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(71) Applicant: SOLIDSVAC PTY LTD [AU/AU]; Unit 1, 5 Boeing Place, Caboolture, Queensland 4510 (AU).

(72) Inventor: KROHN, Mark; Unit 1, 5 Boeing Place, Caboolture, Queensland 4510 (AU).

(74) Agent: IP FLOURISH; 8/82 Berwick Street, Fortitude Valley, Brisbane, Queensland 4006 (AU).

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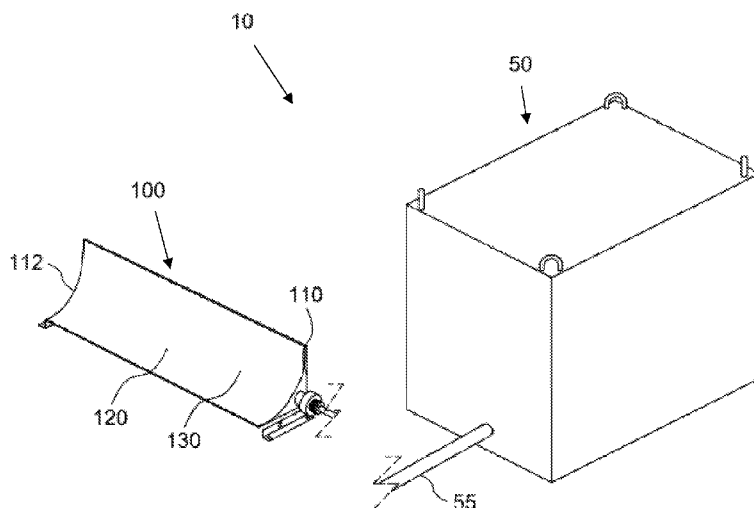


FIG. 1

(57) Abstract: A portable vacuum screen device is provided, the device comprising: a screen face comprising a screen; and a vacuum passage adjacent the screen, wherein the device is adjustable to orient the screen face in response to a rate or volume of material applied to the screen face. Related systems and method are also provided.

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**TITLE**  
**VACUUM SCREEN UNIT**  
**FIELD**

[0001] This invention relates to processing of material containing particulate and flowable components. More particularly, this invention relates to (although is not limited to) a vacuum screen device for processing of drill cuttings and drilling mud.

[0002] This invention has particular application to additional processing of drill cuttings coated with oil-based mud (OBM) after OBM processing using a shaker system or the like. However, it will be understood that the invention could be used for other applications, such as involving separation of suitable particulates from suitable flowable substances more generally.

**BACKGROUND**

[0003] Drilling fluid, also referred to as drilling mud, is used for production of boreholes in a variety of contexts. In oil and gas industry, both water-based mud (WBM) and oil-based mud (OBM) are commonly used for borehole drilling.

[0004] A primary function of drilling mud is removal of cuttings from a borehole as drilling occurs, which produces relatively large amounts of waste containing a combination of drilling mud and drill cuttings. Particularly in the case of drilling with OBM, unprocessed drilling mud and drill cuttings waste (drilling waste) is a potent environmental pollutant.

[0005] Processing of drilling waste can allow for safer disposal and/or recycling of drilling mud and drill cuttings. Typically, drilling waste is processed using a shaker screen arrangement or the like, wherein the drilling mud and drill cuttings combination is passed over one or more vibrating, shaking, and/or rotating screens. Shaker screen processing allows for drilling mud and smaller drill cuttings particles to be separated from larger drill cuttings particles.

[0006] Existing drilling waste processing arrangements are associated with at least certain difficulties or challenges. One primary challenge is minimising residual drilling mud contamination of recovered drill cuttings.

[0007] With the preceding in mind, it would be desirable to develop new approaches to assist with processing of drilling waste. It would be particularly desirable, in at least some instances, to develop new approaches to supplement

existing processing of drilling waste, such as existing processing approaches using shaker screens, to achieve enhanced separation of drill cuttings and drilling mud.

[0008] The reference to prior art in the background is not and should not be taken as an acknowledgement or suggestion that the referenced prior art forms part of the common general knowledge in Australia or in any other country.

### **SUMMARY**

[0009] A first aspect of the invention provides a vacuum screen device comprising: a screen; and a vacuum passage adjacent the screen. Suitably, the vacuum screen device of the first aspect is a portable vacuum screen device.

[0010] Suitably, the vacuum screen device of the first aspect is adapted for separation of particles from a flowable substance. In embodiments, the vacuum screen device is adapted for separation of drill cuttings from drilling mud.

[0011] The screen of the vacuum screen device may be a substantially continuous screen. Alternatively, the screen of the vacuum screen device may comprise a plurality of screen sections or screen portions.

[0012] Suitably, the screen of the device of the first aspect, or the plurality of screen sections or portions thereof, comprises an inner screen surface; and an outer screen surface. Suitably, the vacuum passage of the device is adjacent the inner screen surface of the screen.

[0013] Suitably, the screen of the device of the first aspect is of a screen face of the device. In embodiments, the screen face of the device comprises an inner screen face surface; and an outer screen face surface. The screen face of the device may comprise one or more border portions adjacent the screen, or the plurality of screen sections or portions thereof.

[0014] In embodiments, the screen of the device, or the one or more screen sections or portions thereof, is of a substantially central portion of the screen face of the device.

[0015] Suitably, the screen face of the device comprises one or more screen face edges. The screen and/or the border portions of the screen face may be adjacent one or more of the screen face edges.

[0016] In embodiments, the one or more screen face edges of the screen face comprise an entry screen face edge, for entry of material onto the screen face; and an exit screen face edge, for exit of material off the screen face.

[0017] In embodiments, the screen face comprises a first or front screen face edge; and a second or rear screen face edge. In embodiments, the rear screen face edge is the entry screen face edge; and the front screen face edge is the exit screen face screen edge.

[0018] In embodiments, the screen face comprises side screen face edges extending between the front screen face edge and the rear screen face edge. The screen face may comprise a first or left side screen face edge; and a second or right side screen face edge.

[0019] In embodiments, the screen face of the device of the first aspect is substantially ramped, or comprises one or more substantially ramped screen face sections or portions.

[0020] In embodiments, the screen face of the device is substantially curved, or comprises one or more substantially curved screen face sections or portions.

[0021] In embodiments, the screen of the device, or one or more of the screen sections or screen portions thereof, is substantially ramped. In embodiments, the screen of the device, or one or more of the screen sections or screen portions thereof, is substantially curved.

[0022] In embodiments, one or more of the border portions of the screen face of the device are substantially ramped. In embodiments, one or more of the border portions of the screen face of the device are substantially curved.

[0023] In embodiments, the screen face of the device is ramped from, or from near or towards, one of the screen face edges, to, or to near or towards, another of the screen face edges.

[0024] In embodiments, the screen face of the device is ramped from, or from near or towards, the entry screen face edge, to, or to near or towards, the exit screen face edge.

[0025] In embodiments, the screen face of the device is ramped from, or from near or towards, one of the side screen face edges, to, or to near or towards, another of the side screen face edges.

[0026] In embodiments, the screen face of the device is curved from, or from near or towards, one of the screen face edges, to, or to near or towards, another of the screen face edges.

[0027] In embodiments, the screen face of the device is curved from, or from near or towards, the entry screen face edge, to, or to near or towards, the exit screen face edge.

[0028] In embodiments, the screen face of the device is curved from, or from near or towards, one of the side screen face edges, to, or to near or towards, another of the side screen face edges.

[0029] The screen of the screen face of the device of the first aspect may be an elongated screen.

[0030] The screen face of the device of the first aspect may be an elongated screen face.

[0031] In embodiments, the screen and the screen face of the device of the first aspect are elongated in substantially the same direction or orientation.

[0032] In embodiments, the screen and the screen face of the device are elongated in different directions or orientations. The screen may be elongated in a substantially perpendicular direction or orientation, relative to the screen face.

[0033] A peripheral shape of the screen face of the device may be substantially trapezoidal. In embodiments, the peripheral shape of the screen face of the device is an elongated trapezoidal shape.

[0034] In embodiments, the peripheral shape of the screen face is substantially rectangular. In embodiments, the peripheral shape of the screen face is substantially of an elongated trapezium.

[0035] The vacuum passage of the device of the device of the first aspect may extend substantially along the inner screen surface of the screen of device, or of the plurality of screen sections or portions thereof.

[0036] In embodiments, the vacuum passage of the device extends from, or from near or towards, one edge of the screen face to, or to near or towards, another edge of the screen face.

[0037] In embodiments, the vacuum passage of the device extends from, or from near or towards, one of the side screen face edges, to, or to near or towards, another of the side screen face edges.

[0038] In embodiments, the vacuum passage of the device extends from, or from near or towards, the entry screen face edge, to, or to near or towards, the exit screen face edge.

[0039] In embodiments, the vacuum passage of the device extends substantially centrally along the screen face of the device.

[0040] The vacuum passage of the device may extend along a central portion of the screen face of the device. Suitably, the central portion of the screen face comprises the screen of the device.

[0041] The central portion of the screen face may be bordered by a first portion of the screen face, and a second portion of the screen face. Suitably, the first and second portions of the screen face are border portions of the screen face.

[0042] In embodiments, the first and second border portions of the screen face are or comprise front and rear border portions.

[0043] In embodiments, the first and second border portions of the screen face are or comprise side border portions.

[0044] In embodiments, the vacuum passage of the device of the first aspect comprises a vacuum passage body. Suitably, the vacuum passage body is connected with the screen face. In embodiments, the vacuum passage body is connected with the inner screen face surface of the screen face.

[0045] The vacuum passage body of the vacuum passage may comprise one or more vacuum passage walls or vacuum passage plates.

[0046] In embodiments, the one or more vacuum passage walls or vacuum passage plates comprise a vacuum passage body floor or vacuum passage body base plate; and one or more vacuum passage body side walls.

[0047] In embodiments, the one or more vacuum passage side walls comprise first and second side walls. In embodiments, the one or more vacuum passage side walls comprise third and fourth side walls.

[0048] The first, second, third, and/or fourth vacuum passage side walls of the vacuum passage body may comprise front, rear, left, and/or right vacuum passage side walls.

[0049] Suitably, one or more, or all, of the side walls of the vacuum passage body extend from the floor or base plate of the vacuum passage body to the screen face of the device, or the inner surface thereof.

[0050] In embodiments, one or more, or all, of the side walls of the vacuum passage body extend from the floor of base plate of the vacuum passage body to the screen of the device, or the inner surface thereof.

[0051] In embodiments, one or more, or all, of the side walls of the vacuum passage body are slanted or flared walls. The one or more slanted or flared side walls may extend outwardly from the floor of the vacuum passage body to the screen face or screen of the device, or the inner surface thereof.

[0052] In embodiments, the vacuum passage of the device of the first aspect is a sloped vacuum passage body. Suitably, the sloped vacuum passage body comprises a sloped vacuum passage body floor or base plate.

[0053] In embodiments, the sloped floor of the sloped vacuum passage body slopes away from the screen face and/or screen between respective sides of the vacuum passage body.

[0054] Suitably, the sloped floor of the sloped vacuum passage body slopes towards one or more vacuum inlets of the device of the first aspect.

[0055] The vacuum passage body of the device of the first aspect may comprise one or more vacuum inlets. Suitably, the vacuum inlets facilitate the application of suction into the vacuum passage body via a vacuum source.

[0056] In embodiments, the vacuum inlets facilitate the passage of flowable substance therethrough via suction from the vacuum source.

[0057] Suitably, the vacuum inlets are or comprise apertures or channels, or the like.

[0058] In embodiments, the vacuum inlets comprise vacuum inlet screens, for screening flowable substance passing therethrough.

[0059] In embodiments, the vacuum inlets comprise one or more substantially round vacuum inlets.

[0060] In embodiments, the vacuum inlets comprise one or more substantially trapezoidal inlets.

[0061] In embodiments, the vacuum passage body comprises between 1 and 10 vacuum inlets, including 2, 3, 4, 5, 6, 7, 8, and 9 vacuum inlets.

[0062] In embodiments, the vacuum passage body comprises a plurality of vacuum inlets, including at least: 2, 3, 4, 5, 6, 7, 8, 9, 10 vacuum inlets.

[0063] Suitably, the one or more vacuum inlets are of or connected with the walls of the vacuum passage body.

[0064] In embodiments, one or more, or all, of the vacuum inlets are of the floor or base plate of the vacuum passage body.

[0065] In embodiments, one or more, or all, of the vacuum inlets are of the side walls of the vacuum passage body, such as the first, second, third, and/or fourth side walls of the vacuum passage body.

[0066] The device of the first aspect may comprise a screen vibrator, for vibrating the screen face of the device. In embodiments, the screen vibrator is a pneumatic vibrator.

[0067] Suitably, the screen vibrator is connected with the screen or screen face of the device, or the inner surface thereof. In embodiments, the screen vibrator is mounted or attached to the inner surface of the screen of the device.

[0068] In embodiments, the vacuum screen device of the first aspect is an adjustable vacuum screen device.

[0069] Suitably, the vacuum screen device is adjustable to adjust an orientation of the screen face of the device. In embodiments, the vacuum screen device is adjustable to tilt the screen face of the device.

[0070] The adjustable vacuum screen device may facilitate orientation of the screen face of the device in a relatively more rearward tilted, relatively less forward tilted, or relatively more upright orientation, in the absence of an applicable force against the screen face.

[0071] In embodiments, the adjustable vacuum screen device facilitates orientation of the screen face in a relatively more rearward tilted orientation in the absence of an applicable force against the screen face.

[0072] The adjustable vacuum screen device may facilitate orientation of the screen face of the device in a relatively more forward tilted, relatively less rearward tilted, or relatively less upright orientation, in the presence of an applicable force against the screen face.

[0073] In embodiments, the adjustable vacuum screen device facilitates orientation of the screen face in a relatively more forward tilted orientation in the presence of an applicable force against the screen face.

[0074] Suitably, adjustable embodiments of the vacuum screen device of the first aspect comprise, or are connectable with, an adjustment stand or cradle or the like. The adjustment stand or cradle of or connectable with the device of the first aspect may be or comprise an adjustment stand frame and/or one or more adjustment stand feet.

[0075] In embodiments, the adjustment stand of the vacuum screen device comprises a first foot; and a second foot. In embodiments, the first foot of the adjustment stand is at, or near or towards, one of the side screen face edges of the screen face of the device; and the second foot of the adjustment stand is at, or near or towards, another side screen face edge of the screen face of the device.

[0076] Suitably, the screen face of the device is movably connected with the adjustment stand. In embodiments, the screen face is rotatably connected with the adjustment stand. In embodiments, the screen face is pivotally connected with the adjustment stand.

[0077] In embodiments wherein the vacuum screen device is an adjustable vacuum screen device, the vacuum screen device may comprise one or more stops or checks for constraining movement of the screen face during adjustment.

[0078] Suitably, the adjustable vacuum screen device comprises one or more stops or checks for constraining movement of the screen face relative to the adjustment stand.

[0079] The adjustable vacuum screen device may comprise one or more first or front stops or checks for constraining rotation or pivoting of the screen face relative to the adjustment stand in a first or forwards direction.

[0080] The adjustment vacuum screen device may comprise one or more second or rear stops or checks for constraining rotation or pivoting of the screen face relative to the adjustment stand in a second or rearwards direction.

[0081] One or more of the stops or checks of the adjustable vacuum screen device may be configurable checks.

[0082] In embodiments, the adjustable vacuum screen device is configurable, such as using the one or more configurable stops or checks, to configure the degree or extent of rotation or pivoting of the screen face relative to the adjustment stand in a first direction, such as a forwards direction, prior to constraint by the one or more stops or checks.

[0083] In embodiments, the adjustable vacuum screen device is configurable, such as using the one or more configurable stops or checks, to configure the degree or extent of rotation or pivoting of the screen face relative to the adjustment stand in a second direction, such as a rearwards direction, prior to constraint by the one or more stops or checks.

[0084] In embodiments, the adjustable vacuum screen device is configurable, such as using the one or more configurable stops or checks, to configure an orientation of the screen face, such as a resting orientation of the screen face, in the absence of an applicable force against the screen face.

[0085] The adjustable vacuum screen device may be configurable, such as using the one or more configurable stops or checks, to configure a resting orientation of the screen face between one or more relatively more rearwards and/or relatively less upright orientations, and one or more relatively less rearwards and/or relatively more upright orientations.

[0086] In embodiments of the device of the first aspect wherein the device is an adjustable vacuum screen device, the device may comprise an adjustment mount.

[0087] In embodiments, the adjustment mount comprises an adjustment mount body; and a moveable adjustment mount connector, the adjustment mount connector for connection with the screen face of the device.

[0088] Suitably, the adjustment mount connector is for substantially stable or rigid connection with the screen face, wherein movement of the adjustment mount connector moves the screen face.

[0089] Suitably, the adjustment mount connector comprises an elongated member. In embodiments, the adjustment mount connector comprises a shaft, extending from the adjustment mount body.

[0090] Suitably, the adjustment mount connector is at least partly rotatable relative to the adjustment mount body, wherein rotation of the adjustment mount connector rotates the screen face. In embodiments, the adjustment mount connector is pivotable relative to the adjustment mount body, wherein pivoting of the adjustment mount connector pivots the screen face.

[0091] The adjustment mount may comprise a check body. Suitably, the check body of the adjustment mount forms at least part of the one or more stops or checks of the adjustable vacuum screen device, for constraining movement of the screen face relative to the adjustment stand.

[0092] Suitably, the check body of the adjustment mount is connected with the adjustment mount connector. In embodiments, the check body is stably or rigidly connected with the adjustment mount connector, wherein movement of the adjustment mount connector moves the check body.

[0093] In embodiments, the shaft of the adjustment mount connector is stably engaged substantially centrally with the check body, wherein rotation or pivoting of the shaft of the adjustment mount connector rotates or pivots the check body.

[0094] The adjustment mount may comprise one or more catches for engagement with the check body, to constrain movement of the check body.

[0095] In embodiments, the adjustment mount comprises a first catch for engagement with the check body to constrain rotation or pivoting of the check body in a first direction, such as a forwards direction.

[0096] In embodiments, the adjustment mount comprises a second catch for engagement with the check body to constrain rotation or pivoting of the check body in a second direction, such as a rearwards direction.

[0097] In embodiments, the first and/or second catches of the adjustment body are resiliently deformable catches, such as comprising a spring or the like. In embodiments, the first catch is a resiliently deformable catch, such as comprising a spring or the like.

[0098] In embodiments, the first and/or second catches of the adjustment body are configurable catches.

[0099] The first and/or second catches of the adjustment body may be configurable to configure the degree or extent of rotation or pivoting of the check body prior to constraint by the catches.

[0100] The first and/or second catches of the adjustment body may be configurable to configure an orientation of the screen face, such as a resting orientation of the screen face, in the absence of an applicable force against the screen face.

[0101] In embodiments, the first catch is configurable to configure a resting orientation of the screen face between one or more relatively more rearwards and/or relatively less upright orientations, and one or more relatively less rearwards and/or relatively more upright orientations.

[0102] In embodiments, the check body of the of the adjustment mount is substantially within the adjustment mount body.

[0103] In embodiments, the one or more catches of the adjustment mount for engagement with the check body are substantially within the adjustment mount body.

[0104] In embodiments wherein the adjustment mount comprises one or more configurable catches, the one or more configurable catches may comprise, or be connected with, a catch actuator. The catch actuator may extend from the adjustment mount body.

[0105] In embodiments, the adjustment mount comprises a first catch that is a configurable catch, the first catch comprising a catch actuator, the catch actuator extending from the adjustment mount body.

[0106] In embodiments, the catch actuator of the first catch of the adjustment mount is configurable by turning, twisting, or screwing of the catch actuator. The catch actuator of the first catch of the adjustment mount may comprise a bolt and thread arrangement, or the like.

[0107] The vacuum screen device of the first aspect may comprise an outer device body. Suitably, the outer device body is connected with the screen and/or screen face of the device.

[0108] Suitably, the outer device body comprises one or more outer device body walls; and an outer device body cavity. In embodiments, the cavity of the outer device body is substantially surrounded by the one or more device body walls and the screen face of the device.

[0109] In embodiments wherein the vacuum screen device comprises an outer device body, suitably, the vacuum passage of the device is substantially within the cavity of the outer device body of the device.

[0110] The one or more walls of the outer device body may comprise a first or lower outer device body wall; and a second or upper outer device body wall.

[0111] In embodiments, the lower wall of the outer device body extends from, or from near or towards, the front edge of the screen face of the device. In embodiments, the upper wall of the outer device body extends from, or from near or towards, the rear edge of the screen face of the device. The lower and upper walls of the outer device body may be substantially perpendicular.

[0112] In embodiments, the one or more walls of the outer device body comprise a first or left side wall; and a second or right side wall. In embodiments, the left and right side walls of the device body extend from, or from near or towards, respective side edges of the screen face of the device. The left and right side walls of the outer device body may be substantially parallel.

[0113] In embodiments, one or more of the walls of the outer device body, or parts thereof, form at least part of one or more of the walls or plates of the vacuum passage body of the device.

[0114] In embodiments, the left side wall of the outer device body, or part thereof, forms at least part of the left side wall of the vacuum passage body. In embodiments, the right side wall of the outer device body, or part thereof, forms at least part of the right side wall of the vacuum passage body.

[0115] In embodiments, the outer device body of the device of the first aspect is substantially prismatic. The outer device body may be shaped substantially as an elongated prism.

[0116] In embodiments, the outer device body is shaped substantially as an elongated rectangular prism. In embodiments, the outer device body is shaped substantially as an elongated trapezoidal prism.

[0117] The device of the first aspect may comprise one or more vacuum connectors, for connection with a vacuum source. Suitably, the one or more vacuum connectors are connected with the vacuum passage of the device.

[0118] Suitably, the one or more vacuum connectors of the device of the first aspect are for connection with a vacuum pipe or vacuum hose, or the like.

[0119] In embodiments, one or more of the vacuum connectors are rotatable connectors. In embodiments, one or more of the vacuum connectors are swivel connectors.

[0120] Suitably, the one or more vacuum connectors are connected with the one or more vacuum inlets of device.

[0121] In embodiments, the one or more vacuum connectors are of or connected with the walls of the vacuum passage body.

[0122] In embodiments, one or more, or all, of the vacuum connectors are of the floor or base plate of the vacuum passage body.

[0123] In embodiments, one or more, or all, of the vacuum connectors are of the side walls of the vacuum passage body, such as the first, second, third, and/or fourth side walls of the vacuum passage body.

[0124] In embodiments wherein the device of the first aspect comprises an outer device body, the one or more vacuum connectors may be of or connected with the outer device body. Suitably, in embodiments wherein the device comprises an outer

device body, the one or more vacuum connectors are connected with one or more of the walls of the outer device body.

[0125] In embodiments, one or more of the vacuum connectors are of the first or left side wall of the outer device body. In embodiments, one or more of the vacuum connectors are of the second or right side wall of the outer device body.

[0126] In embodiments, one or more of the vacuum connectors of the device of the first aspect comprise a vacuum connector screen, for screening flowable substance passing therethrough.

[0127] A second aspect of the invention provides a system comprising the vacuum screen device of the first aspect; and a vacuum pump connected with the vacuum screen device. Suitably, the vacuum pump is connected with the vacuum screen device via one or more pipes or hoses, or the like.

[0128] Suitably, the one or more pipes or hoses connecting the vacuum pump with the vacuum screen device are connected with the one or more vacuum connectors and/or vacuum inlets of the vacuum screen device.

[0129] In embodiments of the system of the second aspect, one or more of the pipes or hoses connecting the vacuum pump with the vacuum screen device is pivotally connected via the vacuum connector of the vacuum screen device.

[0130] A third aspect of the invention provides a system comprising the vacuum screen device of the first aspect or the system of the second aspect; and a device for processing and/or transport of material prior to processing of the material with the vacuum screen device.

[0131] Suitably, in accordance with the system of the third aspect, the vacuum screen device of the first aspect or the system of the second aspect is arranged to receive processed and/or transported material from the device for processing and/or transfer of material prior to processing of the material with the vacuum screen device.

[0132] In embodiments of the system of the third aspect, the device for processing and/or transport of material prior to processing with the vacuum screen device comprises a shaker screen device or the like.

[0133] In embodiments of the system of the third aspect, the device for processing and/or transport of material prior to processing with the vacuum screen device comprises one or more chutes or the like.

[0134] In embodiments of the system of the third aspect, the device for processing and/or transport of material prior to processing with the vacuum screen device comprises one or more augers or the like.

[0135] A fourth aspect of the invention provides a method of separating particles from a flowable substance, including a step of processing material containing the particles combined with the flowable substance with a vacuum screen device, the vacuum screen device comprising a screen; and a vacuum passage adjacent the screen.

[0136] Suitably, the vacuum screen device according to the method of the fourth aspect is the device of the first aspect.

[0137] In embodiments, the method of the first aspect includes a step of orienting the screen face of the vacuum screen device in response to a rate or volume of material applied to the screen face.

[0138] In embodiments, the step of orienting the screen face in response to a rate or volume of material applied to the screen face includes orienting the screen face in a relatively more rearwards tilted, relatively more upright, or relatively less forwards tilted orientation in the absence of an applicable rate or volume of material applied to the screen face.

[0139] In embodiments, the step of orienting the screen face in response to a rate or volume of material applied to the screen face includes orienting the screen face in a relatively more forwards tilted, relatively less upright, or relatively less rearward tilted orientation in the presence of an applicable rate or volume of material applied to the screen face.

[0140] In embodiments, the step of orienting the screen face in response to a rate or volume of material applied to the screen face includes increasing forwards tilt of the screen face in the presence of an increased rate or volume of material applied to the screen face.

[0141] A fifth aspect of the invention provides an adjustment mount for adjustable movement of a vacuum screen device, the adjustment mount comprising an adjustment mount body; and a moveable adjustment mount connector, the adjustment mount connector for connection with a screen face of the vacuum screen device.

[0142] Suitably, the adjustment mount of the fifth aspect is the adjustment mount of the vacuum screen device of the first aspect.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0143] The invention will be described hereinafter with reference to typical embodiments illustrated in the drawings and wherein:

[0144] Figure 1 sets forth a perspective view of an embodiment of a system according to an aspect of the invention, system 10. System 10 comprises an embodiment of a vacuum screen device according to an aspect of the invention, device 100, and a vacuum pump.

[0145] Figure 2 sets forth (A) a rear view; (B) a side view; and (C) a bottom view of system 10.

[0146] Figure 3 sets forth a perspective view of device 100. In Figure 3, vacuum passage 130 is shown using dashed lines.

[0147] Figure 4 sets forth a bottom view of device 100.

[0148] Figure 5 sets forth a rear view of device 100.

[0149] Figure 6 sets forth (A) a close-up view of a part of device 100 circled in Figure 4, showing vacuum connector 140 in detail; and (B) a close-up view of a part of device 100 circled in Figure 5, showing foot 151 in detail.

[0150] Figure 7 sets forth (A) a left side view; and (B) a right side view of device 100.

[0151] Figure 8 sets forth a partially transparent, close-up, side view of device 100.

[0152] Figure 9 sets forth device 100 in a series of orientations (A) to (E).

[0153] Figure 10 sets forth a front perspective view of another embodiment of a vacuum screen device according to an aspect of the invention, device 200.

[0154] Figure 11 sets forth a rear perspective view of device 200.

[0155] Figure 12 sets forth a front perspective view of another embodiment of a vacuum screen device according to an aspect of the invention, device 300.

[0156] Figure 13 sets forth a perspective view of an adjustment mount according to an aspect of the invention, adjustment mount 250, of or for use with embodiments of the vacuum screen device according to an aspect of the invention.

[0157] Figure 14 sets forth an exploded view of adjustment mount 250.

[0158] Figure 15 sets forth a perspective view of a check body of adjustment mount 250.

### **DETAILED DESCRIPTION**

[0159] Figures 1-3 show an embodiment of a system according to an aspect of the invention, system 10. System 10 comprises a vacuum pump 50; and an embodiment of a vacuum screen device according to an aspect of the invention, device 100. Vacuum pipe 55 connects vacuum pump 50 with vacuum screen device 100.

[0160] System 10 and device 100 are adapted for separation of drill cuttings from drilling mud. More particularly, system 10 and device 100 are adapted for (although not limited to) use for a latter or final stage of processing to separate drill cuttings from oil-based drilling mud (OBM), typically after processing using a shale shaker or similar.

[0161] Vacuum pump 50 of system 10 may be any suitable vacuum pump. Typically, vacuum pump 50 is a continuous solids pump such as described in International Patent Publication WO 2022020903 A1, incorporated herein by reference.

[0162] Vacuum screen device 100 comprises outer device body 110; screen face 120; and vacuum passage 130.

[0163] Outer device body 110 of vacuum screen device 100 is a substantially hollow body, comprising internal cavity 111; and outer device body walls 112. Walls 112 of outer device body 110 comprise lower outer device body wall 1121; upper outer device body wall 1122; and side outer device body walls 1123.

[0164] Screen face 120 of vacuum screen device 100 may comprise any suitable screen structure, such as a wedge wire or mesh arrangement (although without limitation thereto). Typically, screen aperture size of screen face 120 is between about 0.005 mm to about 5 mm, including about: 0.01 mm, 0.02 mm, 0.03 mm, 0.04 mm, 0.05 mm, 0.06 mm, 0.07 mm, 0.08 mm, 0.09 mm, 0.1 mm, 0.2 mm, 0.3 mm, 0.4 mm, 0.5 mm, 0.6 mm, 0.7 mm, 0.8 mm, 0.9 mm, 1 mm, 1.5 mm, 2 mm, 2.5 mm, 3 mm, 3.5 mm, 4 mm, and 4.5 mm. More typically, screen aperture size of screen face 120 is between about 0.02 mm and about 1 mm, including about: 0.03 mm, 0.04 mm, 0.05 mm, 0.06 mm, 0.07 mm, 0.08 mm, 0.09 mm, 0.1 mm, 0.2 mm, 0.3 mm, 0.4 mm, 0.5 mm, 0.6 mm, 0.7 mm, 0.8 mm, and 0.9 mm.

[0165] Screen face 120 is a ramped, curved screen face comprising outer screen face surface 121; and inner screen face surface 122. Screen face 120 further comprises front screen face edge 123; rear screen face edge 124; and side screen face edges 125.

[0166] Lower outer body wall 1121 of outer device body 110 of device 100 extends from front screen face edge 123 of screen face 120. Upper outer body wall 1122 of outer device body 110 extends from rear screen face edge 124 of screen face 120. Respective side outer device body walls 1123 of outer device body 110 extend from respective side screen face edges 125 of screen face 120.

[0167] As can be seen in Figure 3 (using dashed lines), vacuum passage 130 of vacuum screen device 100 is within internal cavity 111 of outer device body 110. Vacuum passage 130 comprises first vacuum passage end 132 at left side screen edge 1252; and second vacuum passage end 133 at right side screen edge 1251.

[0168] Vacuum passage 130 extends from left side screen face edge 1252 to right side screen face edge 1251 along central portion or screen 1221 of screen face 120. Vacuum passage 130 is bordered by front portion 1222 and rear portion 1223 of screen face 120. Front portion 1222 and rear portion 1223 of screen face may be referred to as border portions 1225 of screen face 120 of vacuum screen device 100.

[0169] In typical embodiments, border portions 1225 of screen face 120 are substantially impermeable border portions, such as substantially impermeable to drilling mud. To avoid doubt, substantially impermeable border portions 1225 of screen face 120 may lack screen apertures, such as apertures hereinabove described, or may comprise a suitable structure (such metallic sheeting or the like, although without limitation thereto) to cover and/or block passage through screen apertures.

[0170] Vacuum passage 130 of vacuum screen device 100 comprises a plurality of vacuum plates. More particularly, vacuum passage 130 comprises floor plate 135; and front and rear wall plates 131. Front and rear wall plates 131 extend from floor plate 135 to inner screen face surface 122 of screen face 120.

[0171] Floor plate 135 of vacuum passage 130 is a sloped plate, sloping away from inner screen surface 122 from first vacuum passage end 132 to second vacuum passage end 133. Front and rear wall plates 131 of vacuum passage 130 are slanted plates, flaring outwards from floor plate 135 to inner screen face surface 122.

[0172] To avoid doubt, it will be understood that outer side body walls 1123 of outer device body 110 of vacuum screen device 100 may be considered to form or comprise left and right wall plates 134 of vacuum passage 130.

[0173] Vacuum screen device 100 also comprises vacuum connector 140. Vacuum connector comprises coupling 141; and swivel mechanism 142.

[0174] Vacuum connector 140 is in flowable connection with vacuum passage 130 via second vacuum passage end 133. More particularly, vacuum connector 140 is in flowable connection with vacuum passage 130 via vacuum inlet 139 at second vacuum passage end 133.

[0175] Typically, vacuum connector 140 is in flowable connection with vacuum passage 132 via vacuum inlet 139 of right wall plate 134 of vacuum passage 130, right wall plate 134 typically formed by right outer side body wall 1123 of outer device body 110.

[0176] Vacuum screen device 100 also comprises device adjustment stand 150. Outer device body 110 and screen face 120 of vacuum screen device are pivotally connected with adjustment stand 150.

[0177] Adjustment stand 150 comprises feet 151. Feet 151 of adjustment stand 150 comprise foot frame 152; foot pivot attachment 153; foot front stop 154; and foot rear stop 155.

[0178] Foot front stop 154 of adjustment stand 150 is a configurable stop. More particularly, foot front stop 154 comprises front stop bolt 1541 fastenable within a selected aperture of plurality of apertures 1521 of foot frame 152. In the embodiment of device 100 depicted in the figures, foot frame 152 comprises three vertically spaced apertures. Typically, fastening of front stop bolt 1541 within selected aperture 1521 is via a threaded arrangement.

[0179] Vacuum screen device may further comprise a screen vibrator (not shown). Typically, the screen vibrator is a pneumatic screen vibrator. Typically, the screen vibrator is mounted to inner screen face surface 122 of screen face 120, and more particularly to screen 1221 of screen face 120.

[0180] Typical use of system 10 and device 100 will now be described.

[0181] To prepare system 10 for use, vacuum pump 50 is connected with device 100 by connecting vacuum pipe 55 with vacuum connector 140 of device 100, such that a vacuum can be applied to device 100 using vacuum pump 50.

[0182] To prepare system 10 for use, device 100 is positioned or arranged in a suitable manner to receive material for processing using device 100. Typically, device 100 is arranged to receive pre-processed material comprising drill cuttings and drilling mud from a shale shaker or similar. More particularly, device 100 is typically arranged such that upper body wall 1122 and rear screen face edge 124 are adjacent an exit of a shale shaker or the like, and lower body wall 1121 and front screen face edge 123 are adjacent a skip or ditch or the like, for collection of drill cuttings.

[0183] In use, vacuum applied to device 100 from vacuum pump 50 via vacuum pipe 55 applies suction through screen face 120 via vacuum passage 130. It will be appreciated that application of vacuum through screen face 120 follows vacuum passage 130, such that (e.g. with reference to Figure 3) application of vacuum is restricted to central portion or screen 1221 of screen face 120.

[0184] In use, screen face 120 of device 100 receives pre-processed material comprising drill cuttings and drilling mud from the shale shaker, or the like, and applies further processing to the material.

[0185] More particularly, pre-processed material flows from the exit of the shale shaker or the like onto screen face 120 at or near rear screen face edge 124 across screen face 120 towards front screen face edge 123. As pre-processed material flows across screen face 120, suction through screen face 120 via vacuum passage 130 separates drilling mud of the material from drill cuttings of the material.

[0186] In use, drilling mud separated from pre-processed material via suction through screen face 120 passes into vacuum passage 130 and moves towards vacuum connector 140. Movement of separated drilling mud is encouraged by vacuum suction within vacuum passage 130 through vacuum connector 140. Movement of separated drilling mud is also encouraged by the slope of vacuum passage 130, with drilling mud urged along vacuum sloped plates 131 towards vacuum connector 140 by gravity.

[0187] In use, separated drilling mud passing through vacuum connector 140 is urged by suction through vacuum pipe 55 towards vacuum pump 50. Subsequently, separated drilling mud can be recycled, disposed of, or further processed.

[0188] In use, drill cuttings of the material pass across screen face 120 such that, after separation of drilling mud of the material, processed drill cuttings exit screen

face 120 across front screen edge 123 thereof. Subsequently, processed drill cuttings can be recycled, disposed of, or further processed.

[0189] Device 100 is an adjustable vacuum screen device. More particularly, device 100 can adjust an amount or degree of tilt of screen face 120 in response to an amount or degree of flow of material across screen face 120 of device 100.

[0190] With reference to Figure 9A, in the absence of force against screen face 120 by flow of material across screen face 120, corner 113 of outer device body 110 (at the intersection of lower body wall 1121 and upper body wall 1122) rests against foot rear stop 155 of adjustment mount 150. With corner 113 of outer device body 110 against foot rear stop 155, screen face 120 is in a resting, rearwards tilting position.

[0191] With reference to Figure 9E, in the presence of sufficient force against screen face 120 by sufficient flow of material across screen face 120, lower body wall 1121 is forced against foot front stop 154 of adjustment mount 150. With lower body wall 1121 forced against foot front stop 154, screen face 120 is in a maximally forwards tilting position.

[0192] With reference to Figures 9B, 9C, and 9D, in the presence of intermediate force against screen face 120 by intermediate flow of material across screen face 120, lower body wall 1121 is forced towards, but not against, foot front stop 154. With lower body wall 1121 forced towards, but not against, foot front stop 154, screen face 120 is in an intermediate position which position may be a rearwards or substantially level position, but which is more typically a forwards tilting position such as depicted in Figure 9C and Figure 9D.

[0193] In use, adjustment of orientation of screen face 120 relative to flow of material across screen face 120 facilitates effective functioning of device 100 under various flow conditions.

[0194] Under relatively low flow conditions, duration of passage of material across screen face 120 is increased by relatively less forwards, more upright, or more backwards tilting of screen face 120. Accordingly, further separation of drilling mud from drill cuttings using device 100 can be increased or maximised under relatively low flow conditions.

[0195] Under relatively high flow conditions, duration of passage of material across screen face 120 is decreased by relatively more forwards, less upright, or less

backwards tilting of screen face 120. Accordingly, clogging, stalling, and/or overflow of material relative to screen face 120 is relatively minimised or constrained under relatively high flow conditions.

[0196] As hereinabove described, foot front stop 154 is a configurable stop. In use, front stop bolt 1541 can be placed in a selected aperture of front stop apertures 1521 to configure foot front stop 154. With reference to Figure 8 and Figure 9, it will be appreciated that configuration of foot front stop 154 configures extent of forward tilt of screen face 120 until constraint by contact of lower body wall 1121 with front stop bolt 1541.

[0197] In use, configuration of foot front stop 154 to configure extent of forward tilt of screen face 120 allows for adjustment of orientation of screen face 120 to be optimised to suit flow properties of different materials, such as materials comprising drilling mud and drill cuttings with different composition.

[0198] As hereinabove described, at least some typical embodiments of device 100 comprise a screen vibrator (not shown), such as a pneumatic screen vibrator. In use, the screen vibrator vibrates screen face 120 of device 100, and more particularly screen 1221 thereof. Vibration of screen face 120 by the screen vibrator assists with movement of material (such as drilling mud and drill cuttings) across screen face 120. Vibrations of screen face 120 by the screen vibrator can also assist with cleaning of screen face 120.

[0199] Typically, the screen vibrator according to embodiments of device 100 is a pneumatic vibrator. In embodiments wherein the screen vibrator is a pneumatic vibrator, suitably, the screen vibrator is pneumatically connected with a gas supply and, optionally, a pneumatic controller. The gas supply and/or pneumatic controller may be of vacuum pump 50.

[0200] Figures 10 and 11 show another embodiment of a vacuum screen device according to an aspect of the invention, device 200. Similarly to device 100, device 200 is adapted for connection with a vacuum pump, such as vacuum pump 50 hereinabove described, to form a system for separation of drill cutting from drilling mud.

[0201] As compared to device 100, device 200 shares significant similarities, and this will be evident from Figures 10 and 11 and the following description. However,

certain key differences between device 100 and device 200 will also be noted as follows.

[0202] Vacuum screen device 200 comprises screen face 220; and vacuum passage 230.

[0203] Screen face 220 of vacuum screen device 200 is a rampable, curved screen face comprising outer screen face surface 221; and inner screen face surface 222. Screen face 220 further comprises front screen face edge 223; rear screen face edge 224; and side screen face edges 225.

[0204] Screen face 220 of vacuum screen device 200 comprises centrally located screen 2221, comprising a suitable screen arrangement, such as comprising screen apertures as hereinabove described for vacuum screen device 100.

[0205] Typically, screen 2221 of screen face 220 also comprises protective frame 2226, such as comprising a polygonal frame structure. A typical protective frame 2226 comprising a hexagonal frame structure overlaying apertured screen structure is shown in Figure 10.

[0206] As seen in Figure 10, screen 2221 of screen face 220 may, although need not necessarily, comprise a plurality of screen sections 2224. As shown in Figure 10, screen 2221 of screen 220 comprises five substantially rectangular, apertured screen sections 2224 overlaid by hexagonal protective frame 2226.

[0207] Similarly to typical embodiments of screen 1221 of screen face 120 of device 100, screen 2221 of screen face 220 of device 200 is bordered by front screen face portion 2222 and rear screen face portion 2223.

[0208] Front screen face portion 2222 and rear screen face portion 2223 are substantially impermeable border portions 2225 of screen face 220, such as hereinabove described for screen face 120 of device 100. The typical embodiment of screen face 220 as shown in Figure 10 also comprises substantially impermeable border portions 2225 extending between screen sections 2224 of screen 2221.

[0209] Similarly to vacuum passage 130 of vacuum screen device 100, vacuum passage 230 of vacuum screen device 200 extends from near to left side screen face edge 2252 to near to right screen face edge 2251, along screen 2221 of screen face 220.

[0210] Vacuum screen device 200 differs from vacuum screen device 100 in that vacuum screen device 200 does not comprise an outer device body. Accordingly,

rather than being formed within an outer device body such as outer device body 110 of vacuum screen device 100, vacuum passage 230 of vacuum screen device 200 comprises vacuum passage body 203 attached to inner screen face surface 222 of screen face 220.

[0211] Vacuum passage body 203 of vacuum passage 230 comprises floor plate 235; front and rear wall plates 231; and left and right wall plates 234. Front and rear wall plates 231 and left and right wall plates 234 extend from floor plate 235 of vacuum passage body 203 to inner screen face surface 222 of screen face 220.

[0212] Differing from the sloped and slanted arrangement of floor plate 135 and wall plates 131 of vacuum passage 130 of vacuum device 100 as hereinabove described, front and rear wall plates 231 and left and right wall plates 234 of vacuum passage body 203 of vacuum passage 230 typically extend substantially perpendicularly from floor plate 235.

[0213] Vacuum screen device 200 also comprises vacuum connector 240, in flowable connection with vacuum passage 230. As will be evident from the following, vacuum connector 240 of vacuum screen device 200 differs from vacuum connector 140 of vacuum screen device 100.

[0214] Vacuum connector 240 of device 200 comprises first and second vacuum connectors 2401 and 2402. Each of first and second vacuum connector 2401 and 2402 extends from floor plate 235 of vacuum passage body 203. Each of first and second vacuum connector 2401 and 2402 is in flowable connection with vacuum passage 230 via floor plate 235.

[0215] More particularly, each of first and second vacuum connector 2401 and 2402 is in flowable connection with vacuum passage 230 via a respective vacuum inlet 239 of floor plate 235. As shown in Figure 11, vacuum inlets 239 may comprise inlet screen mesh and/or inlet protective frame structures.

[0216] Figure 12 shows another embodiment of a vacuum screen device according to an aspect of the invention, device 300. Similarly to devices 100 and 200, device 300 is adapted for connection with a vacuum pump such as vacuum pump 50, to form a system for separation of drill cutting from drilling mud.

[0217] As compared to device 100 and device 200, device 300 shares significant similarities, and this will be evident from Figures 12 and the following description.

However, certain key differences between device 100 and/or device 200 and device 300 will also be noted as follows.

[0218] Vacuum screen device 300 comprises screen face 320; and vacuum passage 330.

[0219] Screen face 320 of vacuum screen device 300 is a rampable, curved screen face comprising outer screen face surface 321; and inner screen face surface 322. Screen face 320 further comprises front screen face edge 323; rear screen face edge 324; and side screen face edges 325.

[0220] Similarly to screen face 120 of vacuum screen device 100 and screen face 220 of vacuum screen device 200, screen face 320 of vacuum screen device 300 is for ramping downwards between rear screen face edge 324 and front screen face edge 323.

[0221] The curvature of screen face 320 of typical embodiments of vacuum screen device 300 differs from that of screen face 120 of typical embodiments of vacuum screen device 100 and that of screen face 220 of typical embodiments of vacuum screen device 200, in that screen face 320 is curved between respective side screen face edges 325 rather than between front screen face edge 123/223 and rear screen face edge 124/224.

[0222] Front screen face edge 323 and rear screen face edge 324 of screen face 320 of vacuum screen device 300 differ from front screen face edges 123/223 and rear screen face edges 124/224 of screen face 120/220 of vacuum screen devices 100/200, in that front screen face edge 323 and rear screen face edge 324 are flared screen face edges.

[0223] Side screen face edges 325 of screen face 320 of vacuum screen device 300 differ from side screen face edges 125/225 of screen face 120/220 of vacuum screen devices 100/200, in that side screen face edges comprise lips 3251 extending outwardly from outer screen face surface 321 of screen face 320.

[0224] Similarly to screen face 120 of vacuum screen device 100 and screen face 220 of vacuum screen device 200, screen face 320 of vacuum screen device 300 comprises a centrally located screen 3221 comprising a suitable screen structure, such as comprising screen apertures as hereinabove described.

[0225] Similarly to screen 2221 of screen face 220 of vacuum screen device 200, screen 3221 of screen face 320 comprises protective frame 3226, such as

comprising a polygonal frame structure. A typical protective frame 3226 comprising a hexagonal frame structure overlaying apertured screen structure is shown in Figure 12.

[0226] Screen 3221 of screen face 320 of vacuum screen device 300 differs from screen 1221/2221 of screen face 120/220 of vacuum screen device 100/200, in that screen 3221 is elongated between front screen face edge 323 and rear screen face edge 324, whereas screen 1221/2221 is elongated between respective side screen face edges 125/225.

[0227] Screen 3221 of screen face 320 is bordered by front screen face portion 3222, rear screen face portion 3223, and side screen face portions 3224. Front screen face portion 3222, rear screen face portion 3223, and side screen face portions 3224 are substantially impermeable border portions 3225 of screen face 320, such as hereinabove described for screen face 120.

[0228] Similarly to vacuum passage 130/230 of vacuum screen device 100/200, vacuum passage 330 of vacuum screen device 300 extends along screen 3221 of screen face 320. Consistent with the differing orientation of screen 3221 as compared to screen 1221/2221 as hereinabove described, vacuum passage 330 of vacuum screen device 330 differs from vacuum passage 130/230 of vacuum screen device 100/200, in that vacuum passage 330 extends from near to rear screen face edge 324 to near to front screen face edge 323 along screen portion 3221.

[0229] Similarly to device 200 and in contrast to vacuum screen device 100, vacuum screen device 300 typically does not comprise an outer device body. Accordingly, rather than being within an internal cavity of an outer device body, vacuum passage 330 of vacuum screen device 300 comprises vacuum passage body 303 attached to inner screen face surface 322 of screen face 320.

[0230] Vacuum passage body 303 of vacuum passage 330 of device 300 is not shown in detail in the figures but is substantially similar to vacuum passage body 203 of vacuum passage 230 of device 200, with the exception that vacuum passage body 303 is elongated between rear screen face edge 324 and front screen face edge 323 rather than between respective side screen face edges 225 as is vacuum passage body 203.

[0231] Vacuum screen device 300 also comprises vacuum connector 340, in flowable connection with vacuum passage 330. Vacuum connector 340 is not shown

in detail in the figures but is substantially similar to vacuum connector 240 of vacuum screen device 200, comprising first and second vacuum connectors, each in flowable connection with vacuum passage 330 via a respective vacuum inlet 339 of floor plate 335 of vacuum passage body 303.

[0232] Similarly to vacuum screen device 100, vacuum screen device 200 and vacuum screen device 300 comprise, or are connectable with, a device adjustment stand (not shown).

[0233] The device adjustment stand of (or for connection with) vacuum screen device 200/300 typically comprises first and second feet for engagement with a substantially flat surface such as a ground surface or the like; and first and second legs extending from the first and second feet for adjustable connection with screen face 220/320 of vacuum screen device 200/300.

[0234] Some typical embodiments of vacuum screen device 200/300 comprise adjustment mount 250, as shown in Figures 13 to 15.

[0235] Adjustment mount 250 is of or connected with an adjustment stand, such as a leg thereof, to facilitate adjustable connection of screen face 220/330 of vacuum screen device 200/300 with the adjustment stand.

[0236] Adjustment mount 250 comprises adjustment mount case 251; adjustment mount shaft 252; adjustment mount check body 253; and adjustment mount catches 254.

[0237] Adjustment mount case 251 comprises inner casing 2511; central casing 2512; and outer casing 2513. Adjustment mount case 251 is shaped substantially as a square prism, comprising upper adjustment mount case surface 2514; lower adjustment mount case surface 2515; front adjustment mount case surface 2516; and rear side adjustment mount case surface 2517.

[0238] Inner casing 2511 of adjustment mount case 251 comprises inner casing cavity 2611; and inner casing aperture 2711.

[0239] Adjustment mount shaft 252 of adjustment mount 250 comprises internal shaft portion 2520; and external shaft portion 2530. Internal shaft portion 2520 of adjustment mount shaft 252 comprises slot and key arrangement 2525.

[0240] Adjustment mount shaft 252 passes through substantially central inner casing aperture 2711 of inner casing 2511 of adjustment case 251. More particularly, internal shaft portion 2520 of adjustment mount shaft 252 is secured within

adjustment case 251 using slot and key arrangement 2525, and external shaft portion 2530 of adjustment mount shaft 252 extends from inner casing 2511.

[0241] External shaft portion 2530 of adjustment mount shaft 252 is connected or connectable with screen face 220/320 and/or vacuum passage body 203/303 of vacuum screen device 200/300. In typical embodiments, adjustment mount shaft 252, or an extension thereof or therefrom, is rotatably engaged with a holding portion of a suitable adjustment stand of or connected with device 200/300.

[0242] Adjustment mount check body 253 of adjustment mount 250 is a disk-like check body comprising substantially central check body aperture 2531; first check body protrusion 2532; and second check body protrusion 2533.

[0243] Adjustment mount check body 253 is substantially within inner casing cavity 2611 of inner casing 2511 of adjustment mount case 251. Check body aperture 2531 of adjustment mount check body 253 securely engages with internal shaft portion 2520 of adjustment mount shaft 252, and slot and key arrangement 2525 thereof.

[0244] Adjustment mount check body 253 and adjustment mount shaft 252 are pivotable relative to adjustment mount case 251 and inner casing cavity 2611 thereof, as further described hereinbelow.

[0245] First check body protrusion 2532 of adjustment mount check body 253 comprises substantially circular indentation 2535. First check body protrusion 2532 and second check body protrusion 2533 of adjustment mount check body 253 are for engagement with respective adjustment mount catches 254.

[0246] Adjustment mount catches 254 of adjustment mount 250 comprise first adjustment mount catch 2541; and second adjustment mount catch 2542. First adjustment mount catch 2541 is towards rear adjustment mount case surface 2517 of adjustment mount case 251. Second adjustment mount catch 2542 is towards front adjustment mount case surface 2516 of adjustment mount case 251.

[0247] First adjustment mount catch 2541 of adjustment mount catches 254 is a configurable catch, as further described hereinbelow. First adjustment mount catch 2541 comprises catch actuator member 2551; catch spring 2561; catch bearing 2571; and catch actuator anchor 2581.

[0248] Second adjustment mount catch 2542 of adjustment mount catches 254 is in the form of a side wall protrusion surrounding inner casing cavity of 2611 of inner casing 2511 of adjustment mount case 251.

[0249] Similarly to vacuum screen device 100, vacuum screen devices 200/300 may further comprise a screen vibrator (not shown). Typically, the screen vibrator is a pneumatic screen vibrator. Typically, the screen vibrator is mounted to inner screen face surface 222/322 of screen face 220/320, and more particularly to screen 2221/3221 thereof.

[0250] Typical use of device 200/300 is similar, although not identical, to that hereinabove described for device 100. Typical use will be briefly described as follows, noting certain key differences as compared to that described for device 100.

[0251] To prepare a suitable system comprising device 200/300 for use, vacuum pump 50 is connected with device 100 by connecting vacuum pipe 55 with vacuum connector 240/340 of device 200/300, such that a vacuum can be applied to device 200/300 using vacuum pump 50.

[0252] As hereinabove described, vacuum connector 240/340 of device 200/300 comprises first vacuum connector 2401/3401 and second vacuum connector 2402/3402. It will be appreciated that separate vacuum pipe connections (which may branch from a shared pipe) are typically used for each of first and second vacuum connectors 2401/3401 and 2402/3402.

[0253] Similarly to device 100, in preparation for use, device 200/300 is positioned or arranged in a suitable manner to receive material for processing.

[0254] Similarly to screen face 120 of device 100, the particular shape and curvature of screen face 220 of device 200, and the orientation of screen 2221 thereof, is particularly adapted to receive pre-processed material comprising drill cuttings and drilling mud from a relatively broad and substantially flat exit edge of a suitable pre-processing device, such as of a shale shaker or similar. More particularly, device 300 is typically arranged such that rear screen face edge 224 is adjacent an exit of a shale shaker, or the like.

[0255] The particular shape and curvature of screen face 320 of device 300, and the orientation of screen 3221 thereof, differs from that of screen face 120/220 of device 100/200 in that these characteristics of screen face 320 are particularly adapted to receive pre-processed material from a chute or the like of or connected

with one or more suitable pre-processing devices. More particularly, device 300 is typically arranged such that rear screen edge 324 is adjacent an exit chute or the like, of or connected with one or more suitable pre-processing devices.

[0256] In use, vacuum applied to device 200/300 from vacuum pump 50 via vacuum pipe 55 applies suction through screen face 220/320 via vacuum passage 230/330. It will be appreciated that application of vacuum through screen face 220/320 follows vacuum passage 230/330, such that application of vacuum is restricted to screen 2221/3221 of vacuum screen device 200/300.

[0257] In use, screen face 220/320 of device 300 receives pre-processed material comprising drill cuttings and drilling mud from the suitable pre-processing device.

[0258] More particularly, pre-processed material flows from the pre-processing device onto screen face 220/320 at or near rear screen edge 224/324 towards front screen edge 223/323. As pre-processed material flows across screen 2221/3221 of screen face 220/320, suction through screen 2221/3221 via vacuum passage 230/330 separates drilling mud of the material from drill cuttings of the material.

[0259] It will be appreciated that the particular shape and curvature of screen face 320, and the orientation of screen 3221, of device 300 as hereinabove described, is adapted to urge flowable material away from side screen face edges 325 towards screen 3221 extending centrally between front screen face edge 323 and rear screen face 324.

[0260] In use, drilling mud separated from pre-processed material via suction through screen face 220/320 passes into vacuum passage 230/330 and moves through vacuum inlets 239/339 towards vacuum connector 240/340. As hereinabove described, vacuum inlets 239/339 may comprise inlet screen mesh and/or protective frame structure; where present, such structure can constrain any remaining particulates from passing into vacuum connector 240/340.

[0261] In use, separated drilling mud passing through vacuum connector 240/340 is urged by suction through vacuum pipe 55 towards vacuum pump 50. Subsequently, separated drilling mud can be recycled, disposed of, or further processed.

[0262] In use, drill cuttings of the material pass over screen face 220/320 such that, after separation of drilling mud of the material, processed drill cuttings exit

screen face 220/320 across front screen edge 223/323 thereof. Subsequently, processed drill cuttings can be recycled, disposed of, or further processed.

[0263] As hereinabove described, device 200/300 comprises, or is connectable with, an adjustment stand, the adjustment stand typically comprising or connected with adjustment mount 250.

[0264] Typical embodiments of device 200/300 comprising an adjustment stand and adjustment mount 250 can adjust an amount or degree of tilt of screen face 220/320 in response to an amount or degree of flow of material onto screen face 220/320 of device 200/300.

[0265] In use, adjustment of screen face 220/320 of device 200/300 in response to an amount or degree of flow of material onto screen face 220/330 is broadly similar as hereinabove described for device 100.

[0266] In particular, screen face 220/320 is typically adjustable between a resting, rearward tilting position in the absence of force against screen face 220/320 by flow of material across screen face 220/320, and a maximally forwards tilting position in the presence of sufficient force against screen face 220/320 by sufficient flow of material across screen face 220/320. Furthermore, in the presence of intermediate force against screen face 220/320 by intermediate flow of material onto screen face 220/320, screen face 220/330 is in an intermediate position which position may be a rearwards, substantially level, or forwards tilting position.

[0267] A description of adjustment mount 250 in typical use for adjustment of tilt of screen face 220/320, in response to flow of material across screen face 220/320, is provided as follows.

[0268] It will be understood that during typical use of adjustment mount 250, first check body protrusion 2532 of adjustment mount check body 253 remains substantially engaged with first adjustment mount catch 2541, wherein catch bearing 2551 of first adjustment mount catch 2541 is within substantially circular indentation 2535 of first check body protrusion 2532.

[0269] In use, in the absence of force against screen face 220/320 by flow of material across screen face 220/320, catch spring 2561 of first adjustment mount catch 2541 is in an uncompressed state, wherein screen face 220/320 of device 200/300 connected to external shaft portion 2530 of adjustment mount shaft 252 is in a resting, typically rearwards tilting position.

[0270] In use, in the presence of sufficient force against screen face 220/330 by sufficient flow of material across screen face 220/320, adjustment shaft 252 rotates and drives corresponding rotation of adjustment mount check body 253 stably engaged therewith, wherein first check body protrusion 2532 applies sufficient force against catch bearing 2551 in the direction of catch spring 2561 of first adjustment mount catch 2541 to force catch spring 2561 into a maximally compressed state.

[0271] In use, when catch spring 2561 of first adjustment mount catch 2541 is in the maximally compressed state by force from first check body protrusion 2532 of adjustment mount check body 253, screen face 220/320 of device 200/300 is in a maximally forwards tilting position.

[0272] In use, in the presence of intermediate force against screen face 220/330 by intermediate flow of material across screen face 220/330, adjustment shaft 252 rotates and drives corresponding rotation of adjustment mount check body 253 stably engaged therewith, wherein first check body protrusion 2532 applies intermediate force against catch bearing 2551 in the direction of catch spring 2561 of first adjustment mount to force catch spring 2561 into an intermediately compressed state.

[0273] In use, when catch spring 2561 of first adjustment mount catch 2541 is in the intermediately compressed state by force from first check body protrusion 2532 of adjustment mount check body 253, screen face 220/320 of device 200/300 is in an intermediate position which position may be a rearwards, substantially level, or forwards tilting position.

[0274] As hereinabove described, first adjustment mount catch 2541 is a configurable catch. In use, first adjustment mount catch 2541 can be configured by screwing or unscrewing of catch actuator member 2551 (a bolt-like member) against threaded catch actuator anchor 2581.

[0275] In use, screwing of catch actuator member 2551 against catch actuator anchor shifts the position of first adjustment catch 2541, and catch bearing 2551 and catch spring 2561 thereof, in the direction of lower adjustment mount case surface 2515.

[0276] In use, when the position of first adjustment catch 2541, and catch bearing 2551 and catch spring 2561 thereof, is shifted in the direction of lower adjustment mount case surface 2515, in the absence of force against screen face 220/320 by

flow of material across screen face 220/320, wherein catch spring 2561 of first adjustment mount catch 2541 is in an uncompressed state and screen face 220/320 is in the resting position, the resting position is a more rearwards tilting, less upright resting position.

[0277] In use, unscrewing of catch actuator member 2551 against catch actuator anchor shifts the position of first adjustment catch 2541, and catch bearing 2551 and catch spring 2561 thereof, in the direction of upper adjustment mount case surface 2514.

[0278] In use, when the position of first adjustment catch 2541, and catch bearing 2551 and catch spring 2561 thereof, is shifted in the direction of upper adjustment mount case surface 2514, in the absence of force against screen face 220/320 by flow of material over screen face 220/320, wherein catch spring 2561 of first adjustment mount catch 2541 is in an uncompressed state and screen face 220/320 is in the resting position, the resting position is a less rearwards tilting, more upright resting position.

[0279] Vacuum screen devices 100/200/300, and components thereof, may be formed using any suitable materials. Typically, vacuum screen devices 100/200/300 comprises metallic materials, such as structural steel, stainless steel, and/or aluminium, although without limitation thereto.

[0280] In some typical embodiments, adjustment mount 250 is formed using durable plastic materials, such as polyethylene, polyvinyl chloride, and/or polypropylene, although without limitation thereto. In some typical embodiments, adjustment mount check body 253 comprises polyvinyl chloride.

[0281] At least typical aspects and embodiments of the invention may offer particular advantages for additional processing of OBM material that has been processed using one or more devices, systems, and/or treatment methods.

[0282] It will be understood that the terms “*pre-processed*”, “*pre-processing*”, and “*pre-processor*” may be used to described material, methods, and/or equipment (devices; systems) associated with processing of material that is subsequently processed using a vacuum screen device according to aspects and embodiments of the invention.

[0283] At least typical aspects and embodiments of the invention may offer particular advantages for additional processing of pre-processed OBM material, to remove residual drilling mud from drill cuttings.

[0284] As hereinabove described, vacuum screen device 100/200 may be particularly advantageous for receiving pre-processed material directly from a shale shaker device or system or the like.

[0285] As hereinabove described, vacuum screen device 300 may be particularly advantageous for receiving pre-processed material from a chute or the like. It will be understood that the use of a chute or the like for delivery to vacuum screen device 300 may be particularly convenient or advantageous in the context of transport of pre-processed material from multiple different devices or systems using a chute or the like, such as multiple different shale shakers or the like, for additional processing using vacuum screen device 300.

[0286] As hereinabove described, at least typical embodiments of vacuum screen devices of the invention are adjustable vacuum screen devices and more particularly are adjustable to tilt a screen face of the device between a resting position and a maximally forwards tilting position.

[0287] With reference to Figure 9 and device 100 by way of example, a tilt angle between the resting position and the maximally forwards tilting position may be about 45 degrees, although without limitation thereto. In some typical embodiments, the tilt angle between the resting position and the maximally forwards tilting position is between about 25 degrees and about 60 degrees, including about: 30; 35; 40; 45; 50; and 55 degrees.

[0288] As hereinabove described, at least typical embodiments of vacuum screen devices according to the invention may comprise one or more configurable stops or checks, for configuring degree or extent of rotation or pivoting of the screen face of the device in a forwards and/or rearwards direction, and/or for configuring the orientation of the screen face in the resting position. It will be appreciated that the one or more configurable stops or checks may configure the tilt angle between the resting position of the screen face and the maximally forwards tilting position of the screen face.

[0289] The particular tilt angle between the resting position and the maximally forwards tilting position of the screen face of the vacuum screen device, and/or the

ability to configure the tilt angle between resting position and the maximally forwards tilting position, may be advantageous in the context of facilitating effective functioning of the vacuum screen device under various flow conditions of suitable material, such as OBM material.

[0290] To avoid doubt, it is noted that advantages of at least typical embodiments of aspects of the invention described herein are not necessarily limited to OBM material processing. Rather, aspects and embodiments of the invention may be advantageous for various other applications, including applications wherein an aqueous waste is produced, such as in tunnelling or pneumatic excavation operations.

[0291] It will be understood that the above description of embodiments of the invention is provided for purposes of description to one of ordinary skill in the related art. It is not intended to be exhaustive or to limit the invention to a single disclosed embodiment. In some instances, well-known components and/or processes have not been described in detail, so as not to obscure the embodiments described herein.

[0292] Numerous alternatives and variations to the present invention will be apparent to those skilled in the art of the above teaching. Accordingly, while some alternative embodiments have been discussed specifically, other embodiments will be apparent or relatively easily developed by those of ordinary skill in the art. The invention is intended to embrace all alternatives, modifications, and variations that have been discussed herein, and other embodiments that fall within the spirit and scope of the invention.

[0293] In particular, it will be fully understood and appreciated that suitable features of typical vacuum screen device embodiments 100/200/300 as hereinabove described, may be exchanged or combined.

[0294] At least certain typical embodiments of systems and devices as described herein will be understood to be “*portable*” vacuum screen systems or “*portable*” vacuum screen devices.

[0295] As used herein, “*portable*” vacuum screen systems and “*portable*” vacuum screen devices will be understood to be systems and devices adapted to be moved for use in various locations and/or settings.

[0296] As least typical embodiments of “*portable*” vacuum screen devices and systems are described herein are adapted for further processing of material that has

already been processed using one or more other devices or systems. For example, at least typical embodiments of “*portable*” vacuum screen systems and “*portable*” vacuum screen devices as described herein will be usable for further processing of processed material obtained from any suitable existing shale shaker devices or systems, as may be desired.

[0297] “*Portable*” vacuum screen systems and “*portable*” vacuum screen devices as described herein will further be understood to be mechanically separate from, or at least readily mechanically separable from, processing equipment such as existing shale shakers and the like.

[0298] In this specification, the use of the terms “*suitable*” and “*suitably*”, and similar terms, is not to be read as implying that a feature or step is essential, although such features or steps may well be preferred.

[0299] In this specification, the indefinite articles “*a*” and “*an*” are not to be read as singular indefinite articles or as otherwise excluding more than one or more than a single subject to which the indefinite article refers. For example, “*a*” screen includes one screen, one or more screens, and a plurality of screens.

[0300] In this specification, the terms “*comprises*”, “*comprising*”, “*includes*”, “*including*”, and similar terms, are intended to denote the inclusion of a stated integer or integers, but not necessarily the exclusion of another integer or other integers, depending on context. That is, a device, method, or system etc., that comprises or includes stated integer(s) need not have those integer(s) solely, and may well have at least some other integers not stated, depending on context.

[0301] In this specification, the terms “*consisting essentially of*” and “*consists essentially of*” are intended to mean a non-exclusive inclusion only to the extent that, if additional elements are included beyond those elements recited, the additional elements do not materially alter basic and novel characteristics. That is, a device, system, or method that “*consists essentially of*” one or more recited elements includes those elements only, or those elements and any additional elements that do not materially alter the basic and novel characteristics of the device, system, or method.

[0302] In this specification, terms such as “*above*” and “*below*”; “*front*” and “*back*”; “*top*” and “*bottom*”; “*left*” and “*right*”; “*horizontal*” and “*vertical*”, and the like, may be used for descriptive purposes. However, it will be understood that embodiments can

potentially be arranged in various orientations, and that such relative terms are not limiting and may be interchangeable in appropriate circumstances.

[0303] In this specification, unless the context requires otherwise, the terms “*connection*”, “*connected*”, “*connecting*”, and the like, are not to be read as limited to direct connections and may also include indirect connections. For example, unless the context requires otherwise, a stated first component “*connected*” to a stated second component may be connected via, through, or by, one or more unstated components.

[0304] Aspects or embodiments of the invention can also be characterised by devices, systems, or methods according to any of the following items:

1. A portable vacuum screen device comprising: a screen face comprising a screen; and a vacuum passage adjacent the screen, wherein the device is adjustable to orient the screen face in response to a rate or volume of material applied to the screen face.
2. The device of item 1, wherein the device is adapted for separation of drill cuttings from drilling mud.
3. The device of item 1 or item 2, wherein the device is adjustable to:  
orient the screen face in a relatively more rearward tilted orientation in the absence of an applicable force against the screen face; and  
orient the screen face in a relatively more forward tilted orientation in the presence of an applicable force against the screen face.
4. The device of any preceding item, comprising an adjustment stand wherein the screen face is rotatably or pivotally connected with the adjustment stand.
5. The device of any preceding item, comprising one or more stops or checks for constraining movement of the screen face during adjustment thereof.
6. The device of item 5, wherein one or more of the stops or checks are configurable stops or checks.
7. The device of item 6, wherein the one or more stops or checks are configurable to configure the degree or extent of rotation or pivoting of the screen face relative to the adjustment stand in a forwards direction, prior to constraint by the stops or checks.
8. The device of item 6 or item 7, wherein the one or more stops or checks are configurable to configure the degree or extent of rotation or pivoting of the screen

face relative to the adjustment stand in a rearwards direction, prior to constraint by the stops or checks.

9. The device of any one of items 6 to 8, wherein the one or more stops or checks are configurable to configure a resting orientation of the screen face, in the absence of an applicable force against the screen face.

10. The device of item 9, wherein the one or more stops or checks are configurable to configure the resting orientation of the screen face between a relatively more rearwards resting orientation, and a relatively less rearwards resting orientation.

11. The device of any preceding item, wherein the device comprises an adjustment mount, the adjustment mount comprising an adjustment mount body; and a rotatable or pivotable adjustment mount connector extending from the adjustment mount body, the adjustment mount connector for connection with the screen face of the device.

12. The device of item 11, wherein the adjustment mount comprises a check body stably connected with the adjustment mount connector, wherein rotation or pivoting of the adjustment mount connector rotates or pivots the check body; and one or more catches for engagement with the check body, to constrain movement of the check body.

13. The device of any preceding item, wherein the screen is of a substantially central portion of the screen face, the screen surrounded by one or more border portions of the screen face.

14. The device of any preceding item, wherein the screen is an elongated screen.

15. The device of any preceding item, wherein the screen face is an elongated screen face.

16. The device of item 15, wherein the screen and the screen face are elongated in substantially the same direction or orientation.

17. The device of item 15, wherein the screen is elongated in a substantially perpendicular direction or orientation, relative to elongation of the screen face.

18. The device of any preceding item, wherein a peripheral shape of the screen face is an elongated trapezoidal shape.

19. The device of any preceding item, wherein the screen face is curved from an entry screen face edge to an exit screen face edge of the screen face.

20. The device of any preceding item, wherein the screen face is curved from one side screen face edge to another side screen face edge of the screen face.
21. The device of any preceding item, wherein the vacuum passage extends substantially along an inner screen surface of the screen.
22. The device of any preceding item, wherein the vacuum passage comprises a vacuum passage body comprising one or more vacuum passage walls or vacuum passage plates.
23. The device of item 22, wherein the vacuum passage body comprises one or more vacuum inlets for application of suction into the vacuum passage.
24. The device of item 23, comprising a plurality of vacuum inlets.
25. The device of any preceding item, comprising one or more vacuum connectors for connection with a vacuum source.
26. A system comprising the vacuum screen device of any preceding item; and a vacuum pump connected with the vacuum screen device.
27. A system comprising the vacuum screen device of any one of items 1 to 25 or the system of item 26; and an additional processing device, wherein the vacuum screen device or system is arranged to receive processed material from the additional processing device.
28. The system of item 27, wherein the additional processing device is a shaker screen device.
29. A method of separating particles from a flowable substance, including steps of:  
processing material containing the particles combined with the flowable substance with a vacuum screen device, the vacuum screen device comprising a screen face comprising a screen and a vacuum passage adjacent the screen, and  
orienting the screen face of the vacuum screen device in response to a rate or volume of material applied to the screen face.

**CLAIMS**

1. A portable vacuum screen device comprising: a screen face comprising a screen; and a vacuum passage adjacent the screen, wherein the device is adjustable to orient the screen face in response to a rate or volume of material applied to the screen face.
2. The device of claim 1, wherein the device is adapted for separation of drill cuttings from drilling mud.
3. The device of claim 1 or claim 2, wherein the device is adjustable to:  
orient the screen face in a relatively more rearward tilted orientation in the absence of an applicable force against the screen face; and  
orient the screen face in a relatively more forward tilted orientation in the presence of an applicable force against the screen face.
4. The device of any preceding claim, comprising an adjustment stand wherein the screen face is rotatably or pivotally connected with the adjustment stand.
5. The device of any preceding claim, comprising one or more stops or checks for constraining movement of the screen face during adjustment thereof.
6. The device of claim 5, wherein one or more of the stops or checks are configurable stops or checks.
7. The device of claim 6, wherein the one or more stops or checks are configurable to configure the degree or extent of rotation or pivoting of the screen face relative to the adjustment stand in a forwards direction, prior to constraint by the stops or checks.
8. The device of claim 6 or claim 7, wherein the one or more stops or checks are configurable to configure the degree or extent of rotation or pivoting of the screen

face relative to the adjustment stand in a rearwards direction, prior to constraint by the stops or checks.

9. The device of any one of claims 6 to 8, wherein the one or more stops or checks are configurable to configure a resting orientation of the screen face, in the absence of an applicable force against the screen face.

10. The device of claim 9, wherein the one or more stops or checks are configurable to configure the resting orientation of the screen face between a relatively more rearwards resting orientation, and a relatively less rearwards resting orientation.

11. The device of any preceding claim, wherein the device comprises an adjustment mount, the adjustment mount comprising an adjustment mount body; and a rotatable or pivotable adjustment mount connector extending from the adjustment mount body, the adjustment mount connector for connection with the screen face of the device.

12. The device of claim 11, wherein the adjustment mount comprises a check body stably connected with the adjustment mount connector, wherein rotation or pivoting of the adjustment mount connector rotates or pivots the check body; and one or more catches for engagement with the check body, to constrain movement of the check body.

13. The device of any preceding claim, wherein the screen is of a substantially central portion of the screen face, the screen surrounded by one or more border portions of the screen face.

14. The device of any preceding claim, wherein the screen is an elongated screen.

15. The device of any preceding claim, wherein the screen face is an elongated screen face.

16. The device of claim 15, wherein the screen and the screen face are elongated in substantially the same direction or orientation.
17. The device of claim 15, wherein the screen is elongated in a substantially perpendicular direction or orientation, relative to elongation of the screen face.
18. The device of any preceding claim, wherein a peripheral shape of the screen face is an elongated trapezoidal shape.
19. The device of any preceding claim, wherein the screen face is curved from an entry screen face edge to an exit screen face edge of the screen face.
20. The device of any preceding claim, wherein the screen face is curved from one side screen face edge to another side screen face edge of the screen face.
21. The device of any preceding claim, wherein the vacuum passage extends substantially along an inner screen surface of the screen.
22. The device of any preceding claim, wherein the vacuum passage comprises a vacuum passage body comprising one or more vacuum passage walls or vacuum passage plates.
23. The device of claim 22, wherein the vacuum passage body comprises one or more vacuum inlets for application of suction into the vacuum passage.
24. The device of claim 23, comprising a plurality of vacuum inlets.
25. The device of any preceding claim, comprising one or more vacuum connectors for connection with a vacuum source.
26. A system comprising the vacuum screen device of any preceding claim; and a vacuum pump connected with the vacuum screen device.

27. A system comprising the vacuum screen device of any one of claims 1 to 25 or the system of claim 26; and an additional processing device, wherein the vacuum screen device or system is arranged to receive processed material from the additional processing device.

28. The system of claim 27, wherein the additional device is a shaker screen device.

29. A method of separating particles from a flowable substance, including steps of:  
processing material containing the particles combined with the flowable substance with a vacuum screen device, the vacuum screen device comprising a screen face comprising a screen and a vacuum passage adjacent the screen, and  
orienting the screen face of the vacuum screen device in response to a rate or volume of material applied to the screen face.

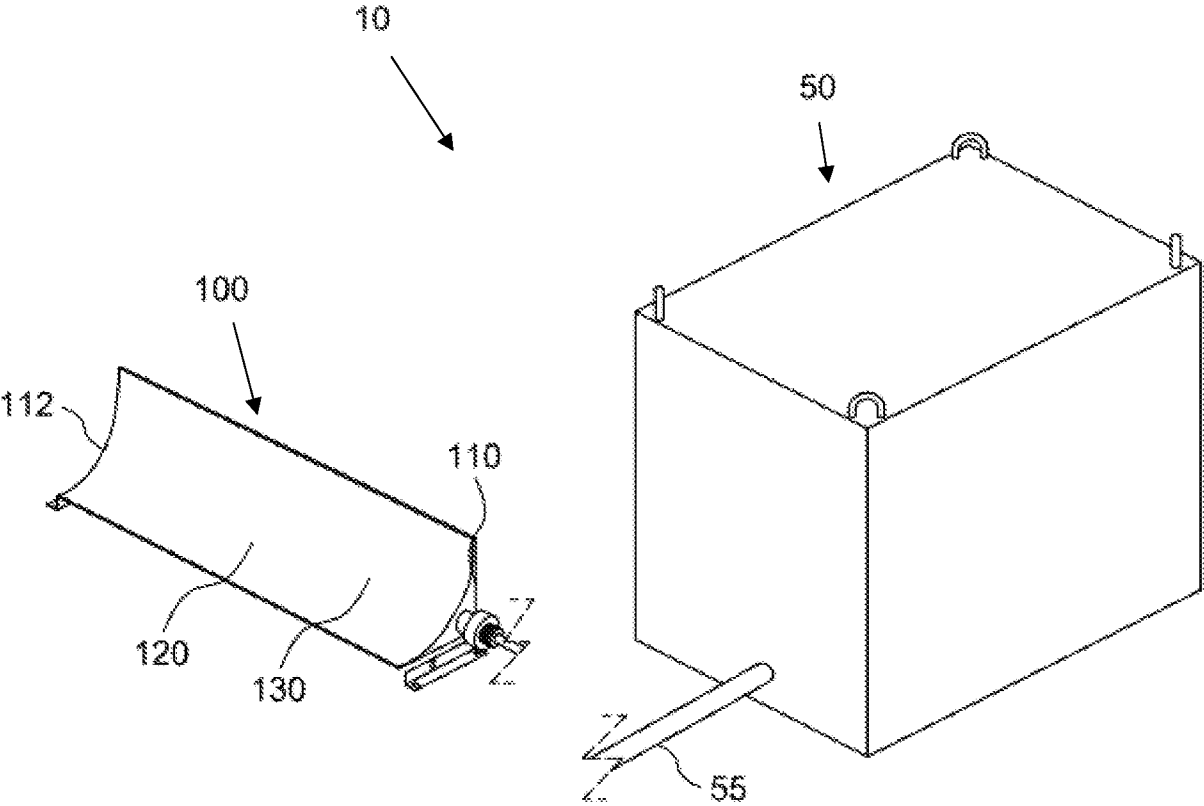


FIG. 1

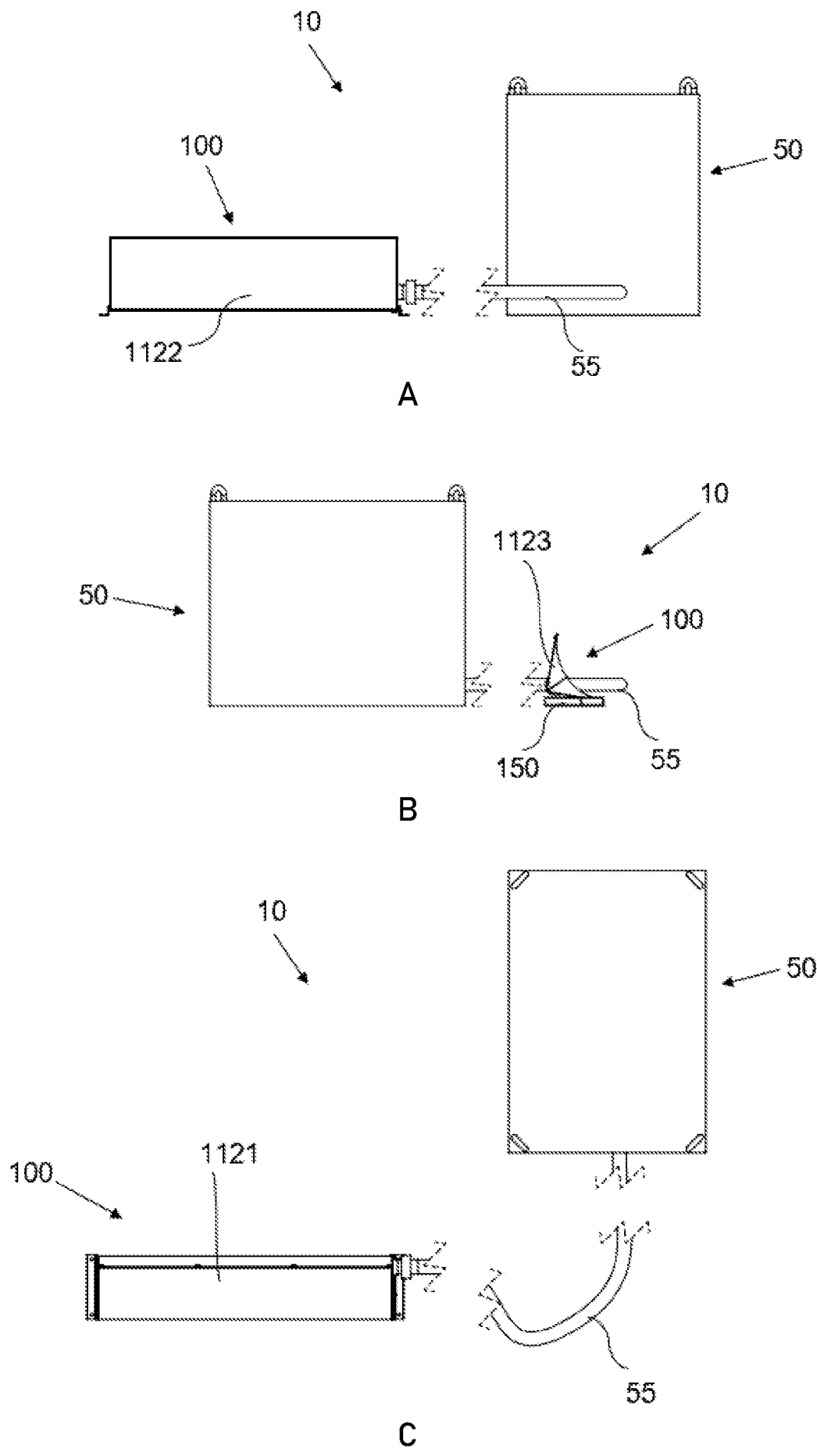


FIG. 2

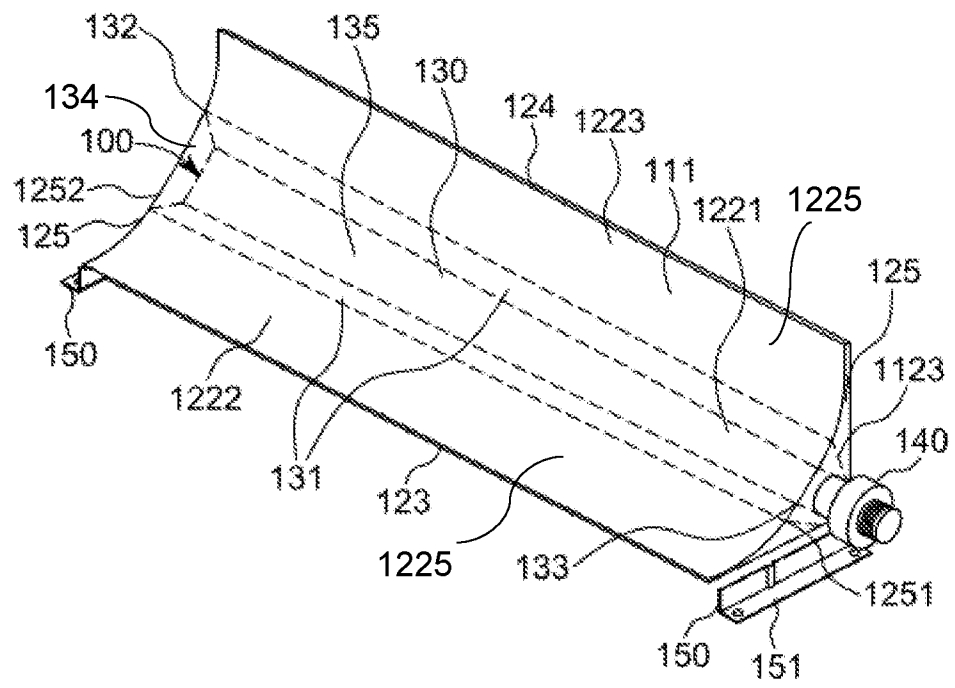


FIG. 3

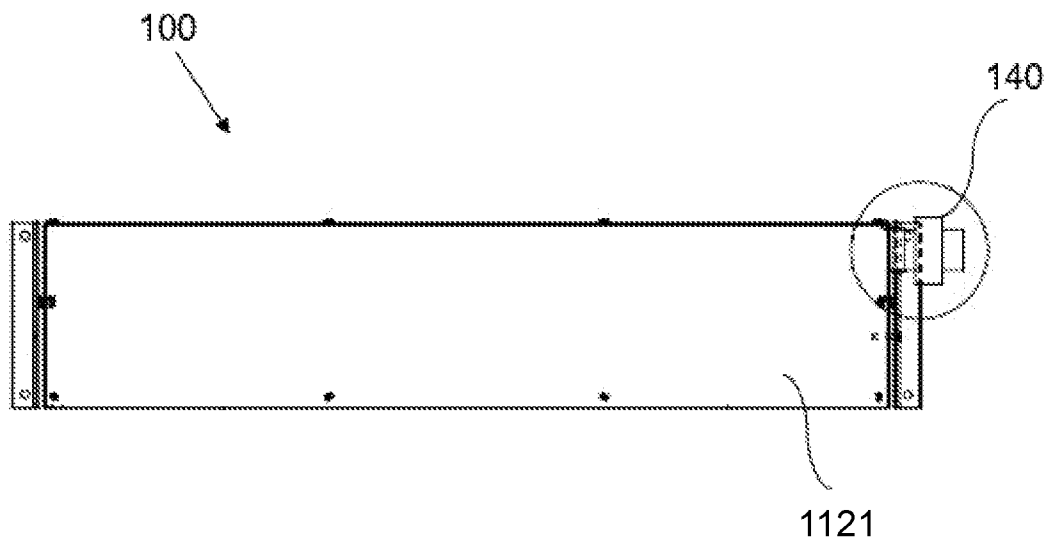


FIG. 4

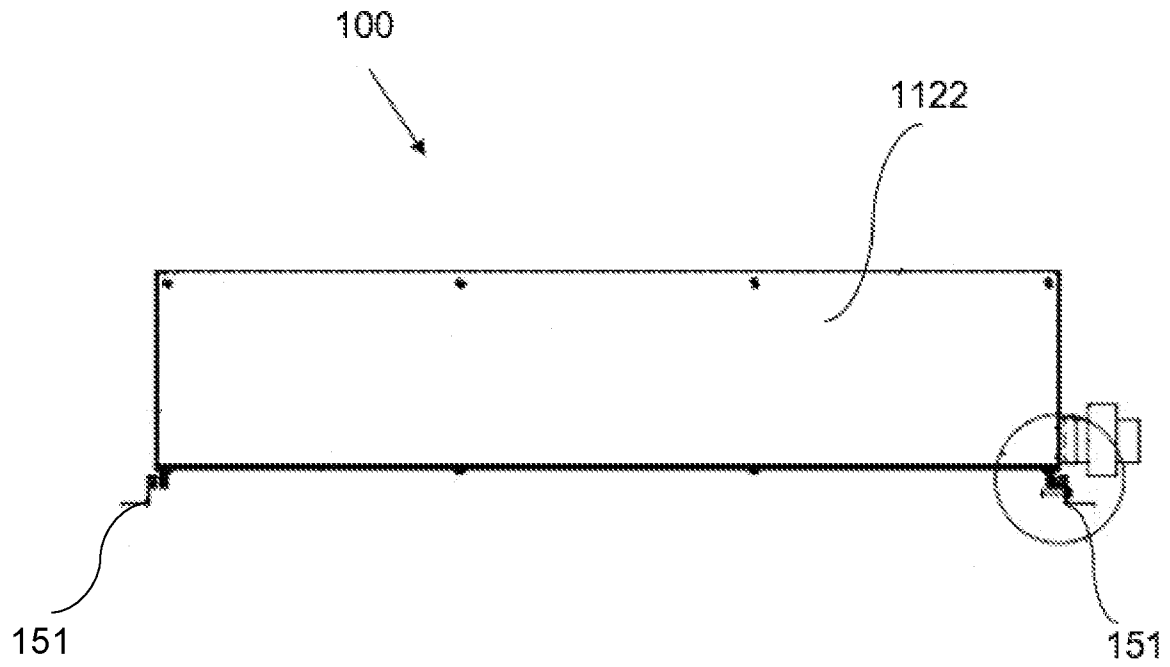


FIG. 5

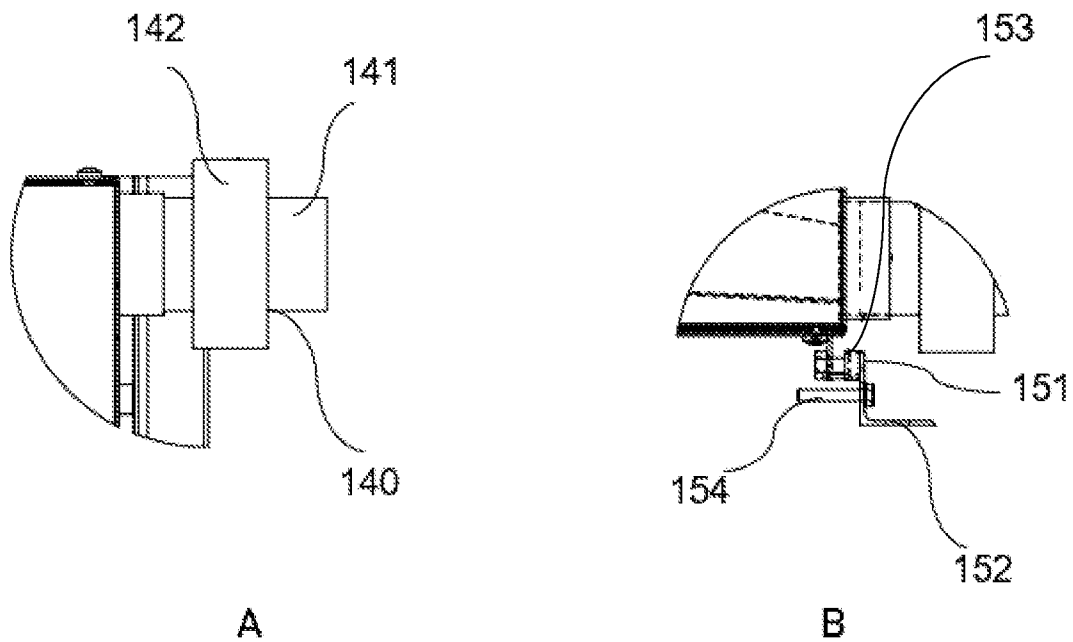


FIG. 6

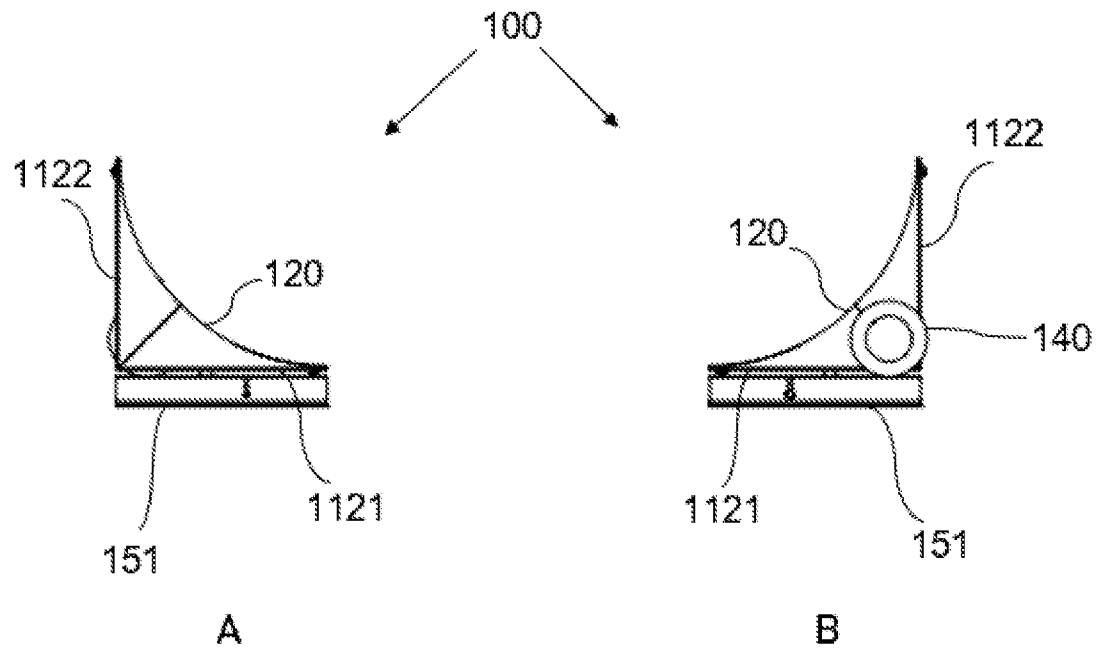


FIG. 7

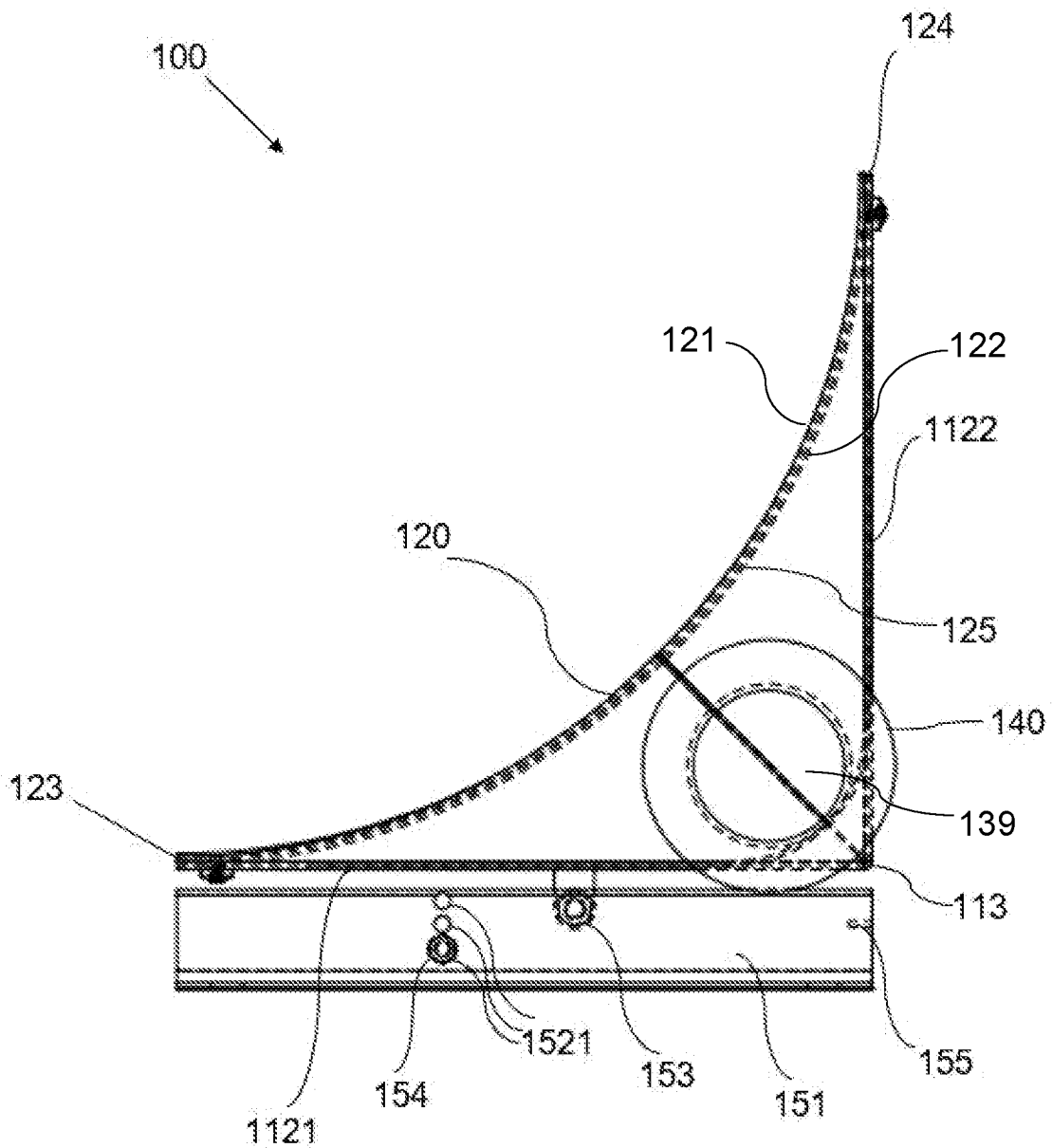
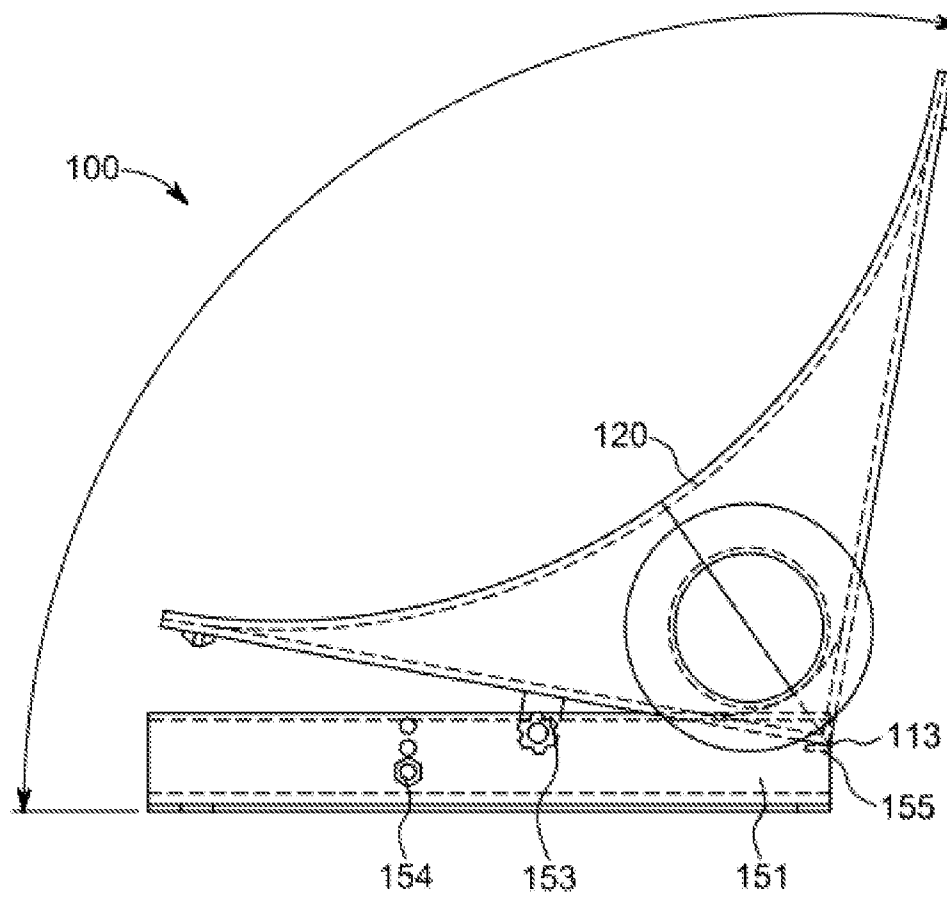
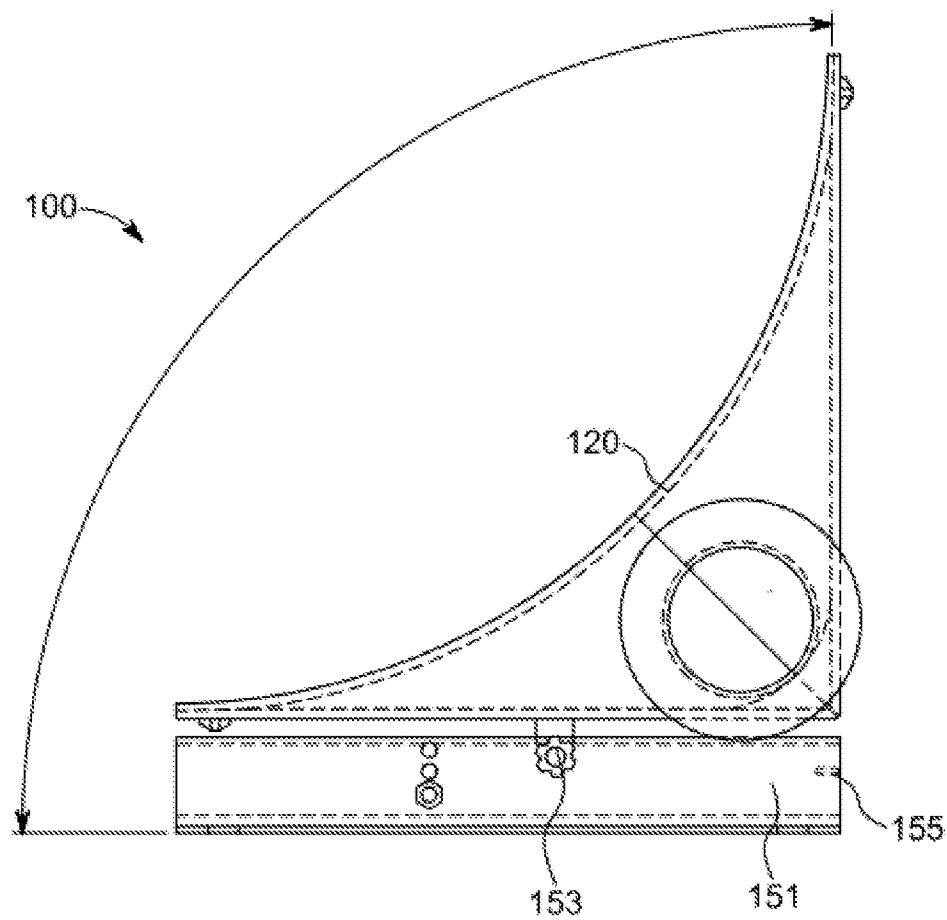


FIG. 8

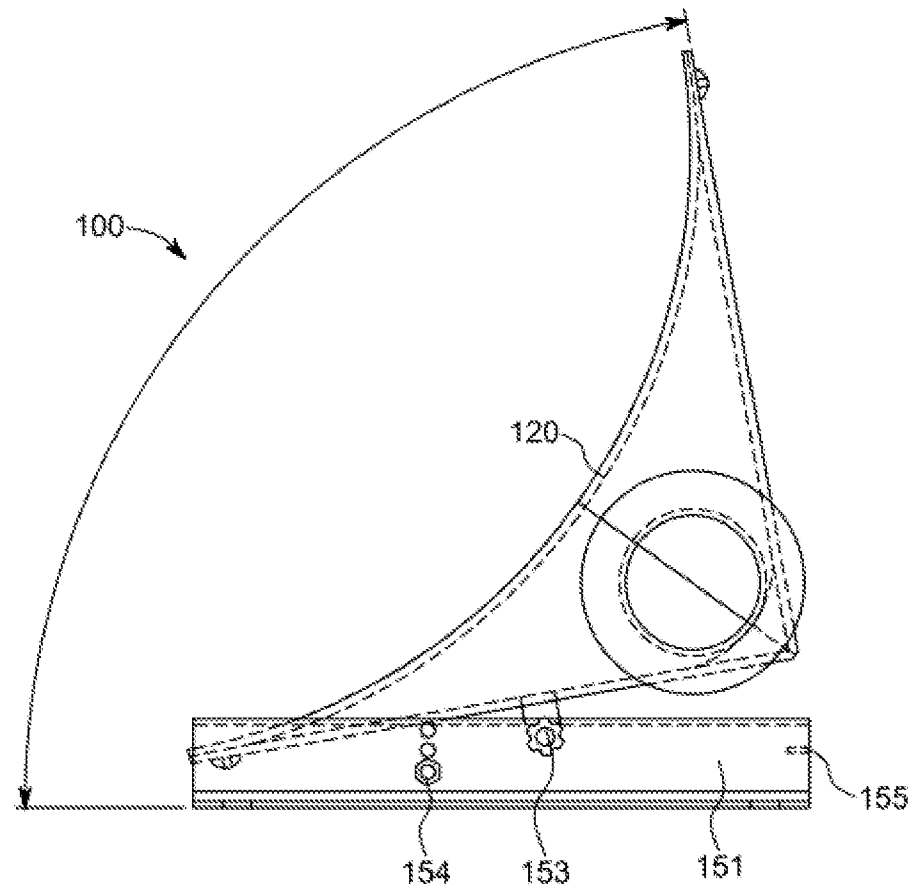


A

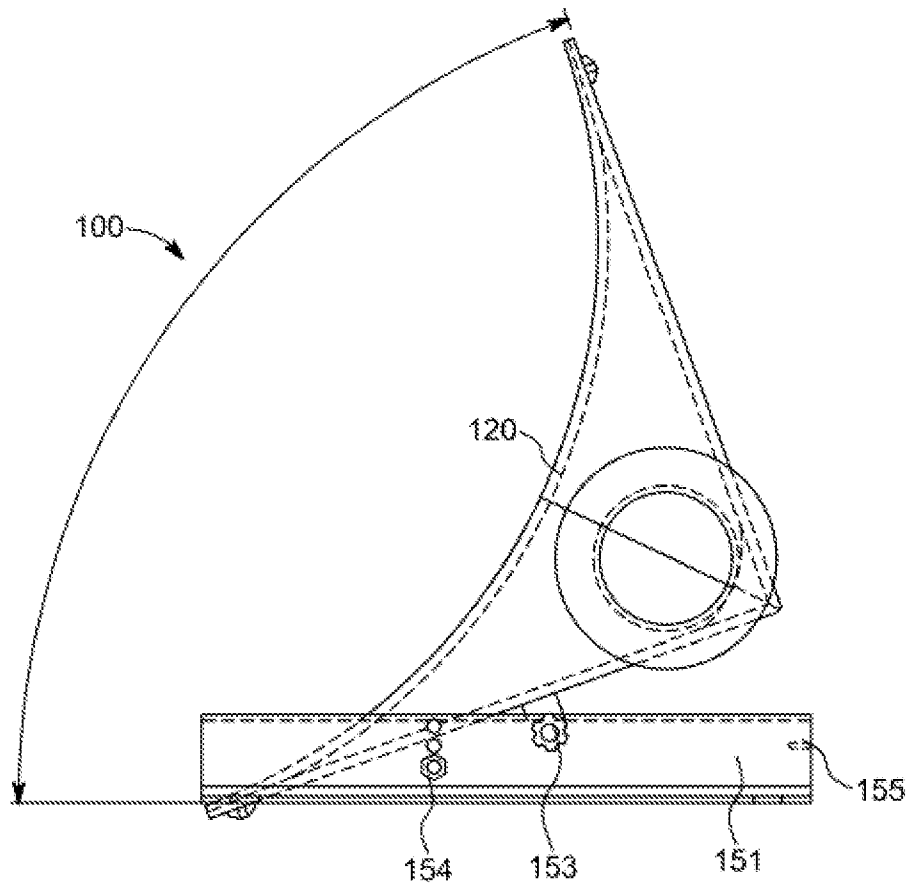


B

FIG. 9

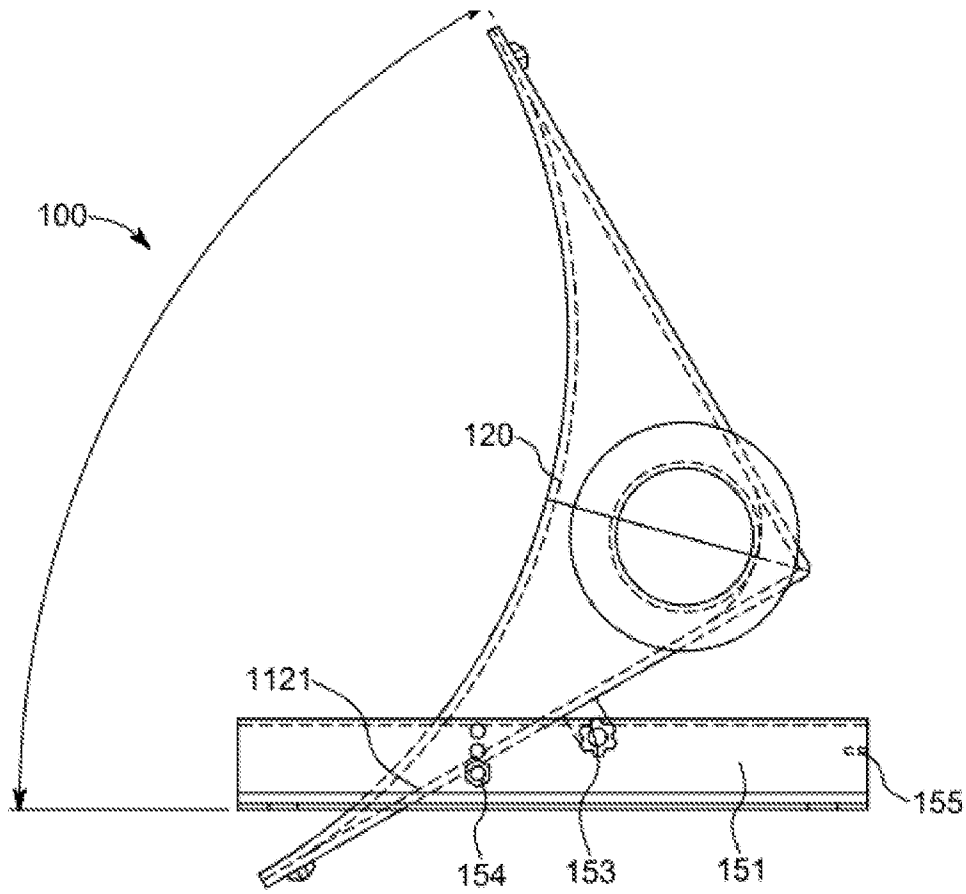


C



D

FIG. 9 cont'd



E

FIG. 9 cont'd

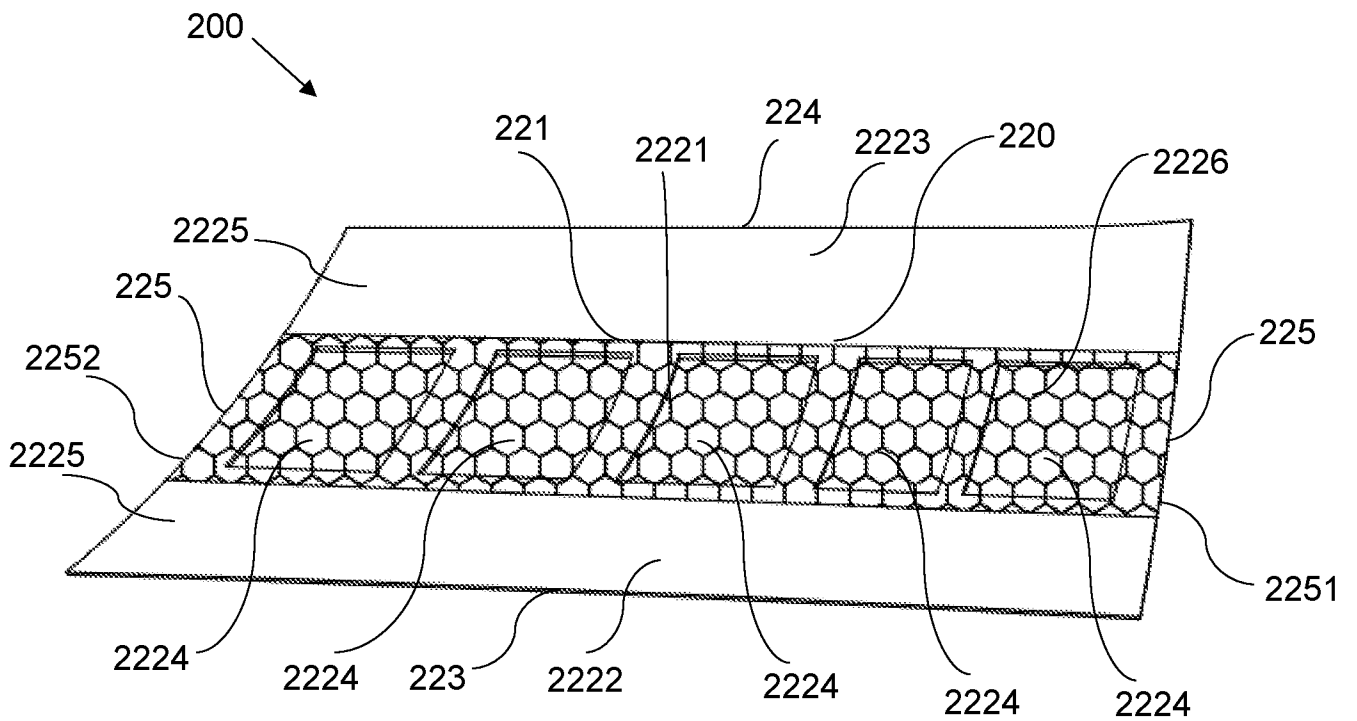


FIG. 10

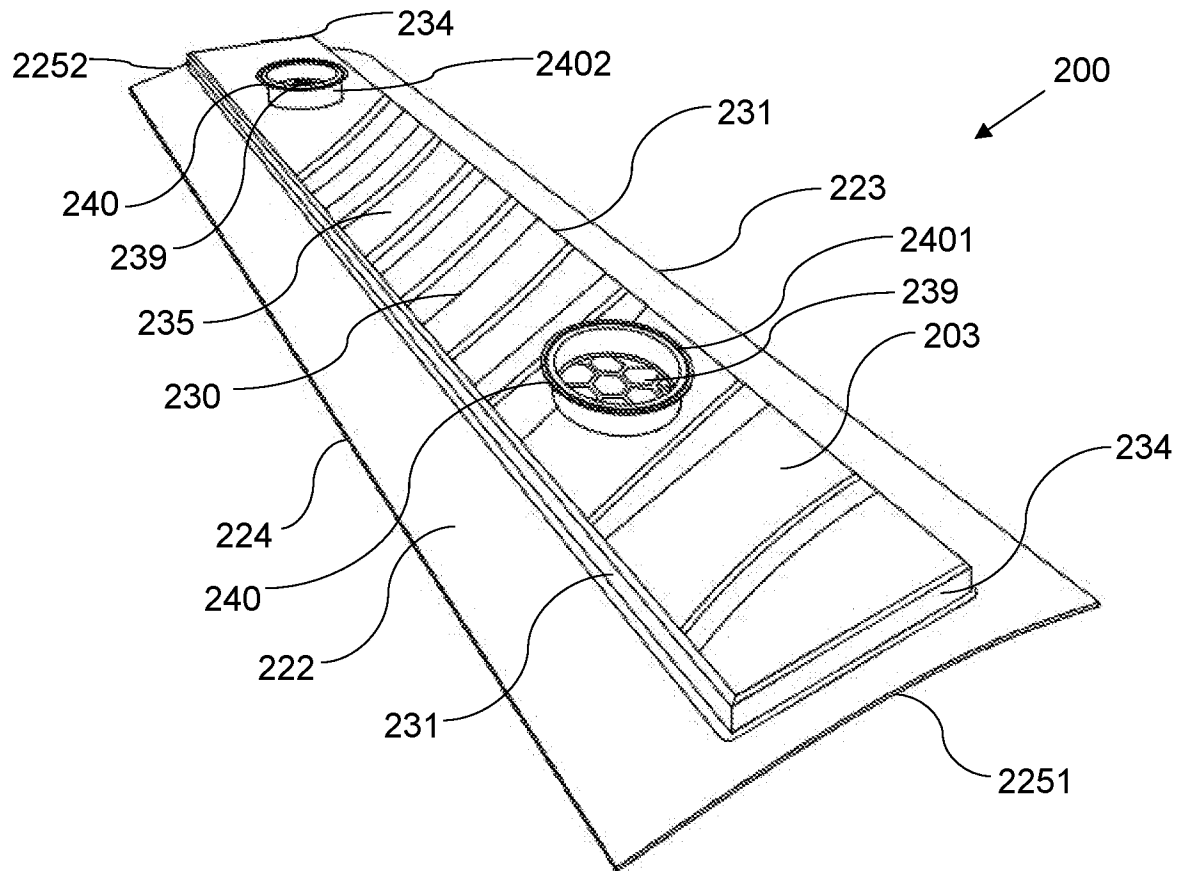


FIG. 11

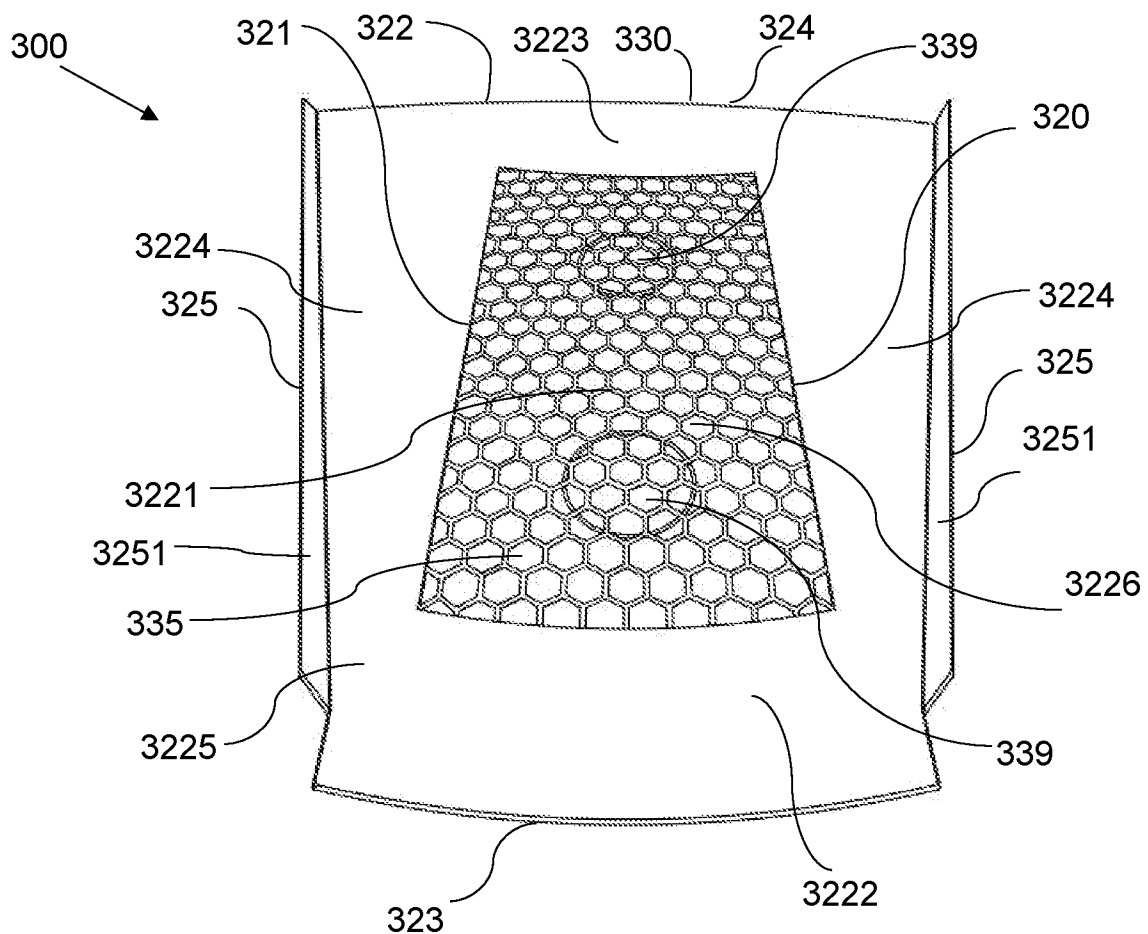


FIG. 12

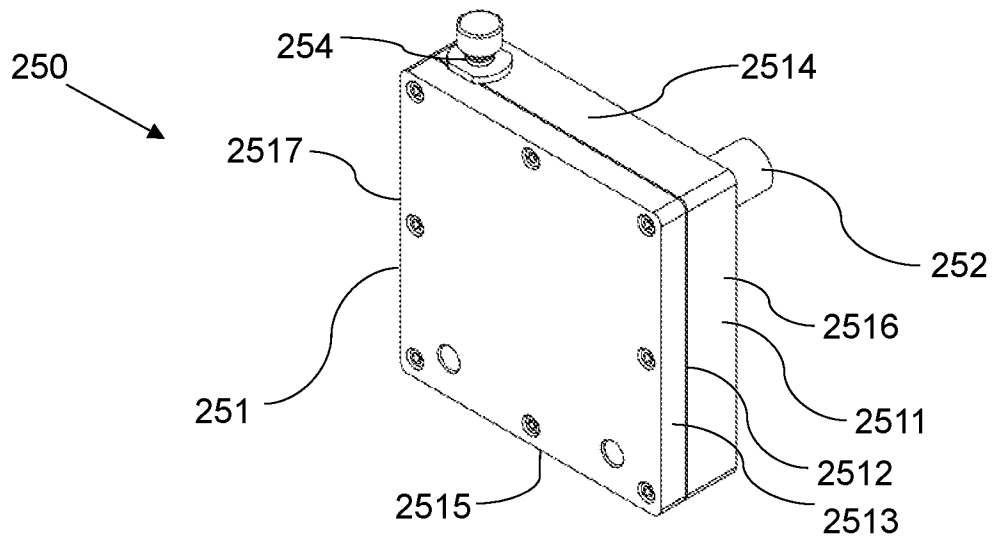


FIG. 13

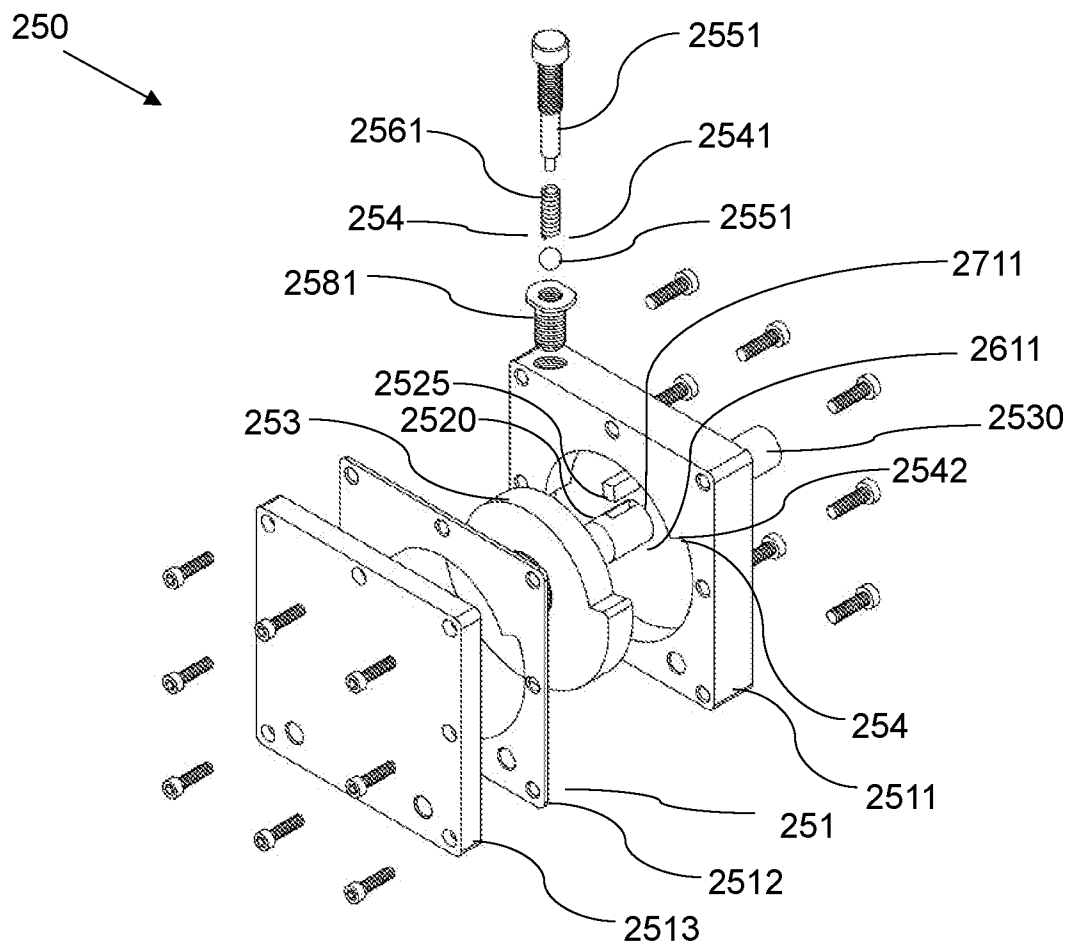


FIG. 14

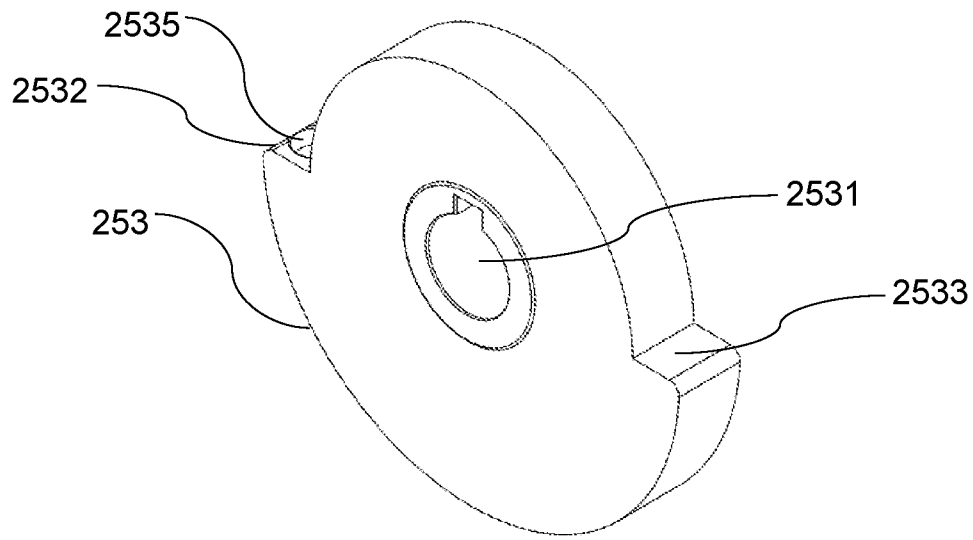


FIG. 15

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2024/050353

## A. CLASSIFICATION OF SUBJECT MATTER

**B01D 29/96 (2006.01) B01D 29/00 (2006.01) B01D 29/03 (2006.01) E21B 21/06 (2006.01)**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PATENW USING IPC/CPC MARKS (E21B21/065, B01D2201/204, B01D29/965, B01D33/15, B01D33/29, B01D33/327, B07B1/28, B01D29/0097, B01D29/0035, B07B1/005, B01D33/0346, B01D2221/08, B01D2201/282, B01D2221/04, B07B1/28, B01D29/0097, B01D29/0035, B07B1/005, B01D33/0346, B01D2221/08, B01D2201/282, B01D2221/04) AND KEYWORDS (VACUUM, SUCTION, ORIENT, INCLINE, ADJUST, CONTROL AND OTHER SIMILAR TERMS); APPLICANT(S)/INVENTOR(S) SEARCH IN DOCDB, DWPI AN DINTERNAL DATABASES PROVIDED BY IP AUSTRALIA

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------|-----------------------|
|           | Documents are listed in the continuation of Box C                                  |                       |



Further documents are listed in the continuation of Box C



See patent family annex

|                                          |                                                                                                                                                                     |                                                                                                                                                                                                                                                  |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| * Special categories of cited documents: |                                                                                                                                                                     |                                                                                                                                                                                                                                                  |
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| "D"                                      | document cited by the applicant in the international application                                                                                                    | "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone                                                                     |
| "E"                                      | earlier application or patent but published on or after the international filing date                                                                               | "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "L"                                      | document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) | "&" document member of the same patent family                                                                                                                                                                                                    |
| "O"                                      | document referring to an oral disclosure, use, exhibition or other means                                                                                            |                                                                                                                                                                                                                                                  |
| "P"                                      | document published prior to the international filing date but later than the priority date claimed                                                                  |                                                                                                                                                                                                                                                  |

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|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Date of the actual completion of the international search<br>20 June 2024                                                                               | Date of mailing of the international search report<br>20 June 2024                                                                         |
| Name and mailing address of the ISA/AU<br><br>AUSTRALIAN PATENT OFFICE<br>PO BOX 200, WODEN ACT 2606, AUSTRALIA<br>Email address: pct@ipaustalia.gov.au | Authorised officer<br><br>Gilbert Lim<br>AUSTRALIAN PATENT OFFICE<br>(ISO 9001 Quality Certified Service)<br>Telephone No. +61 2 6283 2597 |



| INTERNATIONAL SEARCH REPORT                                                                                                                                                                                                                                           |                  | International application No. |                  |
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| Information on patent family members                                                                                                                                                                                                                                  |                  | PCT/AU2024/050353             |                  |
| This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information. |                  |                               |                  |
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