



(51) International Patent Classification:
B03B 4/00 (2006.01)

(21) International Application Number:
PCT/US2017/043576

(22) International Filing Date:
25 July 2017 (25.07.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/367,090 26 July 2016 (26.07.2016) US

(71) Applicant: **M-I L.L.C.** [US/US]; 5950 North Course Drive, Houston, Texas 77072 (US).

(72) Inventor: **FRAZIER, Evan**; 2667 Ridgcrest Lane, Covington, Kentucky 41017 (US).

(74) Agent: **SMITH, David J.** et al.; 10001 Richmond Avenue, IP Administration Center of Excellence, Room 4720, Houston, Texas 77042 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(54) Title: SEPARATOR AND METHOD OF SEPARATION WITH A PRESSURE DIFFERENTIAL SYSTEM

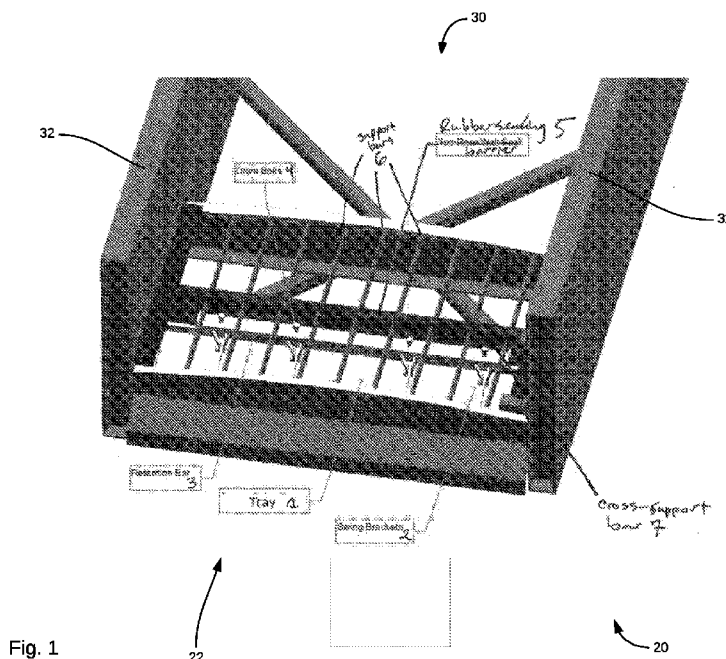


Fig. 1

(57) Abstract: Systems and methods for directing a pressure differential below a screen in a shale shaker to urge fluid to pass through the shaker. A support unit including a tray and a movable arm supports a pressure differential generating device. The support unit can be positioned relative to the shale shaker with the tray in position to collect fluid passing through a screen of the shale shaker. The pressure differential generating device generates a pressure differential that pulls fluid through the screen. One or more slot trays are positioned between the pressure differential generating device, the screen, and some supporting structure of the frame of the shaker. The slot trays distribute the pressure differential around the screen.



Published:

— *with international search report (Art. 21(3))*

SEPARATOR AND METHOD OF SEPARATION WITH A PRESSURE DIFFERENTIAL SYSTEM**CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims priority to U.S. Provisional Patent Application No. 62/367,090 entitled "SEPARATOR AND METHOD OF SEPARATION WITH A PRESSURE DIFFERENTIAL SYSTEM" filed July 26, 2016 which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Various industries, such as oil and gas, mining, agriculture, and the like utilize equipment and/or methods to separate fluid from materials. For example, in the oil and gas industry, oilfield drilling fluid, often called mud, drilling mud, or drilling fluid, serves multiple purposes. Among its many functions, the drilling mud acts as a lubricant for a drilling bit and increases the rate of penetration of the drilling bit. Drilling fluid may also cool the drill bit and provide support for a wellbore during the drilling process. Drilling fluid is pumped through a bore of the drill string to the drill bit where the drilling fluid exits through various nozzles and ports, lubricating the drill bit.

[0003] Another significant purpose of the drilling fluid is to carry the cuttings away from the drill bit to the surface. After exiting through the nozzles, the spent fluid returns to the surface through an annulus formed between the drill string and the drilled wellbore. The returned drilling mud is processed for continued use. The drilling fluid exiting the borehole from the annulus is a slurry of formation cuttings in drilling fluid, and the cutting particulates must be removed before the drilling fluid is reused.

[0004] In order to remove solid particulates, such as cuttings, from the drilling fluid, many in the oil and gas industry use what is known as a shaker. A shaker may also be called a shale shaker, a vibratory separator, or a gyratory sifter. A vibratory separator may be a vibrating, sieve-like table upon which returning, used drilling fluid is deposited and through which substantially cleaner drilling fluid emerges. A vibratory separator is an angled table with a generally perforated filter screen bottom. Returning drilling fluid may be deposited at the top or inlet end of the shaker. As the slurry moves toward a discharge end, which is higher than the

inlet end, the fluid may fall through the perforations to a reservoir below, thereby separating the solid particulate material that is unable to pass through the filter screen.

[0005] Screens used with shakers are placed in a horizontal fashion on a horizontal support within a basket or tray in the shaker. The shaker imparts a rapidly reciprocating motion to the basket and screens. Material from which particles are to be separated is poured onto a back end of the vibrating screen and are conveyed along the shaker toward the discharge end of the basket.

[0006] In some shakers, a fine screen cloth is used with the vibrating screen. The screen has two or more overlaying layers of screen cloth and/or mesh. Layers of cloth and/or mesh are bonded together and placed over a support. The frame of the vibrating screen is suspended and/or mounted on a support and vibrates by a vibrating mechanism to create a flow of trapped solids on top surfaces of the screen for removal and disposal of solids.

[0007] Shakers include one or more sets of screens (in a series or parallel configuration) between the inlet and the discharge end. Shakers may include a system of eccentric weights. For example, a gyratory sifter may include a top weight and a bottom weight. The top weight is coupled to a motor, causing the top weight to rotate in a plane that is close to the center of the mass of assembly. This causes vibration and movement of the screens in the horizontal plane, which causes material input to the screen surface to spread across the screen from the middle to the periphery of the screen. Such movement encourages material too large to pass through the screen to be output and thus removed from the screen surface. A bottom eccentric weight rotates below the center of mass and create a tilt on the screen surface. The imposition of a tilt on the screen surface causes vibration in a vertical and tangential plane. Such movement induces particles smaller than the mesh size to pass through the screen surface at a more rapid pace and encourages particles only slightly smaller than the mesh size to find the correct alignment for passing through the screen, thus increasing turnover. Horizontal or vertical motion is amplified through spring assemblies.

BRIEF DESCRIPTION OF THE FIGURES

[0008] Figure 1 is a top perspective view of a shaker configured to support a pressure differential system according to embodiments of the present disclosure.

[0009] Figure 2 shows a perspective view of an embodiment of a tray and support unit with the swing brackets in a folded configuration according to embodiments of the present disclosure.

[0010] Figure 3 shows a perspective view of an embodiment of a tray and support unit with the swing brackets in a standing configuration according to embodiments of the present disclosure.

[0011] Figure 4 is a perspective view of the shaker and the support unit showing how the support unit is inserted into the shaker according to embodiments of the present disclosure.

[0012] Figure 5 is a perspective view of the shaker and support unit after raising the swing brackets according to embodiments of the present disclosure.

[0013] Figure 6 is an illustration of a tray according to embodiments of the present disclosure including a pressure differential generating system mounted to the tray according to embodiments of the present disclosure.

[0014] Figure 7 is a side sectional drawing that illustrates certain aspects and components of a pressure differential generating system according to embodiments of the present disclosure.

[0015] Figure 8 is a top perspective view of a shaker including a pressure differential generating system according to embodiments of the present disclosure.

DETAILED DESCRIPTION

[0016] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described herein are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the Figures, may be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and make part of this disclosure.

[0017] Figure 1 is a top perspective view of a shaker 20 configured to support a pressure differential system according to embodiments of the present disclosure. Shakers such as shaker 20 can be used to separate material from a fluid, usually by shaking or otherwise moving a screen or other filtering component such that the fluid passes through the screen while

material to be removed does not. The unwanted material can be removed from the screen and the fluid is captured after passing through the screen. Shakers can be used to remove cuttings and other solid material from a drilling mud. The shaker 20 can be a shale shaker. Some shakers are circular and rotate a screen or other components, perhaps in addition to shaking, vibrating, or other movements to encourage the desired separation. Other shakers are rectangular. Some shakers move the fluid in a transverse direction while allowing gravity to pull the fluid downward through a screen. In many configurations, the shaker has a generally flat, generally horizontal surface upon which the fluid is deposited. The screen or other filtering component can rest on this surface supported in various ways including bars, bolts, etc.

[0018] According to some embodiments of the present disclosure, the shaker 20 has a frame 30 which supports a screen (not shown) for separating unwanted, larger particles from a fluid, such as cuttings from a drilling mud while allowing the fluid to collect onto a tray 1 below the screen. The shaker 20 can be configured to move vertically, horizontally, or in any combination to remove material from the fluid. The removed material can be moved off the shaker 20. Frame 30 can have various components such as side walls 32, support bars 6, and cross support bars 7. There can be any number of cross bars and support bars which can extend in a generally horizontal direction to create a generally flat supporting surface which can support the screen. The fluid that passes through the screen also passes through the support bars 6 and the cross support bars 7.

[0019] According to some embodiments, the shaker 20 can include a support unit 22 comprising a tray 1, swing bracket(s) 2, retention bar(s) 3, drive bolt(s) 4, and/or rubber sealing barrier(s) 5. In some embodiments the support unit 22 is modular and can be coupled to an existing shaker to retrofit the shaker 20. The support unit 22 can be altered to fit into various different structures of various shakers. The support unit 22 can be altered in size and/or shape to fit various types of shakers. For example, the support unit 22 can have components such as drive bolts 4 which can be turned to threadably extend to contact the frame of a shaker to hold the support unit 22 in place. In other embodiments the support unit 22 can include rotatable components which rotate into a locking position to engage a frame of a shaker 20 to hold the support unit 22 in place. The support unit 22 may incorporate metal components, ultra-high-

molecular-weight polyethylene components, and/or mixtures thereof. In some embodiments, the support unit 22 includes the tray 1, swing brackets 2 that are rotatably coupled to the tray 1, and a retention bar 3 coupled to the swing brackets 2. The retention bar 3 extends along a portion of the shaker 20 between the side walls 32. The swing brackets 2 may be folded down toward the tray 1 and may swing upward and be locked into a standing position. Figure 2 shows a perspective view of an embodiment of a tray 1 and support unit 22 with the swing brackets 2 in a folded configuration, and Figure 3 shows a perspective view of an embodiment of a tray 1 and support unit with the swing brackets 2 in a standing configuration. The support unit 22 can be introduced into the shaker 20 while in the folding configuration and the swing brackets 2 can be moved into the standing position to lock the support unit 22 into place relative to the shaker 20.

[0020] Figure 4 is a perspective view of the shaker 20 and the support unit 22 showing how the support unit 22 is inserted into the shaker 20 according to embodiments of the present disclosure. Figure 5 is a perspective view of the shaker 20 and support unit 22 after raising the swing brackets 2 according to embodiments of the present disclosure. Referring to both figures 4 and 5 simultaneously, the tray 1 (with the swing brackets 2 in the folded-down configuration) may be inserted into a bottom portion of the shaker 20. In some embodiments, the tray 1 may be slid underneath support bars 6, which may support a screen (not shown). With the tray 1 in a desired position, such as underneath the support bars 6, the swing brackets 2 may be extended into and locked in a standing position as shown in Figure 5. The retention bar 3 can be rotated from the folding configuration to the standing configuration. The drive bolts 4 may be extended, forcing the retention bar 3 against the support bars 6 of the shaker 20. In other embodiments the drive bolts 4 are extendible pins or detents or other fasteners or extendible components. For example, the retention bar 3 may be forced against the underside of the support bars 6, which may support a screen (not shown). As a result, the tray 1 may be forced downward against the shaker and therefore the support unit 22 is held in place relative to the shaker 20. The tray 1 may be shaped to correspond to and engage with the shape of the shaker 20 or its components. The tray 1 may include one or more sealing gaskets 5 along its perimeter or at various other locations to create a seal between the tray 1 and the shaker 20. The drive

bolts 4 may be turned or otherwise extended until the tray 1 and sealing gaskets are forced against the shaker 20 to create a seal.

[0021] Figure 6 is an illustration of a tray 1 according to embodiments of the present disclosure including a pressure differential generating system 24 mounted to the tray 1. Components of the support unit, such as swing brackets 2, retention bar 3, and drive nuts 4 are visible. The pressure differential generating system 24 includes a conduit 14 and a driving fluid source 12, the operation of which will be described below. A perimeter sealing gasket 13 extends around a perimeter of the tray 1. The sealing gasket 13 helps to prevent fluid from flowing downward past the tray 1 after passing through the screen. There can be multiple such screens, some of which can have pressure differential systems 24 mounted thereto, some of which that do not.

[0022] Figure 7 is a side sectional drawing that illustrates certain aspects and components of a pressure differential generating system 24 according to embodiments of the present disclosure. The pressure differential generating system 24 comprises a pressure differential generating device 10, a conduit 14 having an interior channel 15, a driving fluid inlet 16, and a driving fluid source 12. The pressure differential generating device 10 can be a pump or another suitable mechanism for generating a pressure differential in the driving fluid. The driving fluid source 12 can be a tube or a hose that directs the driving fluid into the driving fluid inlet 16. The driving fluid inlet 16 can be angled downward relative to the orientation of the conduit 14 such that the driving fluid moving through the channel 15 of the conduit causes a pressure differential in the channel 15 which urges air and other fluid to move downward in the direction of the arrows A. The conduit 14 can be oriented at an angle relative to vertical as shown in Figure 8. In other embodiments the conduit can be at a different angle including vertical. The conduit 14 can direct the driving fluid into a driving fluid collection unit 17, shown schematically in Figure 8. The driving fluid can be condensed, de-atomized, or otherwise treated in the driving fluid collection unit 17. The driving fluid that is pressurized in the pressure differential generating device 10 and introduced through the driving fluid source 12 can be air, water, or another suitable gas or liquid that will create the appropriate pressure differential to cause the fluid to pass through a screen. In some embodiments, the driving fluid is pulsed from the driving fluid source 12 in a pattern where the pressure differential is created during different, discrete

intervals. For example, the pressure differential generating system 24 may pulse on to remove particles from the fluid but may pulse off again to allow the particles to be discharged from the shaker 20. The pulses can be on for a few seconds, off for a few seconds, as needed. Releasing the pressure differential periodically allows cuttings and other undesirable content to be more easily removed from the shaker 20. One skilled in the art will realize that various pulsing patterns and lengths of time may be applied depending on particular conditions and slurries being run through the shaker 20.

[0023] In some embodiments the pressure differential generating system 24 is mounted to components of the support unit 22. For example, the conduit 14 can be mounted to the tray 1, or to one or more of the support bars 6 or the cross-support bars 7 (shown in Figures 1, 4, and 5). The conduit 14 can pass through the tray 1, with a portion of the conduit 14 being raised up relative to the tray 1. Having the tray 1 below the entrance to the conduit 14 helps to prevent fluid from entering the conduit 14 and encourages it to collect on the tray 1 instead. In some embodiments the tray 1 is much larger than the channel 15, further helping prevent fluid from entering the channel 15. The inlet 16 can be positioned below the conduit 14, allowing the conduit 14 to shield the inlet 16 from fluid coming through the screen.

[0024] Figure 8 is a top perspective view of a shaker 20 including a pressure differential generating system 24 according to embodiments of the present disclosure. Various components of the support unit 22 described with reference to other figures are present here, including a tray 1, swing brackets 2, support bars 6, cross-support bars 7, retention bar 3, drive bolts 4, and sealing barrier 5. Note that in the embodiment pictured in Figure 7 a screen 9 is shown moved out of the way to permit visibility into the shaker 20. In operation the screen 9 would cover most of the visible components because it is placed on and operatively coupled to the shaker 20. Components of the pressure differential generating system 24 are also visible, including pressure differential generating device 10, driving fluid source 12, and conduit 14.

[0025] In certain embodiments, the shaker 20 also includes one or more slot trays 8 positioned beneath the screen 9 close enough to the screen 9 to form at least a partial seal with the screen 9. The seal can be as complete as necessary for a given configuration. There are two slot trays 8 pictured in Figure 8 but in practice there can be any suitable number of slot trays 8. The slot

trays 8 can collectively form a slot tray surface area, which can be nearly as large as the screen 9. In some embodiments the slot tray surface area is larger than the screen 9 or as large as the screen 9. The slot tray surface area can be much larger than an area of the opening in the conduit 14 of the pressure differential generating system 24. For example, the slot tray surface area can be up to 300 times larger than the conduit 14. In the case of multiple conduits the area of the opening of the conduits can be calculated collectively.

[0026] The slot trays 8 can be positioned in the frame of the shaker 20 in a location called a slot, but the slot trays 8 can be positioned in other areas as well. The slot trays 8 can also be called upper trays because in some embodiments they are positioned above the tray 1. They can be called secondary trays, frame trays, or simply trays.

[0027] The slot trays 8 are also fluidly connected to the pressure differential generating system 24 such that the slot trays 8 distribute the pressure differential throughout a larger area of the screen 9 than would otherwise be achieved. The slot trays 8 can be shaped and sized to fit between supporting structures, such as support bars 6 and cross-support bars 7. The supporting structure of the shaker 20 can have various shapes creating corresponding spaces between, such as rectangular spaces, square spaces, circular spaces, hexagonal spaces, etc. The slot trays 8 can be shaped to accommodate the supporting structure. The slot trays 8 can catch fluid as it moves through the screen 9, and can deposit the fluid onto the tray 1 which can be positioned below the slot trays 8.

[0028] The slot trays 8 can be angled or otherwise shaped to divert the fluid onto a desired portion of the tray 1. The slot trays 8 can have one or more openings that permit fluid to enter or leave the slot trays 8. The slot trays 8 pictured in Figure 8 can have a first end 25 and a second end 26. The first end 25 can be open to permit the fluid to slide off onto the tray and the second end 26 can be closed. Either end can be sealed. In some embodiments the slot trays 8 direct the fluid away from the conduit 14 to minimize the quantity of fluid entering the conduit 14. For example, the first end 25 can be open to permit fluid to move onto the screen away from the conduit 14. For another slot tray 8 with one opening over the conduit 14, a different end of that slot tray 8 can be open. The slot trays 8 can have flanges 27 that engage the support bars 6 or other supporting structure to keep the slot trays 8 in place relative to the

supporting structure. The slot trays 8 can be fastened to the shaker 20 or can simply rest on the support bars 6 or other supporting structure. The slot trays 8 can have sealing gaskets (not shown) on an upper surface that contact the screen 9 to further promote a seal between the slot trays 8 and the screen 9.

[0029] In some embodiments the support unit 22 can engage the slot trays 8 to hold the slot trays 8 in place. The support unit 22 includes in some embodiments swing brackets 2 which can rotate into position and drive bolts 4 which can be extended to contact the slot trays 8. The drive bolts 4 can urge the slot trays 8 against the screen 9 to promote the seal between the slot trays 8 and the screen 9.

[0030] The conduit 14 of the pressure differential generating system 24 can be positioned at various locations around the shaker 20 relative to the screen 9. In some embodiments, the conduit 14 is positioned at a central location on the screen and the slot trays 8 distribute the pressure differential around the screen 9. In other embodiments, there can be multiple conduits 14 which can be distributed around the shaker 20. There can be a single pressure differential generating device 10 servicing multiple conduits 14, or there can be a dedicated pressure differential generating device 10 for each conduit. In some embodiments, the conduit(s) 14 are positioned relative to the screen 9 to discourage fluid from entering the conduit(s) 14.

[0031] Embodiments of the present disclosure are directed to a system including a shale shaker having a frame and a screen positioned on or above the frame of the shale shaker to receive a fluid containing particulate material and to separate at least a portion the particulate material from the fluid. The system also includes a pressure differential generating device configured to create a pressure differential across the screen. The pressure differential draws at least a portion of the fluid through the screen. The system also has one or more slot trays supported by the frame, the one or more slot trays being in fluid communication with the pressure differential generating device such that the pressure differential generating device causes the pressure differential upon portions of the screen remote from the pressure differential generating device. The screen can define a screen surface area, and the slot trays can define a

slot tray surface area. The slot tray surface area can be substantially equal to the screen surface area.

[0032] Other embodiments of the present disclosure are directed to a system including a tray and a movable arm coupled to the tray and configured to move between a first position and a second position. The tray and movable arm are configured to be positioned relative to a frame of a shale shaker with the tray being positioned to collect fluid moving through a screen of the shaker. Moving the movable arm from the first position to the second position secures the tray to the shaker. The system can also include a pressure differential generating device coupled to the tray, the pressure differential generating device being configured to direct fluid to move through the screen.

[0033] Still other embodiments of the present disclosure are directed to a method including generating a pressure differential across a screen of a shale shaker and positioning a support unit having a tray and a movable arm relative to the screen, the movable arm being configured to move between a first position and a second position. The method also includes moving the movable arm from the first position to the second position. In the second position the movable arm secures the support unit to the shale shaker with the tray positioned to collect at least one of fluid, air, or vapor after passing through the screen. The tray comprises a first tray and generating the pressure differential comprises generating the pressure differential in a first region of the screen. The method can also include positioning a second tray in fluid communication with the generated pressure differential and engaging the screen to distribute the pressure differential to a second region of the screen.

[0034] While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting.

CLAIMS

1. A system, comprising:
a shale shaker having a frame;
a screen positioned on or above the frame of the shale shaker to receive a fluid containing particulate material and to separate at least a portion the particulate material from the fluid;
a pressure differential generating device configured to create a pressure differential across the screen, wherein the pressure differential draws at least a portion of the fluid through the screen at a first region of the screen; and
one or more slot trays supported by the frame, the one or more slot trays being in fluid communication with the pressure differential generating device such that the pressure differential generating device causes the pressure differential upon a second region of the screen.
2. The system of claim 1, wherein the slot trays contact an underside of the screen.
3. The system of claim 1 wherein the frame comprises a plurality of support bars, and wherein the slot trays are configured to fit between the support bars.
4. The system of claim 1 wherein the slot trays form at least a partial seal between the slot trays and the screen.
5. The system of claim 1 wherein the slot trays are configured to collect at least a portion of the fluid after passing through the screen.
6. The system of claim 5 wherein the slot trays are sloped to direct the fluid onto a tray beneath the slot trays.
7. The system of claim 5 wherein the slot trays form an opening through which the fluid can flow off of the slot trays.

8. The system of claim 1 wherein the slot trays have flanges to support the slot trays relative to the frame.
9. The system of claim 1, the screen defining a screen surface area and the slot trays defining a slot tray surface area, and wherein the slot tray surface area is substantially equal to the screen surface area.
10. The system of claim 1, further comprising a conduit operably coupled to the pressure differential generating device through which a driving fluid is directed, the conduit having an opening defining a conduit opening area, wherein the slot trays define a slot tray surface area, and wherein the slot tray surface area is larger than the conduit opening area.
11. The system of claim 10 wherein the slot tray surface area is between 2 and 300 times the size of the conduit opening area.
12. A system, comprising:
a tray;
a movable arm coupled to the tray and configured to move between a first position and a second position, wherein:
the tray and movable arm are configured to be positioned relative to a frame of a shale shaker with the tray being positioned to collect fluid moving through a screen of the shaker; and
moving the movable arm from the first position to the second position secures the tray to the shaker.
13. The system of claim 12 wherein the tray is configured to secure to an interior of the shale shaker.
14. The system of claim 12, further comprising a pressure differential generating device coupled to the tray, the pressure differential generating device being configured to direct fluid to move through the screen.

15. The system of claim 12 wherein the tray comprises a plurality of slot trays that contact the screen.

16. The system of claim 15, further comprising a pressure differential generating device coupled to the tray, the pressure differential generating device being configured to direct fluid to move through the screen, wherein the slot trays are fluidly connected to the pressure differential generating device.

17. The system of claim 16 wherein the slot trays are configured to distribute a pressure differential to an area of the screen.

18. The system of claim 17 wherein the area of the screen comprises substantially all of the screen.

19. The system of claim 16 wherein the slot trays are substantially coextensive with the screen.

20. The system of claim 12 wherein the movable arm comprises a swing bracket that is substantially parallel with the tray in the first position and extends from the tray in the second position.

21. The system of claim 12 wherein the movable arm comprises an extendible component and wherein the first position comprises a retracted position for the extendible component and the second position comprises an extended position for the extendible component.

22. The system of claim 12, further comprising the shale shaker.

23. A method, comprising:

generating a pressure differential across a screen of a shale shaker;

positioning a support unit having a tray and a movable arm relative to the screen, the movable arm being configured to move between a first position and a second position; and

moving the movable arm from the first position to the second position, wherein in the second position the movable arm secures the support unit to the shale shaker with the tray positioned to collect at least one of fluid, air, or vapor after passing through the screen.

24. The method of claim J wherein the tray comprises a first tray and wherein generating the pressure differential comprises generating the pressure differential in a first region of the screen, the method further comprising positioning a second tray in fluid communication with the generated pressure differential and engaging the screen to distribute the pressure differential to a second region of the screen.

25. The method of claim 23 wherein moving the movable arm from the first position to the second position comprises rotating a swing bracket.

26. The method of claim 24 wherein positioning the second tray comprises positioning a plurality of second trays.

27. The method of claim 24 wherein positioning the second tray comprises positioning a second tray in fluid communication with the generated pressure differential and engaging the screen to distribute the pressure differential to a second region of the screen, wherein the second tray is substantially coextensive with the screen.

28. The method of claim 24, further comprising collecting fluid in the first tray from the second tray.

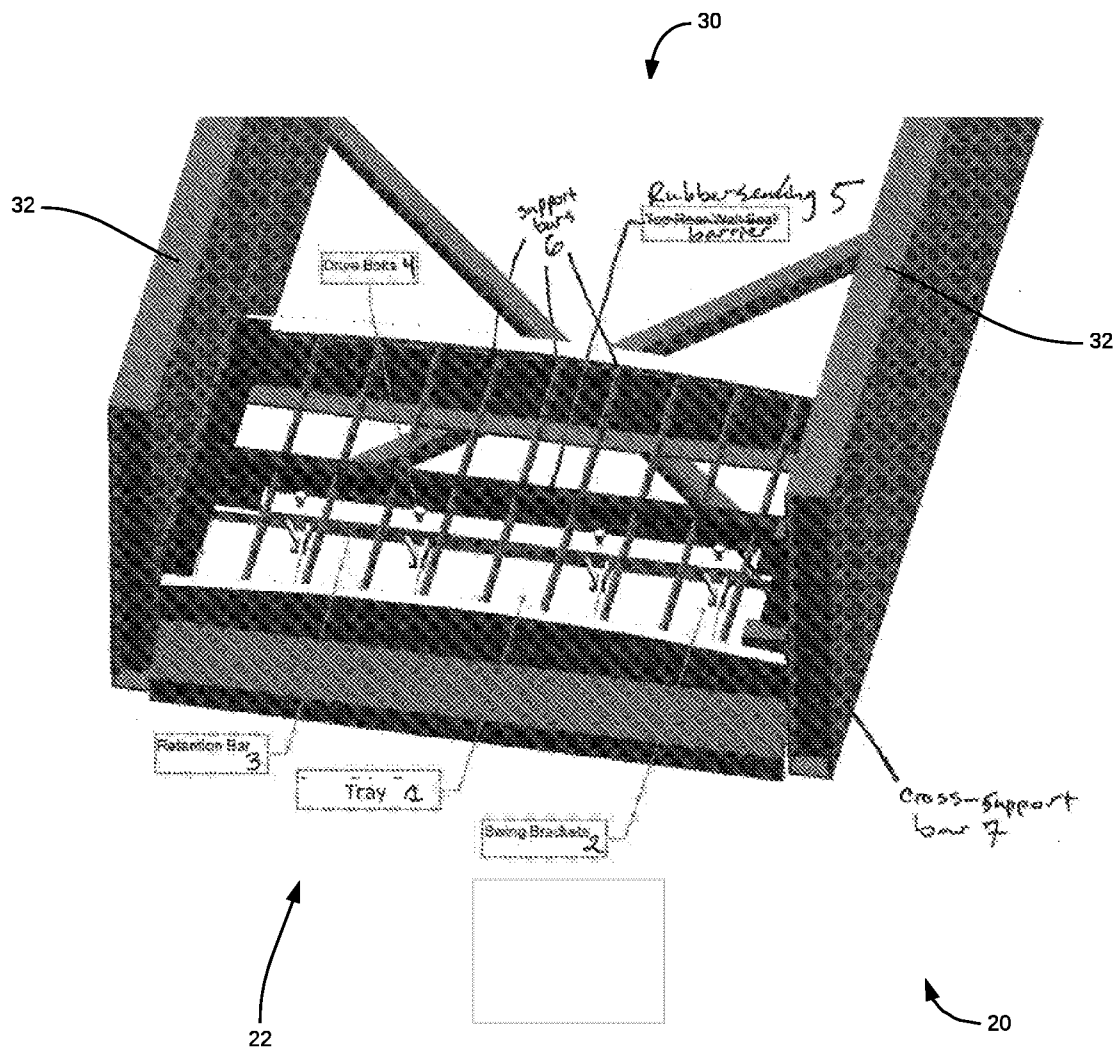


Fig. 1

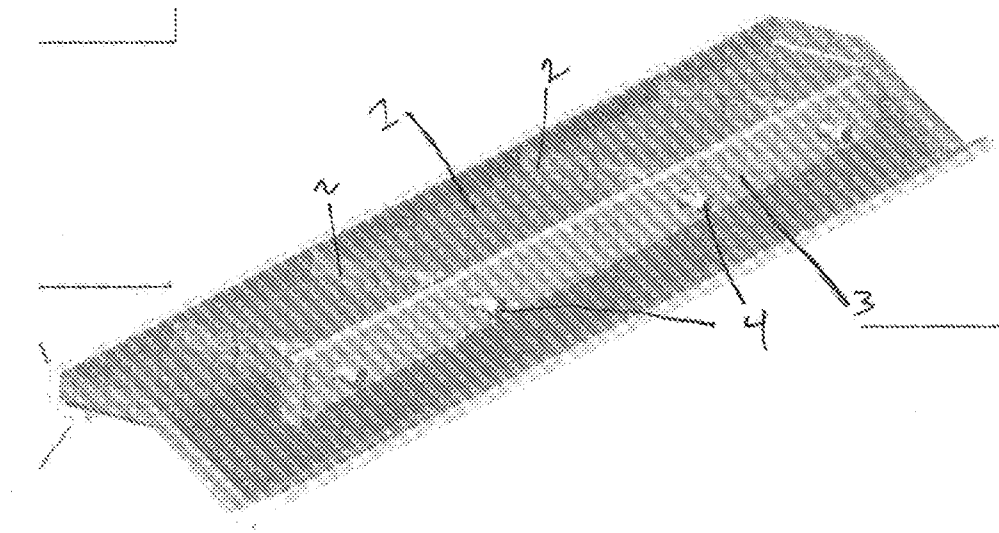


FIG. 2

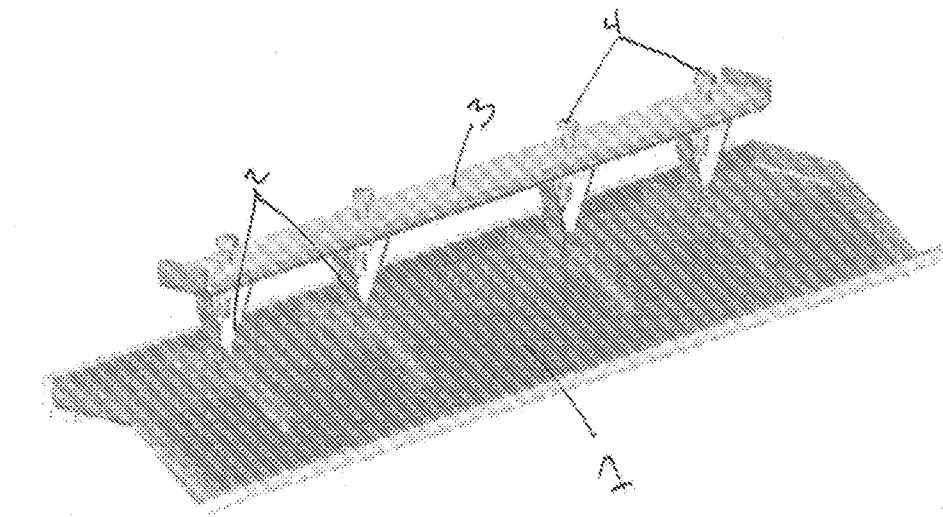
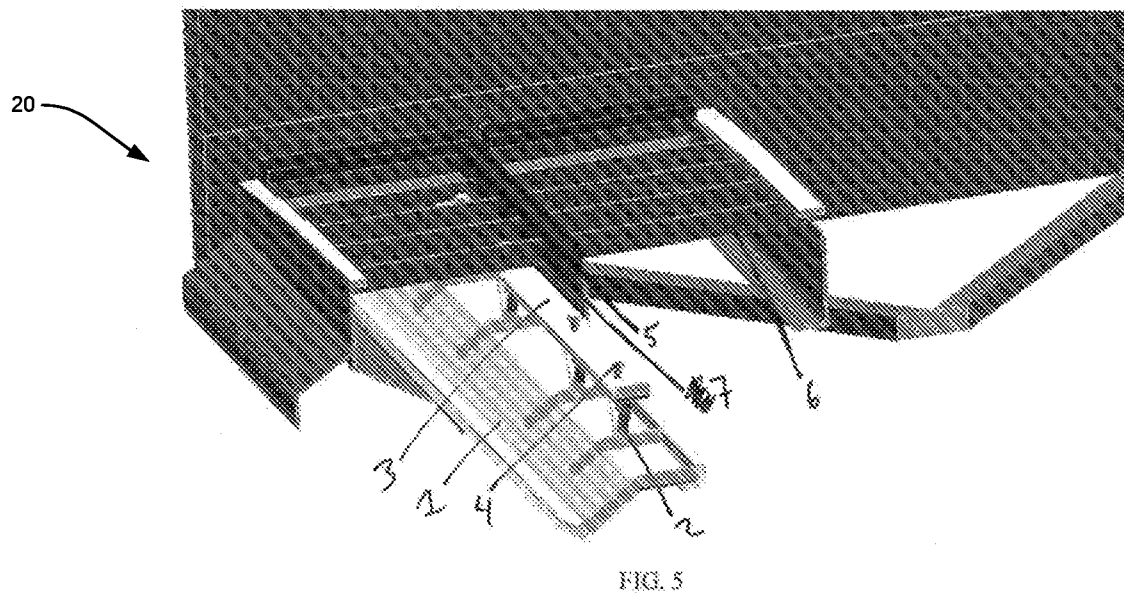
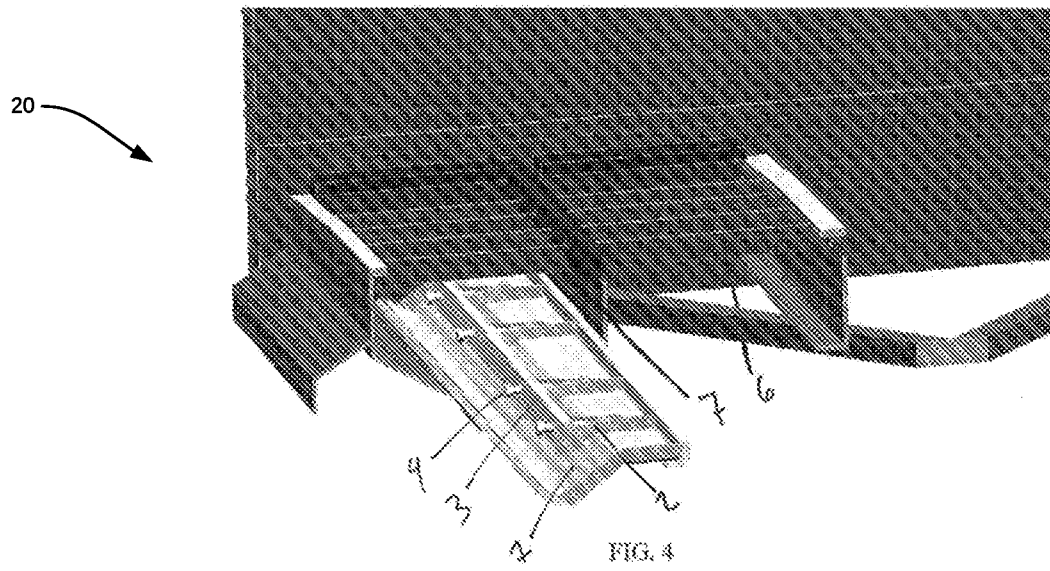


FIG. 3



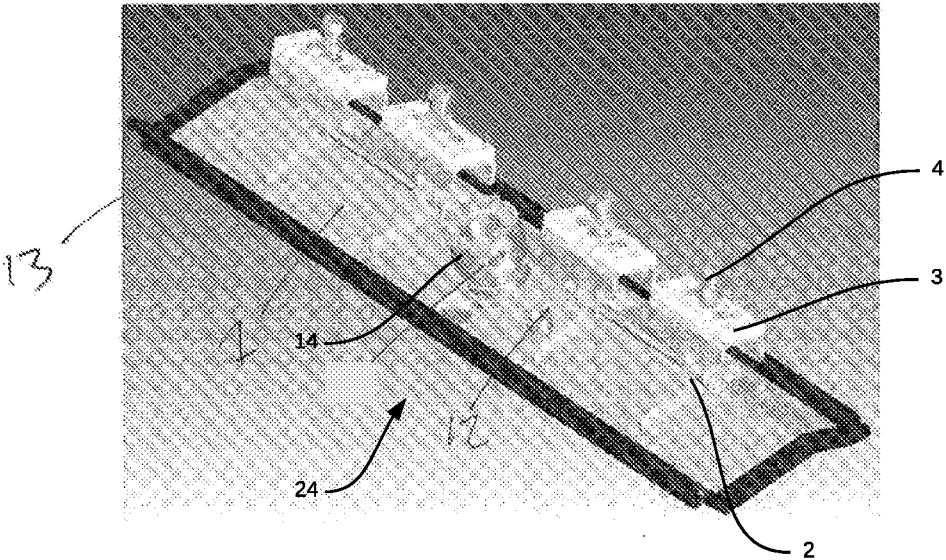


Fig. 6

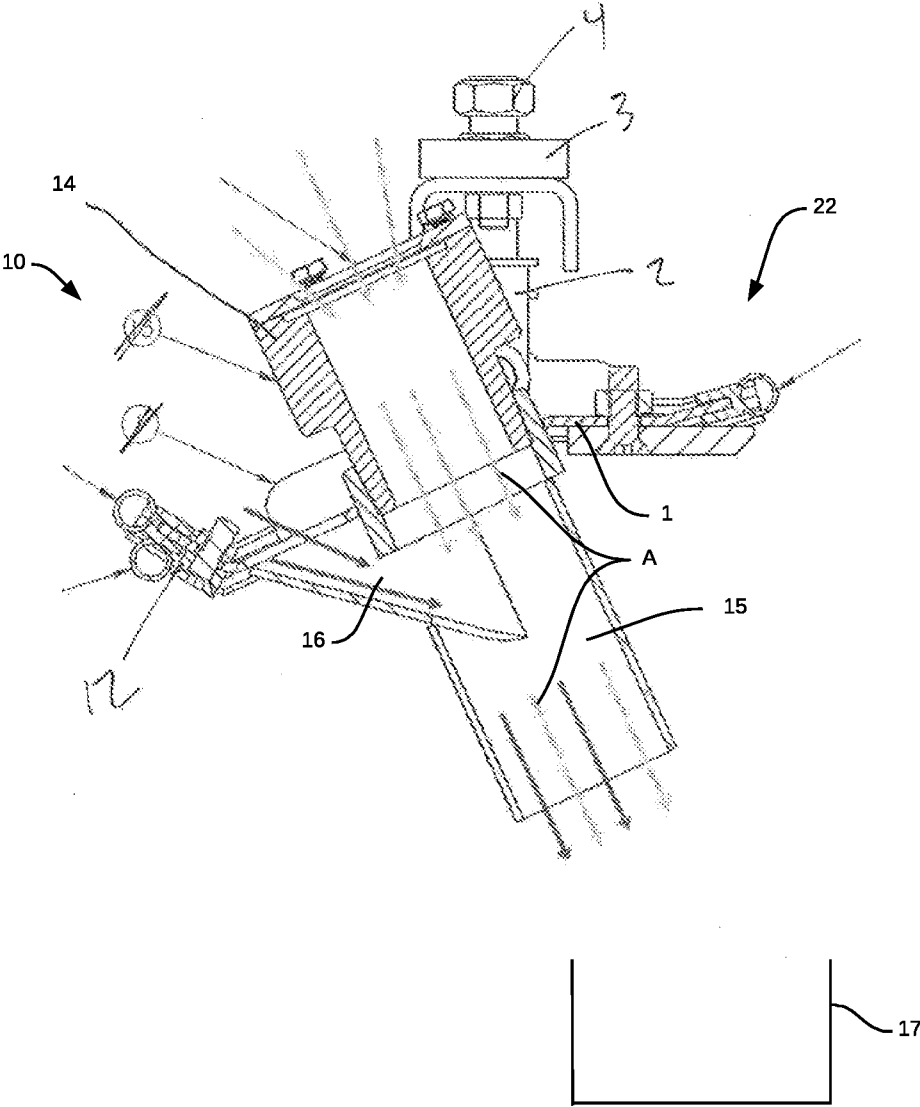


Fig. 7

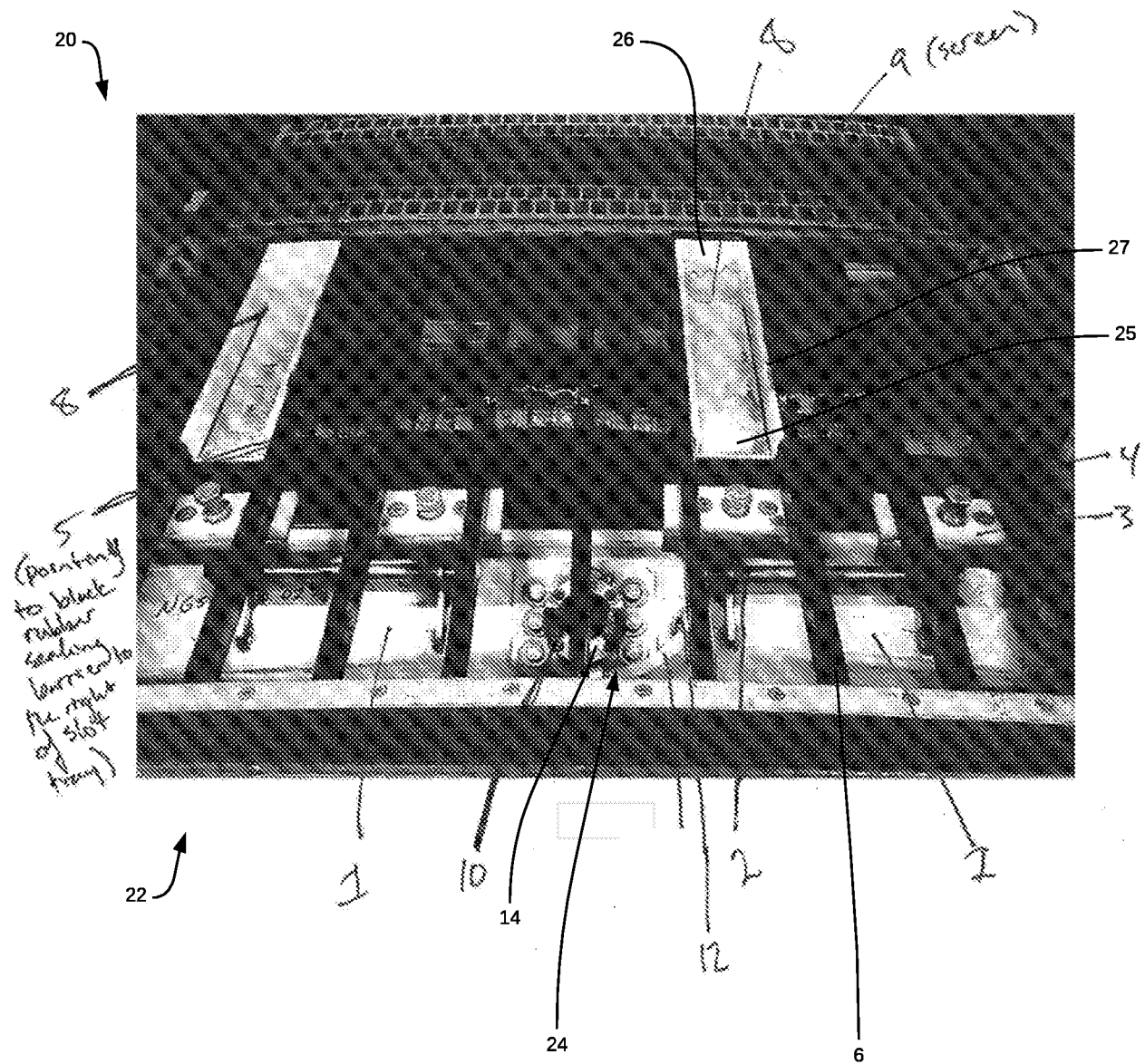


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/043576**A. CLASSIFICATION OF SUBJECT MATTER****B03B 4/00(2006.01)i**

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)

B03B 4/00; B03B 5/04; B01D 33/03; E21B 21/06; B07B 1/22; B07B 13/16; B01D 35/20

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: shale shaker, slot tray, movable arm, pressure differential generating device

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2015-0048037 A1 (M-I L.L.C.) 19 February 2015 See paragraphs [0020]-[0037]; and figures 1-12.	1-28
A	US 2011-0284481 A1 (POMERLEAU, D. G.) 24 November 2011 See the entire document.	1-28
A	WO 92-19354 A1 (BURGESS, H. L.) 12 November 1992 See the entire document.	1-28
A	US 2005-0082236 A1 (DERRICK, M. J. et al.) 21 April 2005 See the entire document.	1-28
A	US 2010-0012556 A1 (POHLE, D. L.) 21 January 2010 See the entire document.	1-28



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search

07 November 2017 (07.11.2017)

Date of mailing of the international search report

08 November 2017 (08.11.2017)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

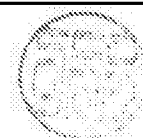
189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

Facsimile No. +82-42-481-8578

Authorized officer

LEE, Dong Wook

Telephone No. +82-42-481-8163



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/043576

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015-0048037 A1	19/02/2015	CA 2921581 A1 EP 3033163 A1 MX 2016002103 A US 2017-0022771 A1 WO 2015-024012 A1 WO 2015-081200 A1	19/02/2015 22/06/2016 15/02/2017 26/01/2017 19/02/2015 04/06/2015
US 2011-0284481 A1	24/11/2011	AU 2009-310586 A1 AU 2009-310586 A2 AU 2009-310586 B2 CA 2741955 A1 CA 2741955 C CN 102187051 A CN 102187051 B CN 105107716 A GB 2477056 A GB 2477056 B MX 2011004303 A NO 20110775 A NO 20110775 A1 RU 2011120971 A RU 2534280 C2 US 2012-0279932 A1 WO 2010-048718 A1	06/05/2010 19/05/2011 16/07/2015 06/05/2010 23/12/2014 14/09/2011 16/09/2015 02/12/2015 20/07/2011 03/07/2013 03/08/2011 27/05/2011 27/05/2011 10/12/2012 27/11/2014 08/11/2012 06/05/2010
WO 92-19354 A1	12/11/1992	AU 2015792 A CA 2102217 A1 CA 2102217 C GB 2255290 A GB 2255290 B MX 9202042 A MX 9202042 A1 NO 302646 B1 NO 933975 A US 5190645 A	21/12/1992 04/11/1992 09/12/1997 04/11/1992 11/01/1995 01/11/1992 01/11/1992 06/04/1998 09/12/1993 02/03/1993
US 2005-0082236 A1	21/04/2005	AU 2003-237214 A1 CA 2487134 A1 CN 1658943 C EP 1528955 A1 US 2003-0230541 A1 US 2005-0133465 A1 WO 03-105988 A1 WO 2006-049927 A2 WO 2006-049927 A3 WO 2006-049928 A2 WO 2006-049928 A3	31/12/2003 24/12/2003 24/08/2005 11/05/2005 18/12/2003 23/06/2005 24/12/2003 11/05/2006 16/04/2009 11/05/2006 16/04/2009
US 2010-0012556 A1	21/01/2010	CA 2672429 A1	21/01/2010