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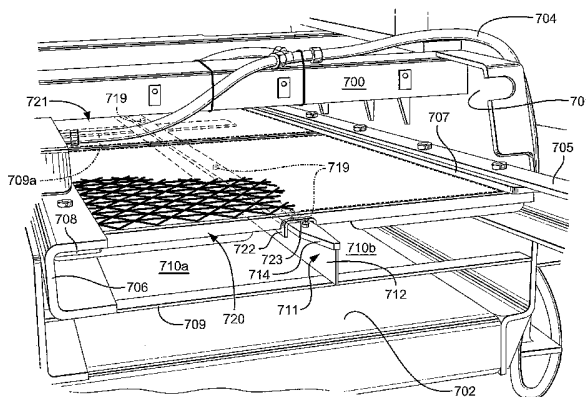
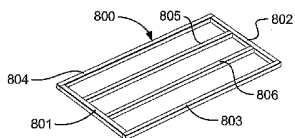
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(54) Title: A SCREENING APPARATUS AND METHOD FOR MOUNTING A SCREEN ASSEMBLY IN A VIBRATORY SEPARATOR



(57) Abstract: A method for mounting a screen assembly to a screen mounting structure of a vibratory separator to effectively seal the screen assembly in place, the method in certain aspects including locating the screen assembly on a screen mounting structure of the separator, positioning the screen assembly so that crossmembers of a four-sided generally rectangular support of the screen assembly are either all parallel to or are all transverse to a direction of material flowing across the screen assembly, forcing two sides of the support of the screen assembly down with a crowning apparatus to effect crowning of the screen assembly, the support sufficiently flexible so that two sides thereof other than the two forced-down sides sealingly contact a surface of the screen mounting structure along substantially all of their length.



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A SCREENING APPARATUS AND METHOD FOR MOUNTING A SCREEN
ASSEMBLY IN A VIBRATORY SEPARATOR

The present invention relates to a screening apparatus comprising a vibratory separator and a screen
5 assembly. The present invention also relates to a method

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
10 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 other solids to the surface through an annulus formed between the drill string and the borehole. The drilling mud contains expensive
15 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 is achieved by processing the drilling fluid. The first part of the process is to separate the solids from
20 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.

Shale shakers generally comprise an open bottomed
25 basket having one open discharge end and a solid walled feed end. A number of rectangular screen assemblies 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 springs above a
30 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,
35 which causes the basket and the screen assemblies fixed

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thereto to shake. Solids laden mud is introduced at the feed end of the basket on to the screen assemblies. The shaking motion induces the solids to move along the screen assemblies towards the open discharge end.

5 Drilling mud passes through the screen assemblies. 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

10 The screen assemblies are generally of one of two types: hook-strip; and pre-tensioned.

The hook-strip type of screen assembly 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 known as a drawbar arranged along each side of a shale shaker. The shale shaker further comprises a crowned set of 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. A variant of this type of screen assembly comprises a supporting mesh and/or a thin sheet panel having apertures therein.

25 The pre-tensioned type of screen assembly 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 rectangular angle iron frame and adhered thereto. The screen assembly 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-35 1,578,948.

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A further example of a known rigid support is a rectangular box section steel tubular frame.

A further example of a known rigid support is disclosed in PCT Publication No. WO 01/76719, which
5 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 been assigned the Trade Mark "UNIBODY" by the applicants.

10 WO 2004/035234 and WO 2004/035236 disclose a third type of screen assembly, which comprises one or more layers of mesh on a semi-rigid support. The semi rigid support is not sufficiently rigid on its own for use in a standard vibratory separator, such as a VSM 100™ or VSM
15 300™ or Cobra™ shale shakers sold by the Brandt, a Varco Company, but requires additional support using one or two intermediate supports over which the semi-rigid support can be deflected to provide additional support, which do not impinge on screening area or affect the flow of
20 material over the screening surface of the screen assembly. The intermediate support can be arranged in a removable rigid tray or fixed to the shale shaker. The semi-rigid support is lighter than a rigid support for a standard pre-tensioned screen assembly, such as those
25 disclosed in WO 01/76719 and thus can be handled more easily and transportation costs reduced.

The layers of mesh in the screen assemblies wears out frequently and therefore needs to be easily replaceable. Shale shakers are generally in the order of
30 5ft wide and 10ft long. A screen of 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.

35 GB-A-2,176,425 discloses a vibratory separator

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having a basket and channels arranged on internal faces of the basket for receiving a screen assembly. The screen assembly comprises screening mesh laid over and fixed to a frame. The channels have an inflatable stocking therein
5 for clamping the frame of the screen assembly in the channels. The screen assembly also has a stiffening screen support along each of two intermediate parts of the screen assembly and the vibratory separator has a tributary of the stocking along each of two intermediate
10 parts of the vibratory separator, such that in use, the tributaries are inflated to engage the stiffening ribs.

It has been recognized that in some vibratory separators employing screening assemblies employing supports (or frames) made of relatively rigid material
15 (e.g., hollow tubular mild steel with a square crosssection and a side measuring about 3/4" with a wall thickness of about 1/8") that an effective seal between an edge or side of the support and part of a bed, basket or mounting structure of the vibratory separator is not
20 achieved. In some aspects, two spaced-apart sides of a screen assembly are secured in place by edge mounting structure, wedge structures, or inflated bladders which push down on or wedge in the two spaced-apart sides, as described above. With a relatively rigid screen support,
25 such mounting can result in insufficient flexing of the support so that ends of the support (not the sides contacted by the wedges or bladders) are not effectively sealed against the bed, etc., (or against a seal member on a bed, etc.) resulting in unsealed areas between the
30 bed and the support through which pieces of drilled cuttings or other solids (which would normally move over and off the top of the screen assembly) can move, i.e., move through the open unsealed area (rather than as intended off the top of the screen for collection) and

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fall into a sump or reservoir (which is intended ideally to receive only filtered drilling fluid) from which they can be recycled back down into the wellbore negatively affecting drilling efficiency. One specific vibratory separator in which this problem may be encountered depending on the screen assemblies used is disclosed in U.S. Patent 5,641,070 issued June 24, 1997, incorporated fully herein for all purposes.

It is important to achieve maximum screening area in a given space and to obviate the need for mechanisms for fixing screen assemblies to shakers which blind areas of the screening material and which will decrease the screen assembly's screening capacity. Frame members and other solid cross support members can block fluid flow and adversely affect screen performance. Many of the frames or supports for screen mesh used in screen assemblies are made of metal or other relatively heavy material. Handling of such heavy members can be difficult and fatiguing.

There is a need, recognized by the present inventors, for efficient and effective screen mounting methods, particularly for mounting relatively rigid screen assemblies with an effective seal between them and screen mounting structure.

There is a need, recognized by the present inventors, for 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 the present invention, there is provided a method for mounting a screen assembly to a screen mounting structure of a vibratory separator to facilitate sealing of an interface between the screen

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assembly and the screen mounting structure, the screen mounting structure including a plurality of support members extending from a first separator side of the vibratory separator to a second separator side thereof with material flowable between said sides in a first direction that is a direction generally parallel to said sides, the screen assembly having a support and screening material on the support for treating material introduced to the vibratory separator, the support including four interconnected sides including two pairs of sides, a first pair with a first side and a second side and a second pair with a third side and a fourth side, the first side spaced-apart from the second side by spaced-apart third and fourth sides, the first side and the second side generally parallel to the first separator side and the second separator side upon installation of the screen assembly in the vibratory separator, the support having generally screening material thereon, the support having a plurality of spaced-apart crossmembers extending between and connected to only one of the pairs of sides, each crossmember not in contact with and independent of all other crossmembers, the screen mounting structure including crowning apparatus for forcible abutment against the third side and the fourth side of the support to effect bending of the first side and the second side of the support and thereby effect crowning of the screen assembly within the vibratory separator, the method comprising locating the screen assembly on the screen mounting structure, positioning the screen assembly with respect to the screen mounting structure so that the crossmembers are all either generally transverse to or all generally parallel to the first direction, and forcing the first and second sides

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of the support down with the crowning apparatus to effect crowning of the screen assembly, the support rigid yet sufficiently flexible so that with the screen assembly in a crowned configuration the third side and the fourth side each along substantially all of the length thereof sealingly contact a surface of the screen mounting structure.

Preferably, the plurality of spaced-apart crossmembers is two crossmembers generally parallel to the third side and the fourth side. Advantageously, the plurality of spaced-apart crossmembers is five crossmembers generally parallel to the first direction. Preferably, the first side and the second side are each made of material less rigid than material of the third side and the fourth side. Advantageously, the first side has at least a portion thereof made of material less rigid than material of the third side and the fourth side. Preferably, the method further comprises connecting a seal member at a first location of an exterior of at least one of the first side or the second side to remedy ineffective sealing at said first location.

Preferably, the seal member has at least a portion thereof within a recess at the first location. Advantageously, the screen mounting structure has a body with at least one upwardly projecting member projecting upwardly from the body member, said at least one upwardly projecting member sized and configured so it is receivable in a corresponding hole in the support, the method further comprising positioning the screen assembly on the screen mounting structure so that the at least one upwardly projecting member is received in the corresponding hole of the support. Preferably, the at least one upwardly projecting member is a plurality of

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spaced-apart upwardly projecting members and wherein the at least one hole in the support is a plurality of spaced-apart holes, each for receiving a corresponding upwardly projecting member. Advantageously, the corresponding hole in the support is in a crossmember of the support.

Preferably, the vibratory separator is a shale shaker for separating components of drilling material introduced thereto, the drilling material including drilling fluid and drilled cuttings, the shale shaker having a basket, the screen mounting structure on the basket, the support having a plurality of spaced apart support holes therethrough, each hole of the plurality of spaced apart support holes for receiving part of a fastener used for releasably connecting the screen assembly to the screen mounting structure, the screen mounting structure having a plurality of spaced-apart deck holes corresponding to the plurality of spaced-apart support holes through the support, and fasteners connecting the screen assembly to the screen mounting structure, each fastener passing through the screening material, through a support hole, and into a deck hole, the method further comprising connecting the support to the screen mounting structure with the fasteners.

Advantageously, the fasteners are from the group consisting of threaded fasteners, screens, bolts, locking fasteners, finger expansion fasteners, air injection fasteners, and friction-fit fasteners. Preferably, the fasteners are adhesively secured in place.

Advantageously, the screening material comprises a plurality of layers of screen mesh. Preferably, the screen assembly has on the support a perforated plate. Advantageously, the sides of the support comprise hollow

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tubular members. Preferably, all of the crossmembers are generally transverse to the first direction, the material introduced to the vibratory separator containing solids not passable through the screening material, the solids
5 movable on a top of the screening assembly by the vibratory separator, the method further comprising moving the solids uniformly on the top of the screening assembly.

Advantageously, the material is drilling material
10 and the solids include drilled solids. Preferably, the solids are moved on the top of the screen assembly without the formation of significant dead zones on the top of the screen assembly.

The invention also provides a screen assembly
15 suitable for carrying out the method. The invention also relates to a screen assembly comprising at least one layer of screening material and a screen support, said screen support comprising a frame comprising four members arranged in a rectangle and at least one cross member, at
20 least one of said member is less rigid than the remaining members.

* * *

A second aspect of the invention relates to a screening apparatus for separating solids from a solids
25 laden drilling fluid, said screening apparatus comprising a vibratory separator and a screen assembly, the vibratory separator comprising a bed, deck or tray having at least one upstanding member and the screen assembly comprising a screen support and at least one layer of
30 screening material characterised in that said screen support comprises channels therein for receiving said at least one.

Preferably, said channels in said screen assembly is

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C-shaped. i.e. in the shape of a C rotated ninety degrees clockwise, such that the mouth faces downwards. Preferably, the support includes two spaced-apart sides and the at least one C-shaped channel part extends along
5 the entire length of each of the two spaced-apart sides.

Advantageously, said vibratory separator comprises side rails into which said screen assembly can be fitted. Preferably, by sliding, advantageously, a C-shape channel.

10 Preferably, said side rails have inflatable bladders. Upon inflation, the screen assembly is preferably deflected over said upstanding member, although the deflection may be forced by the orientation and the position of acting of the inflatable bladders, see US-A-
15 4,582,597.

Preferably, said upstanding member is a pin. Advantageously, a plurality thereof, and most advantageously the upstanding members are located in said rail.

20 Preferably, said tray is removable from said vibratory separator. Advantageously, by sliding the tray from rails in the basket of the separator. An example of this is in the VSM 100 (RTM) shale shaker sold by the applicant.

25 The second aspect of the invention also provides a screen assembly of the screening apparatus of the invention.

The second aspect of the invention also provides a method to separate components of a fluid material with a
30 screen assembly on a vibratory separator apparatus, the vibratory separator apparatus comprising a screen assembly mounting structure, at least one screen assembly positioned on the mounting structure for introduction

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thereon of said fluid material, at least one vibrator connected to the mounting structure for vibrating the at least one screen assembly, the mounting structure comprising a body, said fluid material to be treated by the vibratory separator flowable through the body, at least one upwardly projecting member projecting upwardly from the body, said at least one upwardly projecting member sized and configured so it is receivable in a corresponding channel part in the at least one screen assembly, the method comprising introducing the fluid material onto the at least one screen assembly, the at least one screen assembly comprising a support, screening material on the support, at least one channel part in the support, said at least one channel part sized, configured, and located for receiving said at least one upwardly projecting member of the body of the mounting structure, and separating components of said fluid material with the at least one screen assembly.

The second aspect of the invention also provides a method for mounting a screen assembly to a vibratory separator apparatus, the vibratory separator apparatus comprising a screen assembly mounting structure, the screen assembly having a screen support, the mounting structure comprising a body, at least one upwardly projecting member projecting upwardly from the body, said at least one upwardly projecting member sized and configured so it is receivable in a corresponding at least one C-shaped channel part of the screen support, the method comprising positioning the at least one C-shaped channel part of the screen support over the at least one upwardly projecting member, and placing the at least one screen assembly on the mounting structure with at least part of the at least one upwardly projecting

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member positioned within the at least one C-shaped
channel part.

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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:

Figure 1 is a top view of a prior art support for
5 use in a screen assembly;

Figure 2A is a perspective view of a support for use in a screen assembly in accordance with the present invention;

Figure 2B is a side view and Figure 2C is an end
10 view of the support shown in Figure 2A;

Figures 3A to 8 are perspective views of supports for use in screen assemblies in accordance with the present invention;

Figures 9A and 9B are cross-sectional views of
15 hollow tubular members for supports for use in screen assemblies in accordance with the present invention;

Figures 10A and 10B are side views of part of a tubular member of a support for use in a screen assembly in accordance with the present invention; Figure 10C is a
20 cross-sectional view along line 10C-10C of Figure 10B;

Figure 11 is a perspective view of a support for use in a screen assembly in accordance with the present invention;

Figure 12A is a top perspective view of a support
25 for use in a screen assembly in accordance with the present invention, Figure 12B is a bottom view, Figure 12C is a side view, Figure 12D is a side view (side opposite the side shown in Figure 12C), Figure 12E is an end view, and Figure 12F is an end view (end opposite the
30 end shown in Figure 12E) of the support of Figure 12A;

Figure 13 is a side schematic cross-sectional view of a shale shaker with screen assemblies in accordance with the present invention;

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Figure 14A is a top perspective view of a support for use in a screen assembly in accordance with the present invention;

Figure 14B is a bottom view, Figure 14C is a side view, Figure 14D is a side view (side opposite the side shown in Figure 14C), Figure 14E is an end view, and Figure 14F is an end view (end opposite the end shown in Figure 14E) of the support of Figure 14A;

Figure 15 is a top view of a support for use in a screen assembly in accordance with the present invention (bottom view is the same).

Figure 16A is a top view, partially cutaway, of a screen assembly in accordance with a second aspect of the present invention;

Figure 16B is a side view of the screen assembly of Figure 16A;

Figure 17A is a top view, partially cutaway, of a screen assembly in accordance with a second aspect of the present invention;

Figure 17B is a cross-section view along line 17B-17B of Figure 17A;

Figure 17C is a side view of the screen assembly of Figure 17A;

Figure 18 is a perspective view of part of a screening apparatus in accordance with the present invention comprising a vibratory separator and a screen assembly; and

Figure 19 is a perspective view of a further screening apparatus in accordance with the present invention comprising a vibratory separator and a screen assembly.

Figure 1 shows a prior art screen assembly. However, by removing crossmembers shown in Figure 1 that extend in

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one of two general directions between one or the other pair of two spaced-apart sides thereof, so that the remaining longitudinal members are all positioned so that they lie generally in the direction of material flow on the screen assembly when it is in use on a vibratory separator or are all transverse to such flow direction; i.e., longitudinal members are present in certain of the methods in accordance with the present invention in only one direction, not both; and, in certain aspects, there are two, three, four, five, six or more of such longitudinal members which, in one aspect, are equally spaced-apart across the screen assembly and from the sides thereof. An example of such a support is shown in Figure 2A; and it is to be understood that the structure shown in these figures may be modified so that there are any desired number of longitudinal members and, in one particular aspect, two or five such longitudinal members equally spaced-apart across the support. The support SA is provided with at least one layer of screening material adhered or otherwise attached to the support or to a perforate plate which is then adhered or otherwise attached to the support.

Figures 2A to 2C show a support 800 for a screen assembly in accordance with the present invention (which maybe, but is not limited to, any screen assembly disclosed or referred to herein and which may have on it any screening material referred to or disclosed herein). The support 800 has two spaced-apart sides 801, 802 and two spaced-apart sides 803, 804 (sides 801 and 802 identical; sides 803 and 804 identical). Extending from the ends 801 to the side 802 are two longitudinal members 805, 806. There are no crossmembers extending between the sides 803, 804. In one particular aspect all

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of the sides and crossmembers of the screen assembly are made from pieces of hollow mild steel with a square cross-section, a wall thickness of about 3.2mm (one-eighth inch) with a side about 19mm (three-quarters of an inch) long. In another aspect these pieces are solid (as may be the case with any support disclosed herein). The pieces are, in certain aspects, connected together by any known method, including but not limited to with fasteners, adhesives, and/or welding (e.g., "mig," "tig," or resistance welding) (as may be the case with any support and/or member disclosed herein). In one particular aspect the screen assembly 800 is made of plastic, polymer and/or composite with or without strengthening metal rods and/or fibers therein (as may be the case with any support disclosed herein).

Figures 3A and 3B show alternative designs 800a and 800b of the support 800 of Figure 2A. In the support 800a like numerals indicate like parts; but instead of the longitudinal members 805, 806, there is one longitudinal member 807 and it is closer to the side 804 than to the side 803 so that, in one aspect, in use the support when in a screen assembly may be positioned so that the side 803 is at a material exit end of a vibratory separator or at a material exit side of this particular screen assembly, while in another aspect this positioning is reversed and the side 804 is at the material exit end or side.

The support 800b, Figure 3B, has no longitudinal members 805, 806, but has two longitudinal members 809, 810 each closer to a respective side 804, 803 than to a centre of the screen assembly. Figure 3C shows a screen assembly 816 (like the screen assembly 800 and like numerals indicate like parts) without longitudinal

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members 805, 806; but with a single longitudinal member 817 which may, in accordance with the present invention, be located equidistant between the sides 803, 804.

5 The support 840, Figure 3D, is like the support 800 (like numerals indicate like parts), but the longitudinal members 805 and 806 are deleted and a crossmember 819 extends from the end 801 to the end 802 diagonally. It is also within the scope of the present invention for one end of the longitudinal member 819 to be connected to the
10 side 803 or to the side 804, or for one end to be connected to the side 803 and one end connected to the side 804. It is also within the scope of the present invention to have two spaced-apart crossmembers 819 at the angle shown to the sides 101, 102 or at any desired
15 angle, or they may crisscross across the support.

Figures 4A and 4B illustrate supports 811 and 815 which have ends 801 and 802 and sides 803 and 804 like the support 800, Figure 2A; but which have crossmembers 812, 813 between the sides 801, 802 (the crossmember 812,
20 813 like and connected to sides as the crossmembers 805, 806 except in length). The screen assembly 811 also has at least one longitudinal member 814 extending between and connected to the crossmembers 812, 813. It is within the scope of this invention for the crossmember 814 to be
25 located as is any of the longitudinal members 805, 806, 807, 809, or 810 with respect to the sides 803, 804.

Figure 5 shows a support 820 with ends 801 and 802 and sides 803 and 804 (like in the screen assembly 800, Figure 53); but with no crossmembers between either pair
30 of sides. Instead, diagonal members 821 to 824 extend between and are each connected to an adjacent end and side (connected as any sides and crossmember are connected as disclosed herein). In accordance with the

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present invention diagonal members 823, 824 or 821, 822 may be deleted; diagonal members 823, 821 or 824, 822 may be deleted; and the diagonal members may be any desired length. In certain aspects with respect to a screen assembly side (e.g. 803 or 804) which is to seal against screen mounting structure, the side having an entire length and a middle point, an end of the diagonal member (e.g. 823 or 824) is not within 10% of the length close to the middle point or, put another way, the end of the diagonal member is within 40% of the side to which its other end is connected; for example, in a screen assembly with such a side (e.g. 803 or 804) that is 50" long, the diagonal member's end touching the 50" long side is 10" or more away from the middle of the 50" long side. In one particular aspect a diagonal member (e.g. the diagonal member 824) is connected between the side 803 and the diagonal member 822 and/or the diagonal member 823 is connected between the diagonal member 821 and the side 803. Similarly, either or both diagonal members 821, 822 can be connected between a side and another diagonal member.

Figures 6A and 6B show, respectively, supports 840 and 841 in accordance with the present invention which have ends 801, 802 and a side 804 as in the screen assembly 800, Figure 83; but which have, instead of the side 803, a side 803a (Figure 6A) or a side 803b (Figure 6B). The side 803a is made of less rigid material than the side 803 and, in one aspect, of material less rigid than the other sides. In one particular aspect in which the ends 801, 802, and side 804 are made of mild steel as described above, the side 803a is made of mild steel, aluminum, fiberglass, plastic, polymer and/or composite with the same dimensions and shape but less rigid than

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the other sides, or, in one aspect, with the same outer measurements, but with a wall thickness sufficient to increase the side 803a's flexibility, and in particular aspect with a wall thickness of about 2.5mm (one-tenth of
5 an inch) or less, and, in one aspect it may be made of aluminum with a wall thickness of about 2mm (0.080 inches). The side 803b has a portion 803c which is like the side 803a (in any of its possibilities) but which is only a portion of the side 803c, with end portions 803d
10 like the side 803 (Figure 53) or like the ends 801 - 802 in material, shape, and cross-section.

A side 803a or 803b may be used in any screen assembly support in accordance with the present invention; or it may be used in any known prior art
15 screen assembly; and, in one aspect one or two such sides may be used with a screen assembly as shown in Figure 1 or any known screen assembly with one or more longitudinal members to be positioned so that they are generally aligned parallel with or generally transverse
20 to a general direction of material flow when the screen assembly is in use on a vibratory separator or shale shaker or at least spanning the majority of the length of the support between ends of the support.

A screen assembly 830 in accordance with the present invention shown in Figure 7 is like the screen assemblies of Figures 3A, and 5 (like numerals indicate like parts); but the screen assembly 830 has two diagonal members 831, 832 that each have one end connected to the side 803 and one end connected to a longitudinal member 809a (like the
25 longitudinal member 809, Figure 54A). Alternatively the longitudinal member 809a is deleted and the diagonal members 831, 832 are connected to the ends 801 (diagonal member 831) and 802 (diagonal member 832); or the
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crossmember 809a is deleted and the diagonal members are connected between the side 803 and the side 804 with the diagonal members not parallel to the sides 801, 802 (one such embodiment, screen assembly 830a, shown in Figure 5 59).

It is within the scope of the present invention for the diagonal members to be at any angle to the sides 103, 104 (however, in certain aspects they are not parallel to the sides 101, 102).

10 Any of the supports in accordance with the present invention disclosed in Figures 2 - 8 may have any plate and/or backing cloth or coarse mesh connected thereto and any screening material disclosed or referred to herein, with the screening material on the plate, cloth, or mesh 15 if one is present or, otherwise, directly on the support. Any support in Figures 3A - 11 may have one or more holes for receiving fasteners in accordance with the present invention as described above; and/or one or more holes for receiving a member projecting upwardly from the 20 screen mounting structure as described above.

Figure 9A shows in crosssection one embodiment for a hollow tubular member 850 which may be used for any side, end or crossmember of any embodiment described above. As shown in Figure 9B, as desired a seal member 851 of any 25 desired length may be releasably or permanently affixed to a lower part 852 of the seal member 850, e.g., with a push-on friction fit and/or with adhesive or glue. Such a seal member may be any desired thickness and may be used in discovered areas of actual ineffective sealing or 30 applied to areas of anticipated ineffective sealing. In certain aspects a seal member like the seal member 850 may be provided in standard length and then cut to a desired length at a job site.

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Figures 10A - 10C show another embodiment of a hollow tubular member 855, like the tubular member 850, but with a recessed portion 856 for receiving part of a seal member 857 (like the seal member 851). One or more
5 recessed portions 856 may be provided on any side or crossmember of any support described herein at anticipated locations of ineffective sealing or at discovered locations of ineffective sealing.

Figure 11 shows a support 860 for use in a screen
10 assembly in accordance with the present invention which is similar to the support 800, Figure 12A, but without the longitudinal members 805, 806 and with five spaced-apart crossmembers 861 (like the crossmembers 812, 813, Figure 4A). End and side views of the support 860 are
15 like those views of the support 800 (see Figures 2B and 2C).

Figures 12A - 12F show a support for use in a screen assembly in accordance with the present invention like the support 800, Figure 2A. The ends and sides of the
20 screen assembly shown in Figure 11 are like those views of the screen assembly of Figure 11 - ends (Figures 12E, 12F) and the sides (Figures 12C, 12D).

Figure 13 shows a Brandt King Cobra shale shaker 870 (commercially available from Brandt, a Varco Company)
25 with screen assemblies 871, 872, and 873 in accordance with the present invention (which may be any screen assembly with any support in accordance with the present invention with longitudinal members located so that they are generally transverse to a direction of flow of
30 material indicated by the arrows in Figure 13, including, but not limited to the supports of Figures 2A and 12A). As shown by the arrows in Figure 64, it is desirable that drilled solids 874, debris, etc. in drilling material 875

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introduced to the shale shaker 870 for processing move on the tops of the screen assemblies 871, 872, 873 and that drilling fluid 877 filtered from the material 875 flow down into a sump 876. It is also desirable that as the solids, etc. move on top of the screens that, as viewed from above, the solids are uniformly and evenly distributed across the width of the screen assemblies. With a screen assembly with a prior art support as shown in Figure 1 with crossmembers transverse to the length of the screen (crossmembers that in use would be generally parallel to the direction of material flow on the tops of the screen assemblies in Figure 13), "dead zones" develop on top of the screen assemblies above the transverse crossmembers and solids do not move in these dead zones or do not move as readily in these dead zones, creating a relatively larger mass of solids that moves along areas of the tops of the screen assemblies not above these crossmembers resulting in a non-uniform flow of solids on the tops of the screens. Such undesirable masses of solids may not have as much fluid removed from them if the dead zones were not present. By removing these crossmembers and using a support, e.g. as in Figures 2A and 2A, the occurrence and/or size of these dead zones is reduced and greater processing efficiency is achieved. The relatively large masses of material moving on the top of a screen assembly with the prior art support can increase wear of the screen mesh and contribute to a shorter useful screen assembly life. If a screen assembly with the prior art support has these undesirable relatively large masses of solids moving on top of it, and the screen assembly is ineffectively sealed to the shaker's basket, deck, or bed for supporting screen assemblies, the problem with solids moving through an

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unsealed area into the sump is exacerbated.

Figures 14A to 14F show a support 880 for use in a screen assembly in accordance with the present invention for a screen assembly in accordance with the present invention (which may have on it any screening material, plate, and/or cloth or mesh referred to or disclosed herein). The support 880 has two spaced-apart ends 881, 882 and two spaced-apart sides 883, 884 (like the ends 801 and 802 and the sides 803, 804). Extending from the ends 881 to the end 882 are two spaced-apart longitudinal members 885, 886 (like the longitudinal members 805, 806, Figure 3A). There are two transverse crossmembers 887, 888 extending between the two crossmembers 885, 886. In one particular aspect all of the ends, sides, longitudinal members and crossmembers of the support for use in a screen assembly are made from pieces of hollow mild steel with a square cross-section, a wall thickness of about one-eighth inch with a side about three-quarters of an inch long. In another aspect these pieces are solid. The pieces are, in certain aspects, connected together by any known method, including but not limited to with fasteners, adhesives, and/or welding. In one particular aspect the screen assembly 880 is made of plastic, polymer and/or composite with or without strengthening metal rods and/or fibers therein.

Figure 15 shows an alternative design 880a of the screen assembly 880 of Figure 14A (and like numerals indicate like parts). In the screen assembly 880a instead of the crossmembers 885, 886, there are three spaced-apart crossmembers 889 which are spaced equally apart and equally from the sides 881, 882. It is within the scope of this invention to use any desired number (e.g., one, two, three, four, five, or more) of

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crossmembers 888 spaced as desired (e.g., but not limited to, equally as shown or with any desire spacing from the sides or between each other).

It has been discovered that elimination of all of the vertical (as viewed in Figure 1) crossmembers from the prior art support depicted there, except those shown in Figure 14A or those shown in Figure 2A, e.g., renders the support sufficiently flexible to enhance the sealing of the sides 883, 884 against a seal and/or part of a screen member mounting structure bed, or deck of a vibratory separator or shale shaker.

* * *

Figures 16A and 16B show a screen assembly 900 in accordance with the present invention which has a support 902 supporting a layer of coarse mesh 909 and at least one and preferably two layers of fine mesh 901 lying over the coarse mesh 901. The support frame 902 has sides 903, 904 and ends 905, 906. A plurality of optional cross members 907 and 908 extend between the sides of the frame 902. Fluid may flow transverse to either pair of sides depending on the screen assembly's orientation in a vibratory separator or shale shaker.

The sides 903, 904 are made of channel members with a C-shaped opening. The C-shaped openings can receive and accommodate an upwardly projecting member or members, pin or pins, projecting upwardly from a deck or screen assembly support or channels of a vibratory separator or shale shaker. Also, it is within the scope of the present invention for the sides 905, 906 to be made of such C-shaped channel members. Preferably, the C-shaped channel opening in the screen assembly sides slides over the upwardly projecting members in the vibratory separator, or advantageously, side over the upwardly

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projecting members and fall over the upwardly projecting members when the screen assembly assumes the correct mounting position, whereupon the screen assembly falls over the upwardly projecting members. This ensures correct placement of the screen assembly, correct orientation and inhibits the screen assembly from moving out of correct positioning during use, thereby ensuring an excellent seal between the vibratory separator and adjacent screen assemblies.

10 Figures 17A to 17C disclose a screen assembly 920 in accordance with the present invention which has a frame 922 (like the frame 902, Figure 52A) with an optional support 929 (like the support 909, Figure 16A) supporting screening material 921 (like the screening material 902, 15 Figure 16A). A pair of frame sides 923, 924 is spaced-apart from a pair of frame sides 925, 926.

Frame sides 923, 924 have sections 923a, 924a, respectively which are C-shaped channel members (like the C-shaped channel members of the sides 903, 904 in cross-sectional shape) which can accommodate upwardly projecting member(s) and/or pin(s) as do the sides 803, 20 804 along their entire length.

It is within the scope of the present invention to have one, two, or more C-shaped channel sections 923a and/or 924a in a frame side or end and to locate such a C-shaped channel section or sections so that it (or they) can accommodate upwardly projecting member(s) and/or pin(s) of a deck or screen assembly mounting structure.

Figure 18 shows a screening apparatus in accordance with the present invention, showing a screen assembly 400 30 comprising a perforate plate 401 and a screen support 402. At least one layer of screening material (not shown) overlays the perforate plate 401. The screen support is

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of any of the type disclosed with reference to Figures 16 and 17. C-shape channels 405 in the screen assembly 400 allow the screen assembly to be slid into clamping rails 408, 408a arranged on each side of a basket 413 of a shale shaker 409, over upwardly projecting members, such as round or square section pins 404 spaced along the length of the clamping rails 408, 408a. The screen assembly 400 is slid into clamping rails 408, 408a. The clamping rails 408, 409 comprise a C-shape rails each having a bottom surface on which the support structure 402 of the screen assembly rests. Each of the C-shape rails also has a pneumatically inflatable bladder 414 fixed to an upper part 334 of the C-shape rail 330. Once the screen assembly 400 is slid into the clamping rails 408, 408a, the pneumatically inflatable bladder 414 is inflated which pushes down on left and right side portions 410 and (not shown) pushing and holding the panel 401 over the crowned ribs, rigidly fixing the panel 301. The folded left wing portion 411 and folded right wing portion (not shown), folded front end (not shown) and a folded rear end 412 fit about the support structure 406.

Figure 19 shows a screening apparatus comprising a shale shaker 700 and screen assemblies 720, 721. The shale shaker has a basket 701 with an open bottom 702. The screen assemblies 720, 721 are located within rails 705, 706. Inflatable bladders 707, 708 are arranged on an upper leaf of the rails 705, 706, such that when inflated they push down on the screen assemblies 720, 721. A central support 711 is mounted on a front support 709 and a similar rear support 709a beneath the screen assembly 721). Any suitable number of supports for the central support 711 may be used either at an angle to the

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central support of parallel with it and beneath it. Compressed air is supplied to the bladders 707, 708 via an air supply 704. The central support 711 has a base 712 and a top member 714. The top member 714 is
5 positioned within a channel member 722 of the screen assembly 720 and also within a similar channel member (not shown) of the screen assembly 721. Upstanding members, such as pins 719 are arranged on the central support 711. Upon sliding the screen assembly 720 into
10 the shale shaker 700, a recess channel 723 in fitting 722 is slid over upstanding members 719 to inter alia provide correct location and additional vertical contact area to transmit vibration from the shale shaker to the screen assembly. Upon inflation of the inflatable bladders
15 707,708, the screen assembly is deflected over the upstanding members 719, or in a different embodiment in which the upstanding members 719 are shorter than the depth of the recess channel, then deflected over the top member 714 of the central support 711.

20 In use, screened fluid flows through the screen assemblies 720, 721, through openings 710a, 710b, and then through the open bottom 702 into a typical receptacle or container.

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CLAIMS

1. A method for mounting a screen assembly to a screen mounting structure of a vibratory separator to facilitate sealing of an interface between the screen assembly and the screen mounting structure, the screen mounting structure including a plurality of support members extending from a first separator side of the vibratory separator to a second separator side thereof with material flowable between said sides in a first direction that is a direction generally parallel to said sides, the screen assembly having a support and screening material on the support for treating material introduced to the vibratory separator, the support including four interconnected sides including two pairs of sides, a first pair with a first side and a second side and a second pair with a third side and a fourth side, the first side spaced-apart from the second side by spaced-apart third and fourth sides, the first side and the second side generally parallel to the first separator side and the second separator side upon installation of the screen assembly in the vibratory separator, the support having generally screening material thereon, the support having a plurality of spaced-apart crossmembers extending between and connected to only one of the pairs of sides, each crossmember not in contact with and independent of all other crossmembers, the screen mounting structure including crowning apparatus for forcible abutment against the third side and the fourth side of the support to effect bending of the first side and the second side of the support and thereby effect crowning of the screen assembly within the vibratory separator, the method comprising locating the screen assembly on the screen mounting structure, positioning

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the screen assembly with respect to the screen mounting structure so that the crossmembers are all either generally transverse to or all generally parallel to the first direction, and forcing the first and second sides of the support down with the crowning apparatus to effect crowning of the screen assembly, the support rigid yet sufficiently flexible so that with the screen assembly in a crowned configuration the third side and the fourth side each along substantially all of the length thereof sealingly contact a surface of the screen mounting structure.

2. A method in accordance with Claim 1, wherein the plurality of spaced-apart crossmembers is two crossmembers generally parallel to the third side and the fourth side.

3. A method in accordance with Claim 1, wherein the plurality of spaced-apart crossmembers is five crossmembers generally parallel to the first direction.

4. A method in accordance with any of Claims 1 to 3, wherein the first side and the second side are each made of material less rigid than material of the third side and the fourth side.

5. A method in accordance with any of Claims 1 to 4, wherein the first side has at least a portion thereof made of material less rigid than material of the third side and the fourth side.

6. A method in accordance with any of Claims 1 to 5, further comprising connecting a seal member at a first location of an exterior of at least one of the first side or the second side to remedy ineffective sealing at said first location.

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7. A method in accordance with Claim 6, wherein the seal member has at least a portion thereof within a recess at the first location.
8. A method in accordance with any of Claims 1 to 7,
5 wherein the screen mounting structure has a body with at least one upwardly projecting member projecting upwardly from the body member, said at least one upwardly projecting member sized and configured so it is receivable in a corresponding hole in the support, the
10 method further comprising positioning the screen assembly on the screen mounting structure so that the at least one upwardly projecting member is received in the corresponding hole of the support.
9. A method in accordance with any of Claims 1 to 8,
15 wherein the at least one upwardly projecting member is a plurality of spaced-apart upwardly projecting members and wherein the at least one hole in the support is a plurality of spaced-apart holes, each for receiving a corresponding upwardly projecting member.
- 20 10. A method in accordance with any of Claims 1 to 9, wherein the corresponding hole in the support is in a crossmember of the support.
11. A method in accordance with any of Claims 1 to 10,
25 wherein the vibratory separator is a shale shaker for separating components of drilling material introduced thereto, the drilling material including drilling fluid and drilled cuttings, the shale shaker having a basket, the screen mounting structure on the basket, the support having a plurality of spaced apart support holes
30 therethrough, each hole of the plurality of spaced apart support holes for receiving part of a fastener used for releasably connecting the screen assembly to the screen mounting structure, the screen mounting structure having

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a plurality of spaced-apart deck holes corresponding to the plurality of spaced-apart support holes through the support, and fasteners connecting the screen assembly to the screen mounting structure, each fastener passing
5 through the screening material, through a support hole, and into a deck hole, the method further comprising connecting the support to the screen mounting structure with the fasteners.

12. A method in accordance with Claim 11, wherein the
10 fasteners are from the group consisting of threaded fasteners, screens, bolts, locking fasteners, finger expansion fasteners, air injection fasteners, and friction-fit fasteners.

13. A method in accordance with Claim 11 or 12, wherein
15 the fasteners are adhesively secured in place.

14. A method in accordance with any of Claims 1 to 13, wherein the screening material comprises a plurality of layers of screen mesh.

15. A method in accordance with any of Claims 1 to 14,
20 wherein the screen assembly has on the support a perforated plate.

16. A method in accordance with any of Claims 1 to 15, wherein the sides of the support comprise hollow tubular members.

25 17. A method in accordance with any of Claims 1 to 16, wherein all of the crossmembers are generally transverse to the first direction, the material introduced to the vibratory separator containing solids not passable through the screening material, the solids movable on a
30 top of the screening assembly by the vibratory separator, the method further comprising moving the solids uniformly on the top of the screening assembly.

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18. A method in accordance with any of Claims 1 to 17, wherein the material is drilling material and the solids include drilled solids.
- 5 19. A method in accordance with any of Claims 1 to 18 wherein the solids are moved on the top of the screen assembly without the formation of significant dead zones on the top of the screen assembly.
- 10 20. A screen assembly comprising at least one layer of screening material and a screen support, said screen support comprising a frame comprising four members arranged in a rectangle and at least one cross member, at least one of said member is less rigid than the remaining members.
- 15 * * *
21. A screening apparatus for separating solids from a solids laden drilling fluid, said screening apparatus comprising a vibratory separator and a screen assembly, the vibratory separator comprising a bed, deck or tray
- 20 having at least one upstanding member and the screen assembly comprising a screen support and at least one layer of screening material characterised in that said screen support comprises channels therein for receiving said at least one.
- 25 22. A screening apparatus as claimed in Claim 22, wherein said channels in said screen assembly is C-shaped.
23. A screening apparatus as claimed in Claim 21 or 22, wherein said vibratory separator comprises side rails
- 30 into which said screen assembly can be fitted.
24. A screening apparatus as claimed in Claim 21, 22 or 23, wherein said side rails have inflatable bladders
25. A screening apparatus as claimed in any of Claims 21

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to 24, wherein said upstanding member is a pin.

26. A screening apparatus as claimed in any of Claims 21 to 25, wherein said tray is removable from said vibratory separator.

5 27. A screen assembly of the screening apparatus as claimed in any of claims 21 to 26.

28. A method to separate components of a fluid material with a screen assembly on a vibratory separator apparatus, the vibratory separator apparatus comprising a
10 screen assembly mounting structure, at least one screen assembly positioned on the mounting structure for introduction thereon of said fluid material, at least one vibrator connected to the mounting structure for vibrating the at least one screen assembly, the mounting
15 structure comprising a body, said fluid material to be treated by the vibratory separator flowable through the body, at least one upwardly projecting member projecting upwardly from the body, said at least one upwardly projecting member sized and configured so it is
20 receivable in a corresponding channel part in the at least one screen assembly, the method comprising introducing the fluid material onto the at least one screen assembly, the at least one screen assembly comprising a support, screening material on the support,
25 at least one channel part in the support, said at least one channel part sized, configured, and located for receiving said at least one upwardly projecting member of the body of the mounting structure, and separating components of said fluid material with the at least one
30 screen assembly.

29. A method for mounting a screen assembly to a vibratory separator apparatus, the vibratory separator apparatus comprising a screen assembly mounting

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structure, the screen assembly having a screen support,
the mounting structure comprising a body, at least one
upwardly projecting member projecting upwardly from the
body, said at least one upwardly projecting member sized
5 and configured so it is receivable in a corresponding at
least one C-shaped channel part of the screen support,
the method comprising positioning the at least one C-
shaped channel part of the screen support over the at
least one upwardly projecting member, and placing the at
10 least one screen assembly on the mounting structure with
at least part of the at least one upwardly projecting
member positioned within the at least one C-shaped
channel part.

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Fig.1
Prior Art

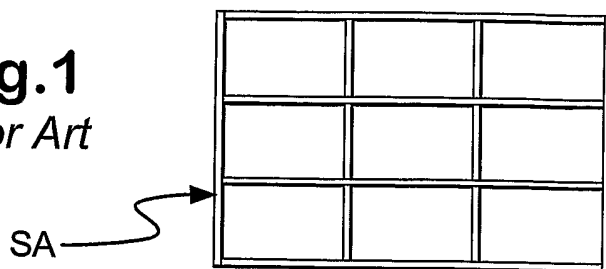


Fig.2A

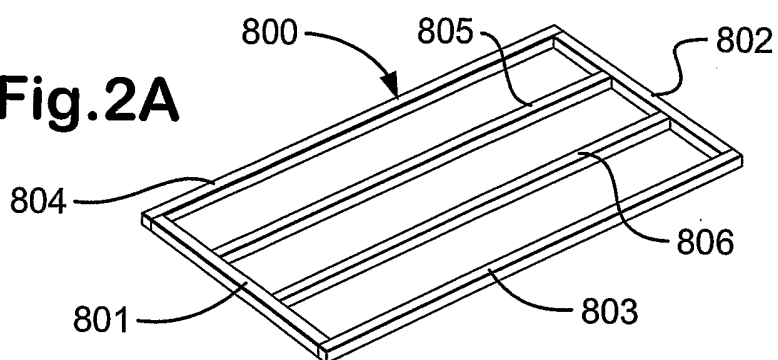


Fig.2B

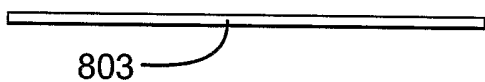


Fig.2C

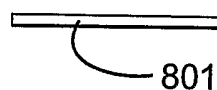


Fig.3A

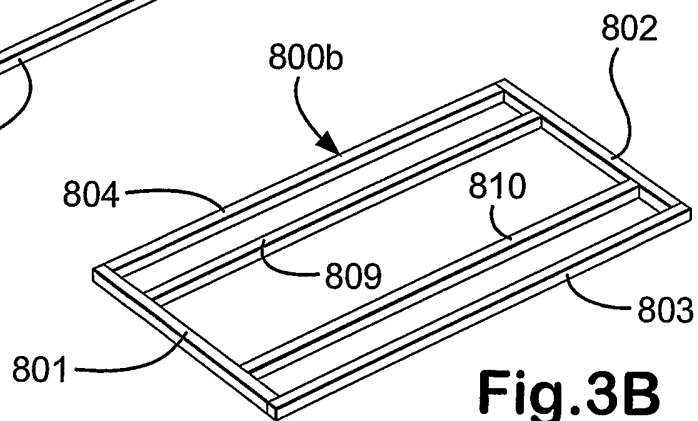
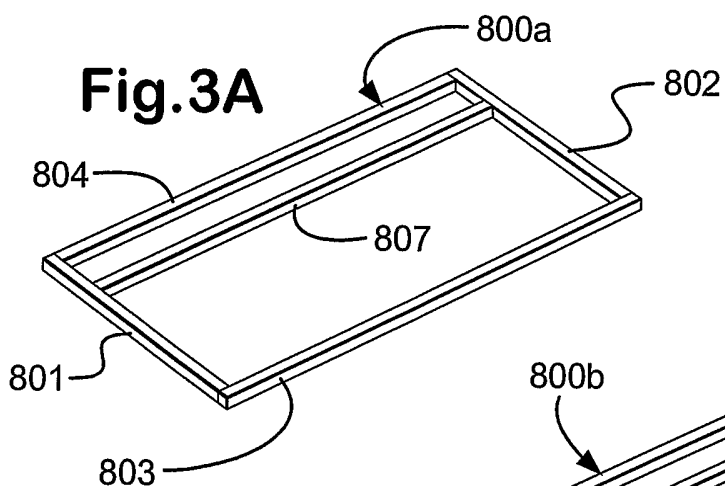


Fig.3B

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Fig.3C

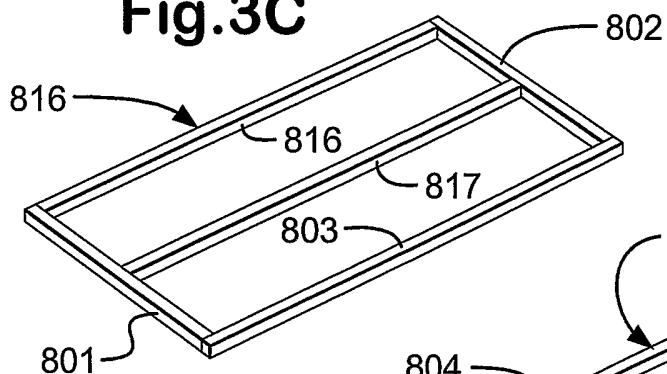


Fig.3D

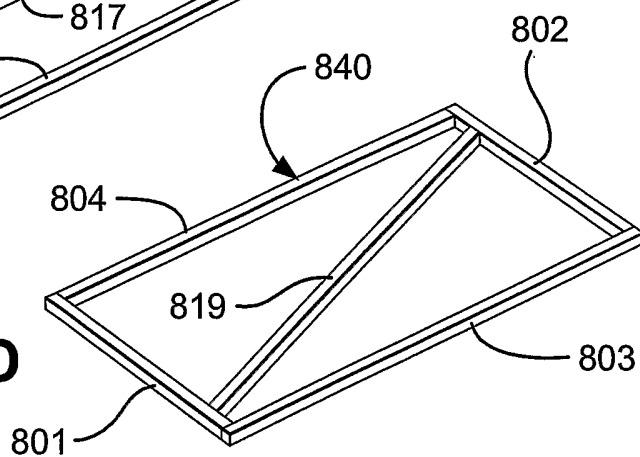


Fig.4A

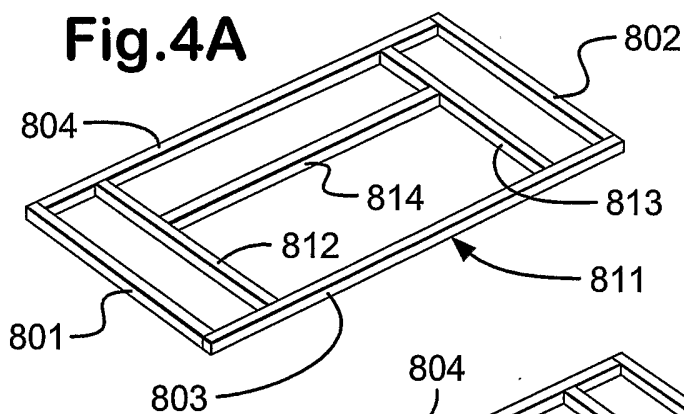


Fig.4B

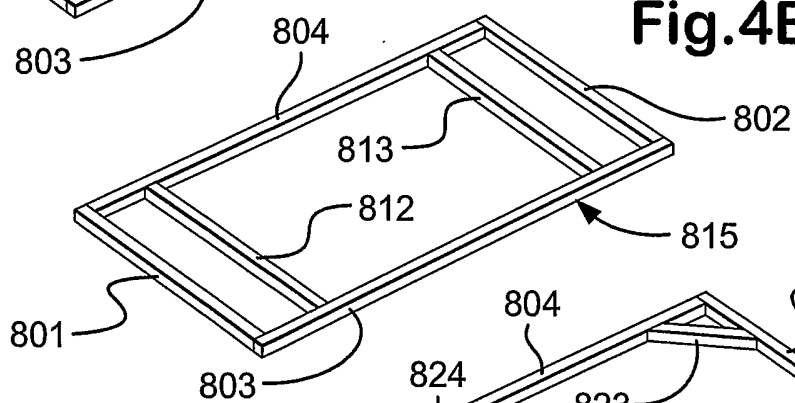
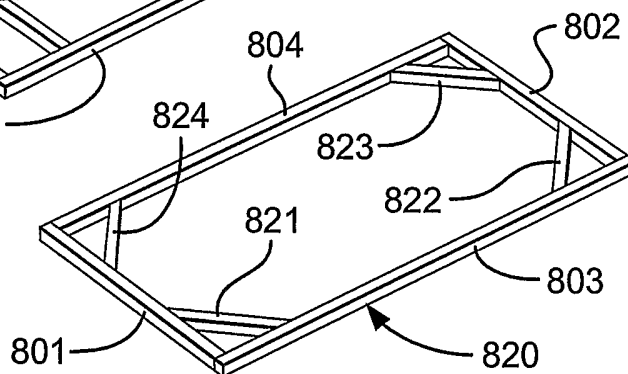


Fig.5



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Fig.6A

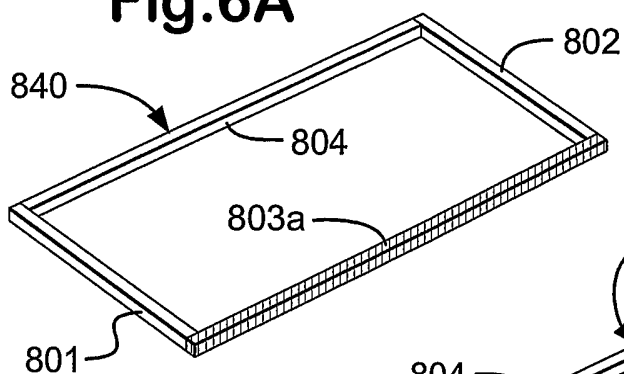


Fig.6B

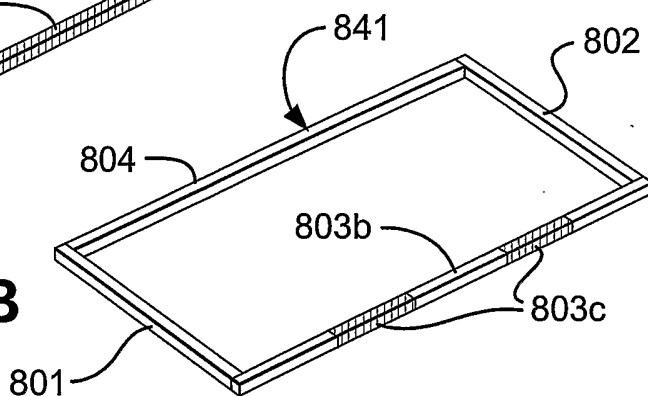


Fig.7

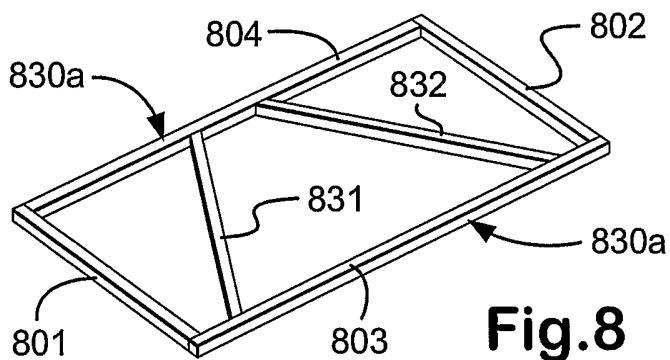
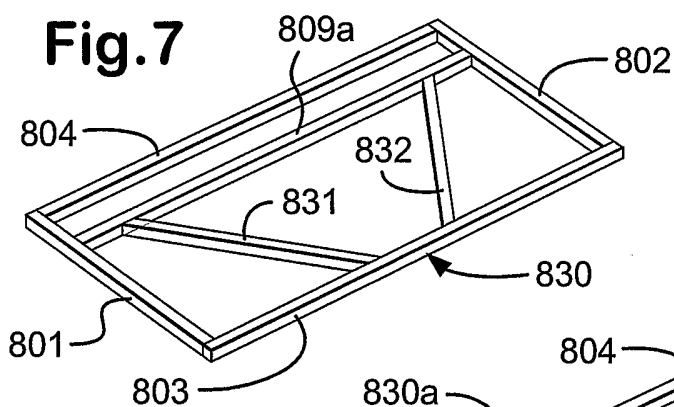


Fig.8

Fig.9A

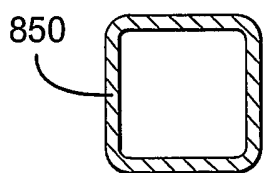


Fig.9B

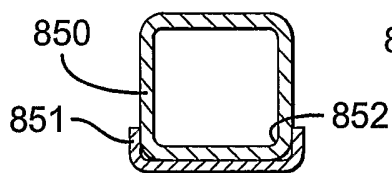
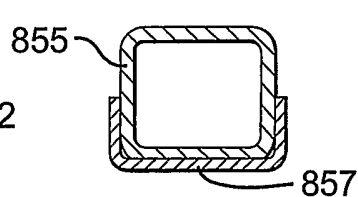
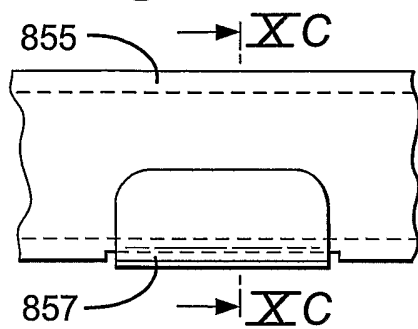
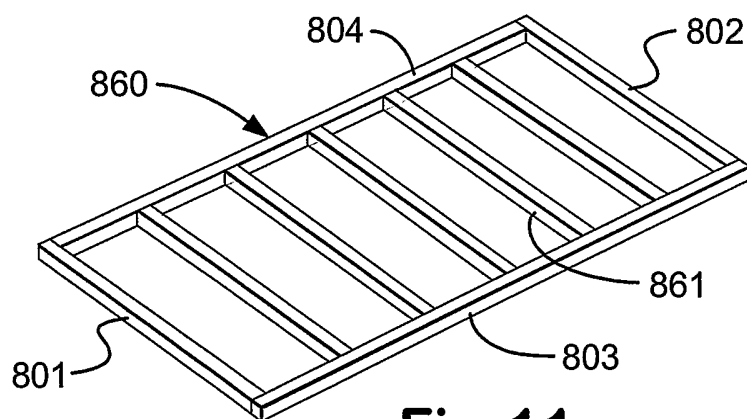
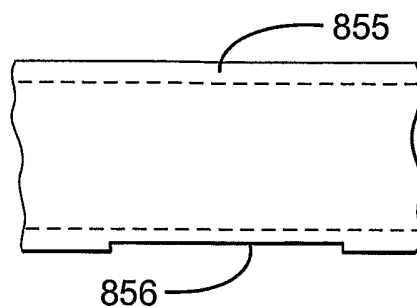
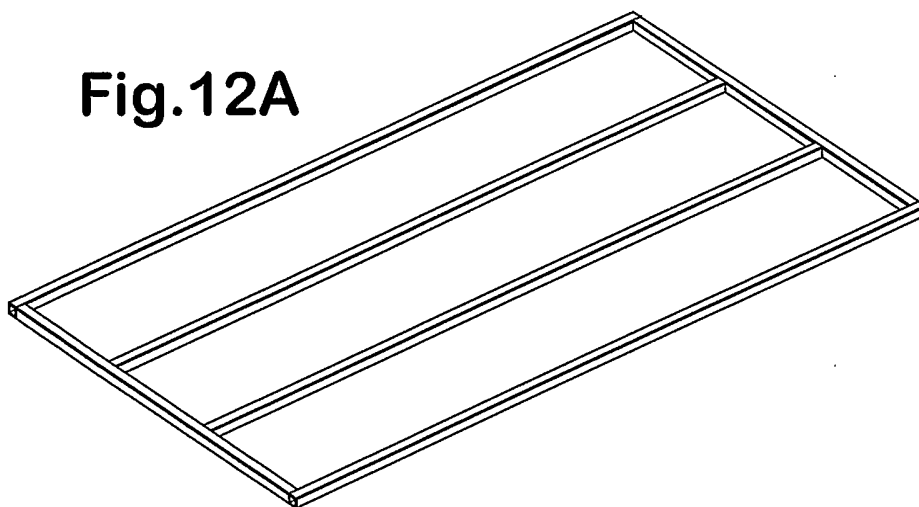


Fig.10C



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Fig.10A**Fig.10B****Fig.11****Fig.12A**

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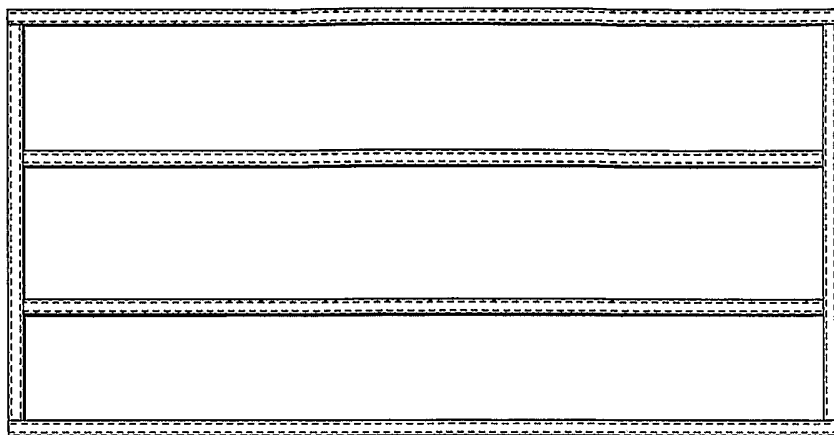


Fig.12B

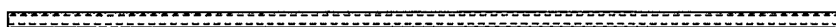


Fig.12C



Fig.12D



Fig.12E



Fig.12F

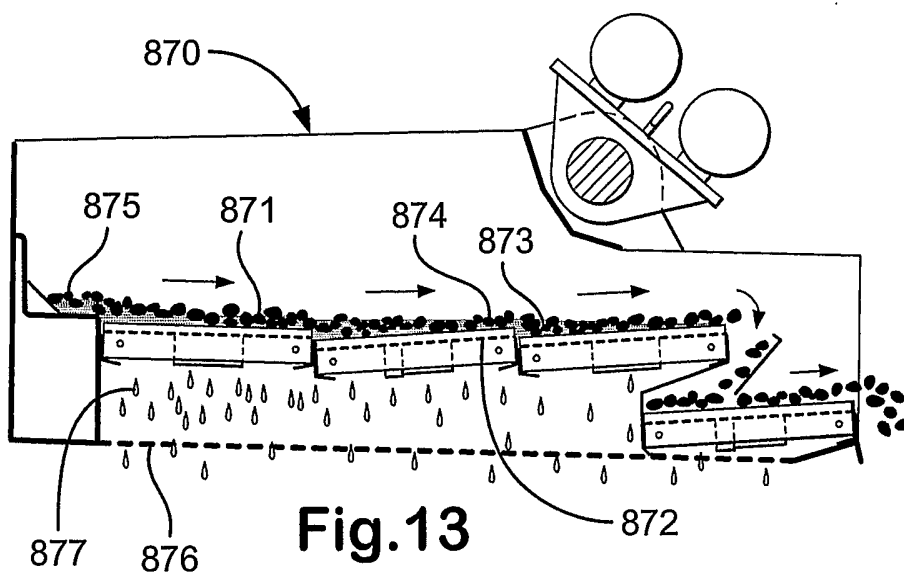
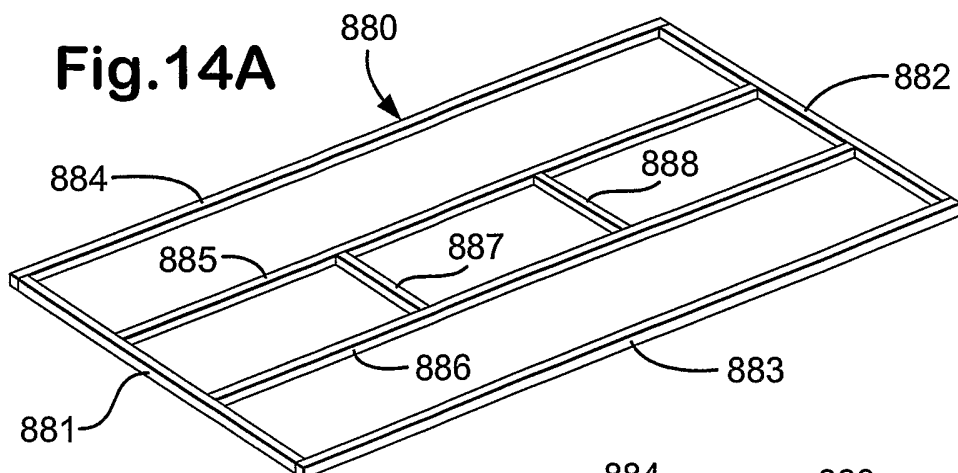
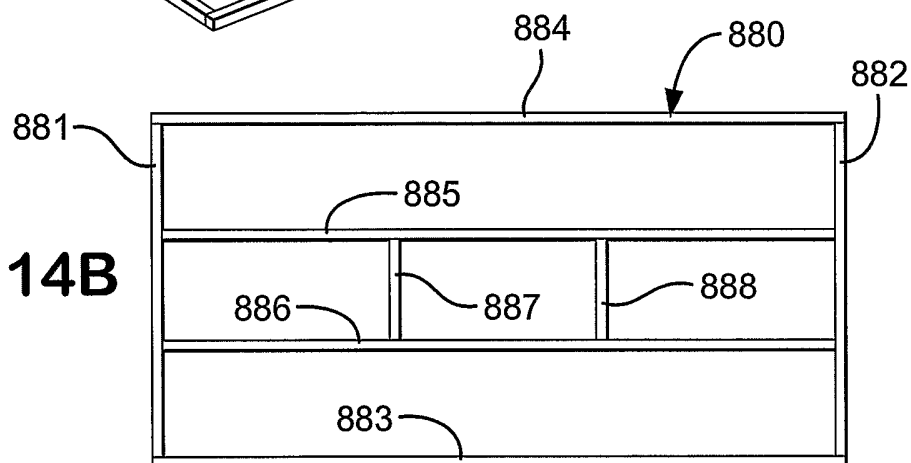
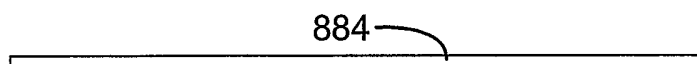
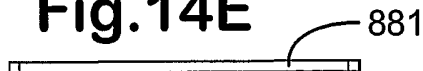
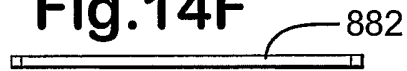
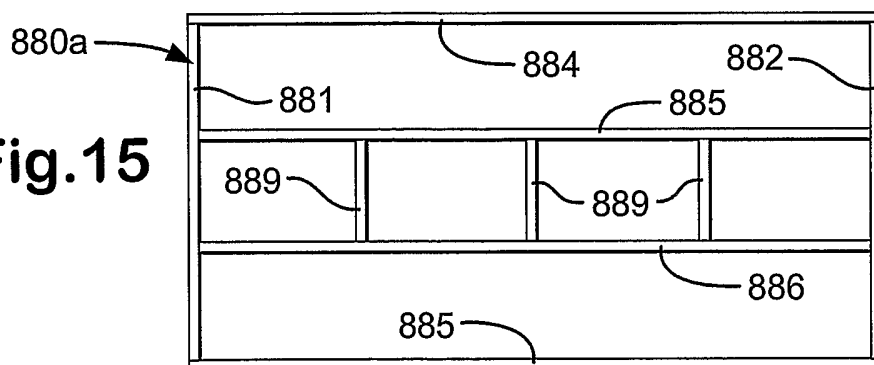
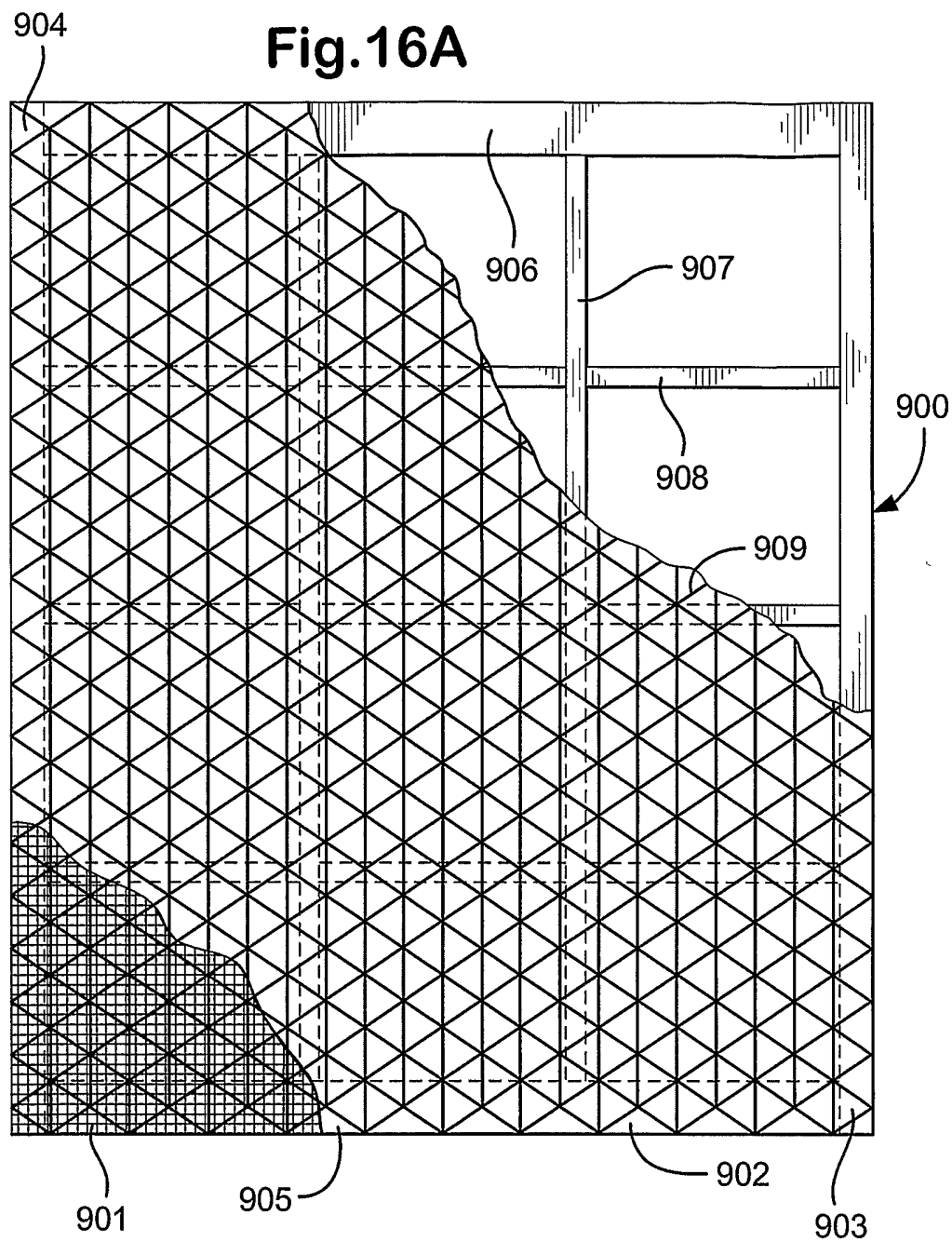
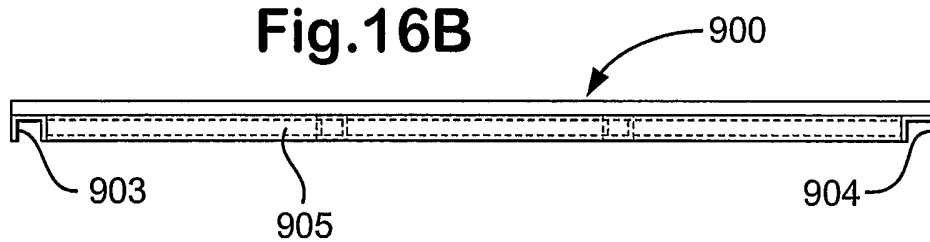


Fig.13

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Fig.14A**Fig.14B****Fig.14C****Fig.14D****Fig.14E****Fig.14F****Fig.15**

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Fig.16A**Fig.16B**

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Fig.17A

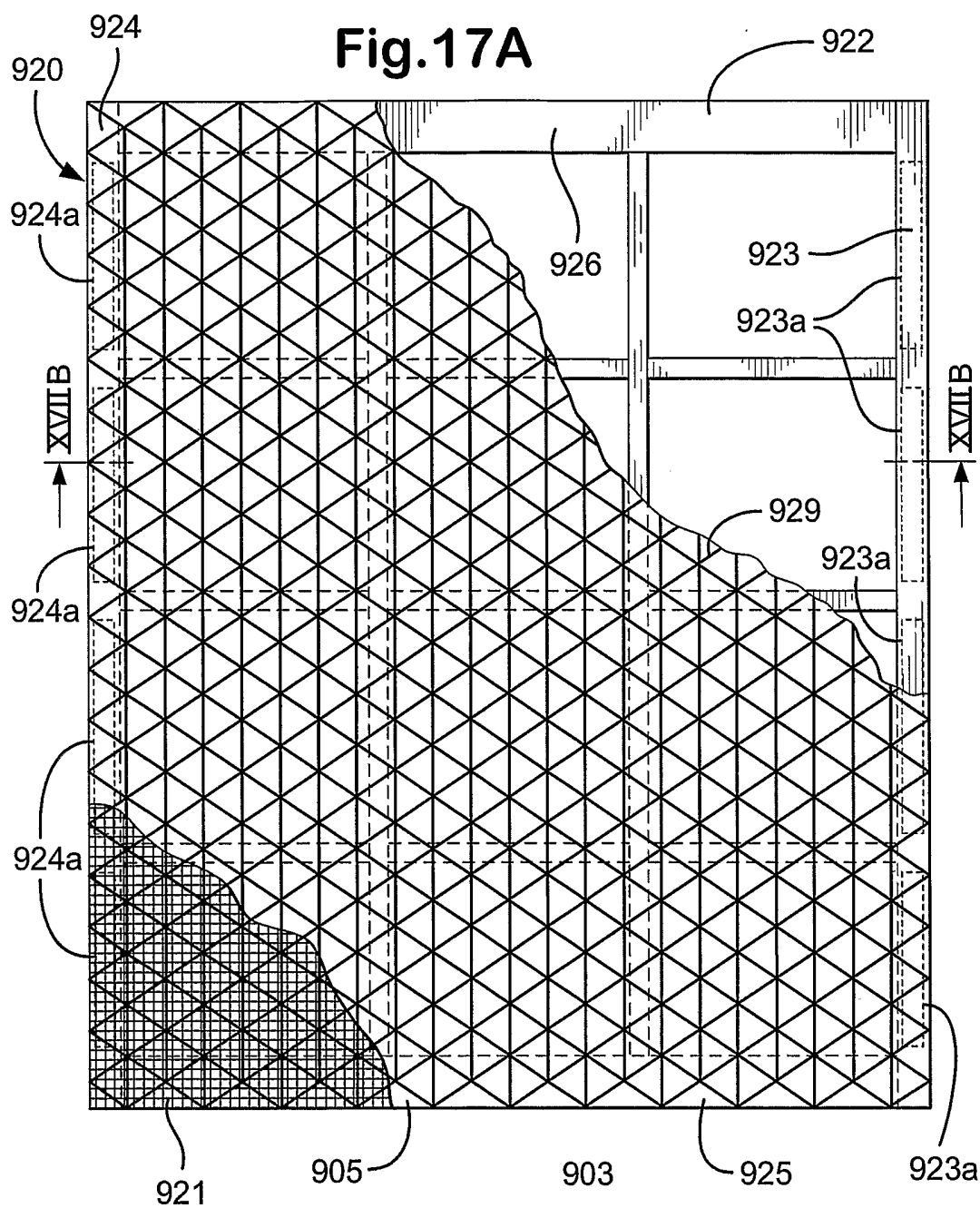


Fig.17B

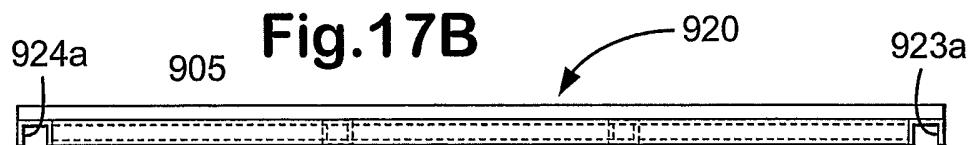
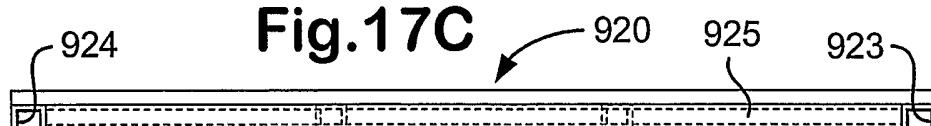


Fig.17C



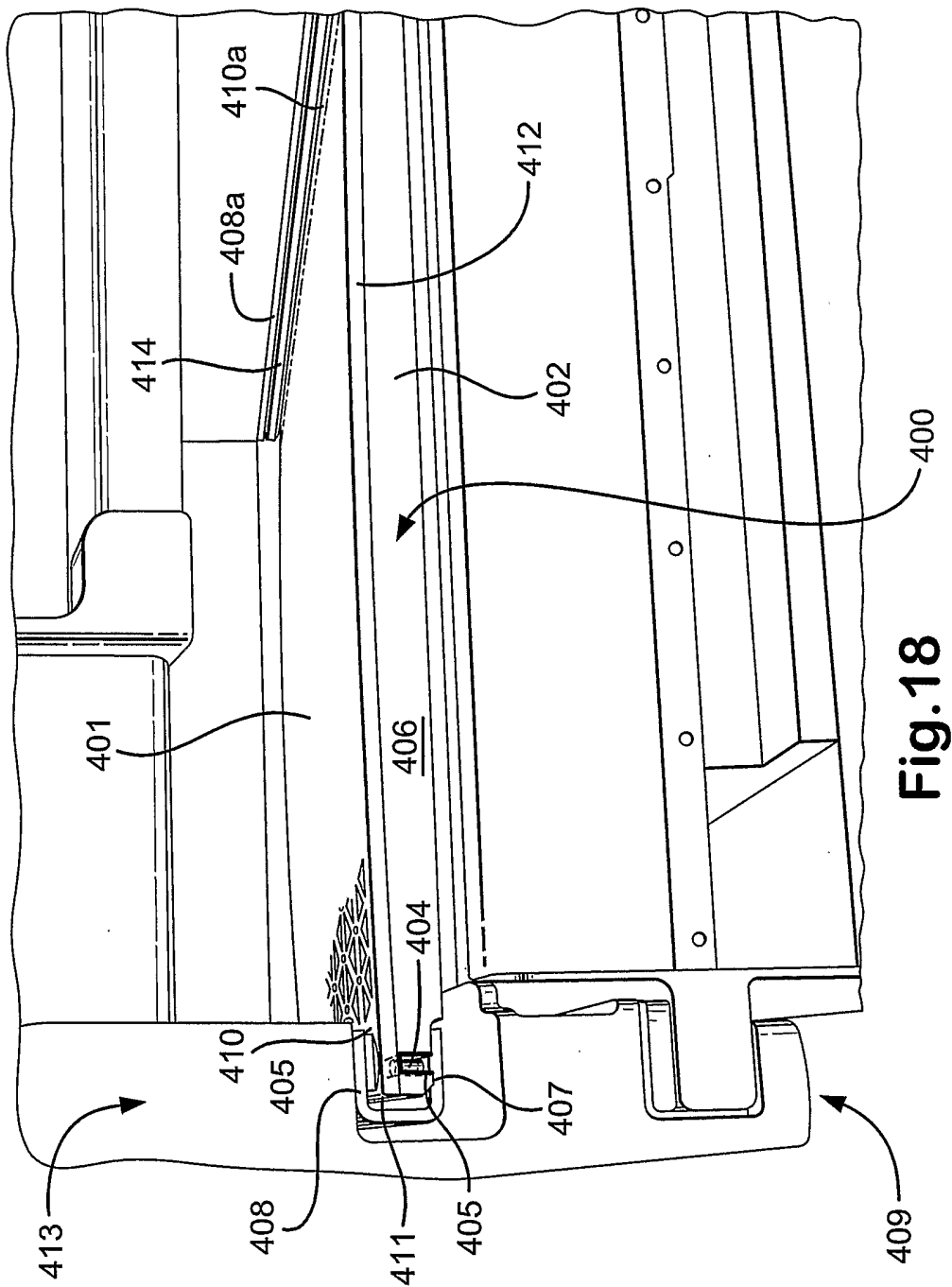


Fig.18

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