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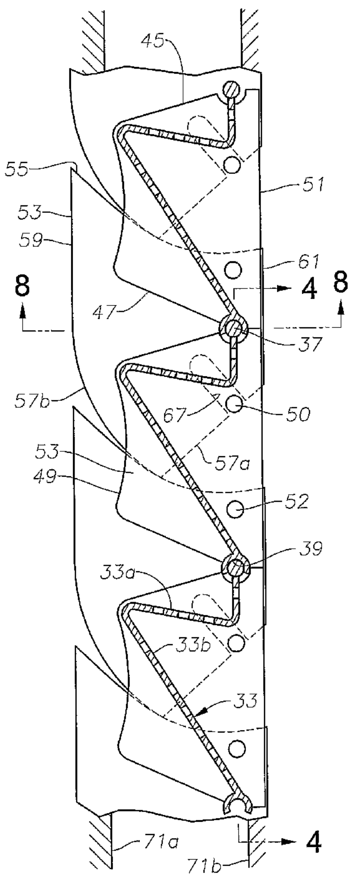
(54) Title: CENTER FLOW PERFORATED PLATE FILTER



(57) Abstract: A waste water filter has a perforated conveyor made up of a plurality of segments. Each of the segments has a shelf portion to lift trapped filtered material. Drive chains on opposite sides of the conveyor rotate the conveyor in an oblong loop. End plates on the ends of each segment have leading and trailing edges that extend at an acute angle relative to one another. Each of the end plates is rigidly mounted to a link of one of the chains. A socket mounted on a first edge of each of the segments engages a rod mounted on a second edge of an adjacent segment. Seal plates arelocated between the chains and the end plates. Each of the seal plates is rigidly mounted to one of the end plates and has an overlapping portion that extends alongside in sliding contact with an adjacent one of the end plates.

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CENTER FLOW PERFORATED PLATE FILTER

Cross-Reference to Related Application

This application claims priority to provisional application 60/561,964, filed April 14, 2004.

Field of the Invention

This invention relates in general to large screen filters, and particularly to a filter that utilizes a conveyor of perforated plates with the flow entering a central area between the upward and downward runs of the conveyor.

Background of the Invention

Large filtration units are used by municipalities and various industries to filter material from the water. One type of filter uses a perforated conveyor having a large number of apertures. The conveyor is rotated in an oblong loop as the water flows through the conveyor. The conveyor is made up of a number of segments pivotally linked to each other. Each segment has a shelf portion that lifts filtered material trapped by the conveyor.

One type of unit is oriented normal to the direction of flow. The water flows through the upward moving run of the conveyor, then the downward moving run. Another type of unit, referred to herein as a center-flow unit, is oriented with the upward and downward moving runs in planes parallel with the direction of flow. The water enters an inlet between upward and downward moving runs and flows out both runs simultaneously.

In both types, chains are located on opposite ends of the segments to drive the conveyor. A variety of devices are employed to connect the segments to the chains. Different types of seal members are used to block fluid flow outward past the ends of the segments. In one type that orients normal to the flow, the unit has end plates mounted to each segment, each end plate being rigidly fastened to one of the links of the chain. That unit also has a seal plate mounted to each end plate. In that unit, the leading and trailing edges of each end plate are parallel with each other. The edges of adjacent end plates are close together on the linear portions of the conveyor and separate at the curved portions. The seal plate has a portion that overlaps an adjacent end plate to block a portion of the gap created at the curved portions. The seal plates have concave and convex edges that slidingly engage each other. While workable for a normal-to-flow filter, a conveyor with end plates and seal plates as described would not work with a center flow type filter.

Summary of the Invention

In this invention, the filter has a perforated conveyor for placement in a fluid flow to trap filtered material. The conveyor has a plurality of segments pivotally linked together, each of the segments having a shelf portion to lift trapped filtered material. A socket is mounted on a first edge of each of the segments. A rod is rigidly mounted to a second edge of each of the segments. The rod of each of the segments fits within the socket of an adjacent one of the segments to pivotally link the segments together.

End plates are rigidly mounted on opposite ends of each of the segments. Each of the end plates has leading and trailing edges that extend at an acute angle relative to one another. The leading edge of each of the segments is at an acute angle relative to the trailing edge of an adjacent one of the segments while on a linear portion of the conveyor, creating a V-shaped gap. The gap closes up while the segments round the axis at each end.

A plurality of seal plates located between the chains and the end plates. Each of the seal plates has a first portion rigidly mounted to one of the end plates and a second portion that overlaps with and is pivotal to an adjacent one of the end plates to block fluid flow through the V-shaped gap.

Brief Description of the Drawings

FIG. 1 is a schematic sectional view taken along the line 1-1 of FIG. 2 of a center flow perforated plate filter constructed in accordance with this invention.

FIG. 2 is a schematic sectional view of the filter of FIG. 1, taken along the line 2-2 of FIG. 3.

FIG. 3 is a front view of the filter of FIG. 1.

FIG. 4 is an enlarged partial sectional view, taken along the line 4-4 of FIG. 7, of two of the screen members and portions of the chain drive.

FIG. 5 is a sectional view of one of the screen members of FIG. 4, taken along the line 5-5 of FIG. 4 but not showing the end seal plates.

FIG. 6 is an elevational view of one of the end seal plates utilized with the screen members of FIG. 4.

FIG. 7 is a sectional view of three of the screen members as shown in FIG. 4, taken along the line 5-5, and also showing the end seal plates.

FIG. 8 is a sectional view of a portion of the conveyor, taken along the line 8-8 of FIG. 7.

FIG. 9 is a view similar to FIG. 7, but taken at an upper turnaround of the conveyor run.

Detailed Description of the Invention

Referring to FIGS. 1-3, filter 11 is typically mounted in a flow channel 13, but it could also be connected into a flow line. Filter 11 has a rotating conveyor 15 that has an upward run 15a and a downward run 15b, shown in FIG. 2. While upward run 15a is shown on the right side in FIG. 2, conveyor 15 could alternately be made to rotate clockwise. A drive member 17 rotates conveyor 15, drive member 17 preferably being a pair of chain sprockets driven by an electrical motor 19. Drive member 17 could alternately be powered by a hydraulic or pneumatic motor. Drive member 17 could also be located on the outer side of the housing of filter 11. Drive member 17 and motor 19 are preferably located on the upper end. A lower turn around member 21, such as guides or sprockets, is located at the lower end. Drive member rotates conveyor 15 along an oblong path with two straight portions 15a, 15b and arcuate upper and lower ends.

A pair of deflector plates 23 mounts to the forward side of filter 11. Deflector plates 23 extend from filter 11 to the side walls of channel 13. Deflector plates 23 converge toward each other to direct all of the flow in channel 13 into the interior of filter 11 between the two conveyor runs 15a, 15b. Filter 11 has a frame or housing with a closed downstream wall 25, forcing all of the fluid to flow simultaneously through conveyor runs 15a, 15b and trapping filtered material or filtered material on the inner sides of conveyor runs 15a, 15b. Conveyor 15 is configured in a stair-step configuration. Upward run 15a lifts the filtered material until reaching drive member 17, where the filtered material is dislodged, such as by brushes or downwardly directed spray nozzles 26. The filtered material falls into a chute 27 or conveyor that delivers the filtered material from channel 13. FIG. 2 also discloses an access door 31 to provide access to conveyor 15. Additionally, FIG. 3 shows a gear reducer 29 that couples motor 19 to drive member 17 (FIG. 2).

Referring to FIG. 4, conveyor 15 is made up of a plurality of individual segments or screen members 33. Each screen member 33 is pivotally linked to adjacent screen members 33 to make up conveyor 15. As shown in FIG. 5, each screen member 33 has a lifting shelf 33a that rotationally leads a riser 33b that extends diagonally from the lifting shelf 33a. Screen members 33 have a plurality of perforations 35 extending throughout, although only a few are shown in FIG.4.

Referring to FIGS 5, 7 and 9, in this embodiment, screen members 33 are pivotally linked and sealed to each other by a rod 37 and a socket 39 in engagement with each other. Rod 37 is mounted to one edge of each screen member 33, which is shown in this embodiment to be the leading edge. Socket 39 is semi-cylindrical and is located on the opposite edge of each screen member 33. Rod 37 of one screen member 33 slides into socket 39 of the adjacent screen member 33, forming a seal. Socket 39 has a slot 41 through which the leading edge of screen 33 extends. Rod 37 could alternately be located on the trailing edge of screen member 33 and socket 39 on the leading edge.

Referring to FIGS 5 and 7-9, an end plate 43 is rigidly mounted to each end of screen 33, preferably by welding. End plate 43 has a leading edge 45, a trailing edge 47, an inner edge 49, and an outer edge 51. In the preferred embodiment, inner edge 49 is slightly concave and outer edge 51 is straight. Leading and trailing edges 45, 47 are inclined to converge toward each other from outer edge 51 to inner edge 49. An angle between two lines projecting from leading and trailing edges 45, 47 is acute. Cutouts are formed on leading edge 45 and trailing edge 47 to provide access to rod 37 and socket 39. The cutouts enable rod 37 to slide from one end into socket 39.

In this embodiment, a leading hole 50 and a trailing hole 52 are located in each end plate 43. Holes 50, 52 are located on a line that it is parallel to outer edge 51 and intersects rod 37 and socket 39. Outer edge 51 is parallel to conveyor runs 15a, 15b. Lifting shelf 33a is at an angle that is preferably slightly less than 90 degrees relative to outer edge 51 for retaining filtered material on upward conveyor run 15a.

Referring to FIGS. 6-9, a seal plate 53 is rigidly secured to the outer side of each end plate 43. Seal plates 53 serve to prevent leakage of channel fluid and the passage of filtered material laterally outward through gaps between the leading and trailing edges 45, 47 of adjacent end plates 43. Each seal plate 53 is preferably formed of an elastomeric material, such as ultra-high molecular weight plastic, but they could also be of metal. Each seal plate 53 has a leading edge 55 that is concave. The trailing edge has an outer portion 57a that is straight and an inner portion 57b that is concave at approximately the same radius as leading edge 55. Seal plate 53 has an inner edge portion 59 that is straight and parallel to an outer edge 61 in this embodiment. Trailing edge outer portion 57a extends from trailing edge inner portion 57b to outer edge 61 at an angle that is about 45 degrees in this embodiment.

Seal plate 53 has a leading hole 63 and a trailing hole 65 for receiving fasteners. Holes 63, 65 are located on a line that is parallel with outer edge 61. A recess or cutout 67 extends from trailing edge outer portion 57a selected distance inward to allow pivotal movement of each seal plate 53 with the end plate 43 of an adjacent screen member 33.

Each end plate 43 has an overall axial length Le measured parallel to inner edge 51 from socket 39 to rod 37. Each seal plate 53 has a greater overall axial length Ls measured from the junction of trailing edge portions 57a, 57b to where the inner tip of leading edge 55 extends. The curved leading and trailing edges 55 and 57b of adjacent seal plates 53 are closely spaced to each other to block outward flowing leakage. The transverse distance or height from inner edge 59 to outer edge 61 of each seal plate 53 is greater than the transverse distance or height from outer edge 51 to inner edge 49 of each end plate 43. Consequently, seal plates 53 protrude inwardly more than end plates 43, as shown in FIGS. 7 and 9.

As illustrated in FIG. 4, preferably chains 69 on each end of conveyor 15 engage the sprockets of drive member 17 (Fig 2) to rotate conveyor 15. Preferably, tension does not pass through rods 37 and sockets 39, rather the tensional force due to movement of conveyor 15 passes through chains 69. End plates 43 and seal plates 53 are fastened to each link of chains 69 for being pulled along conveyor runs 15a and 15b. The ends of rods 37 are spaced from chains 69 by clearances and are not directly connected to chains 69.

Each seal plate 53 is mounted to a single end plate 43, but it is axially offset so that a leading edge 45 of each end plate 43 leads the end plate 43 to which it is attached. Trailing edge 47 of each end plate 43 leads trailing edge portions 57a, 57b of its mating seal plate 53. Each seal plate 53 overlaps in sliding engagement a substantial portion of the adjacent trailing end plate 43.

Leading hole 63 of seal plate 53 aligns with trailing hole 52 of end plate 43 for receiving a fastener that also extends through a link of chain 69. Trailing hole 65 of seal plate 53 is aligned with rod 37 and a pin of chain 69 (FIG 8). A separate fastener or a protruding end of rod 37 locates in trailing hole 65 to prevent pivotal movement of seal plate 53 with the end plate 43 to which it is fastened. Leading hole 50 of end plate 43 does not connect to any of the seal plates 53 in this embodiment. Rather, a fastener extends from hole 50 into engagement with one side of a link of chain 69. Cutout 67 in seal plate 53 allows arcuate pivotal movement of each seal plate 53 relative to the adjacent lagging end plates 43 as they pass over drive member 17 or lower arcuate portion 21 (FIG. 2). The fastener that extends from hole 50 in the adjacent end plate 43 into engagement with chain 69 moves in cutout 67, as can be seen by comparing FIG. 7 and FIG. 9. Each end plate 43 is thus secured to a link of chain 69 by two fasteners. Each seal plate 53 is secured to one of the end plates 43 at two points.

Referring to FIGS. 7-9, sidewall portions 71a, 71b of the housing of filter 11 extend along the outer sides of seal plates 53. A recess for each of the chains 69 is formed between sidewall portions 71a, 71b. The upper and lower portions of the outer sides of plates 53 slidingly engage frame portions 71a, 71b to prevent water and filtered material from flowing between frame portions 71a, 71b and end plates 43 into contact with chains 69. Sidewall portions 71a, 71b are curved at the lower arcuate portion 21 and at the upper end, as shown in FIG. 9.

In operation, the upward run 15a will appear as shown in FIG. 7. Chains 69 (FIG. 4) rotate conveyor15, bringing filtered material up on shelves 33a. Water enters between runs 15a, 15b (Fig 2) and flows outwardly in opposite directions through perforations 35 in screen members 33. The engagement of rods 37 with sockets 39 prevents any significant leakage from between the individual screen members 33. The contact of seal plates 53 with end plates 43 and housing portions 71a, 71b (FIGS 7 and 8) prevent leakage through the gaps between trailing edge 47 and leading edge 45 of each plate 43.

When going over drive member 17 or lower arcuate curved portion 21(FIG.2), the gaps between leading edge 45 and trailing edge 47 of adjacent end plates 43 close up. Leading edge 45 of one end plate 43 becomes parallel and approximately touches trailing edge 47 of the adjacent end plate 43, as shown in FIG. 9. The gap between end plate edges 45, 47 becomes smaller in the curved portions of the conveyor. Each seal plate 53 is fixed relative to the end plate 43 to which it is attached, but pivots relative to the adjacent end plate 43. Consequently, the curved leading and trailing edges 55 and 57b of the adjacent seal plates 53 slide relative to one another. The clearance is small, preventing substantial leakage.

While in the upward moving run 15a, as shown in Figure 7, or the downward moving run 15b, each seal plate 53 fully eclipses or blocks the entire gap between end plate edges 45 and 47 of adjacent end plates 43. Similarly, while in the arcuate upper portion, shown in Figure 9 or the arcuate lower portion, each seal plate 53 fully eclipses or blocks the entire gap between end plate edges 45, 47.

The invention has significant advantages. The rod and socket linkage provides an effective seal. The connection of the end plates with the chains transfers weight to the chains rather than through the rod and socket joint. The seal plates create a labyrinth seal, effectively sealing both during the linear portions and curved portions of the conveyor.

While the invention has been shown in only one of its forms, it should be apparent to those skilled in the art that it is not so limited but is susceptible to various changes without departing from the scope of the invention. For example, one could also employ the rod and socket between screen members with a filter that mounts the conveyor normal to the flow.

I claim:

1. In a filter having a perforated conveyor for placement in a fluid flow to trap filtered material, a drive assembly for rotating the conveyor, the conveyor having a plurality of segments pivotally linked together, each of the segments having a shelf portion to lift trapped filtered material, the improvement comprising:

a socket mounted on a first edge of each of the segments; and

a rod rigidly mounted to a second edge of each of the segments, the rod of each of the segments being rotatably located within the socket of an adjacent one of the segments to pivotally link the segments together.

2. The filter according to claim 1, wherein each of the sockets extends continuously a full width of each of the segments.

3. The filter according to claim 2, wherein:

each of the sockets has a cylindrical interior with a slot extending the full width of each of the segments; and

each of the rods extends the full width of each of the segments, and the second edge of each of the segments extends through the slot of an adjacent one of the segments.

4. The filter according to claim 1, wherein:

the drive assembly comprises a pair of chains, the chains being located on opposite sides of the conveyor; wherein

end plates are secured to opposite sides of each of the segments; and

a fastener extends between each of the end plates of the segments and a link of one of the chains to secure the segments to the chains.

5. The filter according to claim 1, wherein:

the drive assembly comprises a pair of chains, the chains being located on opposite sides of the conveyor and secured to the segments by fasteners; and

the rods have ends that are separated from the chains by a clearance so that lifting forces on each the segments pass from the end plates to the chains and not through the rods and sockets.

6. The filter according to claim 1, further comprising:

end plates secured to opposite ends of each of the segments, each of the end plates having first and second edges extending at an acute angle relative to each other; and

a plurality of seal plates, each of the seal plates having a second portion pivotally mounted to one of the end plates and a first portion extending past the first edge of the end plate to which it is mounted and alongside in flush sliding contact with an adjacent one of the end plates.

7. The filter according to claim 6, wherein the first edge of each of the end plates and the second edge of an adjacent one of the end plates are at an acute angle relative to one another while on linear portions of the conveyor, and substantially flush with one another while turning at ends of the conveyor.

8. In a center flow filter having a perforated conveyor for placement in a fluid flow to trap filtered material, a pair of chains on opposite sides of the conveyor for rotating the conveyor in a loop defining a linear upward moving run, an upper curved portion around an upper axis, a linear downward moving run, and a lower curved portion around a lower axis, the conveyor having a plurality of segments pivotally linked together, each of the segments having a shelf portion to lift trapped filtered material, the improvement comprising:

a plurality of end plates, the end plates being rigidly mounted on opposite ends of each of the segments, each of the end plates having leading and trailing edges, the leading edge of one of the end plates and the trailing edge of an adjacent one of the end plates having gaps between them while on the upward and downward moving runs that decrease while on the upper and lower curved portions of the conveyor; and

a plurality of seal plates located between the chains and the end plates, each of the seal plates having a first portion rigidly mounted to one of the end plates and a second portion that slidingly overlaps and is pivotal to an adjacent one of the end plates to overlay the gaps between adjacent ones of the end plates.

9. The filter according to claim 8, wherein each of the chains has a plurality of links, and wherein each of the end plates and each of the seal plates are rigidly attached to one of the links.

10. The filter according to claim 8, wherein the leading and trailing edges of each of the end plates extend at an acute angle relative to one another, creating a V-shaped gap between adjacent ones of the end plates while on the upward and downward moving runs and being substantially parallel while on the upper and lower curved portions of the conveyor.

11. The filter according to claim 8, wherein:

each of the seal plates has a convex edge and a concave edge; and

the convex edge of each of the seal plates is in flush sliding engagement with the concave edge of an adjacent one of the seal plates while on the upward and downward moving runs.

12. The filter according to claim 8, further comprising:

a frame that supports the conveyor; and

wherein the seal plates slidingly engage a portion of the frame to block filtered material from contact with the chain.

13. The filter according to claim 8, further comprising:

a socket welded to a first edge of each of the segments, the socket having a cylindrical interior and an elongated slot; and

a cylindrical rod welded to a second edge of each of the segments, the rod of each of the segments being rotatably located within the socket of an adjacent one of the segments, the second edge extending through the slot.

14. A filter, comprising:

a frame having an inlet on one side and a closed opposite side;

a perforated conveyor having a plurality of segments pivotally linked together, each of the segments having a shelf portion to lift trapped filtered material;

a pair of chains on opposite sides of the conveyor for rotating the conveyor in a loop defining a linear upward moving run, an upper arcuate portion, a linear downward moving run, and a lower arcuate portion, the conveyor being oriented so that fluid flowing through the inlet of the frame passes first between the upward and downward moving runs, then outward through the upward and downward moving runs;

a plurality of end plates, the end plates being rigidly mounted on opposite ends of each of the segments, the end plate of adjacent ones of the segments having gaps between them while on the upward and downward moving runs, the gaps decreasing while on the upper and lower arcuate portions;

a socket mounted on a first edge of each of the segments, each of the sockets having a cylindrical interior and extending a full width of each of the segments, each of the sockets having a slot extending the full width of each of the segments;

a rod rigidly mounted to a second edge of each of the segments and extending a full width of each of the segments, the rod of each of the segments being rotatably located within the socket of an adjacent one of the segments and the second edge extending through the slot; and a plurality of seal plates located between the chains and the end plates, each of the seal plates being rigidly mounted to one of the end plates and having an overlapping portion that extends alongside in sliding contact with an adjacent one of the end plates, each of the seal plates fully eclipsing one of the gaps between the end plates both while in the upward and downward moving runs and while in the upper and lower arcuate portions.

15. The filter according to claim 14, wherein:

the frame has spaced-apart wall portions on each side that define a recess through which each of the chains extend; and

the seal plates slidingly engage the wall portions to reduce fluid flowing into contact with the chains.

16. The filter according to claim 14, wherein each of the seal plates has a leading edge, a trailing edge, an outer edge and an inner edge, and wherein the outer edge has a portion located in the overlapping portion.

17. The filter according to claim 14, wherein:

each of the end plates is secured to a link of one of the chains by a pair of fasteners; and

the overlapping portion of each of the seal plates pivots relative to the end plate being overlapped while passing through the arcuate portions of the conveyor and has a cutout to accommodate the pivotal movement relative to one of the fasteners of the end plate being overlapped.

18. The filter according to claim 14, wherein:

each of the end plates has leading and trailing edges that extend at an acute angle relative to one another, the leading edge of each of the segments being at an acute angle relative to the trailing edge of an adjacent one of the segments while on the upward and downward moving runs, creating a V-shaped gap, and being substantially parallel while on the arcuate portions.

19. The filter according to claim 14, wherein:

the rods have ends that are separated from the chains by a clearance so that lifting forces on each the segments pass from the end plates to the chains and not through the rods and sockets.

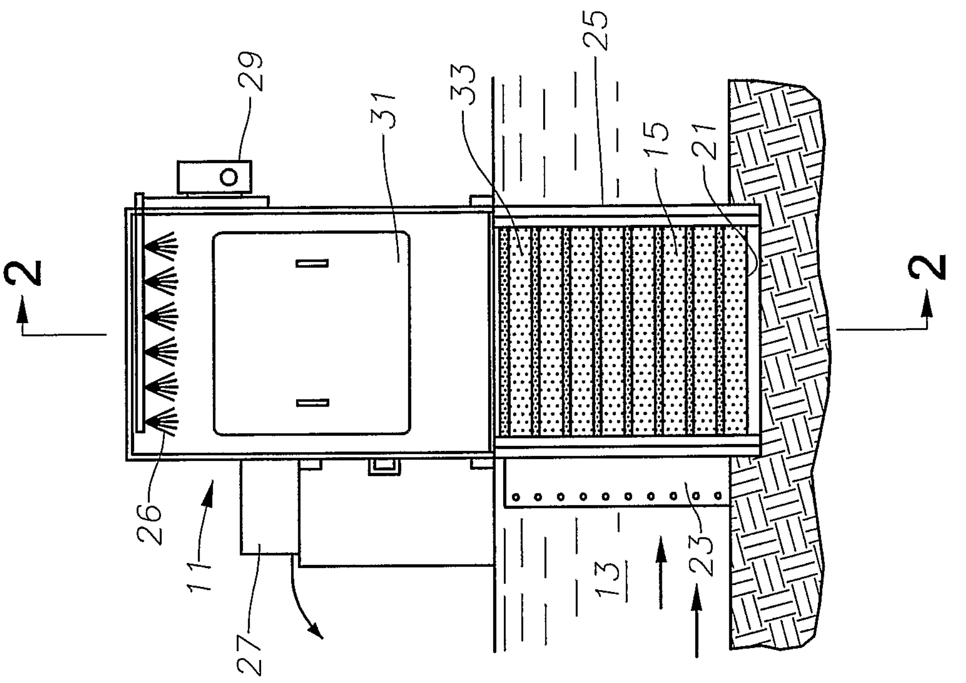


Fig. 3

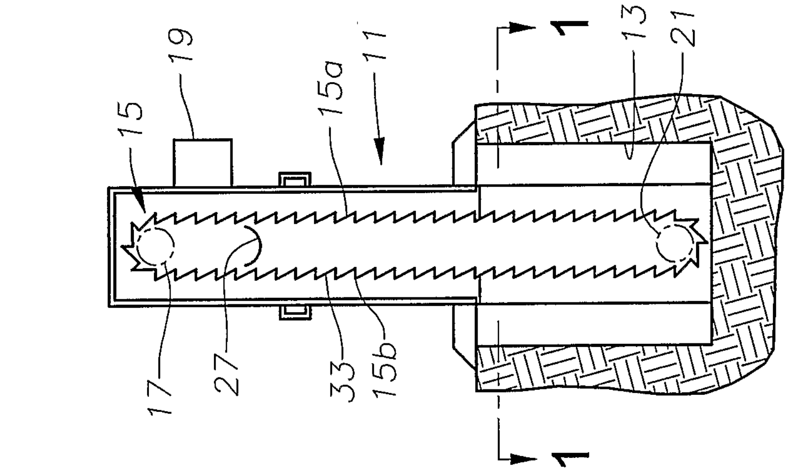


Fig. 2

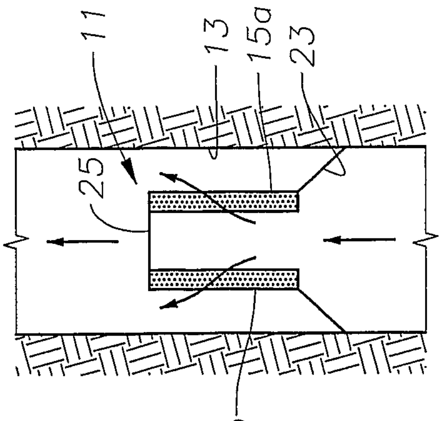


Fig. 1

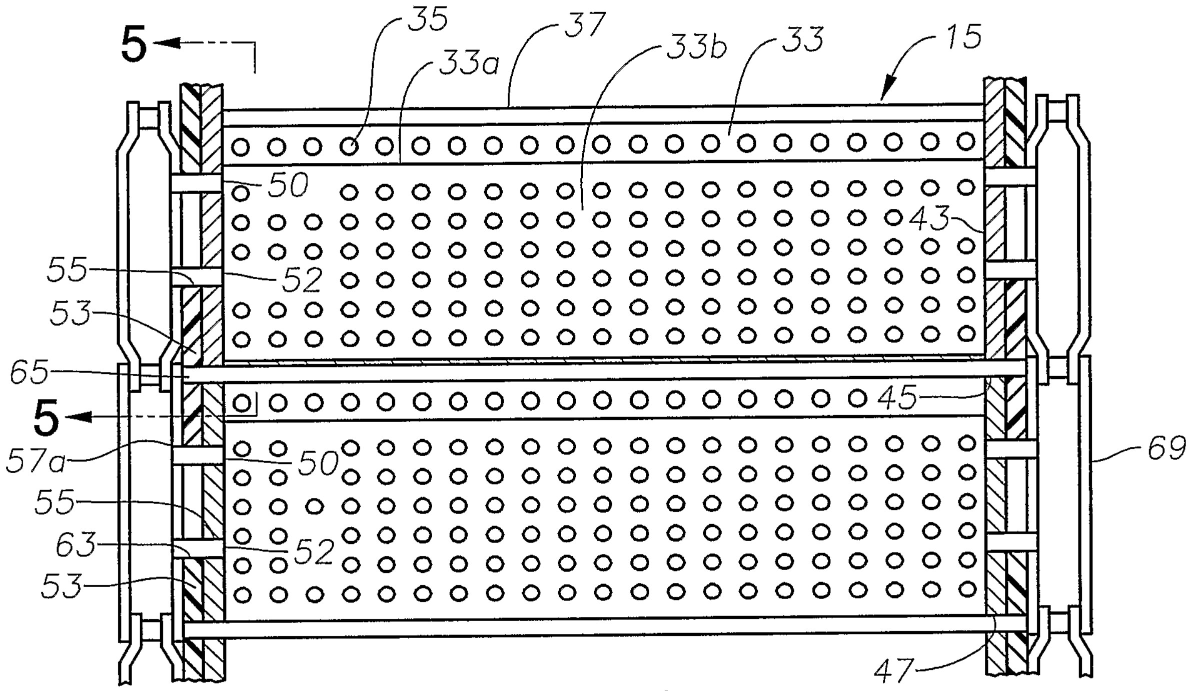


Fig. 4

Fig. 5

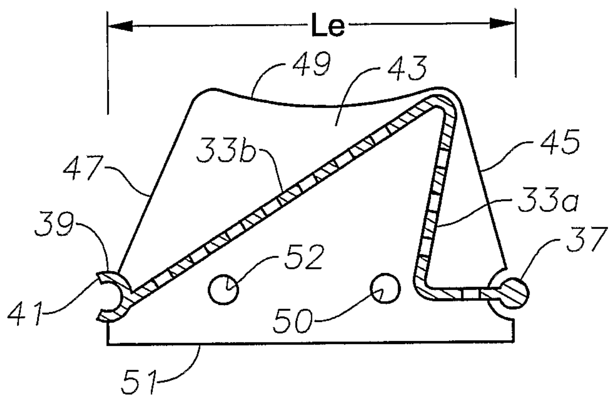
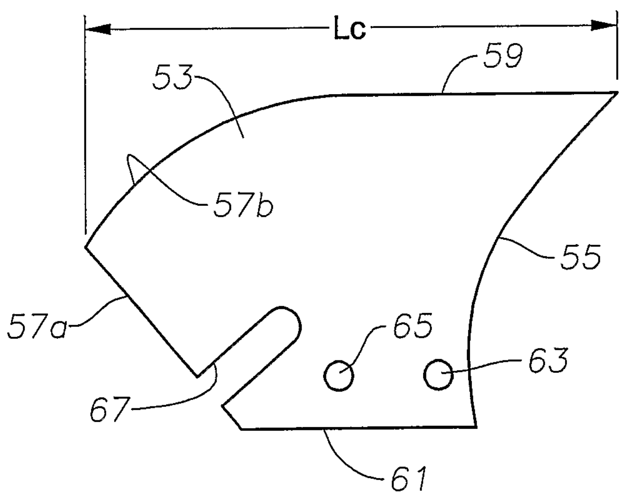


Fig. 6



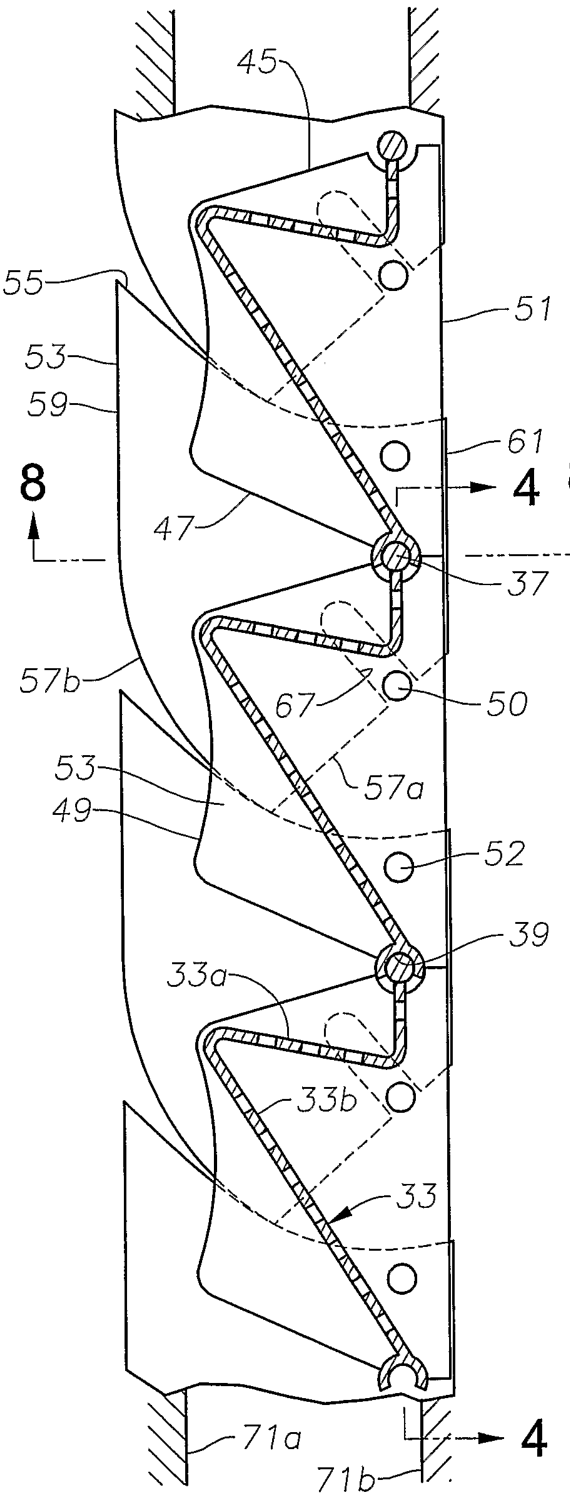

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Fig. 7

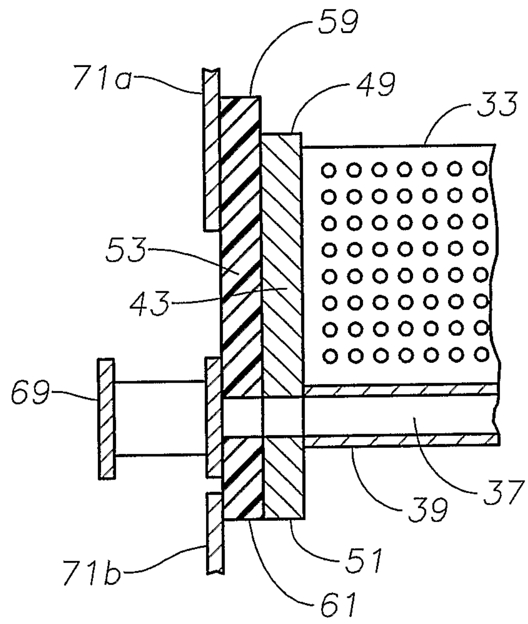
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Fig. 8

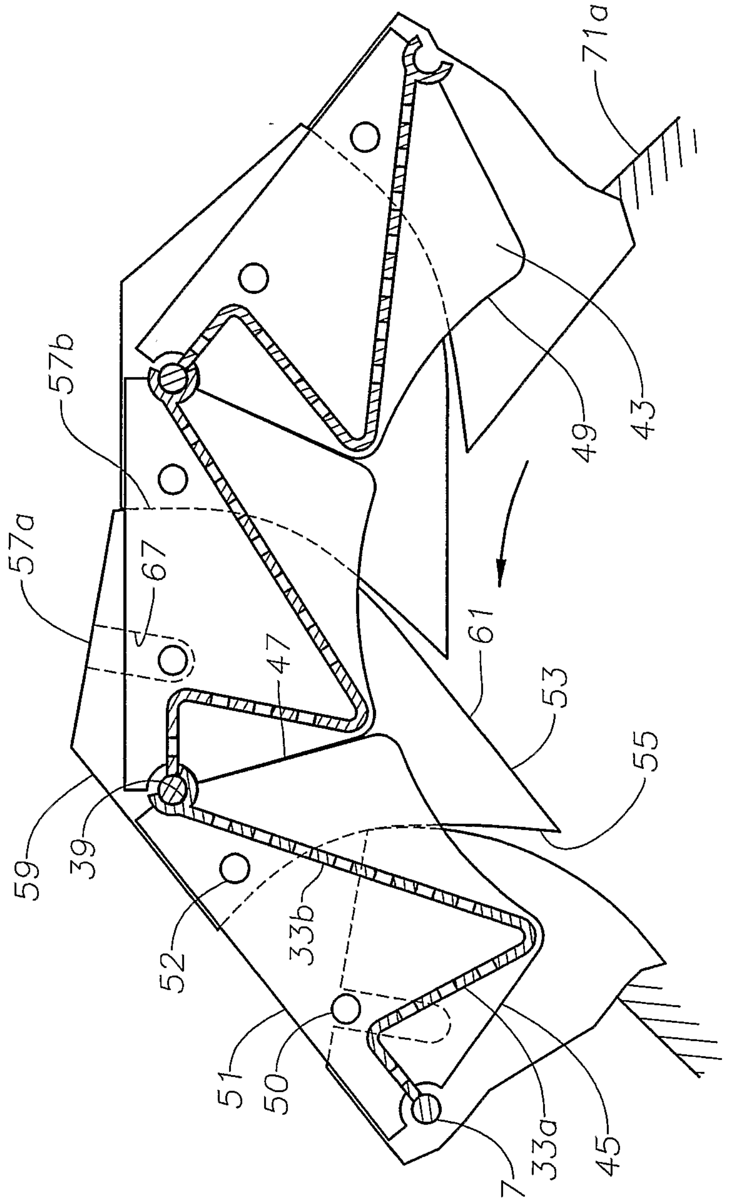

Fig. 9

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/012914

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01D33/056 B01D33/333

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)
IPC 7 B01D

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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 202 15 591 U1 (LONKWITZ ANLAGENBAU GMBH & CO. KG) 23 January 2003 (2003-01-23) page 6, paragraphs 2,3; figure 2	1,8,14
A	GB 2 379 175 A (* BRACKETT GREEN LIMITED) 5 March 2003 (2003-03-05) page 8, paragraph 2 - page 10, paragraph 1	1,8,14
A	GB 263 693 A (BRACKETT AND CO.) 1 June 1927 (1927-06-01) column 2, line 63 - column 3, line 86; figure 3	1,8,14
A	US 5 213 303 A (WALKER ET AL) 25 May 1993 (1993-05-25) the whole document	1,8,14

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
25 August 2005	01/09/2005

Name and mailing address of the ISA	Authorized officer
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