Sept. 29, 1970 R. A. KIPP 3,530,987

AIR FLOTATION SEPARATOR

Filed July 29, 1968 3 Sheets-Sheet 1

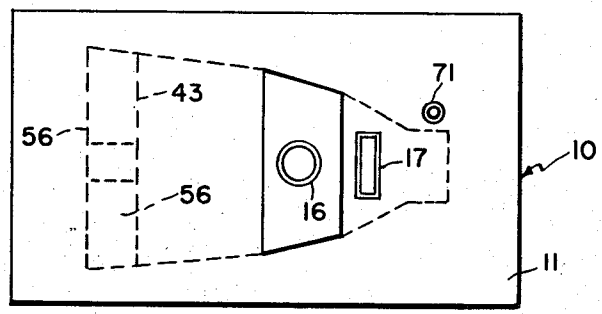

FIG. 1

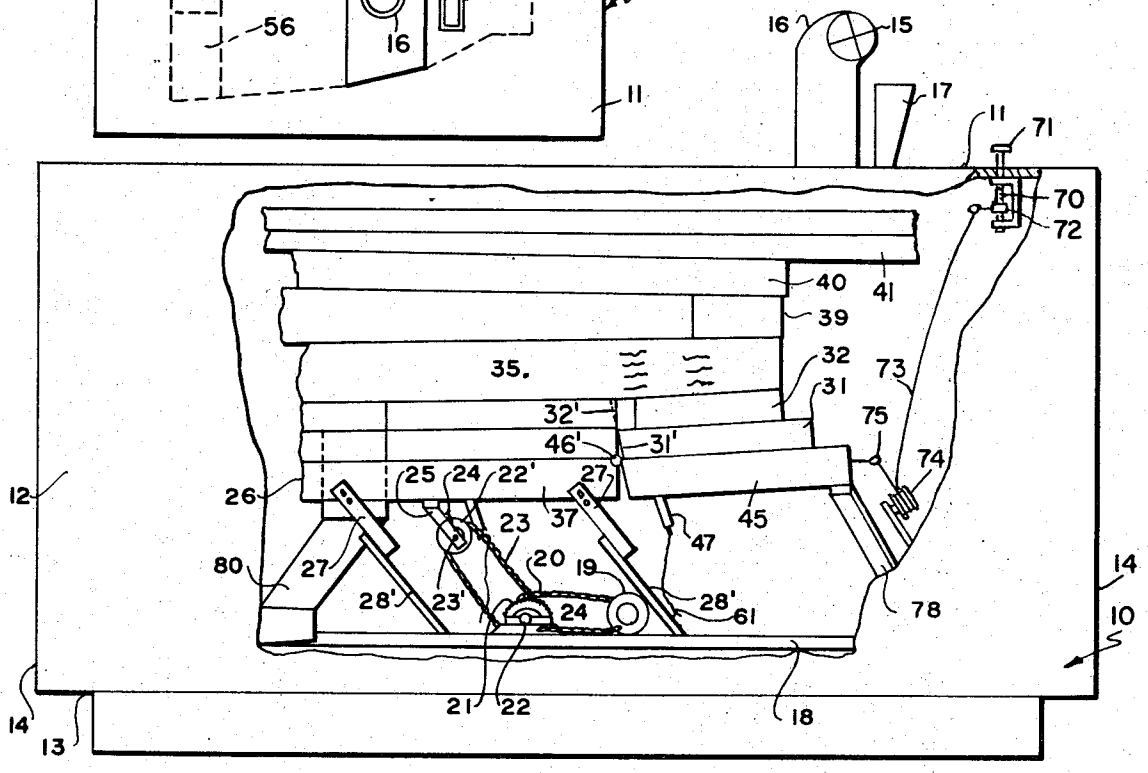

FIG. 2

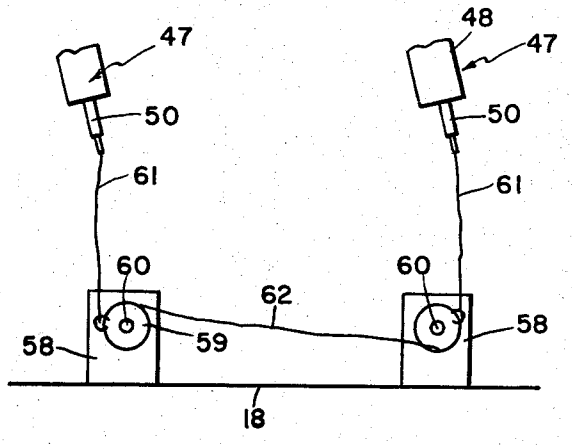

FIG. 6

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AIR FLOTATION SEPARATOR

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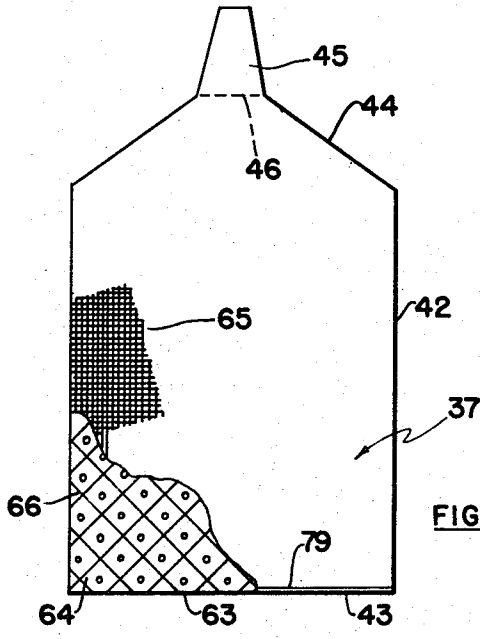

FIG. 7

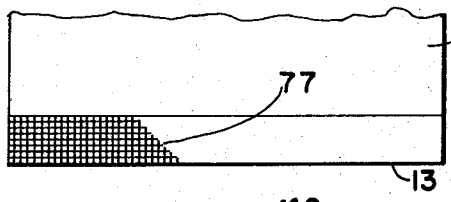

FIG. 9

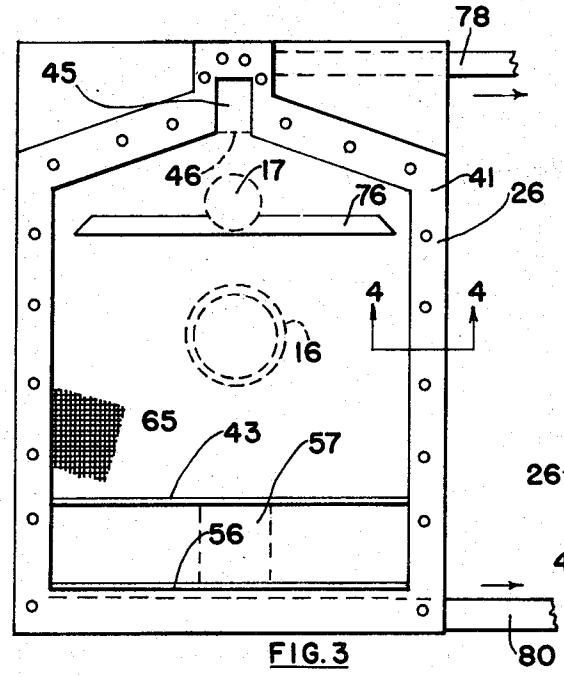

FIG. 3

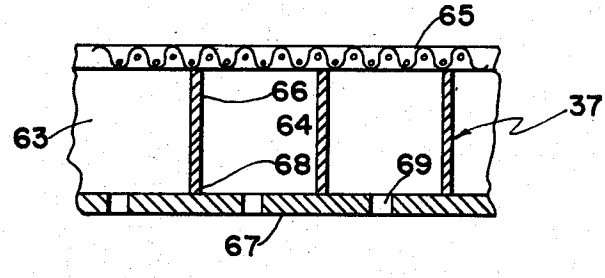

FIG. 8

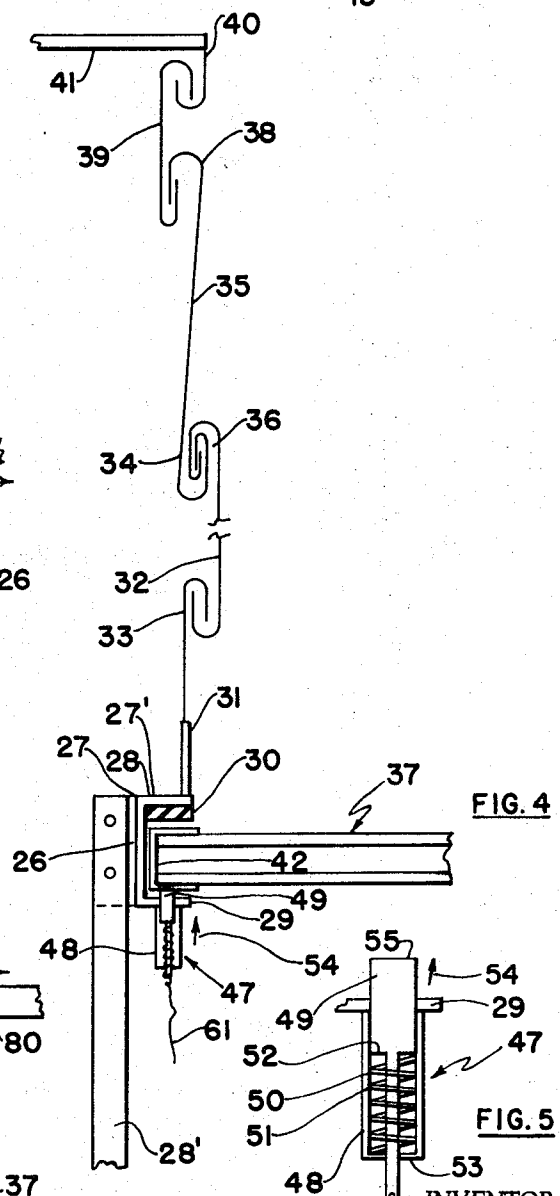

FIG. 4

FIG. 5

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AIR FLOTATION SEPARATOR

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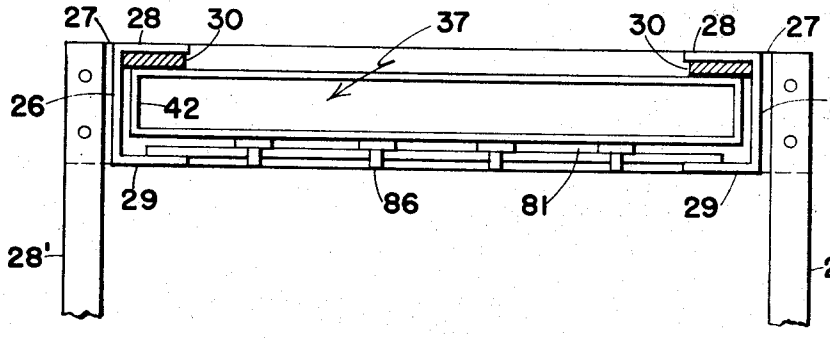

FIG. 10

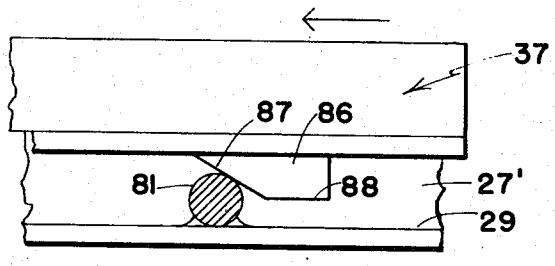

FIG. 11

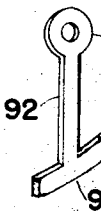

FIG. 13

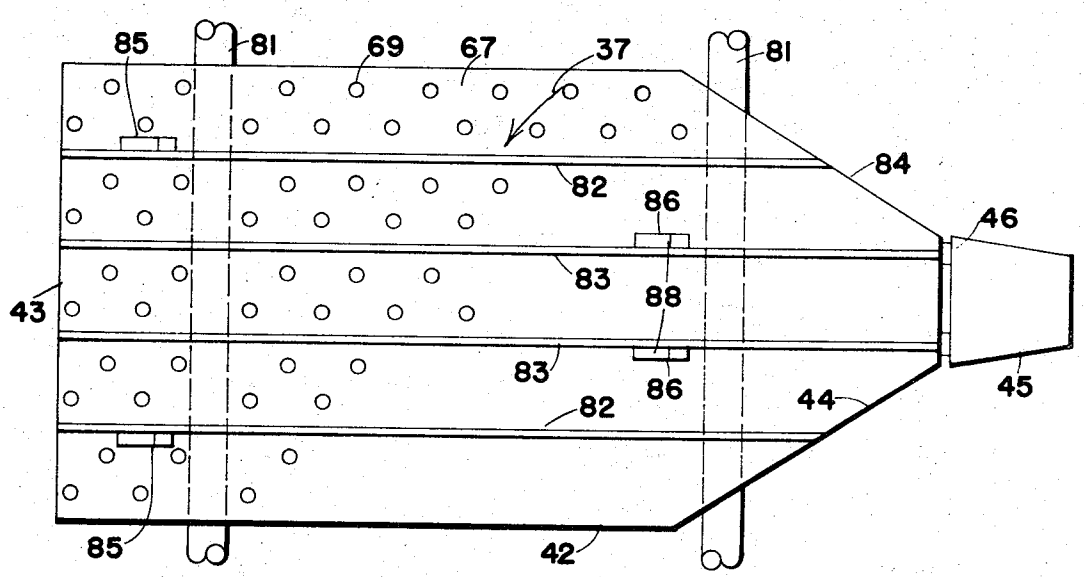

FIG. 14

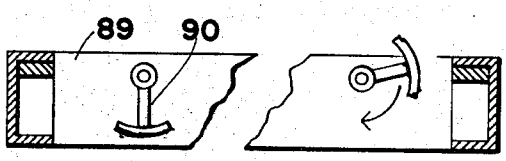

FIG. 12

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United States Patent Office 3,530,987 Patented Sept. 29, 1970

3,530,987

AIR FLOTATION SEPARATOR

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Continuation-in-part of application Ser. No. 712,054, Mar. 11, 1968. This application July 29, 1968, Ser. No. 748,520

Int. Cl. B03b 3/12, 3/34

U.S. Cl. 209—467 19 Claims

ABSTRACT OF THE DISCLOSURE

An air flotation machine having a shaker frame suspended by a flexible rubber web or the like with a removable screen assembly being held in the frame by upward spring pressure and having the discharge end of the screen assembly adjustable in inclination within limits to control the contaminant discharge characteristics.

The invention relates to improvement in air flotation stoner machines of the type which incorporates an oscillating or vibrating screen situated on an incline and constitutes a continuation-in-part to Ser. No. 712,054, filed Mar. 11, 1968 and now abandoned. The material to be cleaned such as grain or the like, is fed onto the upper side of the screen and this material is fluidized by the passage of air through the screen and material either by blowing from the underside thereof or by suction upon the upper side thereof or a combination of both. This causes the bed of material to fluidize and move downwardly to be discharged at the lower end. Contaminants having the highest specific gavity such as stones, nails or the like, remain in contact with the screen and are not fluidized by the airflow. The vibration of the screen causes these contaminants to move upwardly against the downward flow of material whereupon they are collected within a narrow throat and discharged over the end thereof.

The improvements consist firstly of a shaker screen construction which is easily removed from the machine for cleaning or repair purposes. This is accomplished by suspending the shaker screen assembly by a rubber or similar resilient material web which not only supports the screen for easy removal, but also causes the area above the screen to be sealed thus facilitating the air flow therethrough.

Secondly, it will be appreciated that the characteristics of the machine's operation will be varied by the degree of slope of the screen and this usually has been accomplished by tilting the entire machine.

The improvement herein described permits the screen to be at a fixed slope, it being the throated contaminant discharge end which is readily adjustable as required and while the machine is operating in order to maintain the efficient separation of the contaminants and the material being cleaned.

Thirdly, the construction of the screen utilizes a honeycomb core covered on the upper side by a plastic or nylon mesh screen.

It is desirable to be able to control the amount of air passing through each cell of the honeycomb in order that the fluidized bed of the product be maintained.

This is accomplished in the present application by attaching sheets or strips of perforated paper over the underside of the honeycomb, there being a perforation for each cell of the honeycomb. By varying the strips and sizes or numbers of perforations, infinite control of the the air flow passing through the honeycomb is achieved.

With the foregoing considerations in view, and such other objects, purposes or advantages as may become

apparent from consideration of this disclosure and specification, the present invention consist of the inventive concept exhibited in the method, process, construction, arrangement of parts, or new use of any of the foregoing herein particularly exemplified in one or more specific embodiments of such concept, reference being had to the accompanying figures in which:

FIG. 1 is a top plan view of the machine.

FIG. 2 is an enlarged side elevation thereof fragmented to show the interior thereof.

FIG. 3 is a top plan view of the machine with the upper cover removed for clarity.

FIG. 4 is an enlarged fragmentary sectional view substantially along the line 4—4 of FIG. 3 and showing the mounting of the shaker frame.

FIG. 5 is an enlarged fragmentary view showing the details of one of the plunger assemblies.

FIG. 6 is an enlarged fragmentary view showing the control for the plunger assemblies.

FIG. 7 is a top plan view of the screen assembly fragmented in part to show the interior thereof.

FIG. 8 is a partial section of the screen of FIG. 7 enlarged for clarity.

FIG. 9 is an end view of the lower half of the machine showing the air intake means.

FIG. 10 is an end view of the shaker frame with the screen assembly in place and showing the preferred retaining means for the screen assembly.

FIG. 11 is an enlarged fragmentary side elevation of the screen assembly being engaged with the retaining means.

FIG. 12 is a partially sectioned end view of the shaker frame showing the screen retaining latches and reduced in scale from FIGS. 10 and 11.

FIG. 13 is an isometric view of one of the latches enlarged wtih respect to the other drawings.

FIG. 14 is an underside view of the preferred embodiment of the screen assembly.

In the drawings like characters of reference indicate corresponding parts in the different figures.

Proceeding therefore to describe the invention in detail, reference character **10** illustrates generally the supporting framework and enclosing casing of the machine including an upper side **11**, sides **12**, base **13**, and end walls **14**.

A source of air shown schematically by fan **15** connects to a discharge conduit **16** which extends through the upper side **11** to the interior of the machine.

Material to be cleaned is fed through intake hopper **17** also situated on the upper side **11**, said hopper extending through the upper side to the interior of the machine as will hereinafter be described.

Within the enclosure, is a base frame work **18** which includes a source of power **19** in the form of an electric motor, connected by means of chain **20** to a double sprocket **21** mounted within bearings **22** also supported upon the base framework **18**. A further chain **23** extends from double sprocket **21**, to a further sprocket **22'** mounted upon a shaft **23'** which also includes an off center weight **24** to provide reciprocating vibration to the device. This shaft **23'** is mounted between hangers **25** depending from a substantially rectangular shaker frame **26**. This shaker frame is provided with brackets **27** and spring leaves **28'** extend from the brackets downwardly to the base frame **18** thus mounting the shaker frame for the vibrating reciprocating motion imparted by the rotatable off center weight **24**.

This shaker frame is substantially in the form of a channel **27'** having an upper flange **28** and a lower flange **29**. Details of this are shown in FIG. 4 and it will be observed that the upper flange **28** is provided with a resilient strip **30** secured to the underside thereof and it should

be understood that this resilient strip extends clear around the perimetrical shaker frame **26**.

Extending upwardly from the shaker frame channel **27'** is a perimetrical vertical flange **31** having a further flanged portion **32** interlocked therewith as shown at **33**. Also interlocked with the upper end of this portion **32** is the lower end **34** of a flexible resilient web **35**, the connection being shown exploded for clarity as at **36** in FIG. 4. This web **35** is preferably made of rubber or synthetic material.

The upper end **38** of the web **35** is also interlocked into a similar vertically extending flange portion **39** which in turn is locked to a perimetrical member **40** secured to the upper end **41** of the stationary framework of the machine. The flanges **31**, **32**, **39** and the web **35** enclose the space between the perimetrical member **40** and a shaker screen assembly **37** contained in the shaker frame **26**, so that air may be drawn upwardly through the shaker screen assembly by action of the fan **15**.

It will be seen that the offset weight **24** will cause the frame **27** to vibrate longitudinally upon the leaf spring members **28'** and being held by the flexible web **35**, it being understood that this web is slightly pretensioned when the device is assembled and is held in this position, of course, by the location of the brackets **27** upon the leaf springs **28'**.

The shaker screen assembly **37** is provided with side edges **42**, lower edge **43**, and inwardly inclining upper edges **44** and the screen assembly also includes an upper end portion **45** which is hinged transversely to the edges **44** along the line **46** shown in FIG. 7.

The perimetrical channel **27'** of the shaker frame is also shaped similarly and the shaker screen assembly **37** is dimensioned to fit within the flange or channel forming the frame **27**.

The shaker screen assembly **37** is normally held upwardly in sealing engagement with the resilient sealing strip **30** by means of plunger assemblies collectively designated **47** secured to the lower flange **29** of the frame **27**. These plunger assemblies consist of cylinders **48** within which plungers **49** engage, said plungers extending through apertures within the lower flange **29**. The plungers are provided with stems **50** and surrounded by compression springs **51** which react between the lower sides **52** of the plungers and the base **53** of the cylinders so that the plungers **49** are normally urged upwardly or biased upwardly in the direction of arrow **54**. The upper ends **55** of these plungers engage the underside of the screen assembly **37** and bias it upwardly into contact with the sealing strip **30** with sufficient pressure to completely seal the screen assembly into position within the frame and also to supply sufficient friction so that the vibration of the frame **27** is imparted equally to the screen assembly **37**.

When it is desired to remove the screen assembly **37** for replacement purposes, the plungers **49** have to be drawn downwardly against pressure of springs **51** thus releasing the frame which can then be manipulated from the frame **27**, it being understood that the lower end **43** of the screen assembly **37** terminates spaced from the lower end **56** of the frame to define a discharge area **57** for the material being cleaned as will hereinafter be described.

Secured to brackets **58** attached to the base framework **18**, are wheels or pulleys **59** mounted on spindles **60**. Cables **61** extend from extensions of stems **50** of the plungers **49** and are connected to the perimeters of these wheels or pulleys **59**. A cable **62** may interconnect adjacent pulleys so that rotation of one pulley by any conventional means will tighten all four cables at the same time thus withdrawing plungers **49** from contact with the underside of the screen assembly **37** and releasing same to the position shown in FIG. 4.

Conversely, release of the cables **61** will enable the compression springs **51** to urge the plungers upwardly as hereinbefore described.

The screen assembly **37** consists of a honeycomb core portion **63** defining cells **64**, said core portion being formed from aluminium, paper or plastic as desired.

A relatively fine meshed screen panel **65** is adhesively secured to the upper side **66** of the honeycomb core portion **63** which supports the material being cleaned and allows air to flow therethrough.

An apertured sheet **67** for controlling the air flow characteristics through the honeycomb core, is adhesively secured to the lower side **68** of the honeycomb core portion **63** and this sheet is provided with apertures **69** connecting with individual cells **64** of the honeycomb portion. This lower sheet can take the form of perforated strips or sheets of paper or metal which can be supplied with various sizes of apertures and in various patterns and can be adhesively removed and replaced quite readily. It can be placed on the underside of the honeycomb core portion in strips so that a flow pattern can be established for maximum efficiency depending upon the characteristics desired. In effect, there is created an infinitely variable air flow pattern as any individual cell **64** can be varied at will.

The aforementioned upper end **45** is hingedly connected along the line **46** as hereinbefore described and FIG. 2 shows details of this hinge connection, reference character **46'** illustrating a conventional piano hinge extending across the line **46**. The various portions **31** and **32** are cut at this point and are provided with overlapping sides as illustrated at **31'** and **32'** so that this entire upper end can be moved upwardly and downwardly without destroying the seal formed by the web **35**.

The pretension in the web **35** normally pulls the upper end **45** upwardly to the maximum position shown in FIG. 2. Means are provided to move this end downwardly within limits until it is in complete alignment with the remaining portion of the screen assembly **37**, said means taking the form of a screw-jack **70** rotatable by means of control wheel **71** on the upper panel **11** of the enclosure. Rotation of this screw-jack moves block **72** upwardly or downwardly upon the screw-jack **70**. A cable **73** extends from block **72**, around a sheave **74**, to be connected to the end **45** as at **75** so that by moving the block **72** upwardly on the jack **70**, the end **45** is pulled downwardly against tension of web **35** so that the desired inclination control of the portion **45** relative to the main portion **37**, is obtained.

In operation, material to be cleaned is fed into the hopper **17** and is discharged upon the upper side **65** of the screen assembly **37**, adjacent the hinge line **46**. The material may be spread across the screen assembly by means of a flanged deflector **76**.

The screen is vibrated by means of the source of power **19** as hereinbefore described, and air is drawn upwardly through the honeycomb screen assembly **37** including the end portion **45**, by means of the fan assembly **15**, air entering through the grill **77** within one end of the enclosure. By controlling the velocity of the air flow and the apertures **69** within the underside of the screen assembly, the material upon the screen assembly may be fluidized so that the contaminants of heavier specific gravity are moved upwardly towards the hinge line **46**. Adjacent this hinge line, a contaminant zone is established and the upper end **45** has to be adjusted in positive inclination so that contaminants move over this throated discharge end **45** but material being cleaned does not. The theoretically perfect inclination creates the contaminant zone so that when one more piece of contaminant is added, one is discharged over the throated end **45** thus maintaining the contaminant zone which acts as a barrier for the cleaned material. The discharged contaminants are conveyed by trough **78** to exteriorly of the machine. Cleaned material is discharged over the lower end **43** of the screen assembly, an upwardly extending flange **79** restricting this dis-

charge to ensure that all contaminants are cleaned before the material is discharged.

It discharges over the end **43** and into a conveyor or trough **80** also extending exteriorly of the machine.

A viewing panel (not illustrated) may be provided within the upper side of the enclosure so that the contaminant zone can be seen and the upper end **45** of the screen assembly adjusted for the optimum performance while the machine is operating.

FIGS. 10 to 14 show the preferred embodiment of the device insofar as the retaining means for the screen assembly is concerned.

I have provided a pair of spaced and parallel rods or bars **81** spanning the shaker frame side channels **27'** and being secured to the lower flanges **29** as by welding.

The underside of the shaker screen assembly **37** is provided with four spaced and parallel longitudinally extending stiffener members **82** and **83**, members **82** being the outer pair and members **83** being the inner pair as clearly shown in FIG. 14. These are secured to the perimetrical frame **84** surrounding the honeycomb core assembly of the screen assembly.

Adjacent the lower edge **43** of the shaker screen assembly I have secured wedge plate members **85** to the outer stiffeners **82** and towards the junctions between the side edges **42** and the inclined edges **44** of the frame **84** I have provided a further pair of wedge plates **86** secured to the inner pair of stiffeners **83**.

All of these wedge plates are of similar configuration and one of these is shown in FIG. 11 in side elevation. It consists of an inclined ramping surface **87** which is adapted to engage the bars or rods **81** when the shaker screen assembly is pushed into position.

As the shaker frame assembly is moved forwardly and upwardly within the channels of the frame **27**, the wedge or inclined surfaces **87** ride upwardly on the rods **81** thus forcing the upper edges of the screen assembly in compression contact with the resilient strips **30** on the underside of the upper flanges **28**. When fully forward, the rods **81** register below the horizontal lower surfaces **88** of the wedge plates thus holding the screen assembly firmly in position and resiliently mounted within the frame **27**.

A cross member **89** spans the rear of the frame **27** and is provided with a pair of latches **90** which are swung downwardly into position to register against the lower edge **43** of the screen assembly thus preventing vibration from moving the screen assembly out of engagement with rods **81**, inadvertently. These latches consist of pivot bearing end **91**, stem **92**, and curved shoe portions **93**, it being understood that the curved shoe portions engage the lower edge **43** of the screen assembly.

This method of detachably retaining the screen assembly within the shaker frame is the preferred embodiment of the invention over the method described and illustrated in FIGS. 4 and 5.

What is claimed to be the present invention is:

1. In an air flotation separator for separating a mixture of particles having different specific gravities, the combination of a reciprocable shaker screen assembly including a honeycomb screen component adapted to have an air stream passing upwardly therethrough, said screen assembly having an elongated substantially rectangular main body portion with a lower end edge and also having a convergently-sided throat portion hinged on a transverse axis to the upper end of said main body portion for raising and lowering adjustment relative thereto, means for depositing a mixture of particles to be separated on the main body portion of said screen assembly, means for imparting vibratory motion to the screen assembly, means for passing an air stream upwardly through the honeycomb screen component whereby the mixture of particles on the screen assembly is fluidized so that particles of relatively lower specific gravity are discharged over said lower end edge and particles of relatively higher specific gravity migrate into said throat portion of the screen assembly for discharge over the upper end edge of the throat portion, said upper end edge of the throat portion being of a substantially smaller transverse dimension than the transverse dimension of said main body portion of the screen assembly so that the particles of higher specific gravity are laterally funneled during their migration through the throat portion and prior to their discharge over the upper end edge of the throat portion, means biasing said throat portion about its hinge axis to its raised position, and remotely actuated means connected to the throat portion for lowering the same against the bias of said last mentioned means.

2. The device as defined in claim **1** which also includes a supporting framework, a shaker frame mounted for reciprocating movement in said framework, said shaker frame containing said shaker screen assembly, and means including a resilient flexible web enclosing the space in the framework above said shaker frame so that a stream of air may be drawn upwardly through said shaker screen assembly by said air passing means.

3. The device as defined in claim **2** which also includes a supporting framework, a reciprocable shaker frame mounted in said framework and containing said shaker screen assembly, said shaker frame including a perimetric flange and sealing means at the underside of said flange, said shaker screen assembly having its perimetric portion engageable with said sealing means, and means biasing the shaker screen assembly into sealing engagement with the sealing means.

4. The device as defined in claim **3** wherein said resilient flexible web is tensioned and constitutes said means for biasing said throat portion of the shaker screen assembly to its raised position.

5. The device as defined in claim **4** wherein said shaker screen assembly also includes a screen component covering the top of said honeycomb component, and an apertured sheet component at the underside of the honeycomb component, the apertures in said sheet component communicating with cells of the honeycomb component.

6. The device as defined in claim **3** wherein said shaker screen assembly also includes a screen component covering the top of said honeycomb component, and an apertured sheet component at the underside of the honeycomb component, the apertures in said sheet component communicating with cells of the honeycomb component.

7. The device as defined in claim **3** wherein said means biasing said shaker screen assembly into engagement with said sealing means comprise a plurality of upwardly spring-loaded plungers mounted in said shaker frame and engaging the underside of the shaker screen assembly, and remotely actuated means connected to said plungers for retracting the same downwardly to facilitate releasing of the screen assembly and removal thereof from the shaker frame.

8. The device as defined in claim **3** wherein said means biasing said shaker screen assembly into engagement with said sealing means comprise a plurality of rods spanning said shaker frame, and a plurality of wedge plates on the underside of the shaker screen assembly cooperating with said rods when the screen assembly is moved into operating position in the shaker frame to bias the screen assembly upwardly.

9. The device as defined in claim **8** together with stiffeners extending longitudinally of said shaker screen assembly and having said wedge plates secured thereto, and latch means for retaining the screen assembly in its operating position in said shaker frame.

10. The device as defined in claim **2** wherein said resilient flexible web is tensioned and constitutes said means for biasing said throat portion of the shaker screen assembly to its raised position.

11. The device as defined in claim **10** wherein said shaker screen assembly also includes a screen component covering the top of said honeycomb component, and an

apertured sheet component at the underside of the honeycomb component, the apertures in said sheet component communicating with cells of the honeycomb component.

12. The device as defined in claim **1** which also includes a supporting framework, a reciprocable shaker frame mounted in said framework and containing said shaker screen assembly, said shaker frame including a perimetric flange and sealing means at the underside of said flange, said shaker screen assembly having its perimetric portion engageable with said sealing means, and means biasing the shaker screen assembly into sealing engagement with the sealing means.

13. The device as defined in claim **12** wherein said shaker screen assembly also includes a screen component covering the top of said honeycomb component, and an apertured sheet component at the underside of the honeycomb component, the apertures in said sheet component communicating with cells of the honeycomb component.

14. The device as defined in claim **13** wherein said means biasing said shaker screen assembly into engagement with said sealing means comprise a plurality of upwardly spring-loaded plungers mounted in said shaker frame and engaging the underside of the shaker screen assembly, and remotely actuated means connected to said plungers for retracting the same downwardly to facilitate releasing of the screen assembly and removal thereof from the shaker frame.

15. The device as defined in claim **13** wherein said means biasing said shaker screen assembly into engagement with said sealing means comprise a plurality of rods spanning said shaker frame, and a plurality of wedge plates on the underside of the shaker screen assembly cooperating with said rods when the screen assembly is moved into operating position in the shaker frame to bias the screen assembly upwardly.

16. The device as defined in claim **15** together with stiffeners extending longitudinally of said shaker screen assembly and having said wedge plates secured thereto,

and latch means for retaining the screen assembly in its operating position in said shaker frame.

17. The device as defined in claim **12** wherein said means biasing said shaker screen assembly into engagement with said sealing means comprise a plurality of upwardly spring-loaded plungers mounted in said shaker frame and engaging the underside of the shaker screen assembly, and remotely actuated means connected to said plungers for retracting the same downwardly to facilitate releasing of the screen assembly and removal thereof from the shaker frame.

18. The device as defined in claim **1** wherein said shaker screen assembly also includes a screen component covering the top of said honeycomb component, and an apertured sheet component at the underside of the honeycomb component, the apertures in said sheet component communicating with cells of the honeycomb component.

19. The device as defined in claim **2** wherein said shaker screen assembly also includes a screen component covering the top of said honeycomb component, and an apertured sheet component at the underside of the honeycomb component, the apertures in said sheet component communicating with cells of the honeycomb component.

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R. HALPER, Assistant Examiner

U.S. Cl. X.R.

209—138, 319, 502, 508