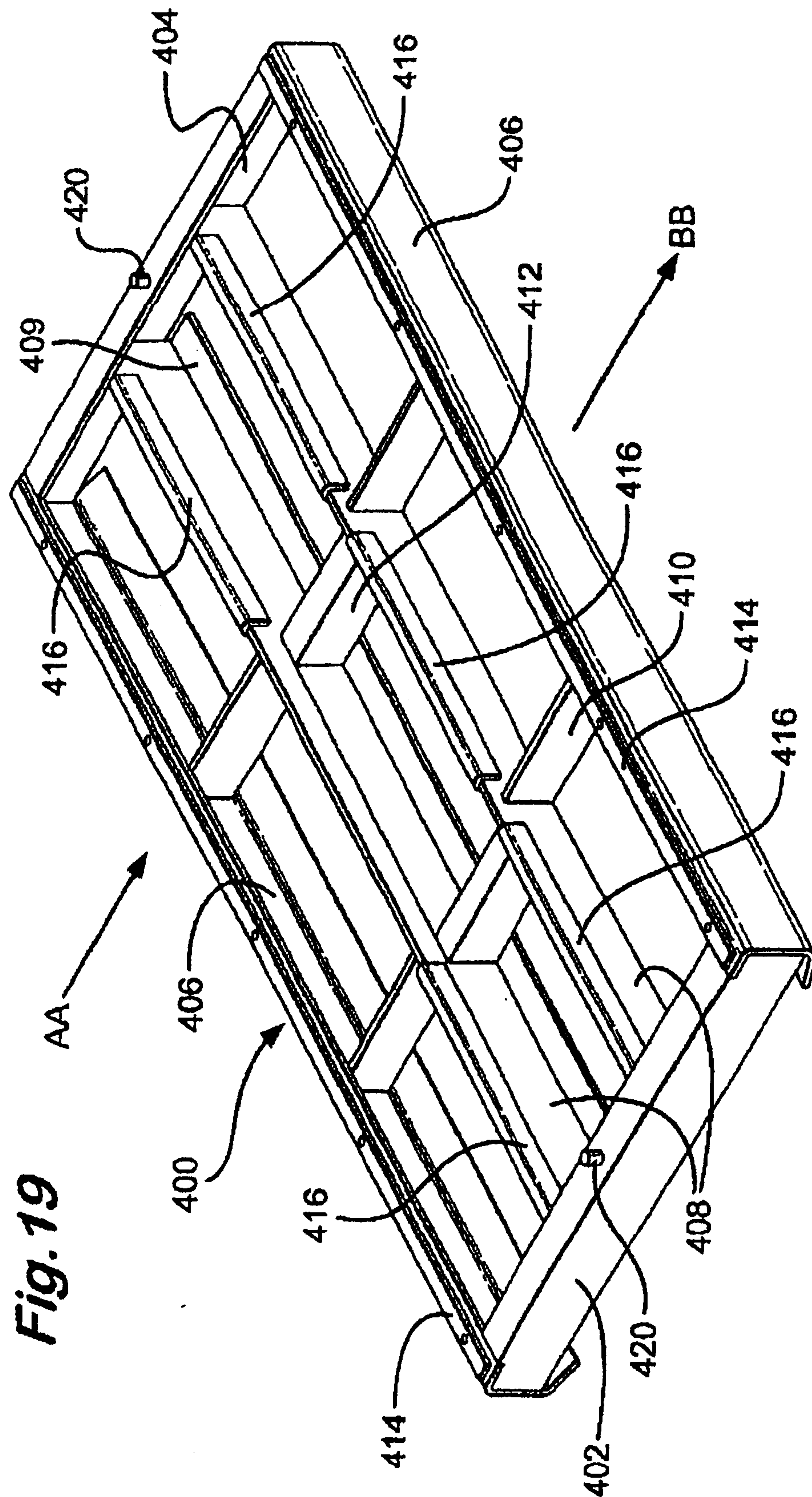
Fig. 18C



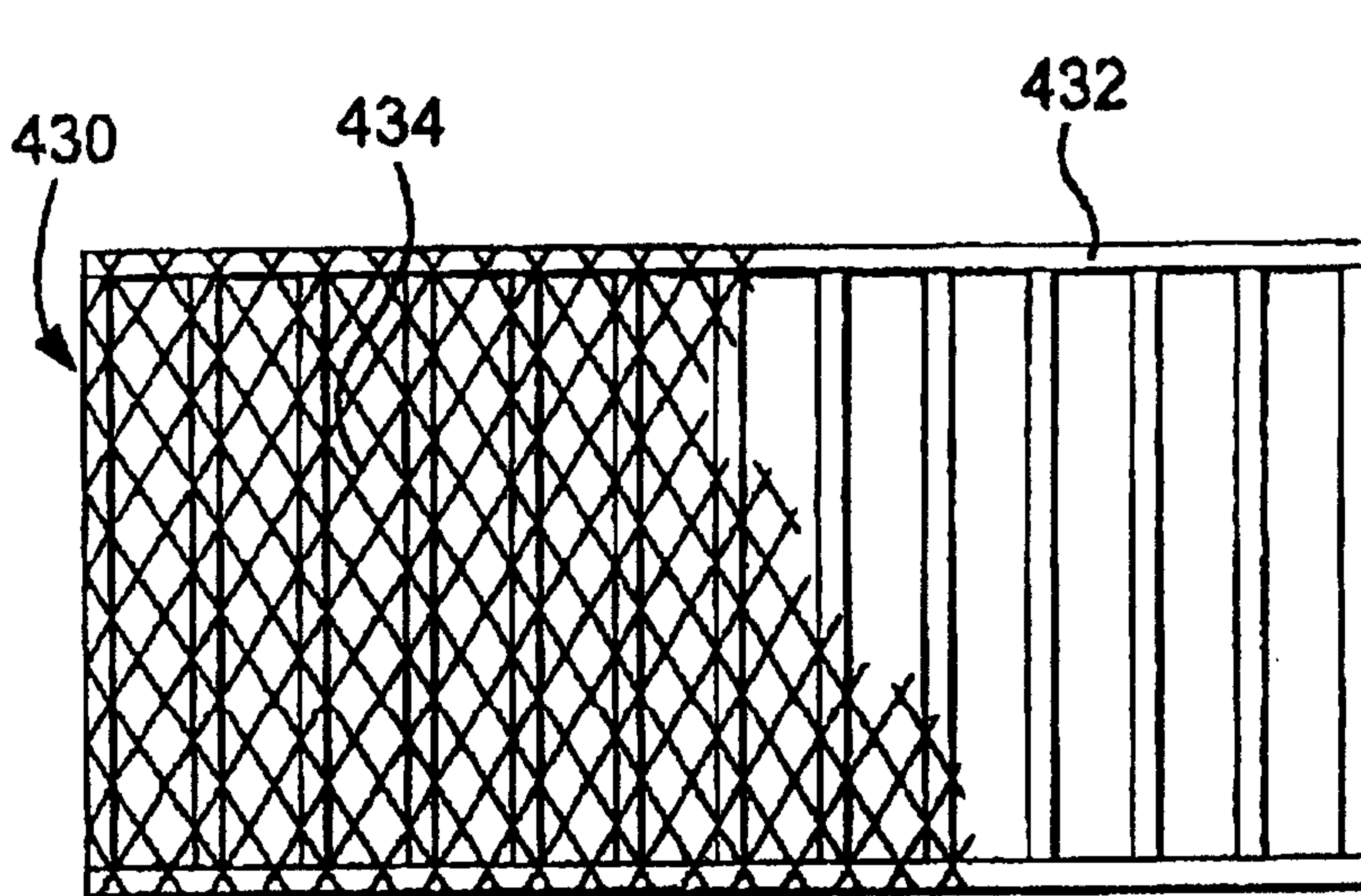
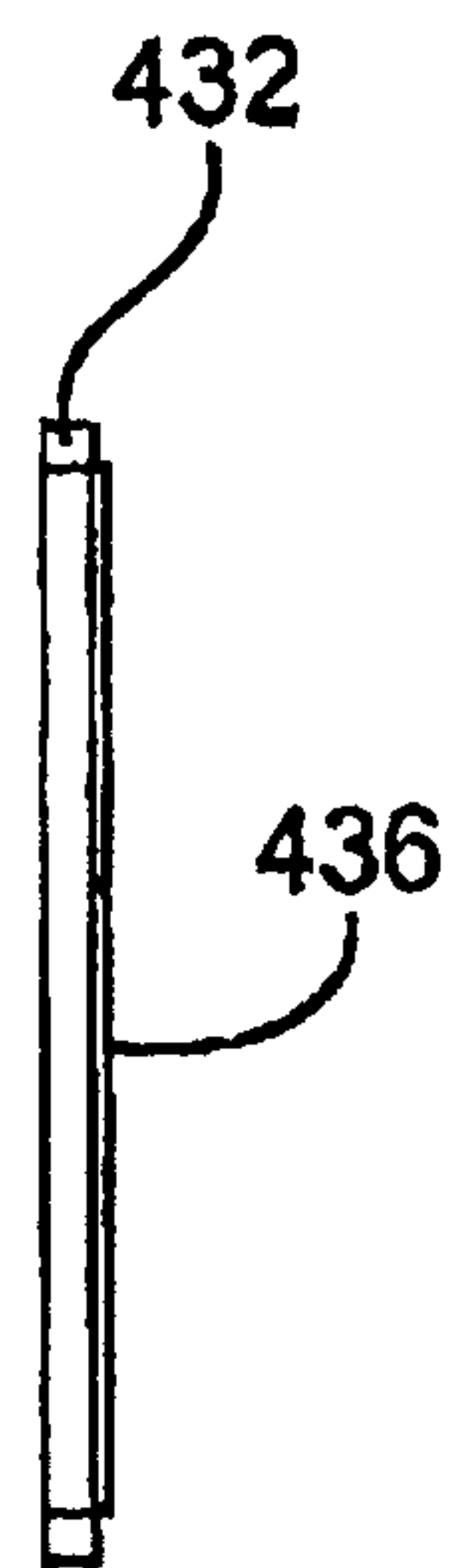
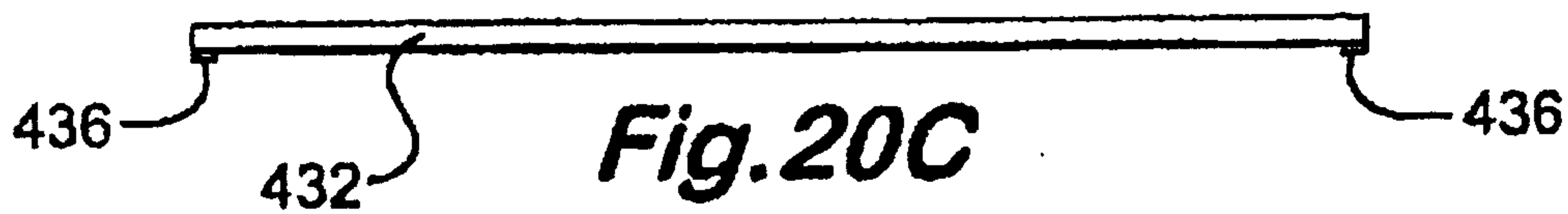
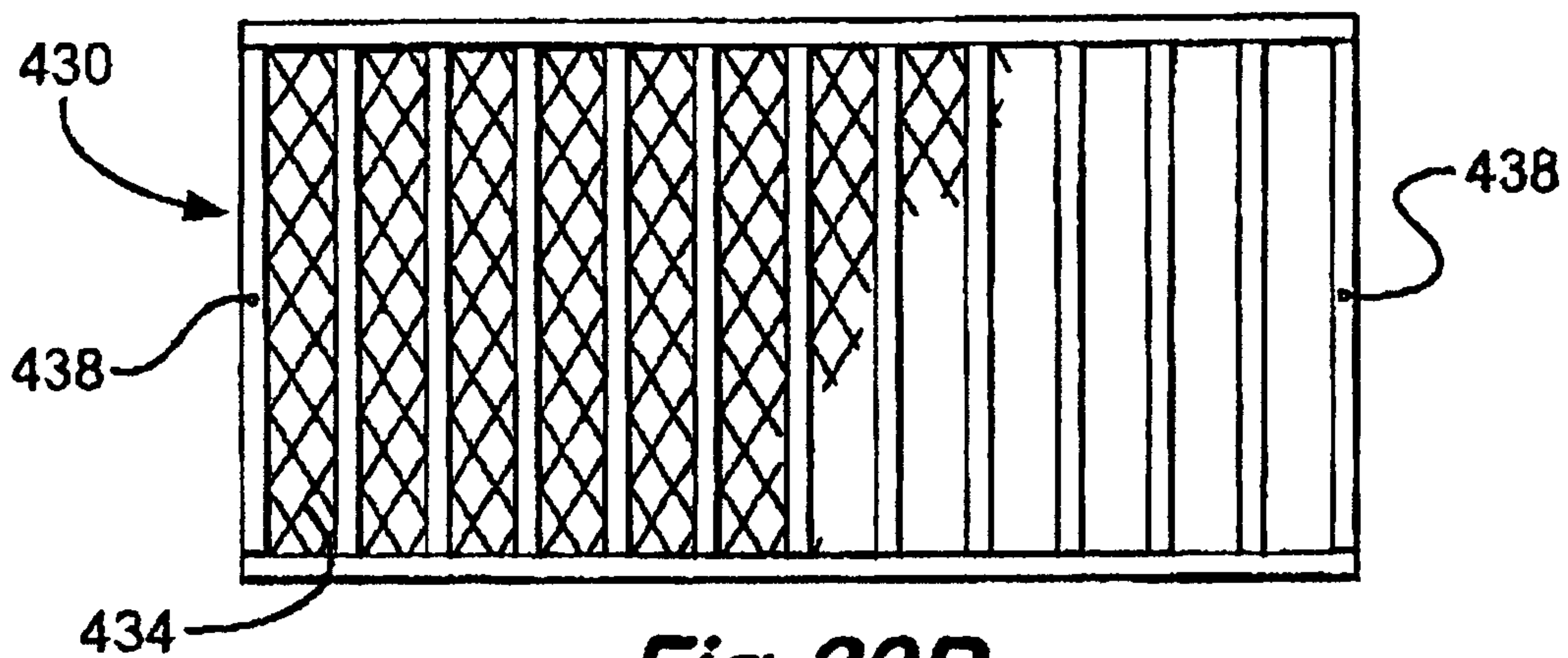
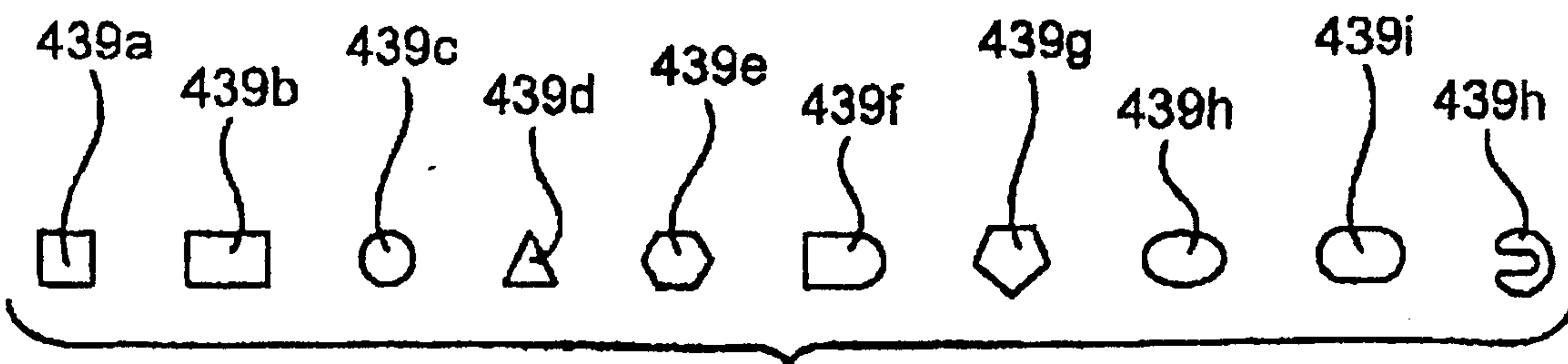
Fig. 18D

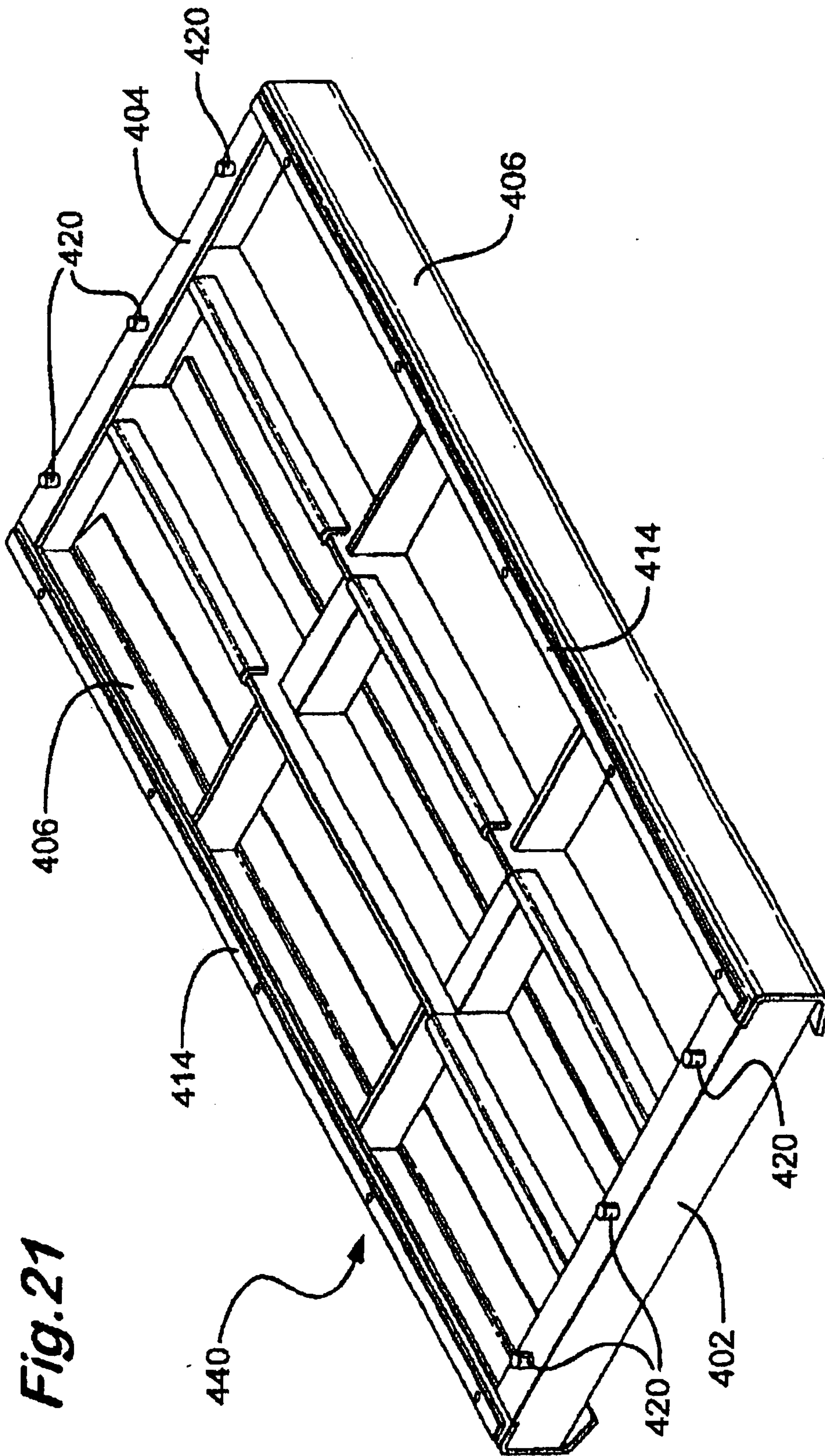
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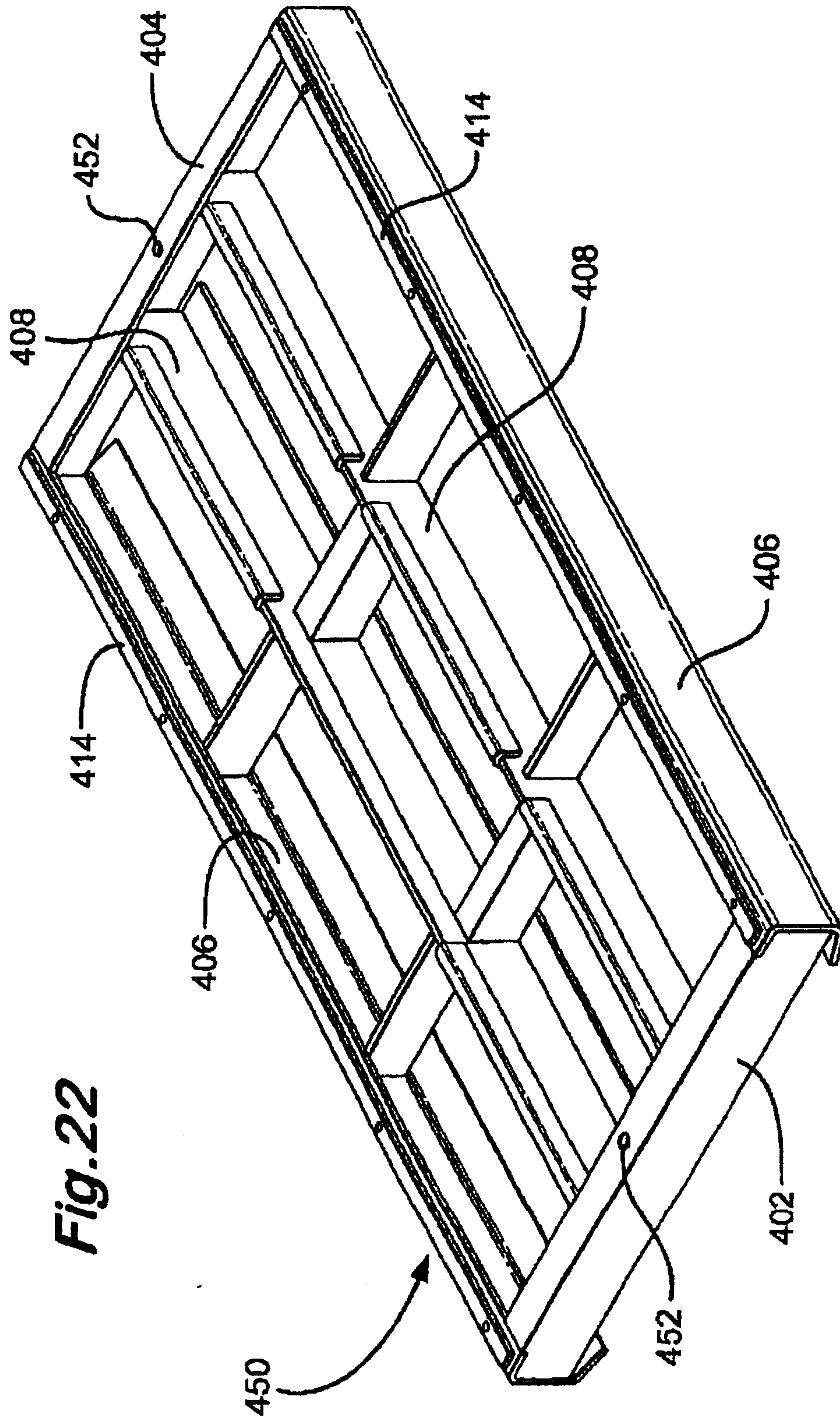




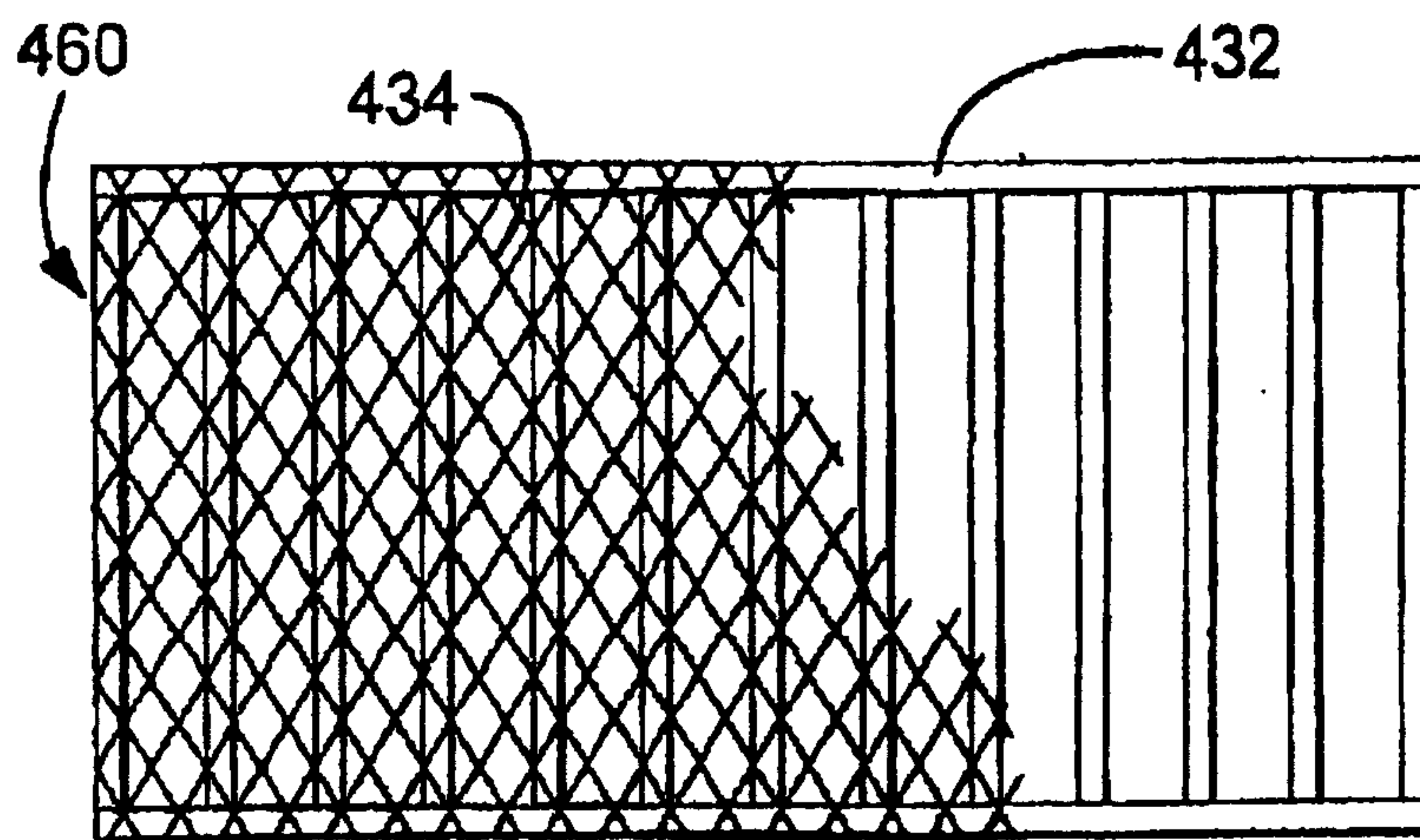
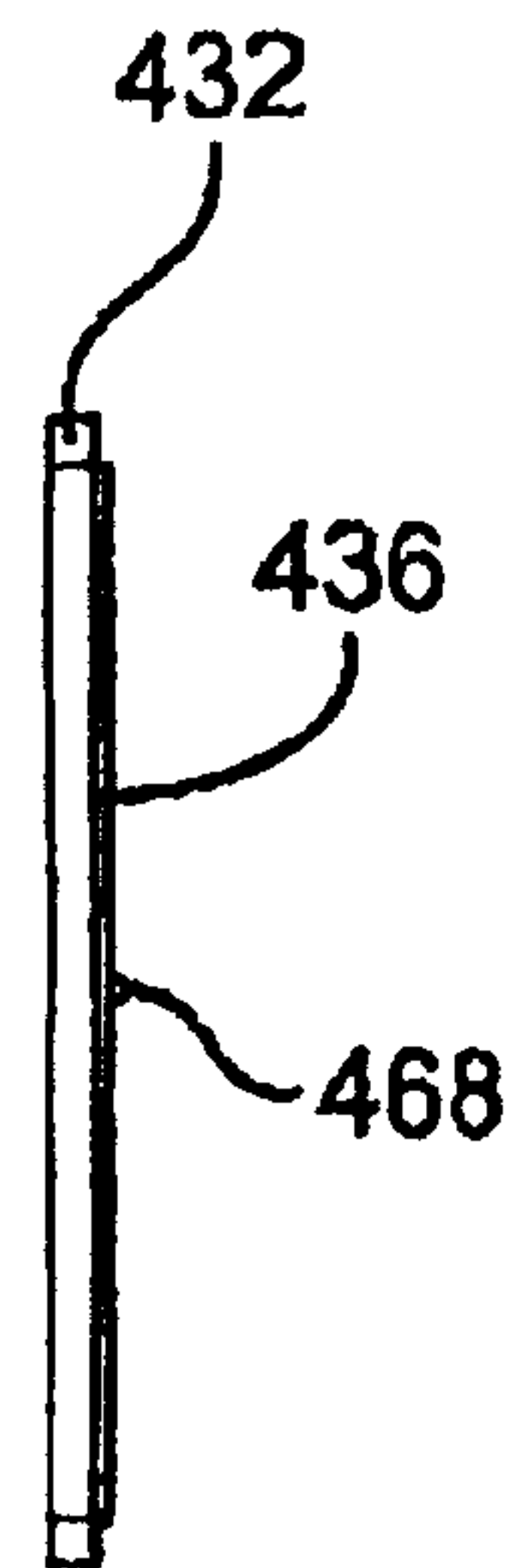
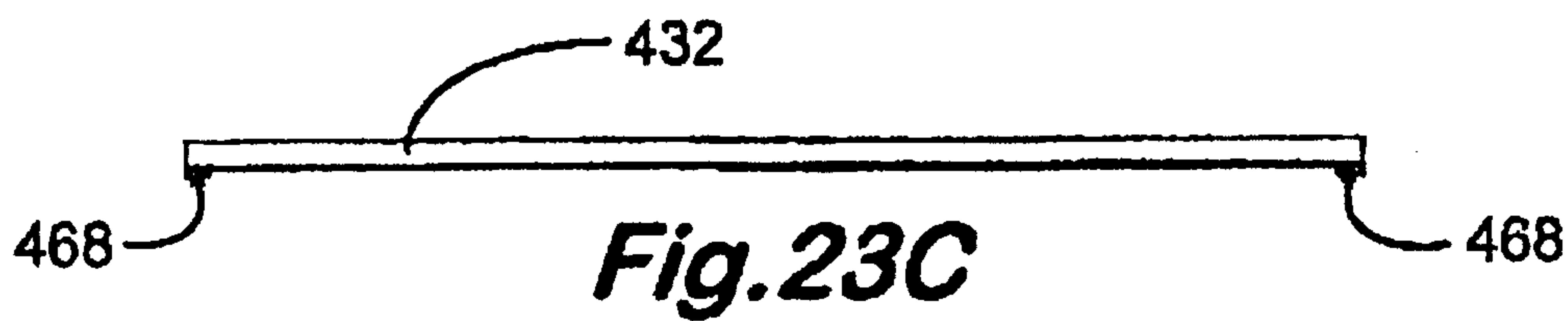
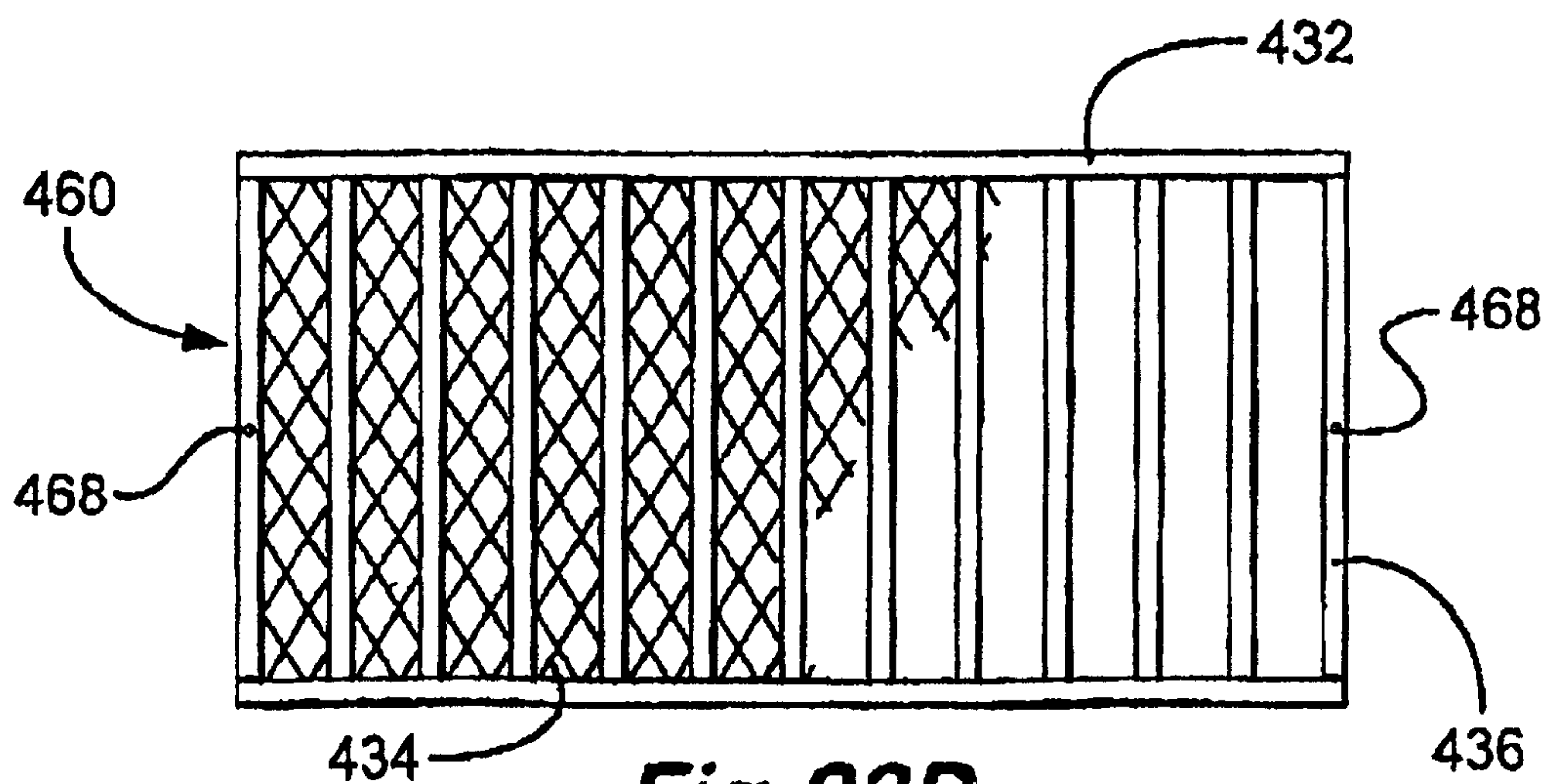
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**Fig. 20A****Fig. 20B****Fig. 20C****Fig. 20D****Fig. 20E**





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**Fig. 23A****Fig. 23B****Fig. 23C****Fig. 23D**

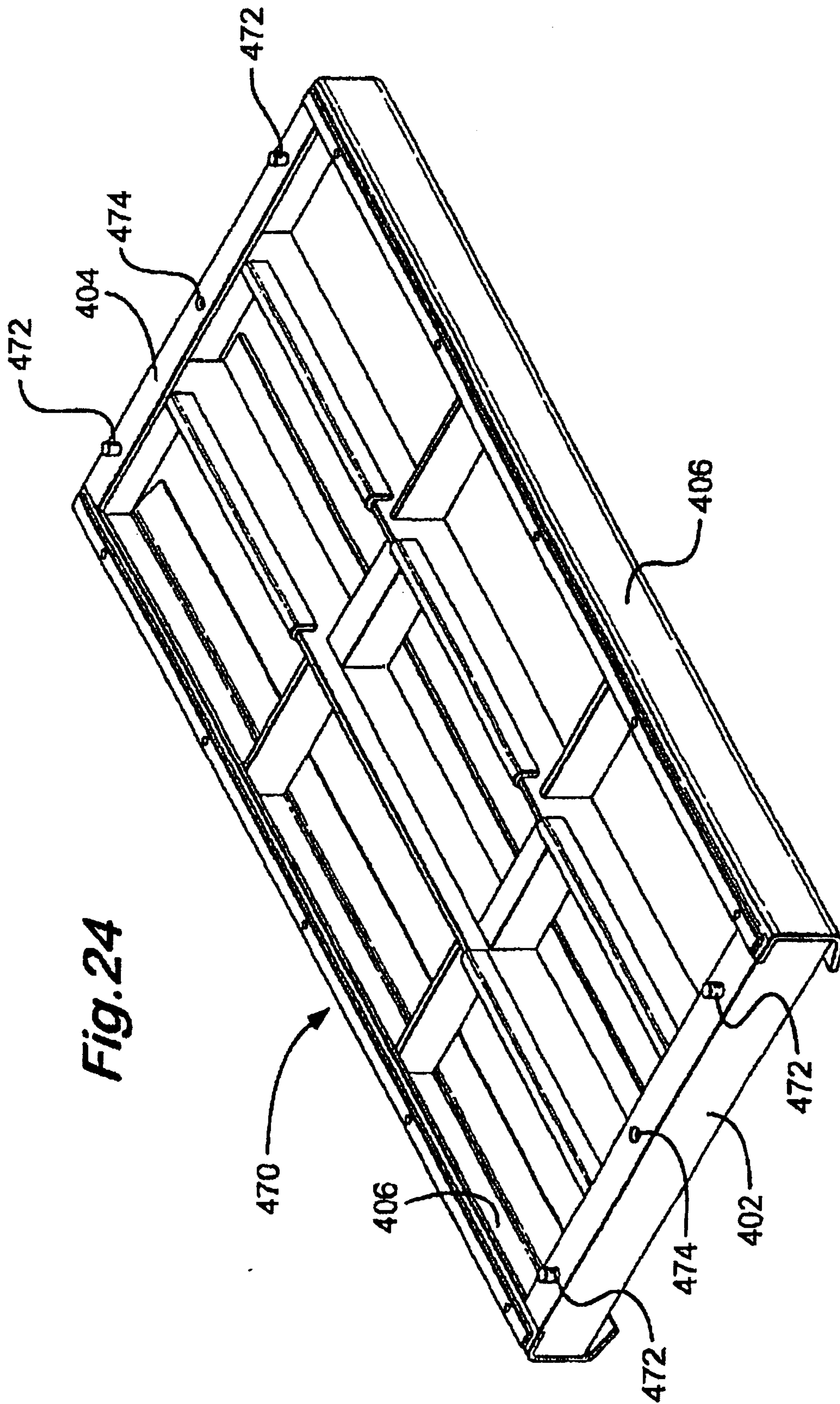


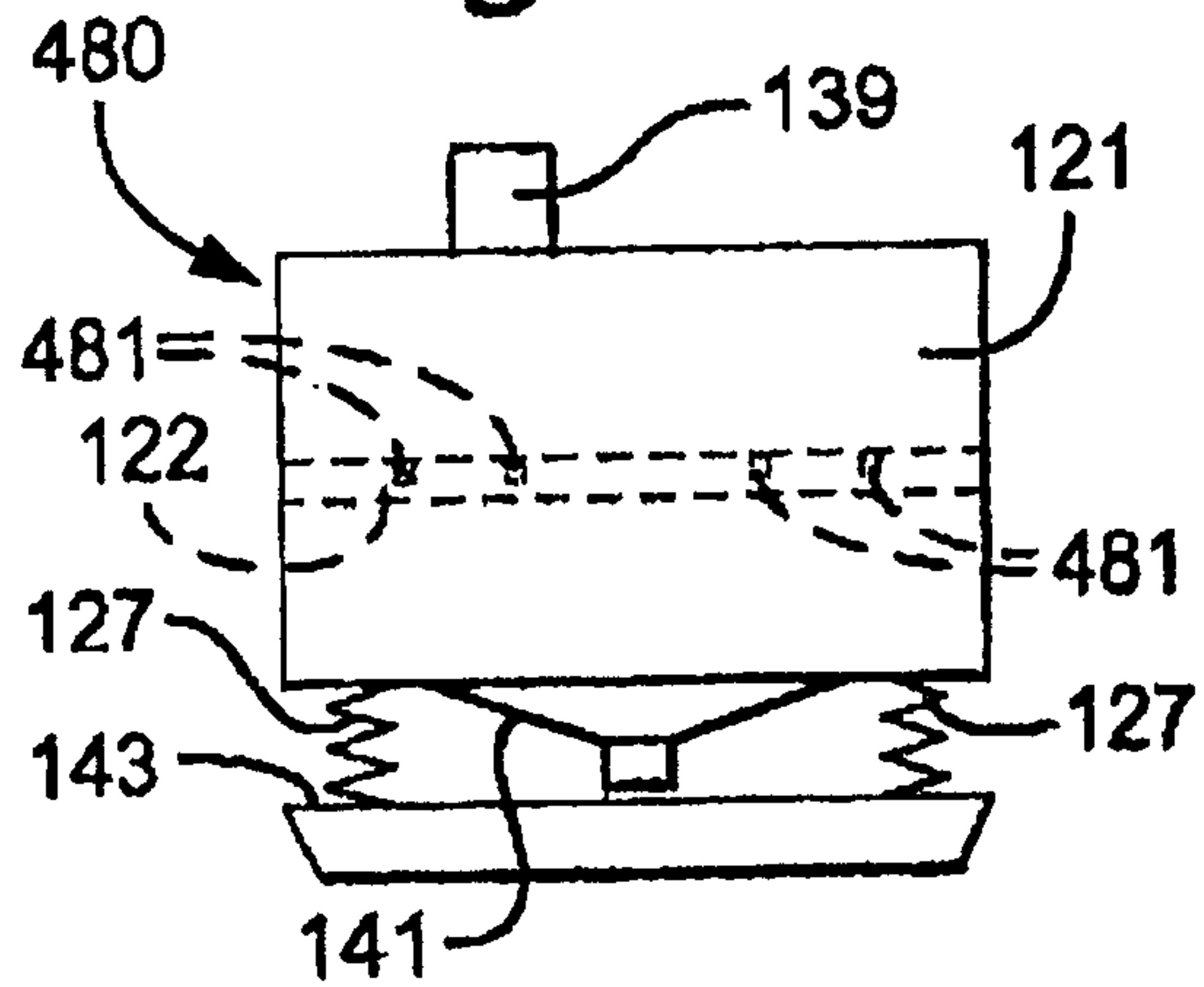
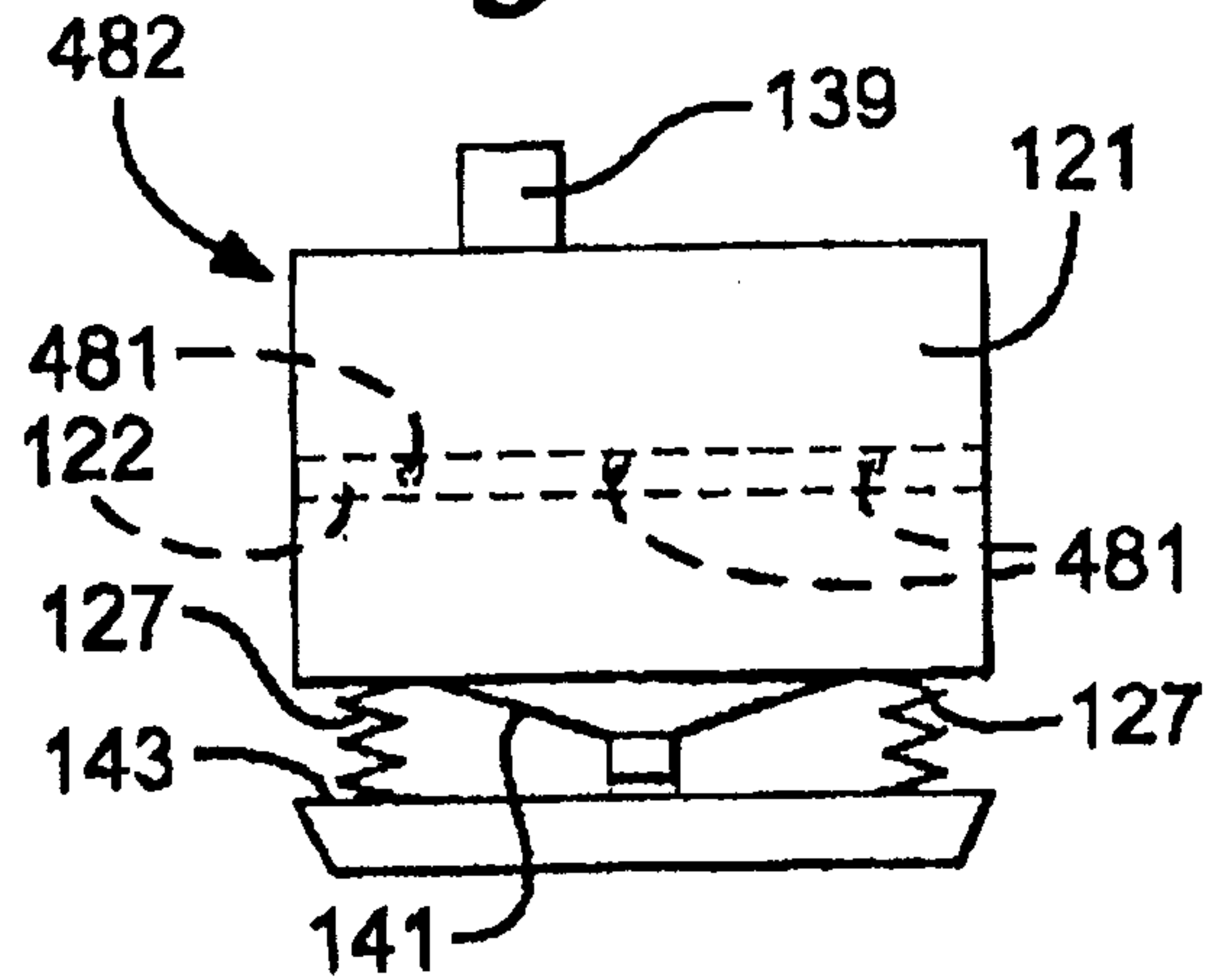
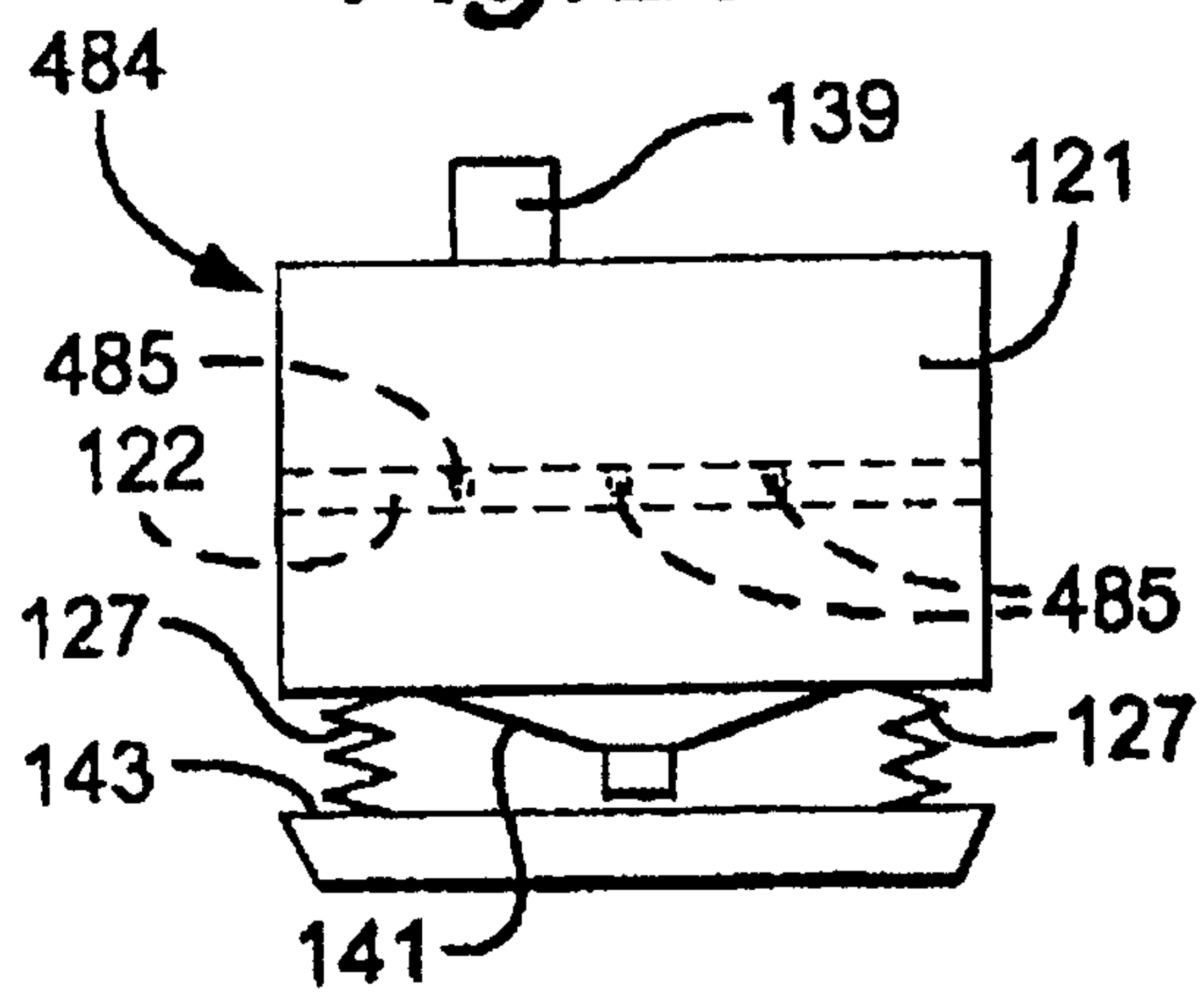
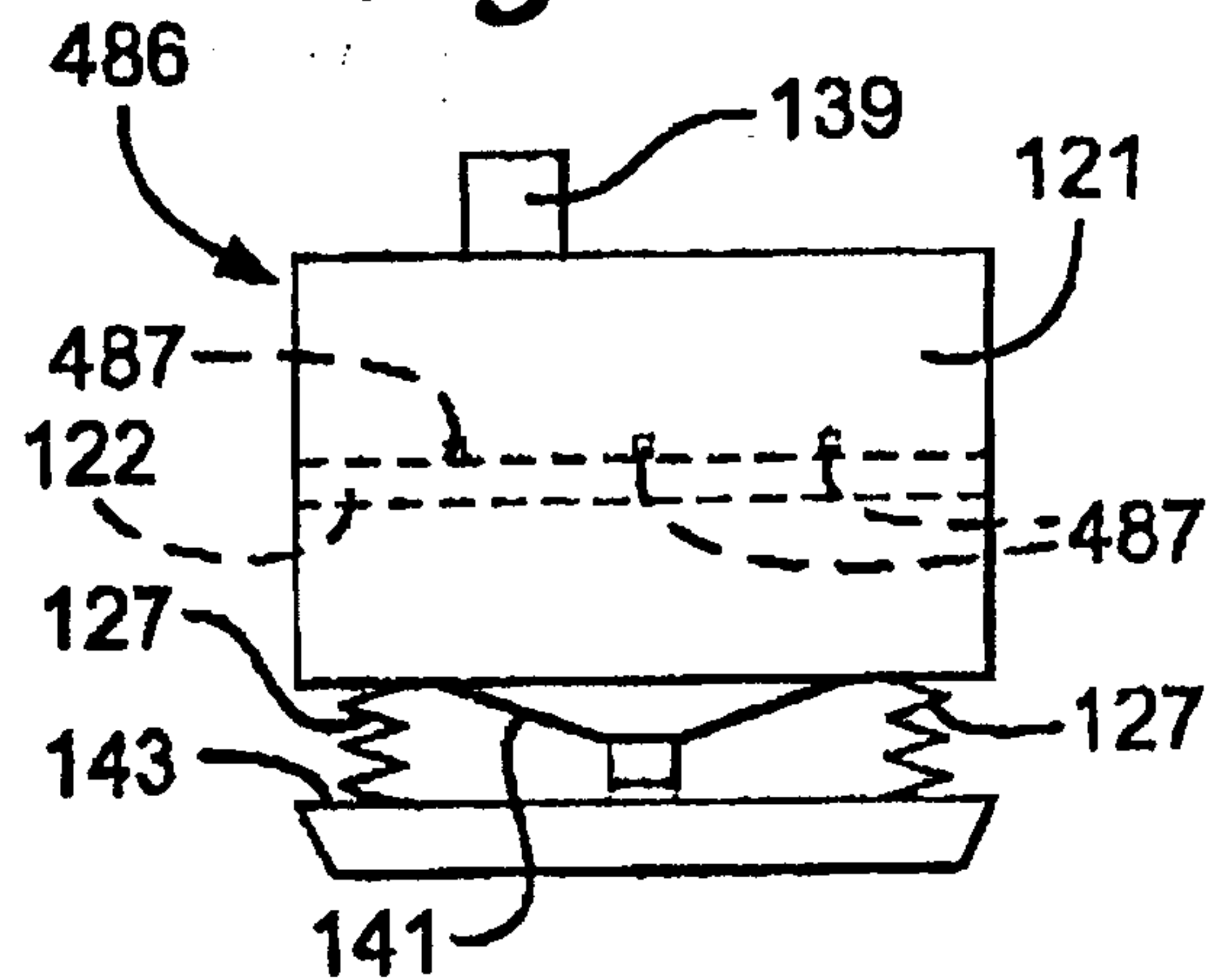
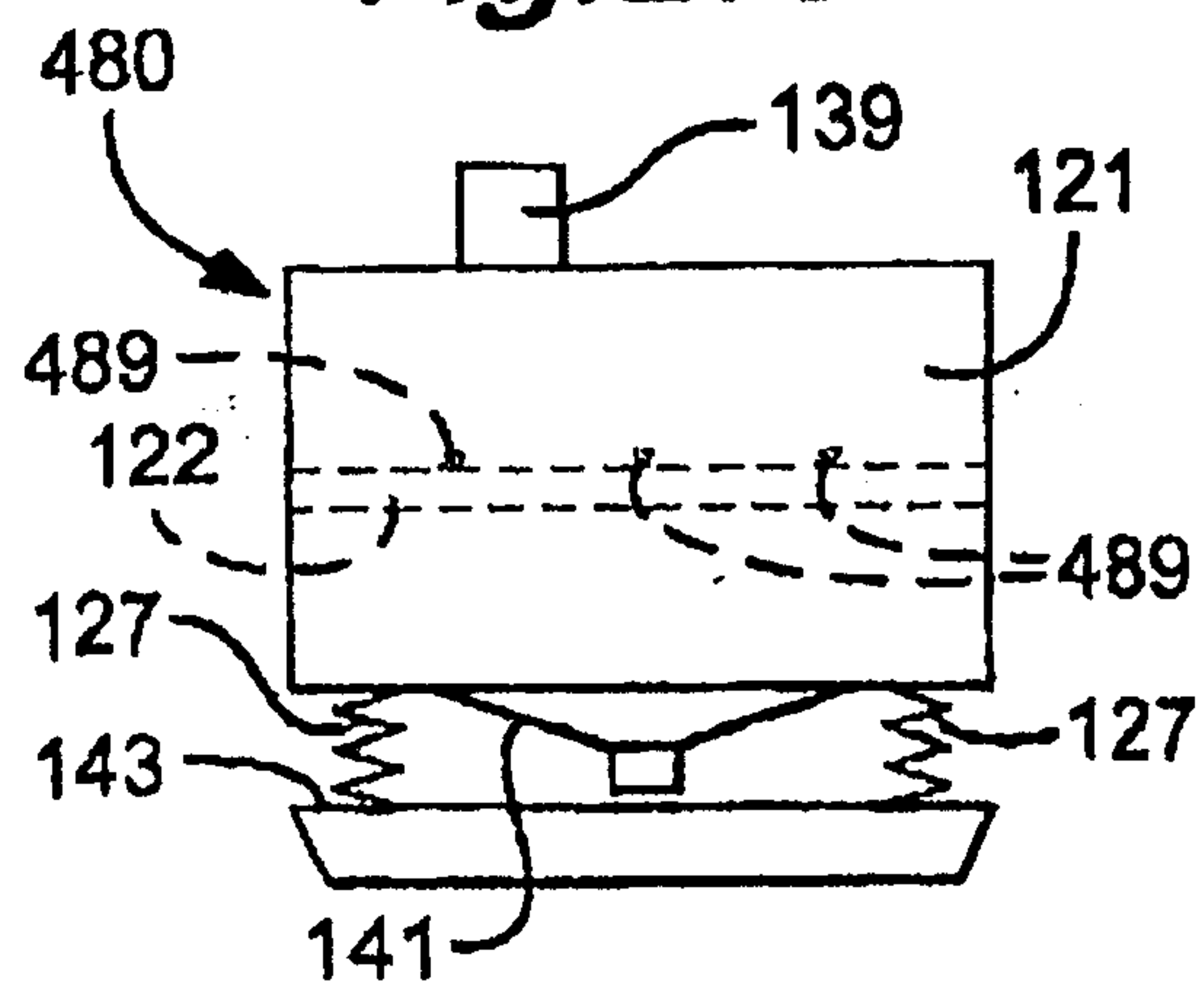
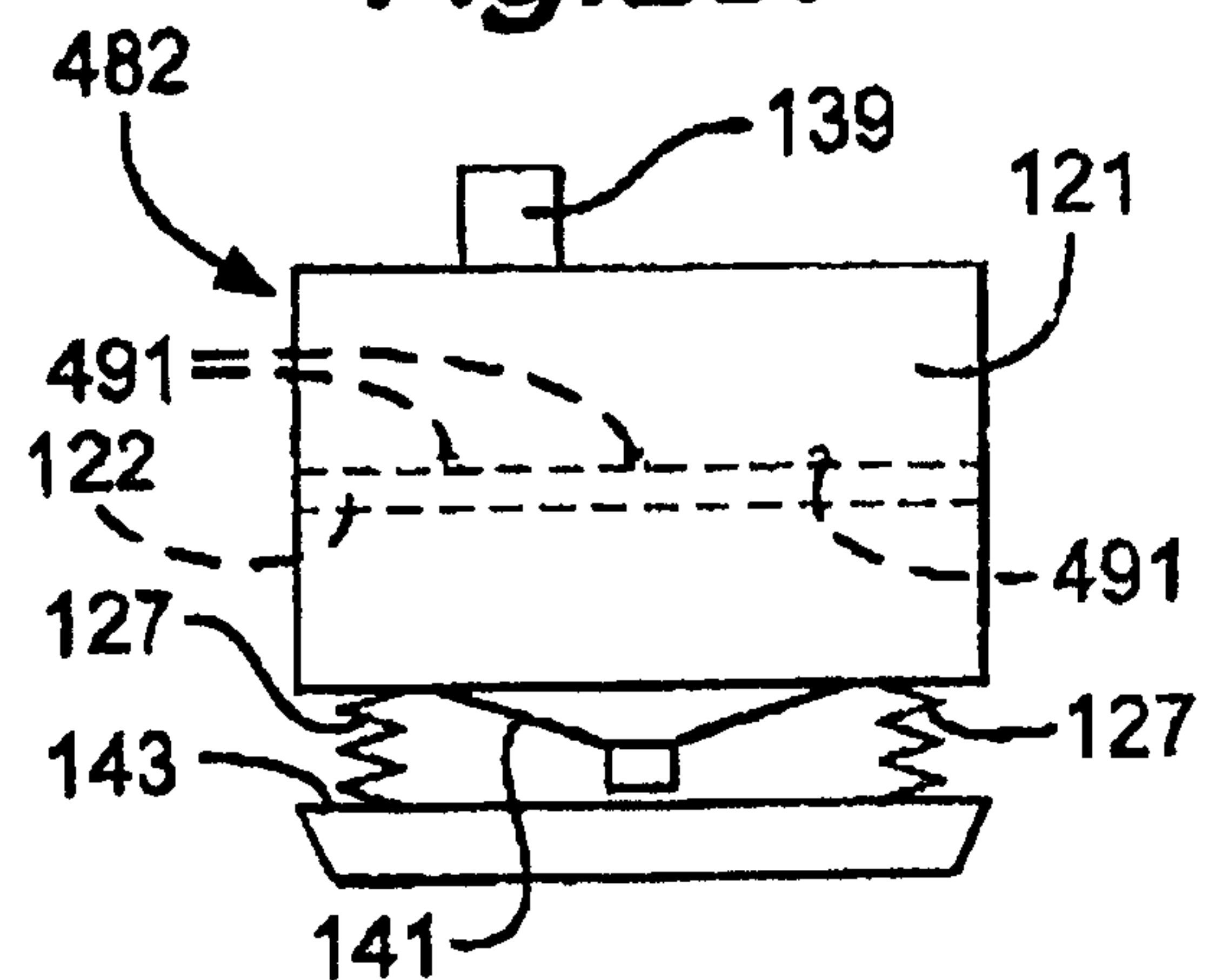
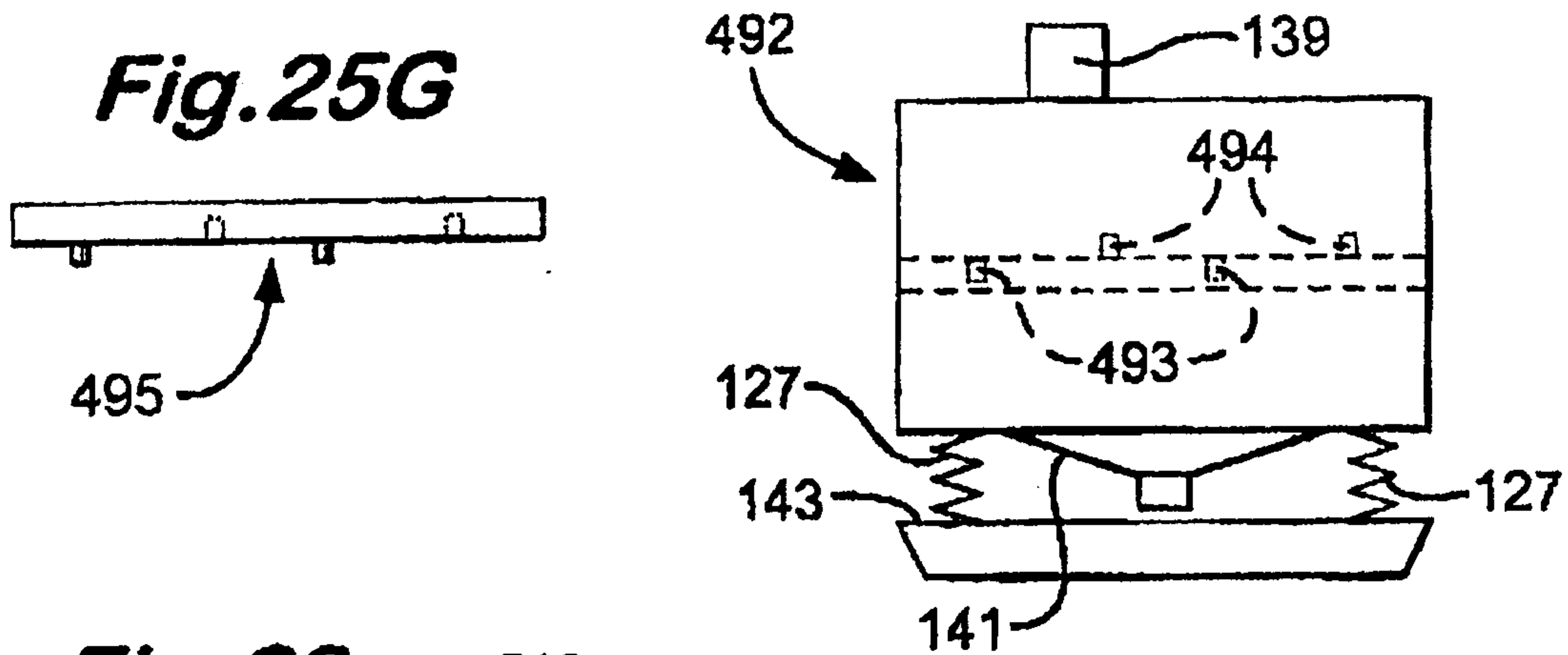
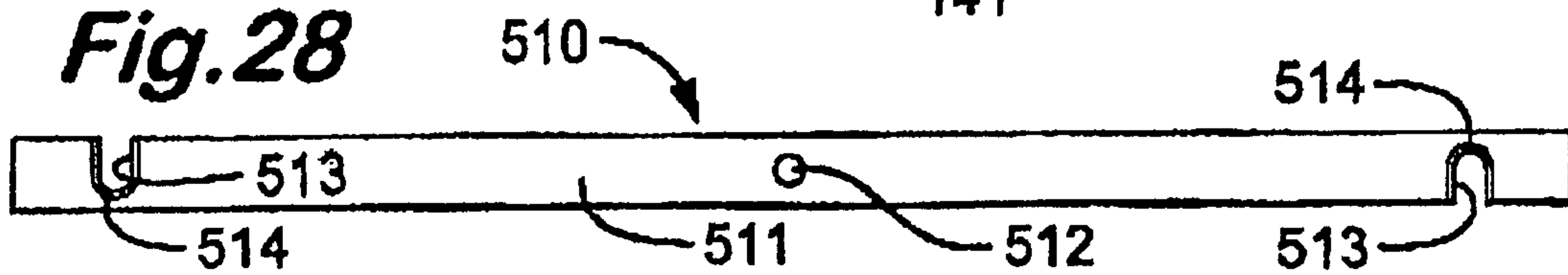
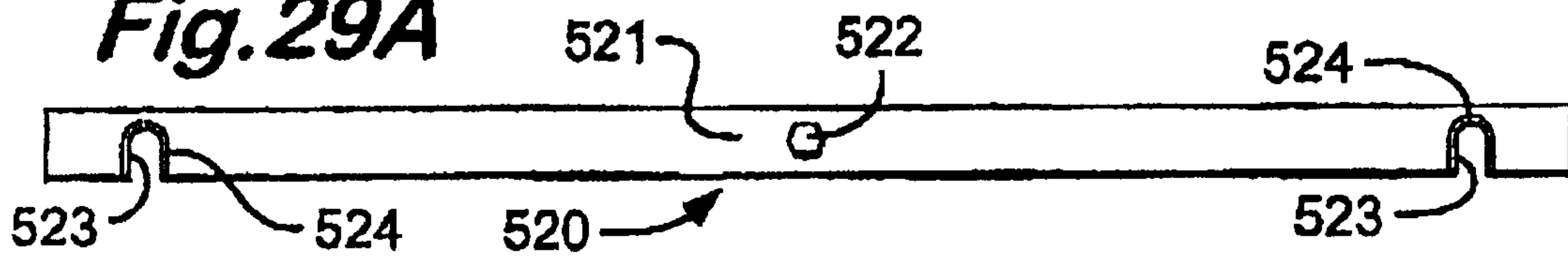
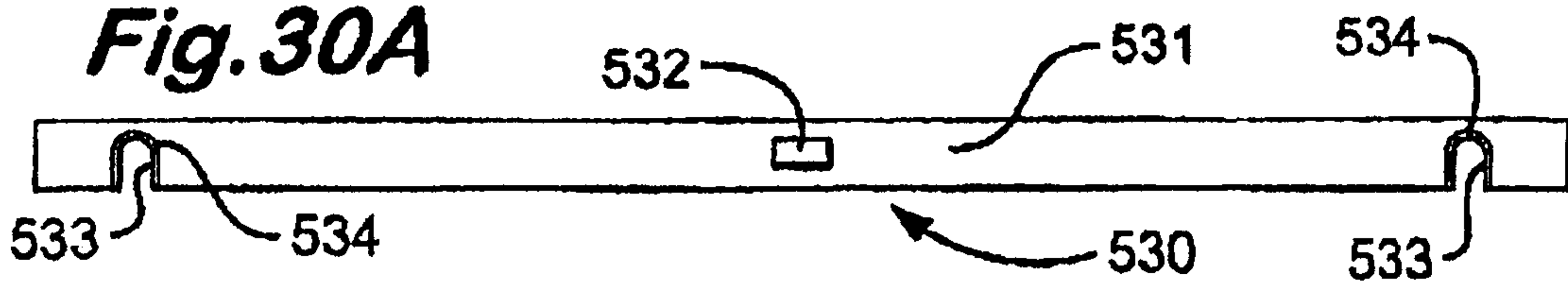
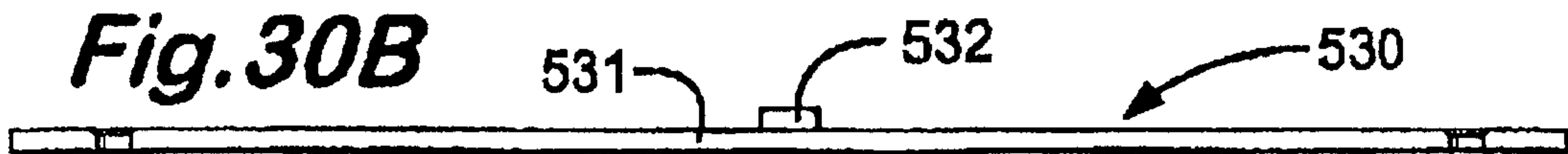
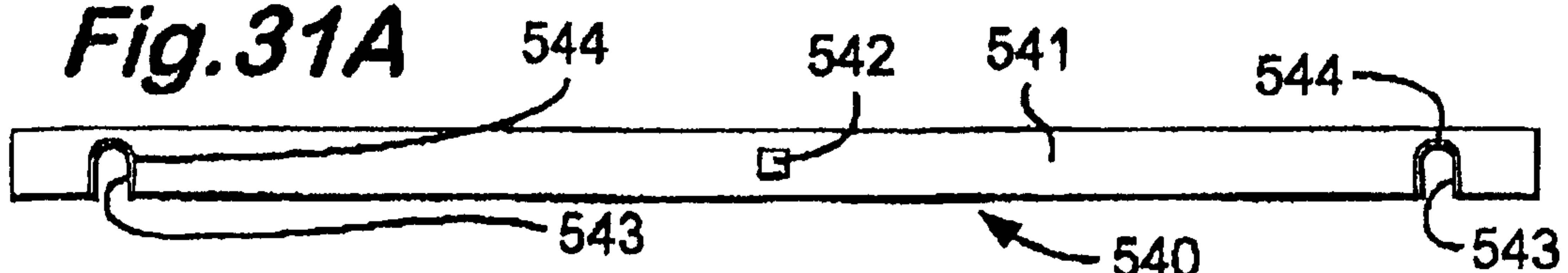
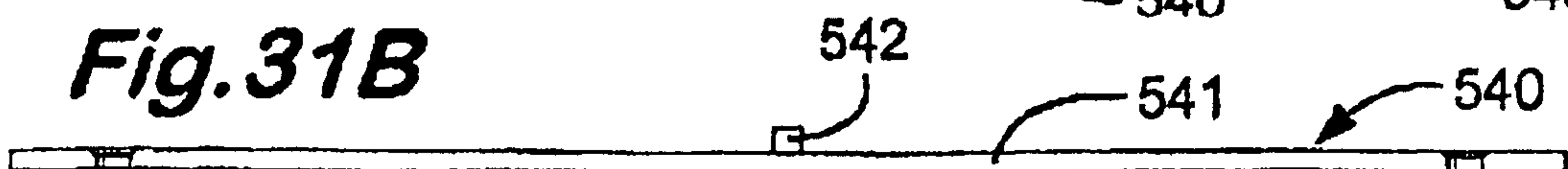
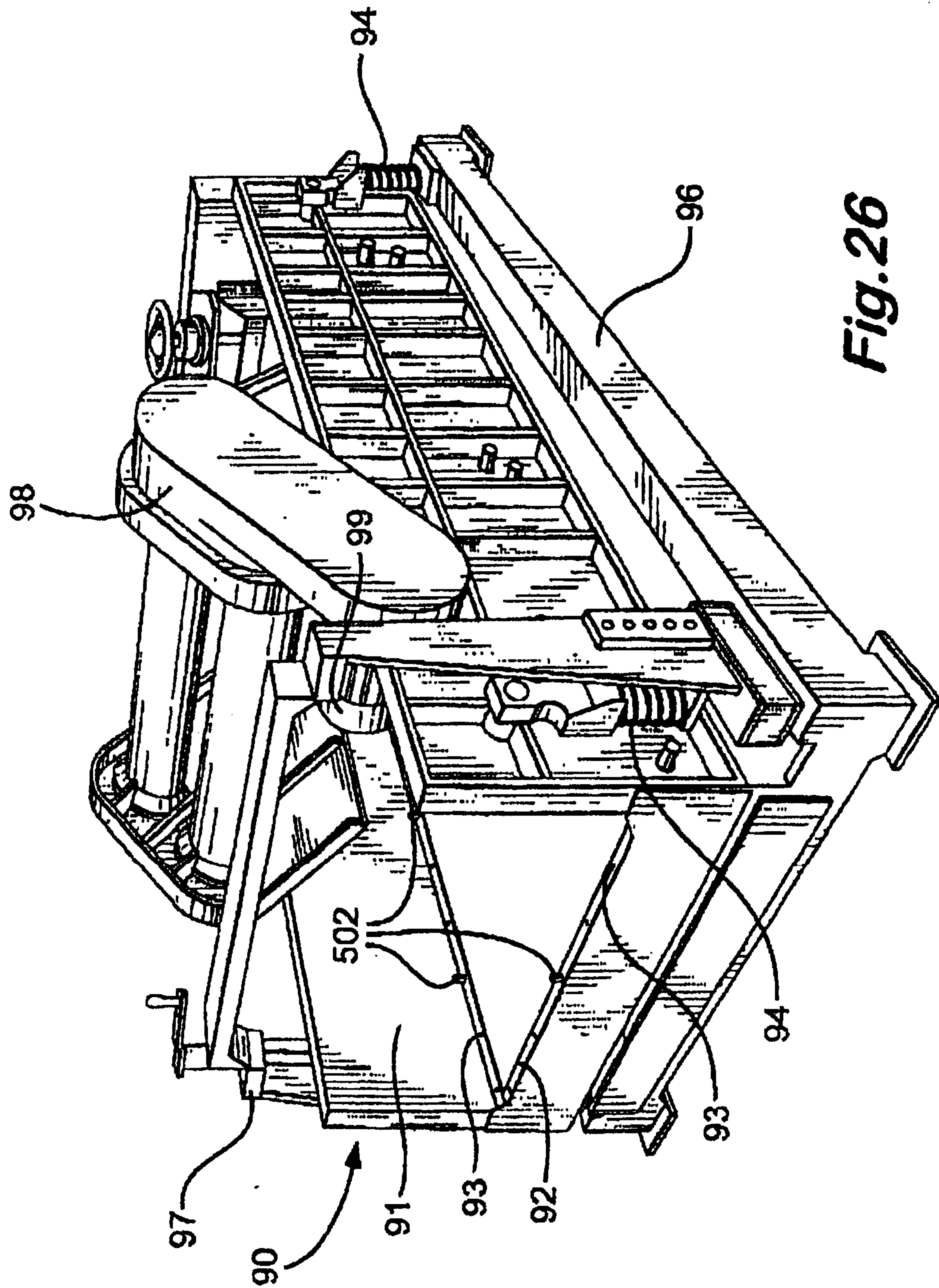
Fig.25A**Fig.25B****Fig.25C****Fig.25D****Fig.25E****Fig.25F**

Fig.25H**Fig.28****Fig.29A****Fig.29B****Fig.30A****Fig.30B****Fig.31A****Fig.31B**



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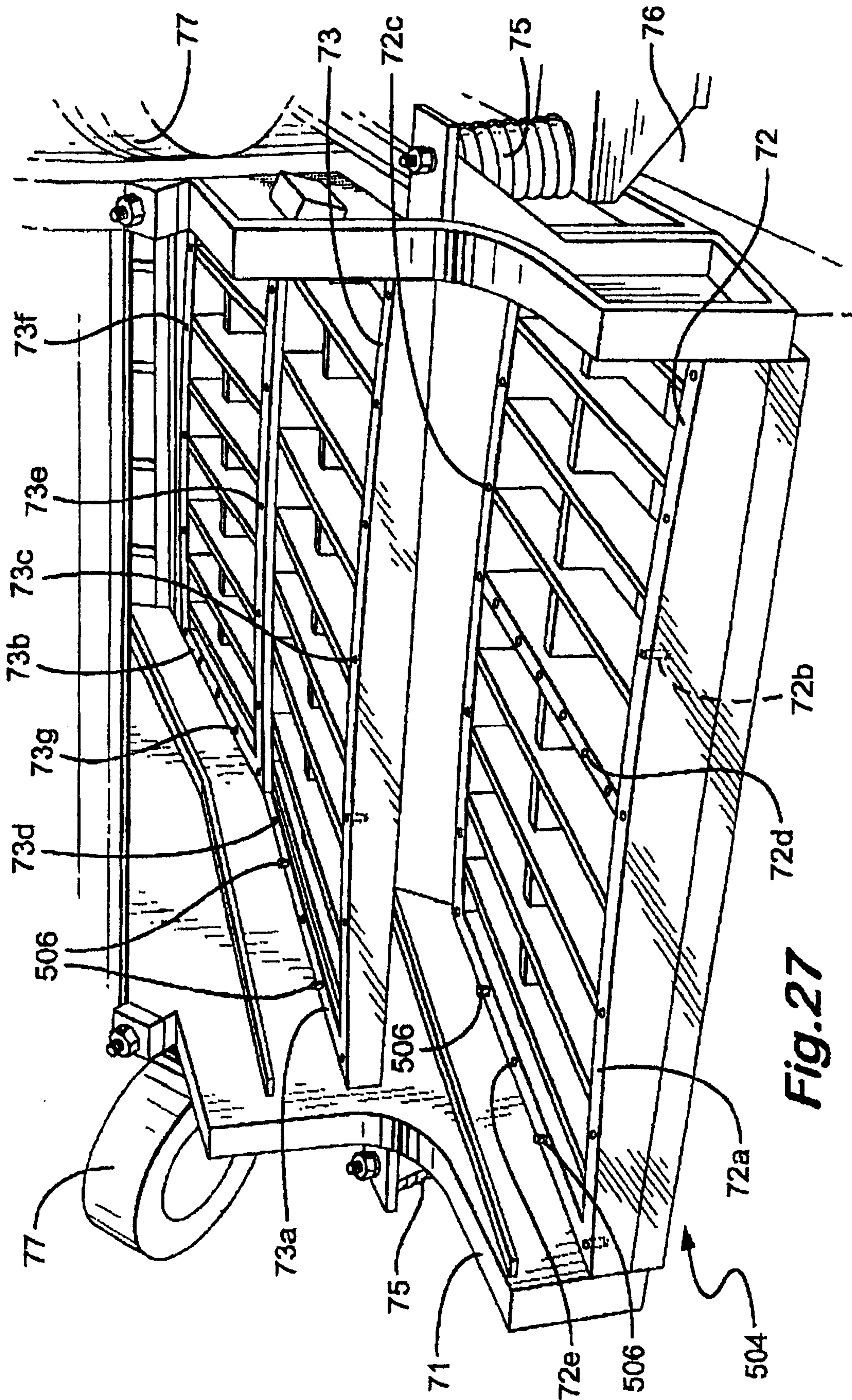
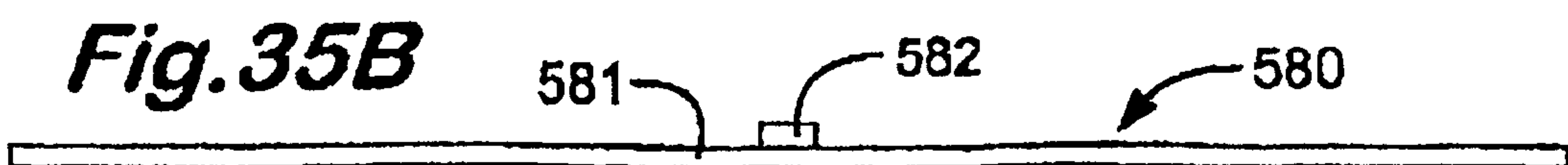
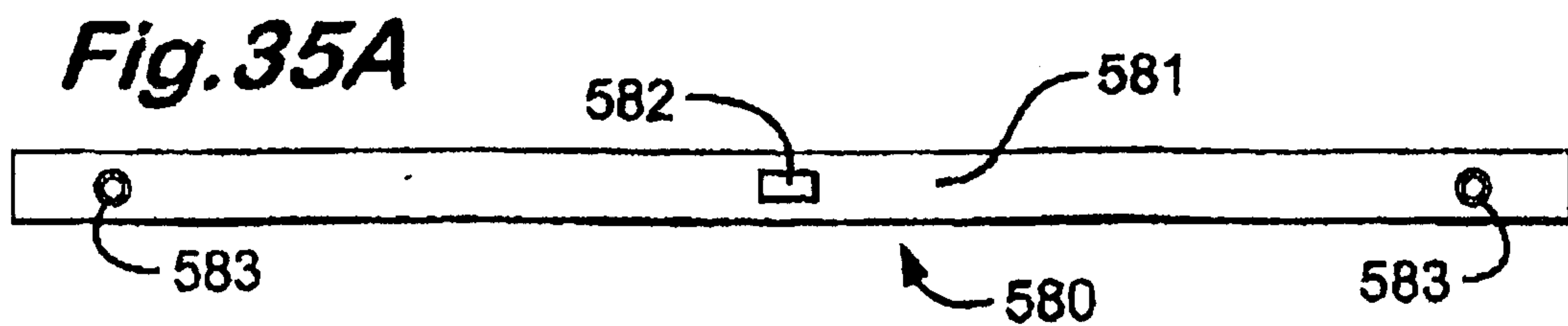
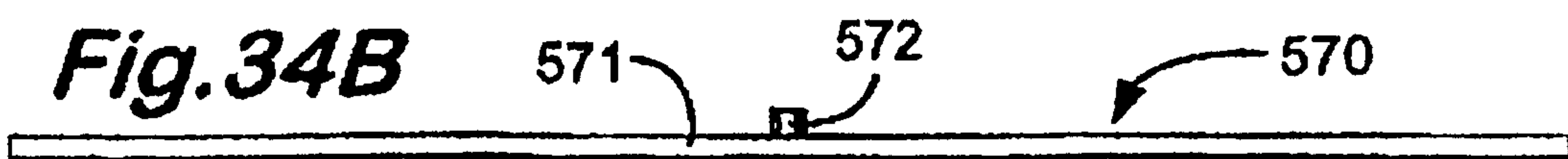
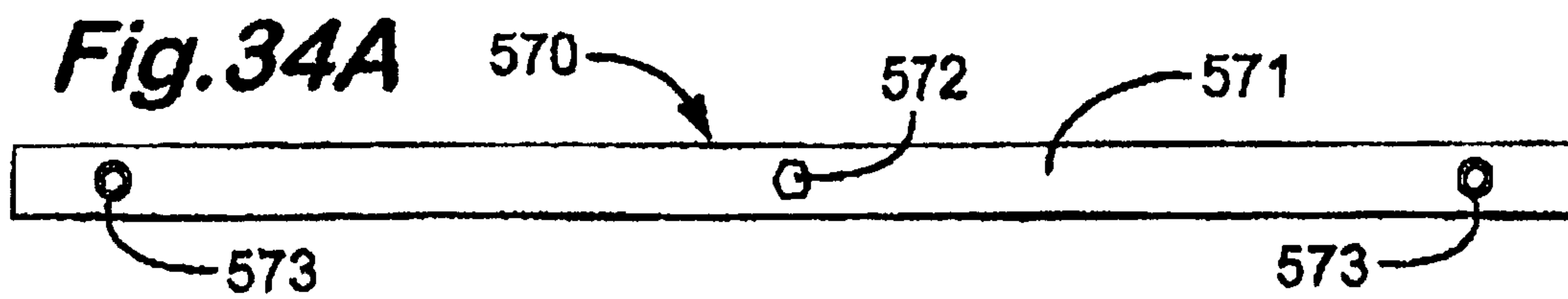
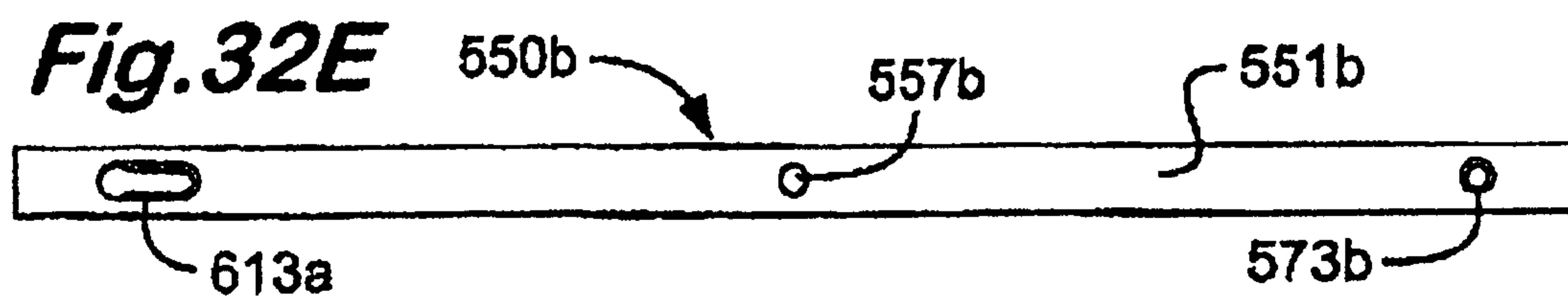
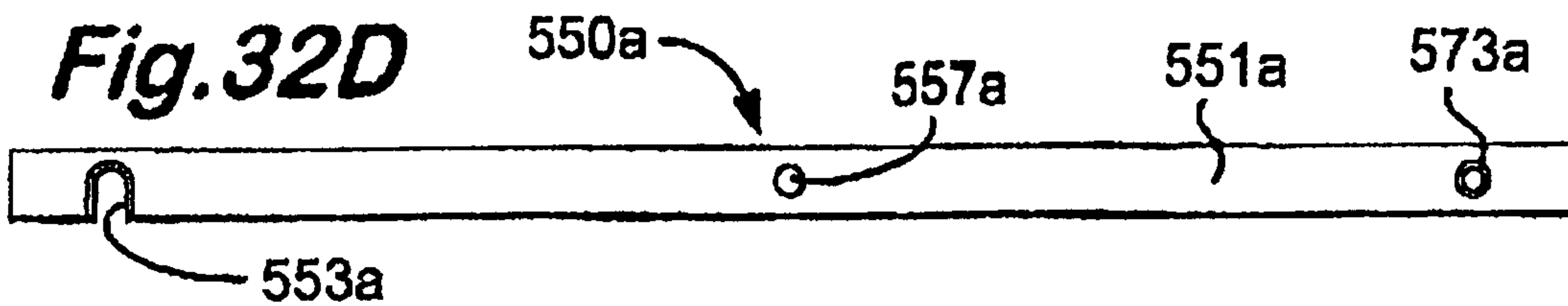
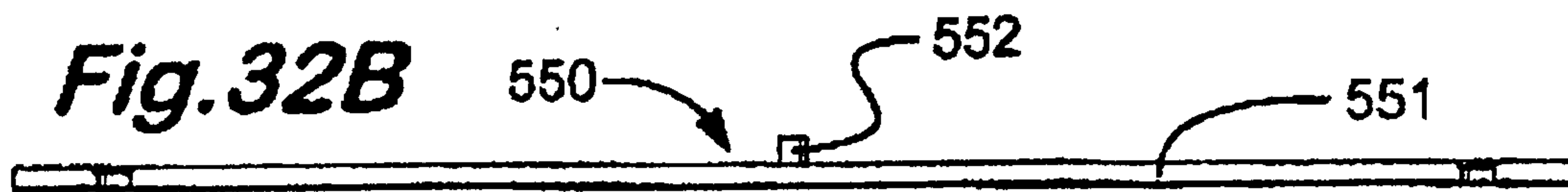
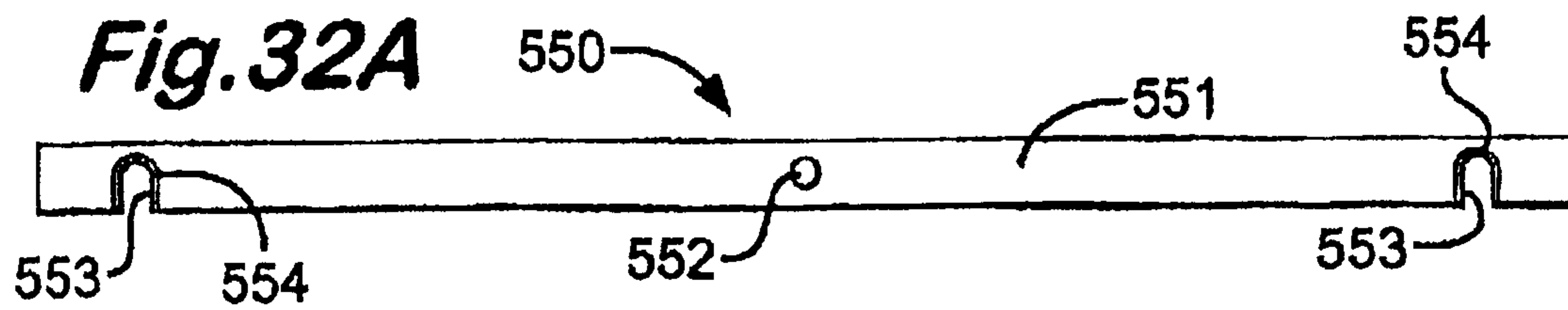
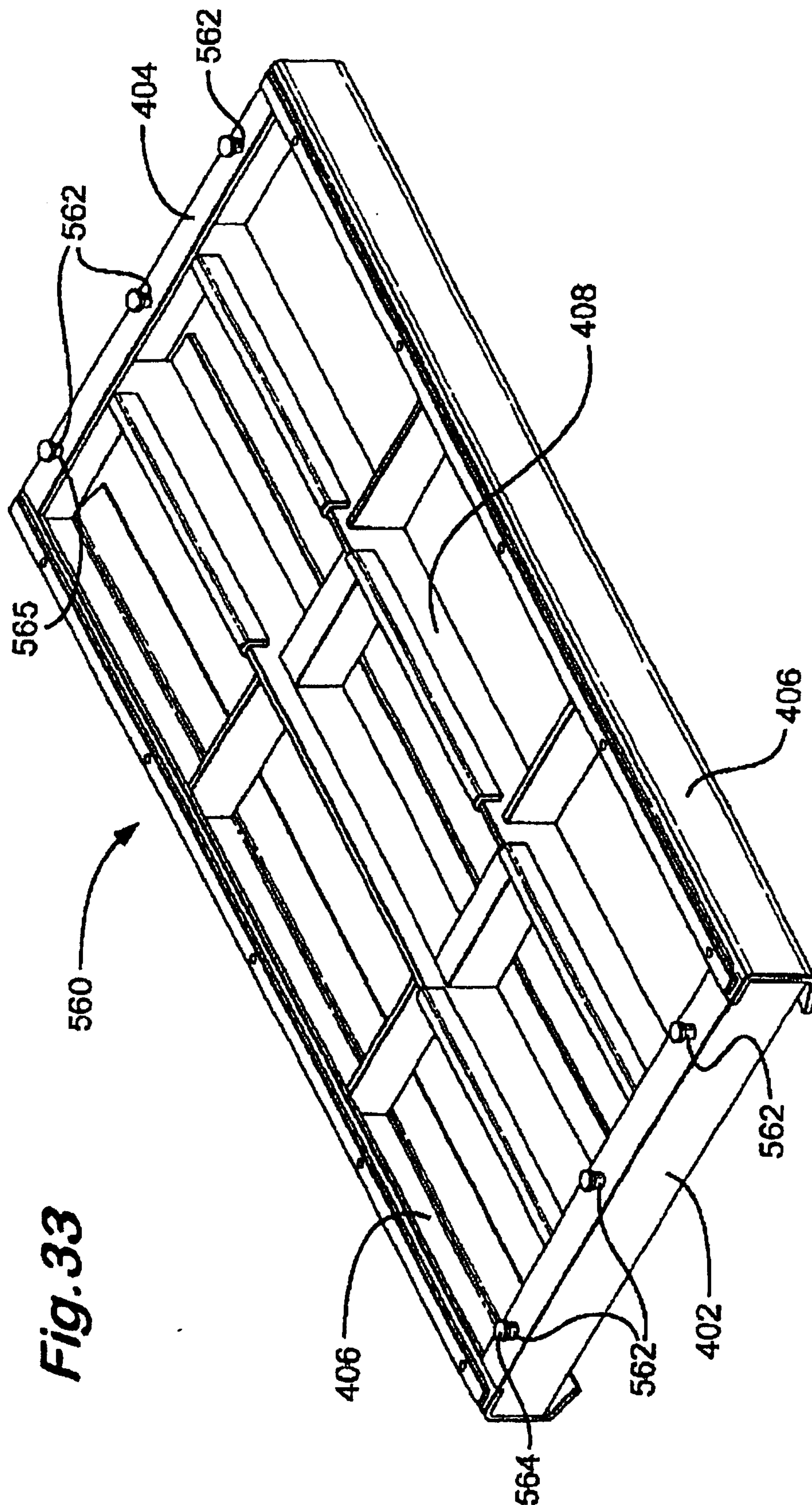
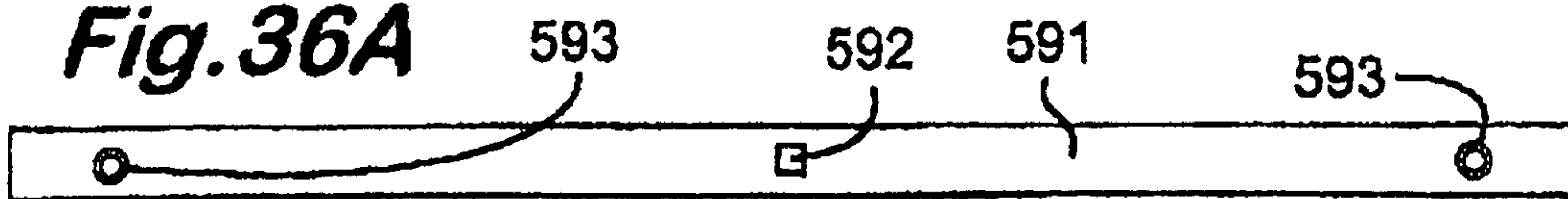
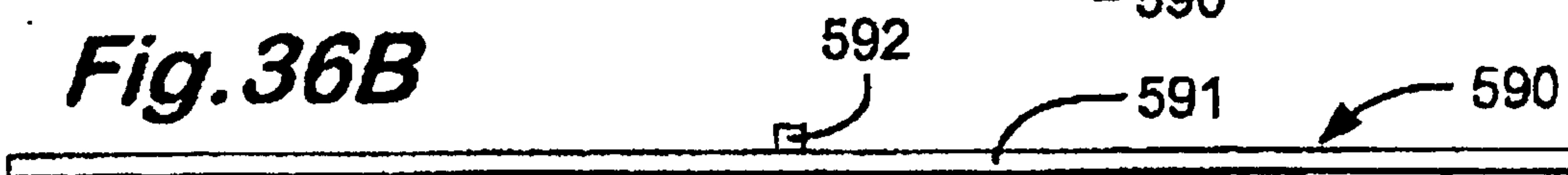
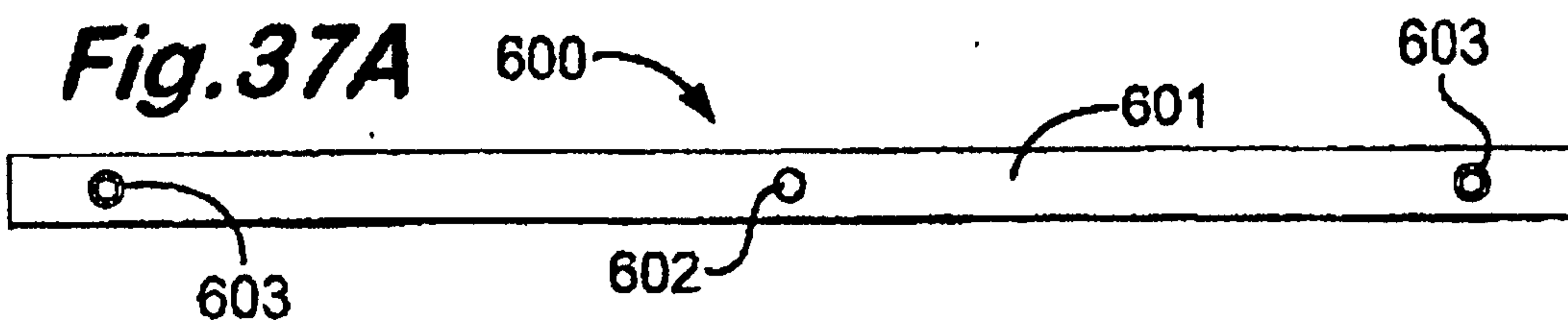
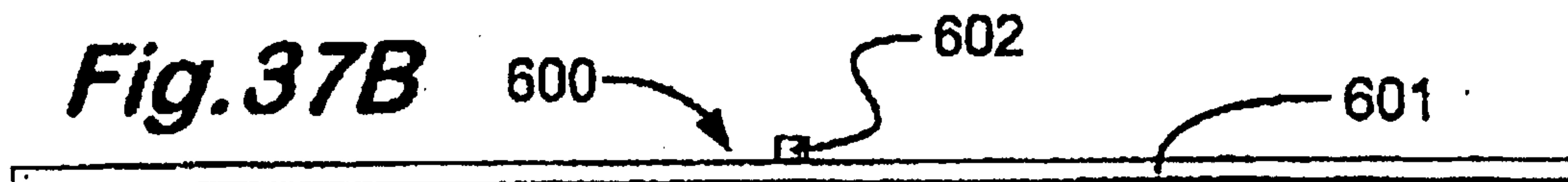
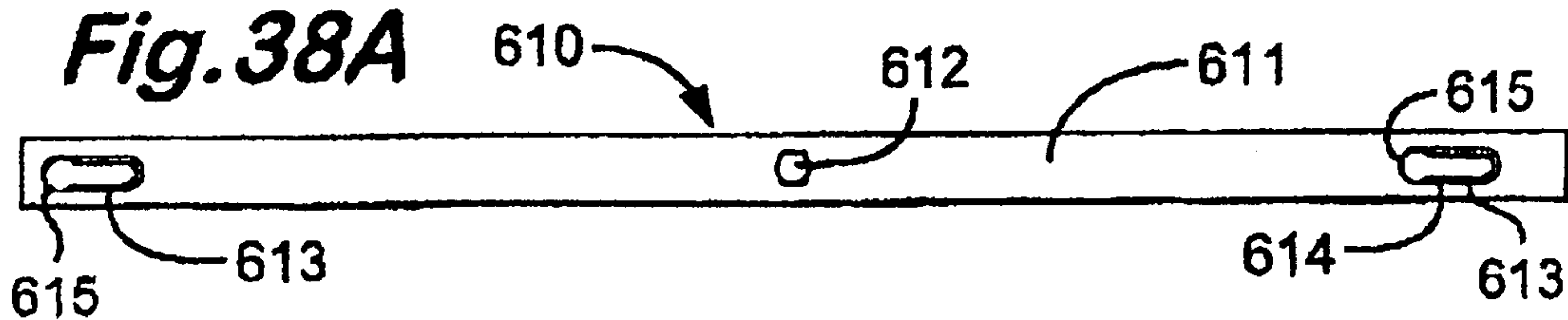
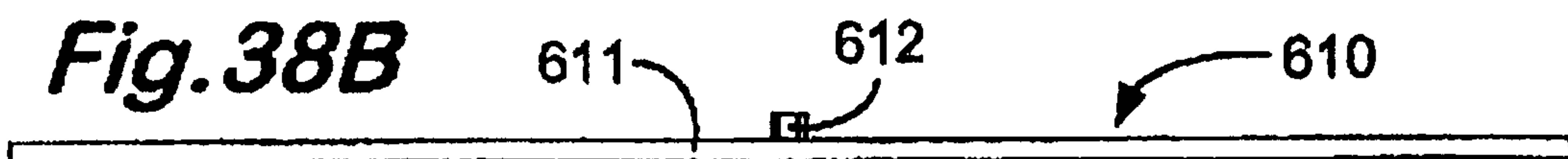
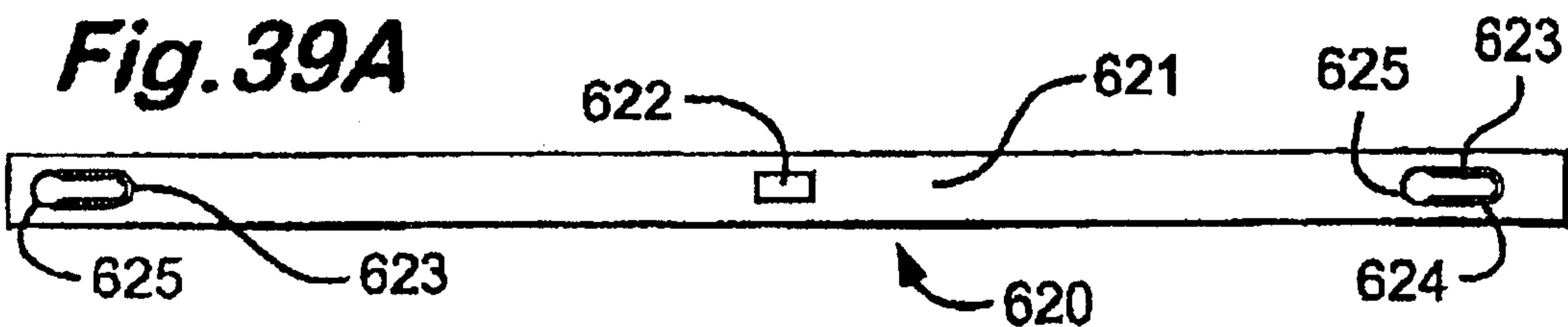
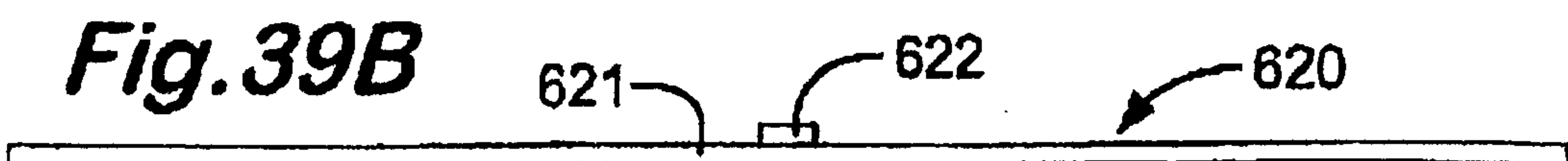
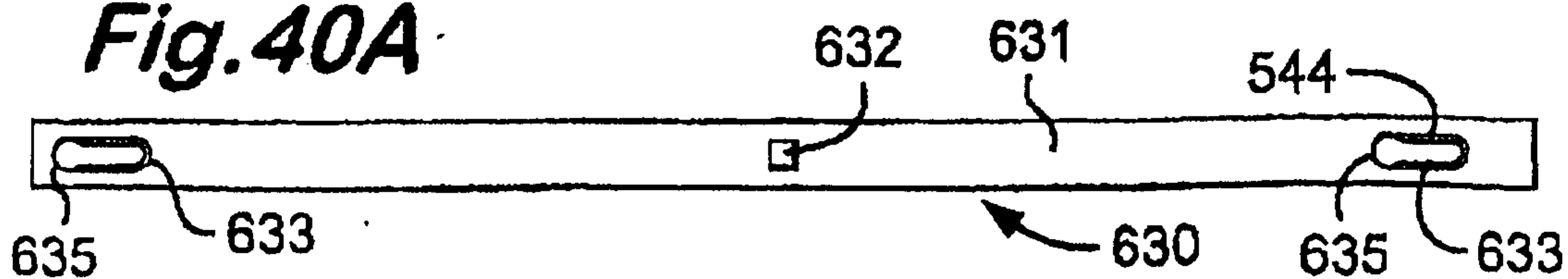
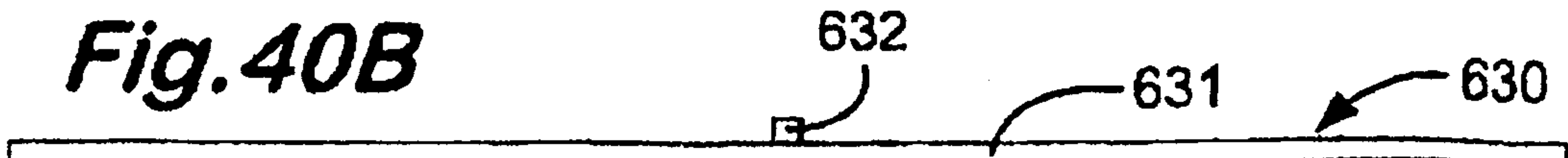


Fig. 27

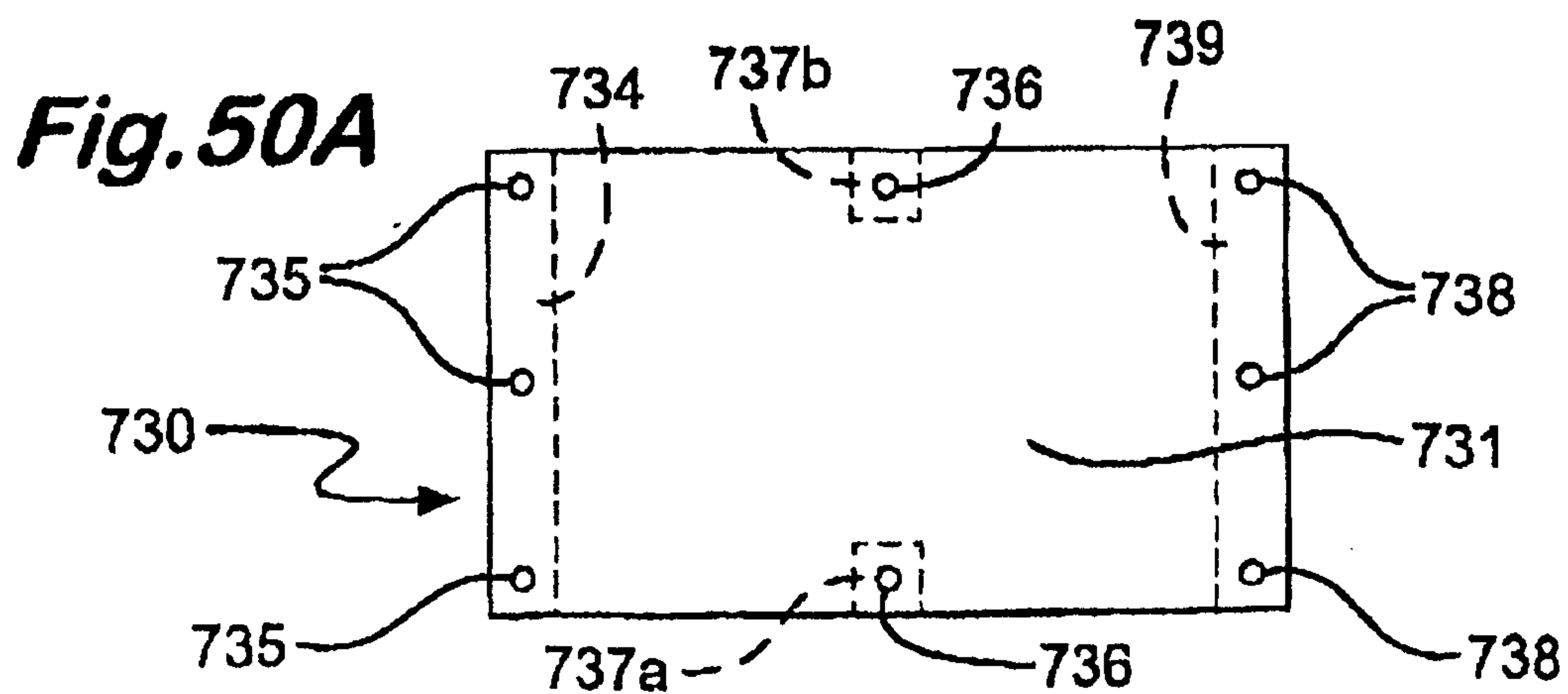
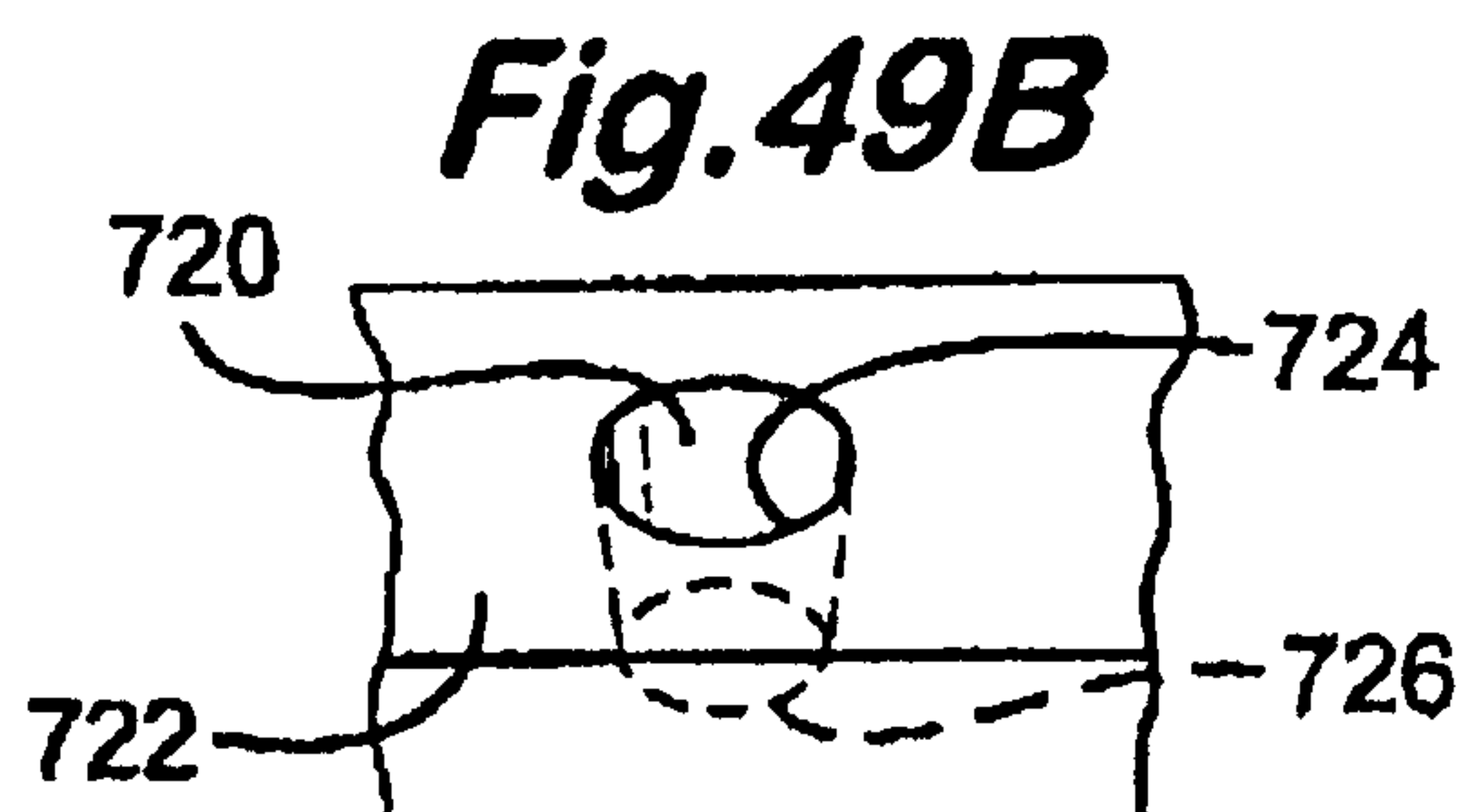
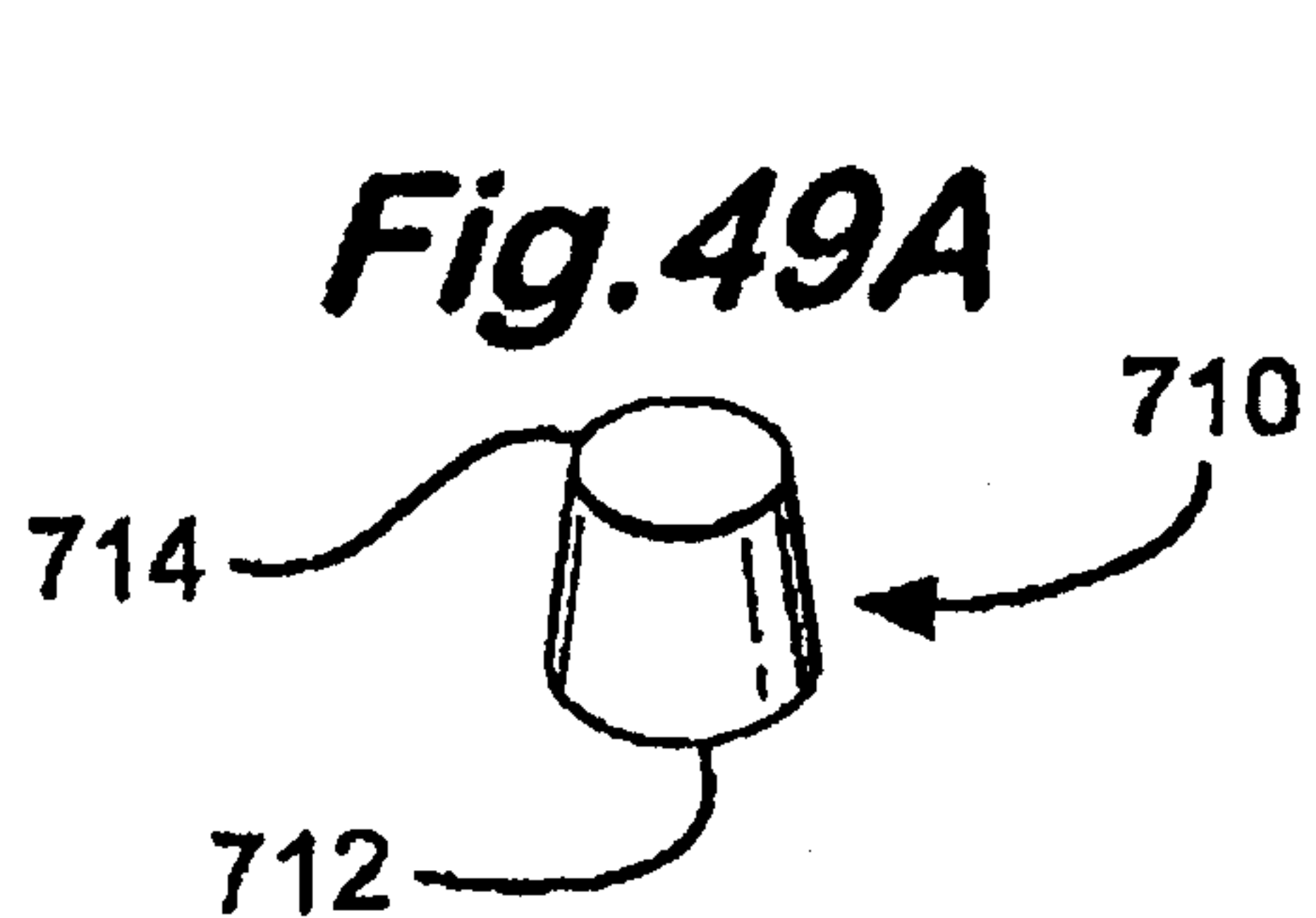
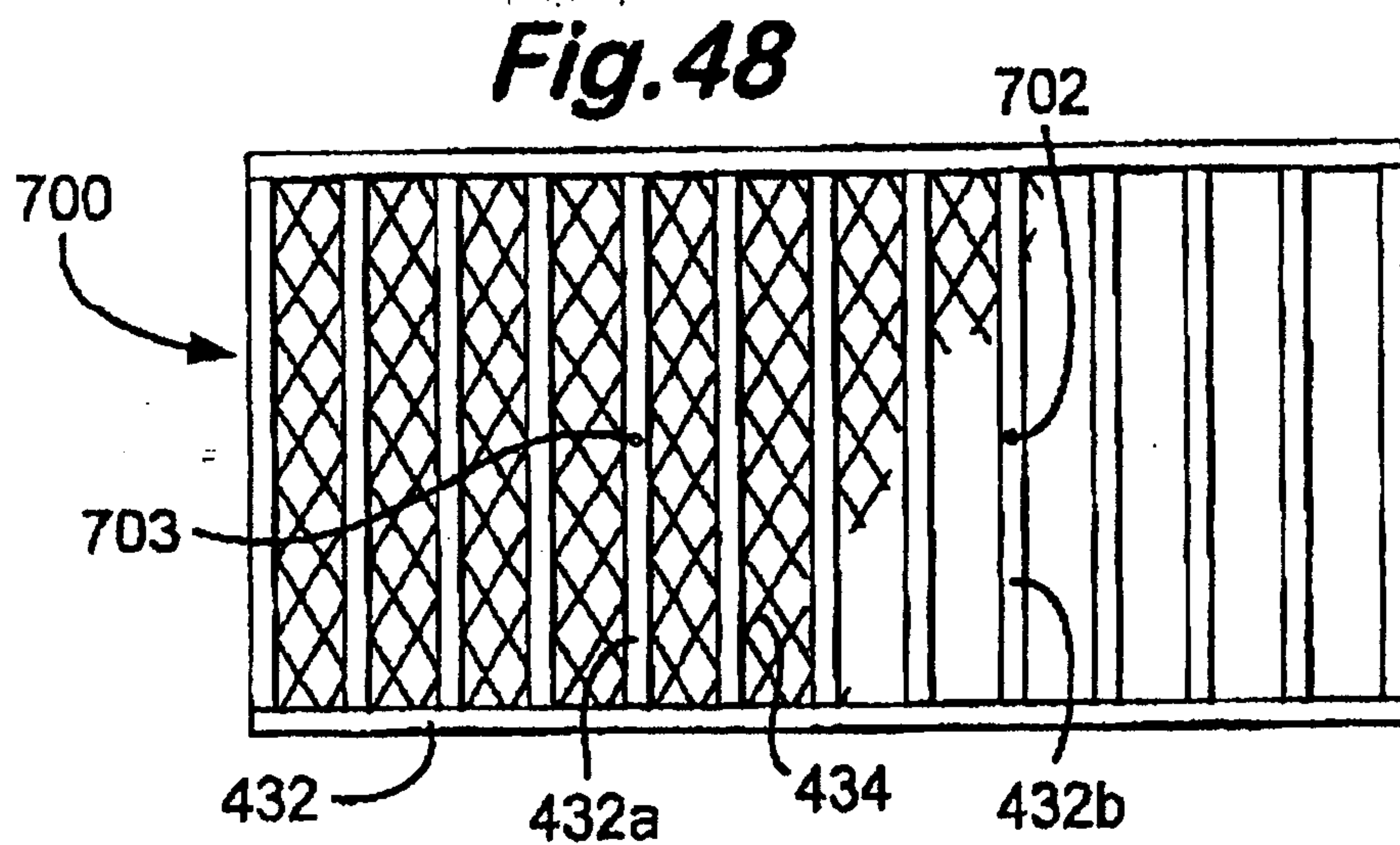
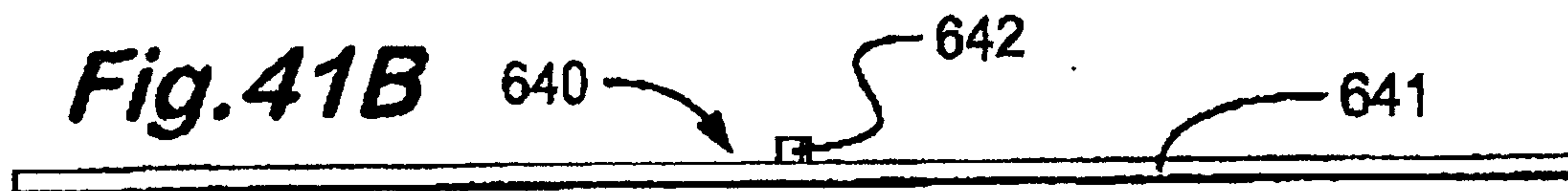
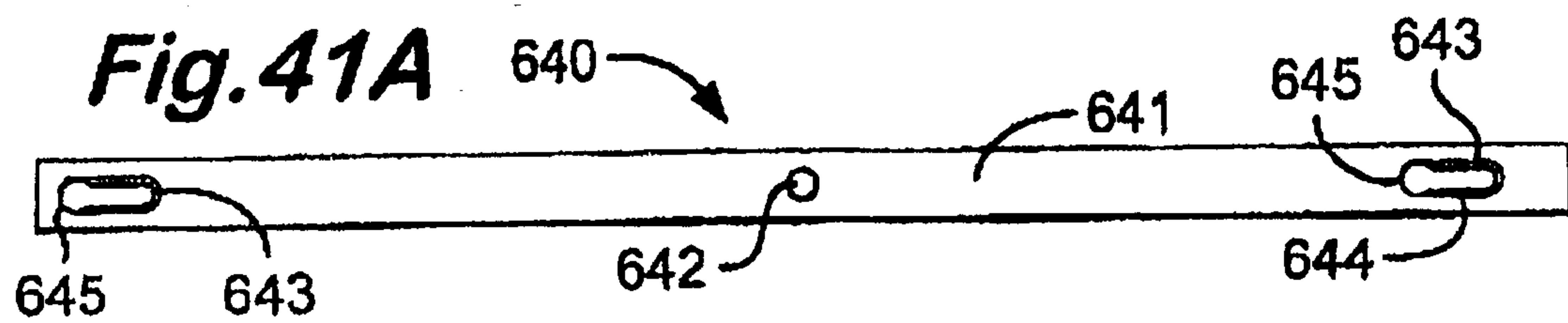




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Fig. 36A**Fig. 36B****Fig. 37A****Fig. 37B****Fig. 38A****Fig. 38B****Fig. 39A****Fig. 39B****Fig. 40A****Fig. 40B**

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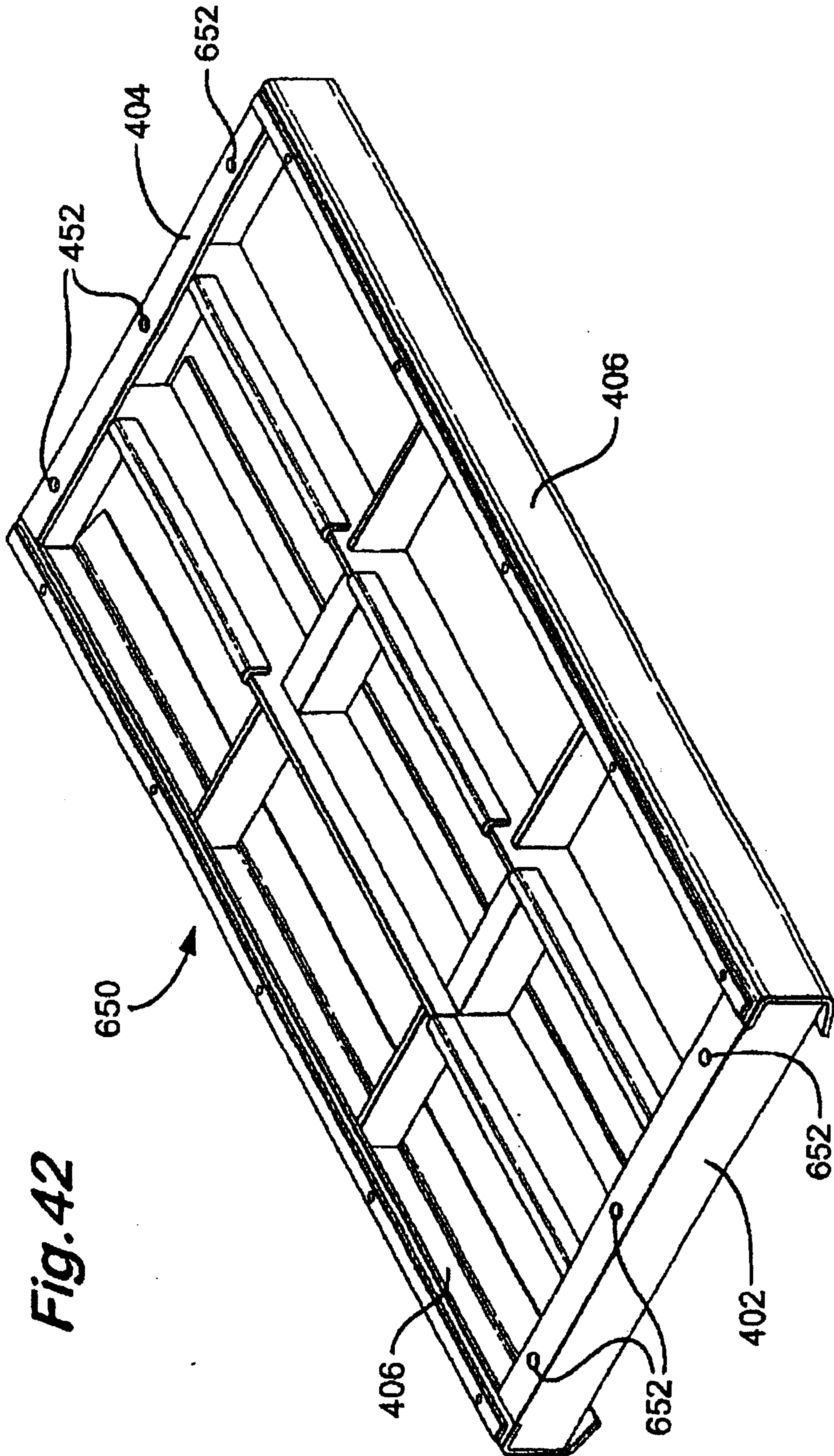
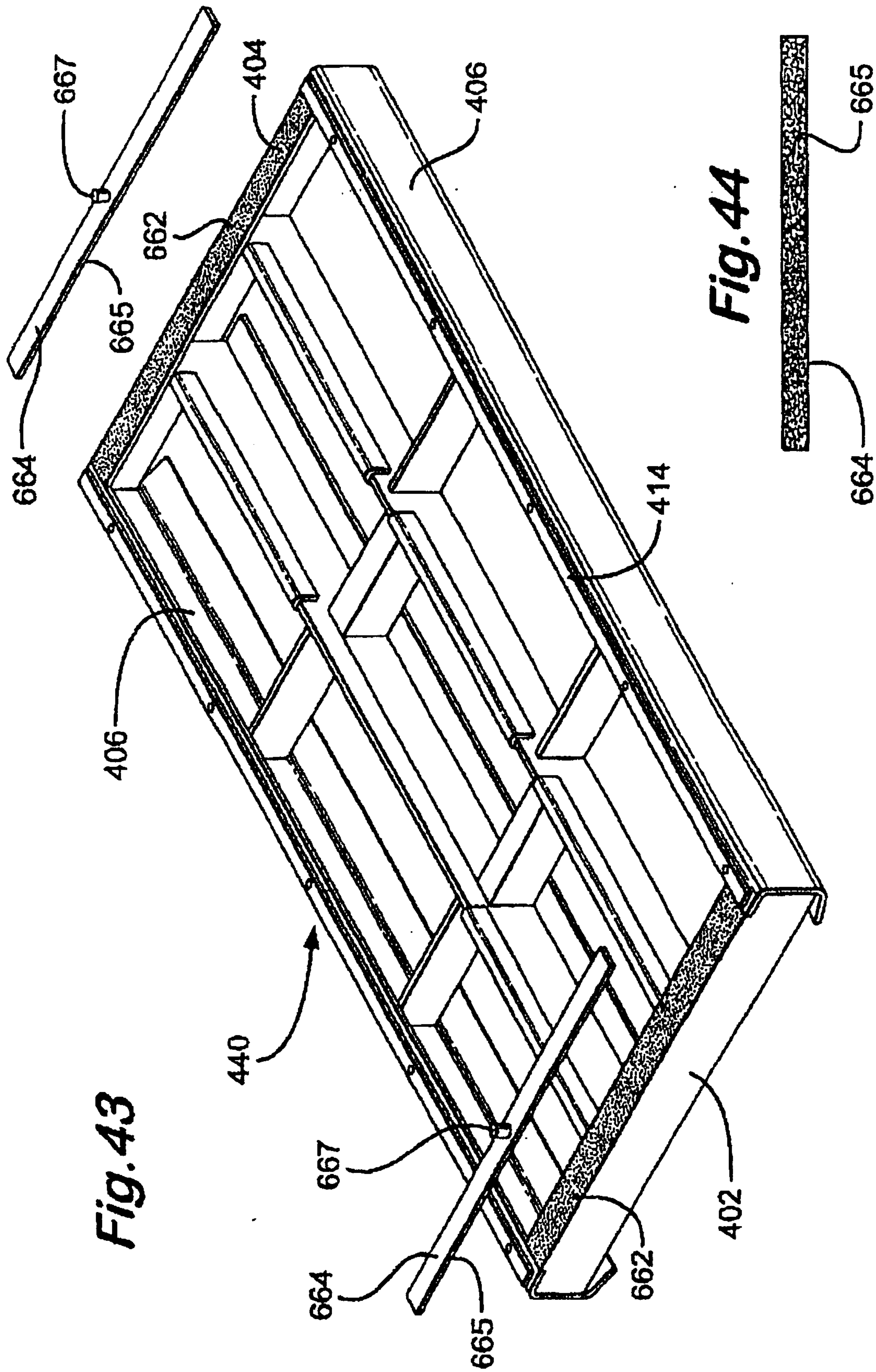
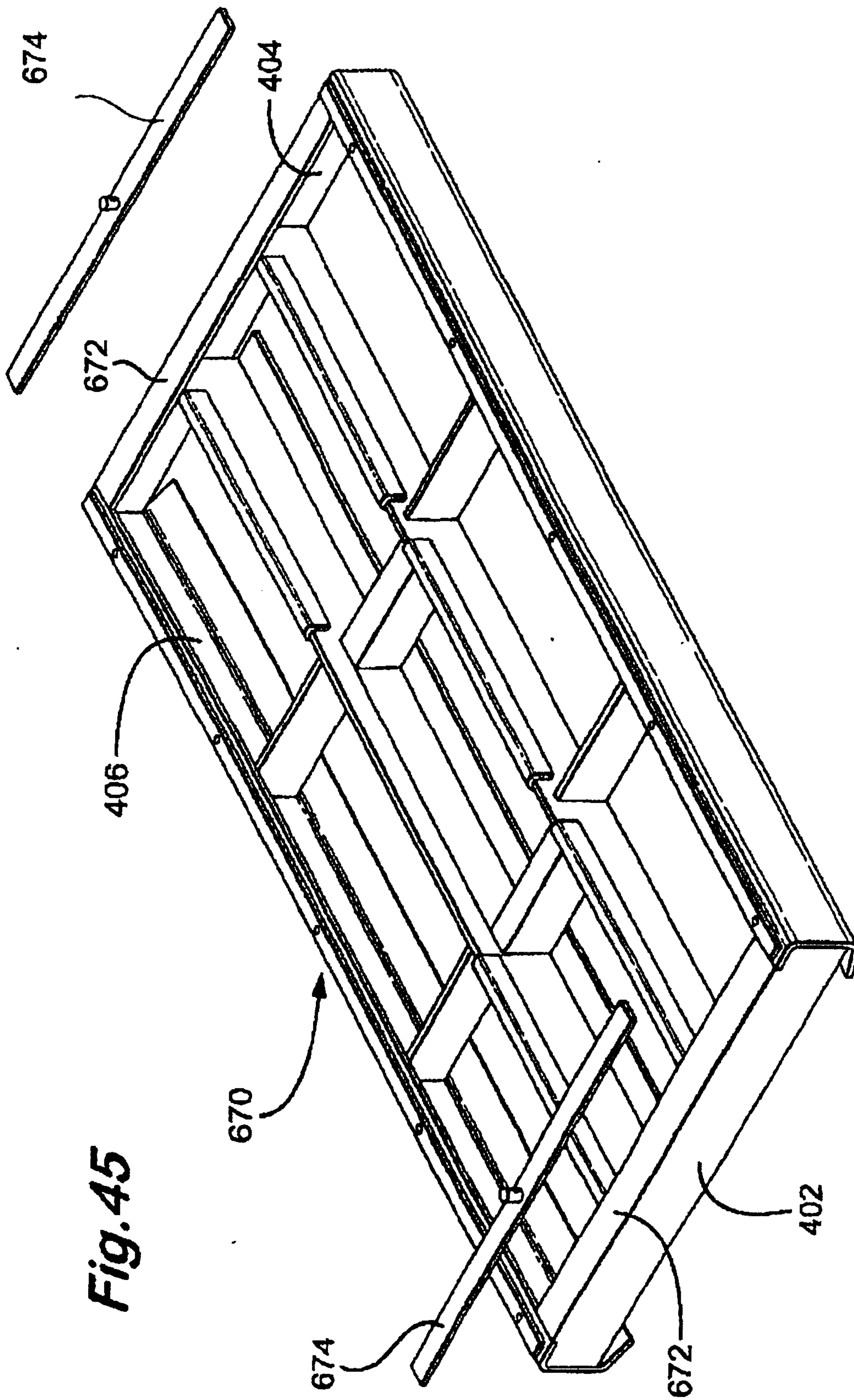
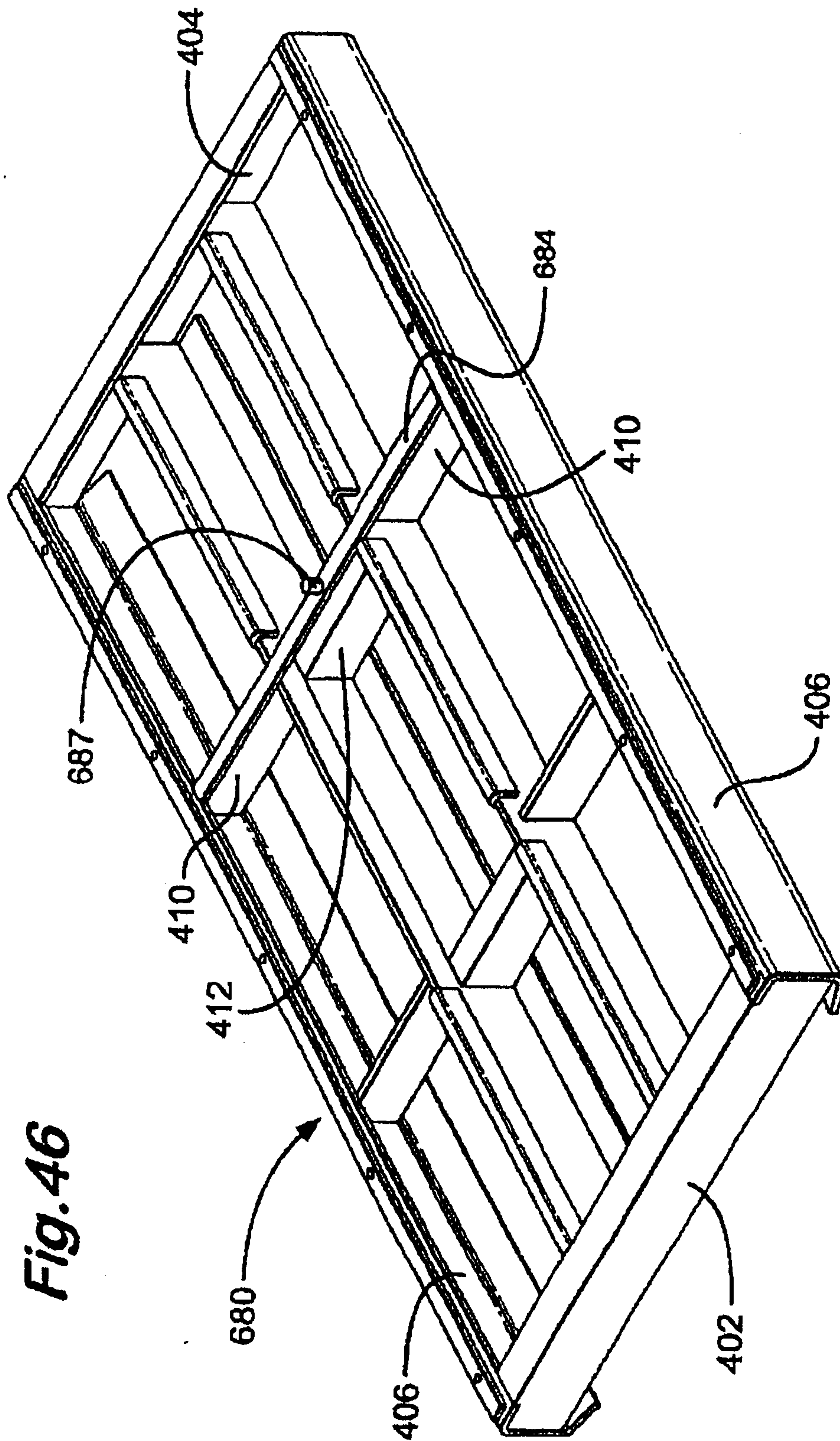
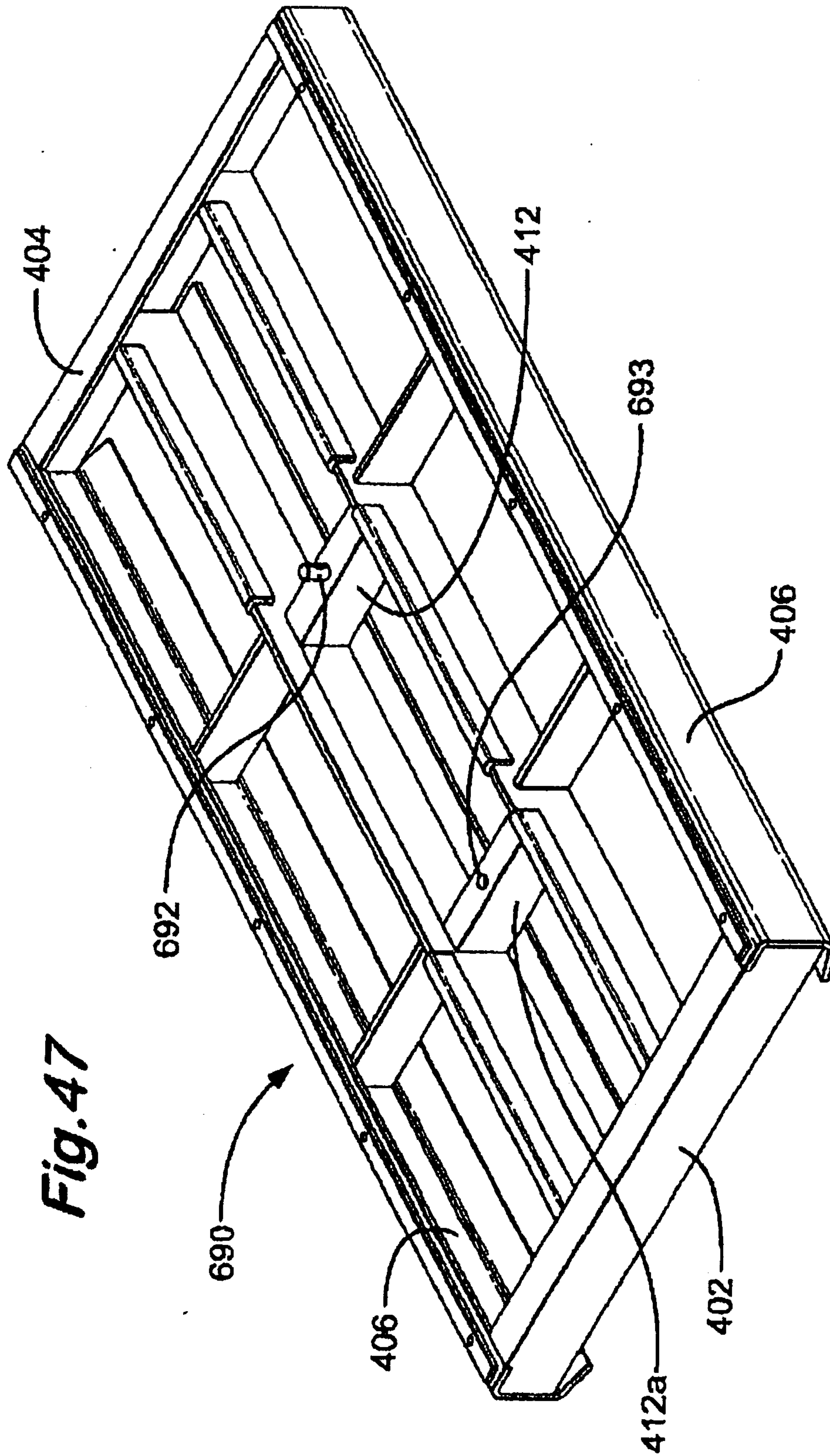


Fig. 42

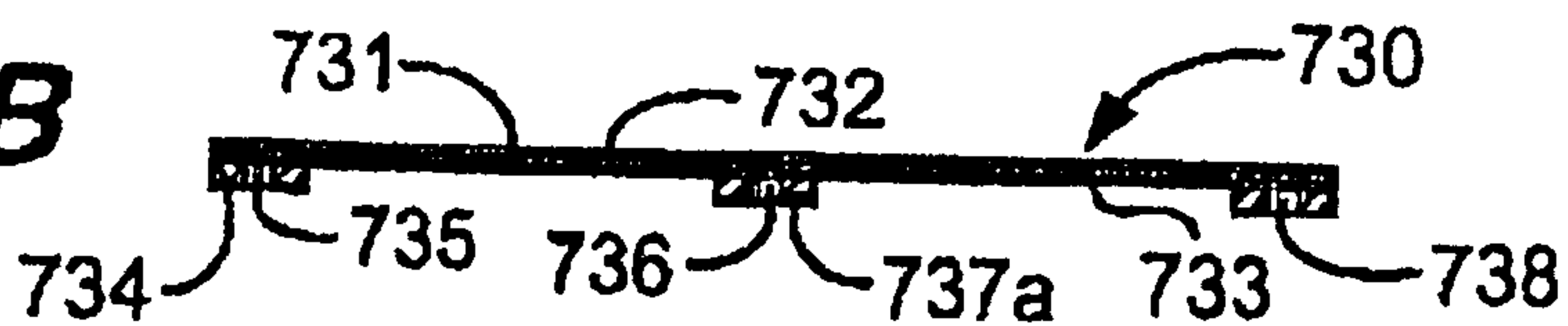
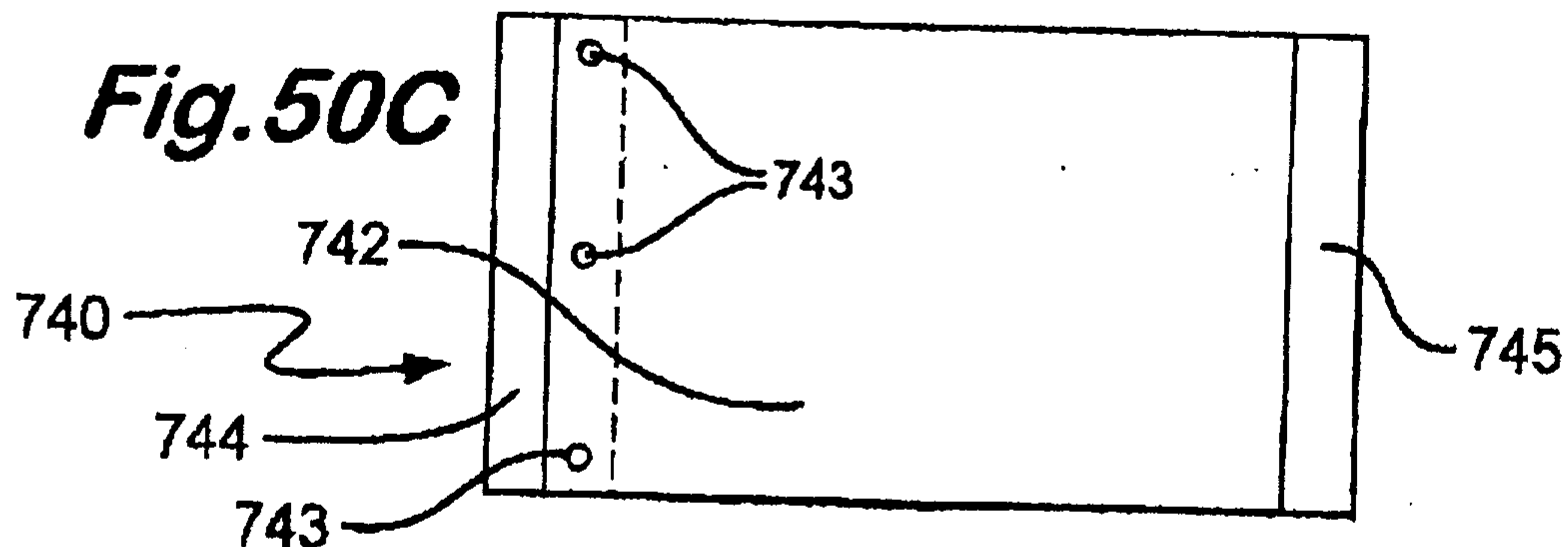
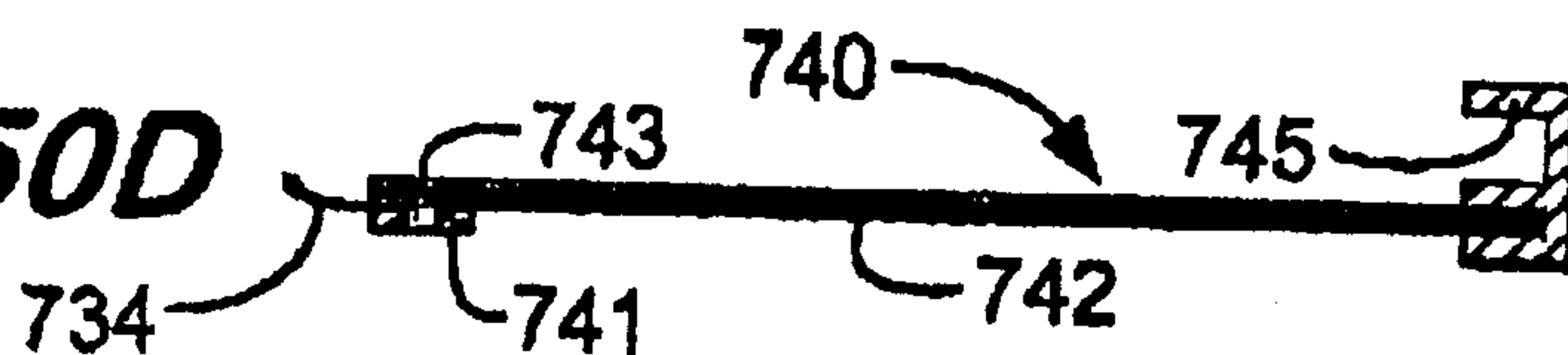
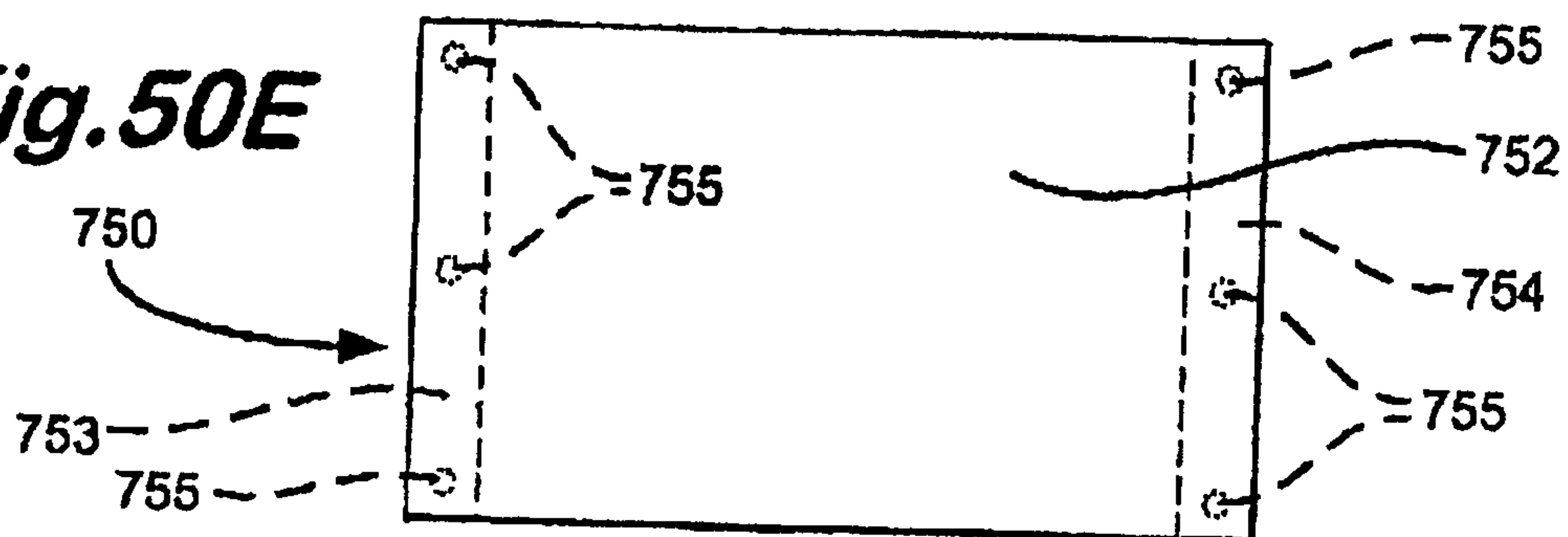
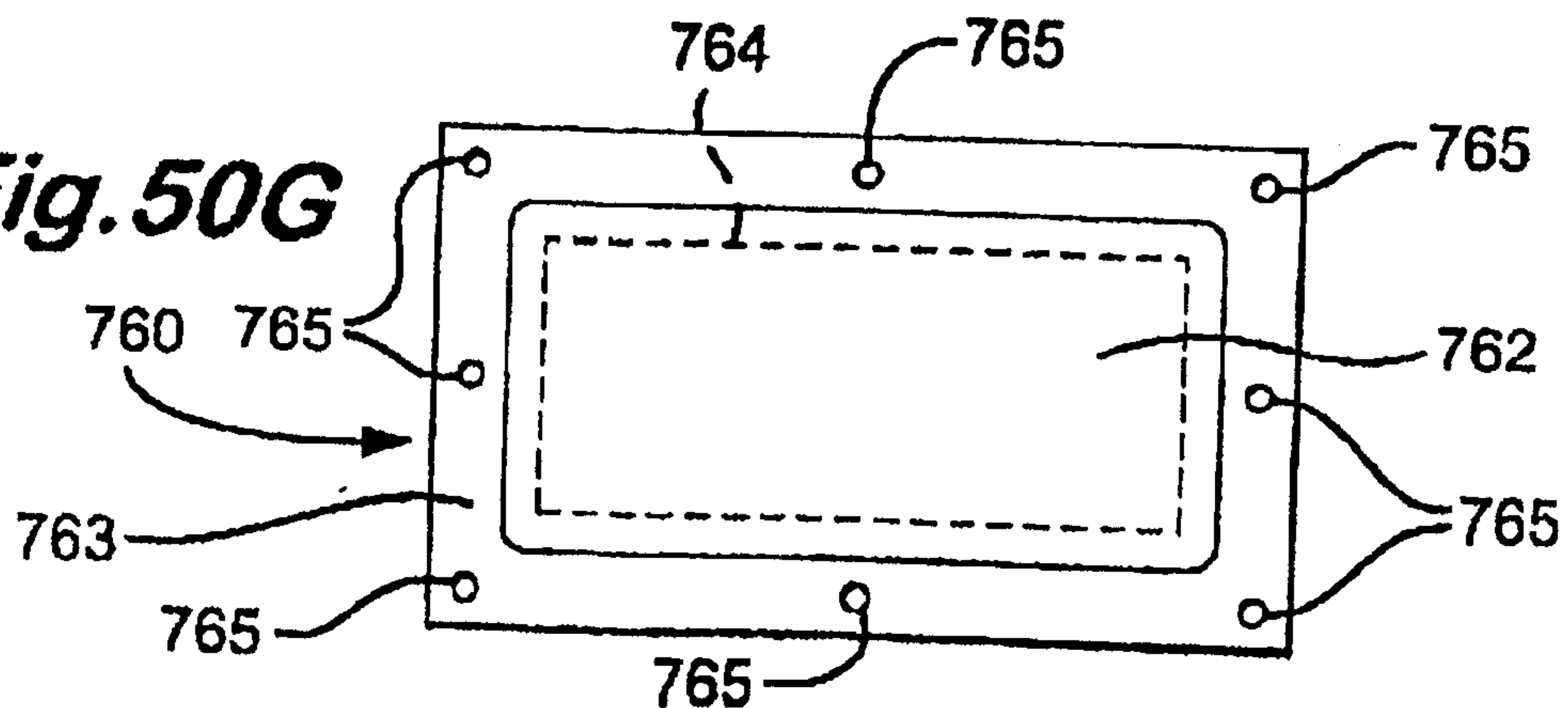








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Fig. 50B**Fig. 50C****Fig. 50D****Fig. 50E****Fig. 50F****Fig. 50G****Fig. 51**