March 17, 1970 W. J. TALLEY, JR 3,501,002

VIBRATORY SEPARATOR

Filed Nov. 28, 1966 3 Sheets-Sheet 1

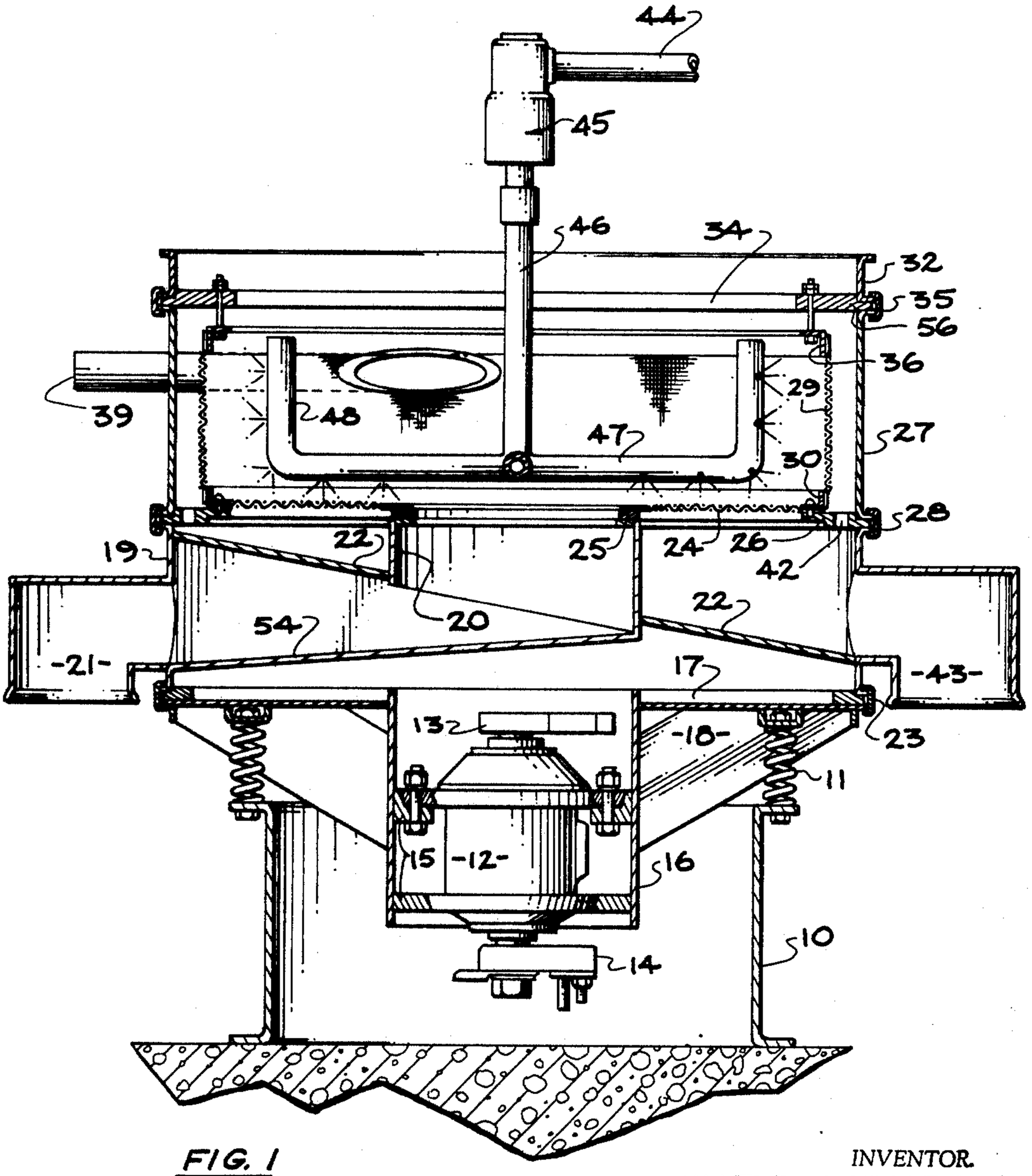

FIG. 1

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VIBRATORY SEPARATOR

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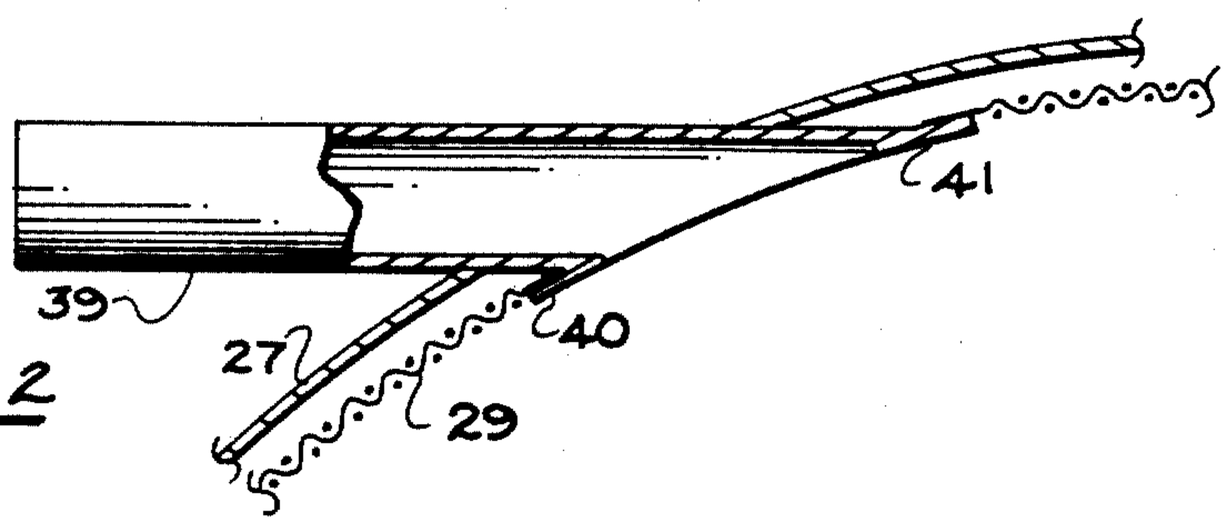

FIG. 2

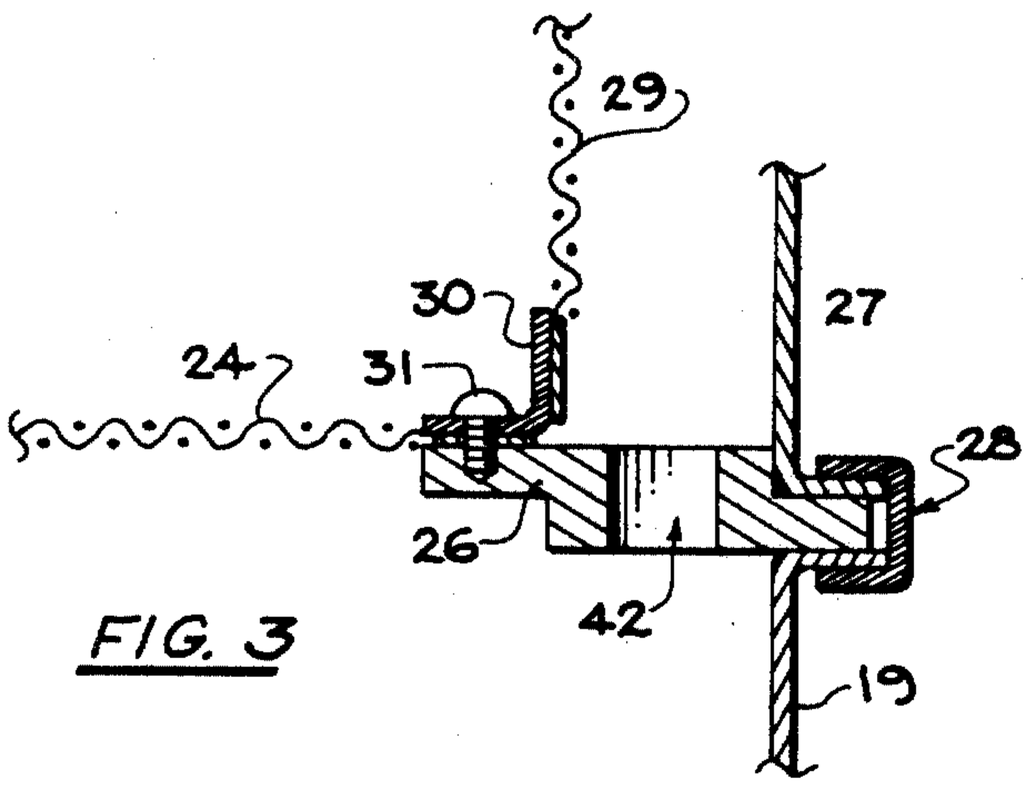

FIG. 3

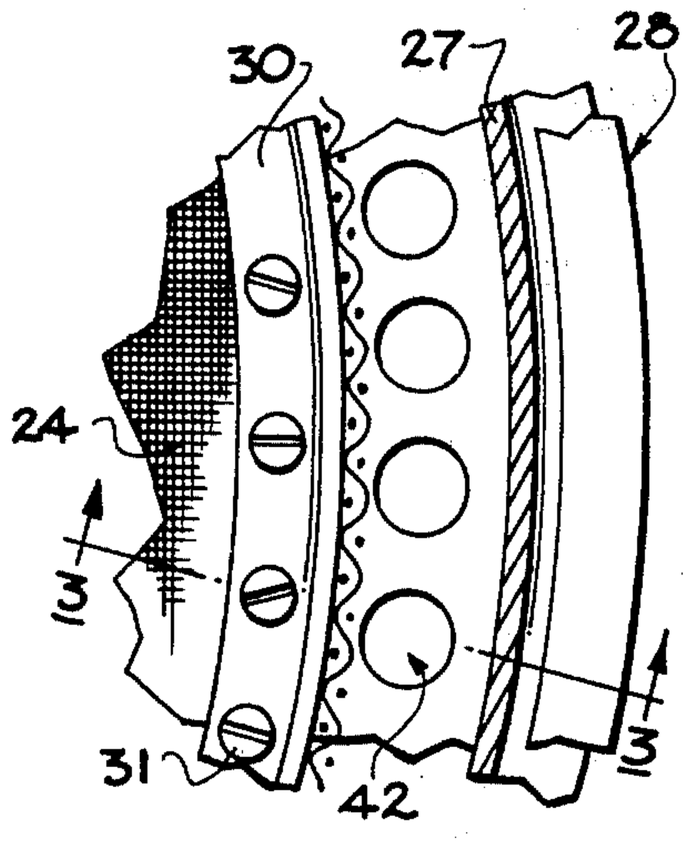

FIG. 4

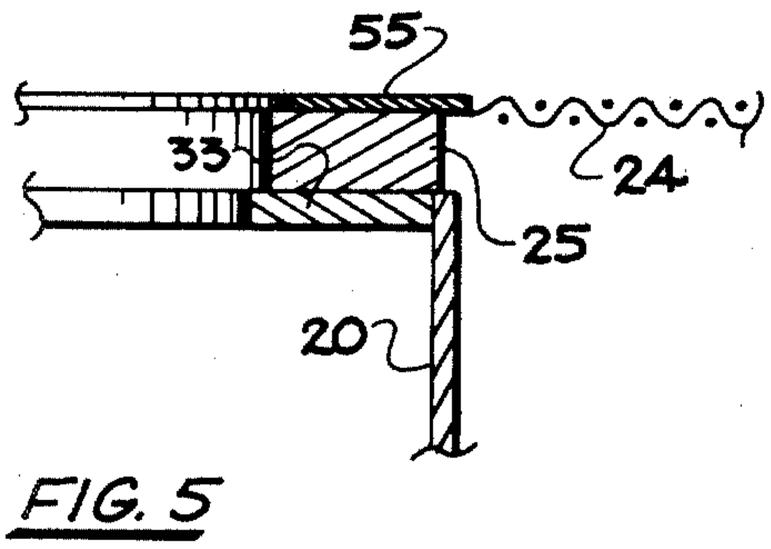

FIG. 5

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March 17, 1970 W. J. TALLEY, JR 3,501,002

VIBRATORY SEPARATOR

Filed Nov. 28, 1966 3 Sheets-Sheet 3

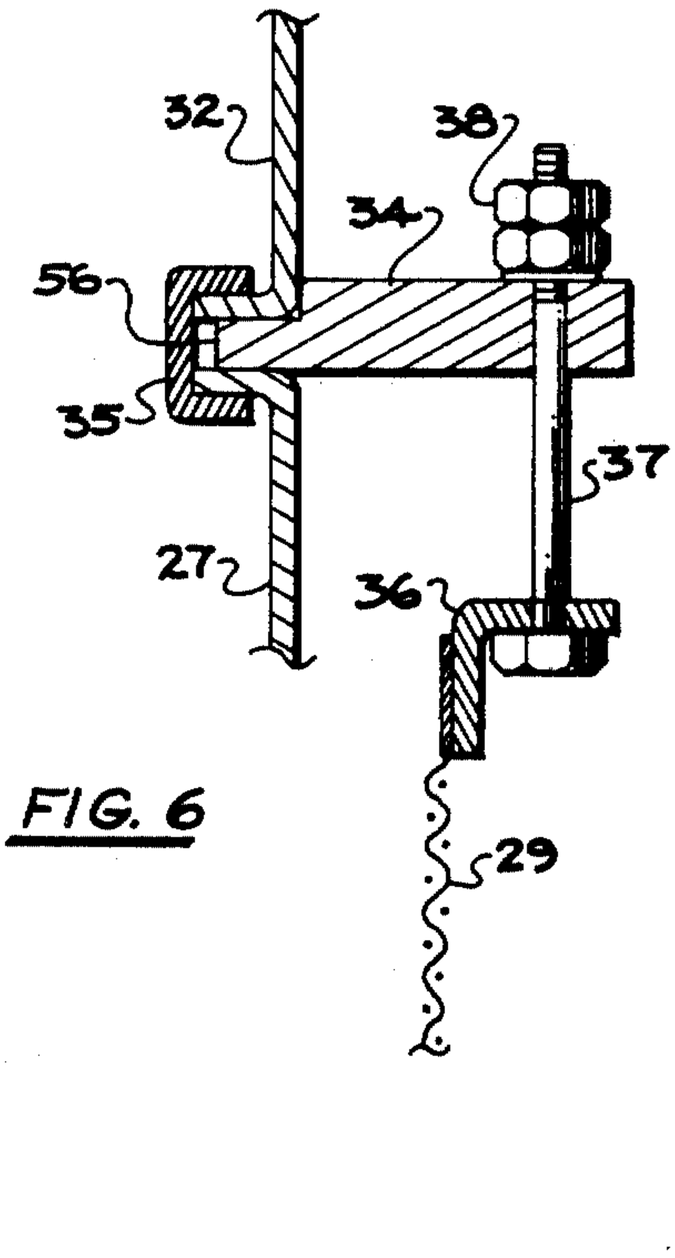

FIG. 6

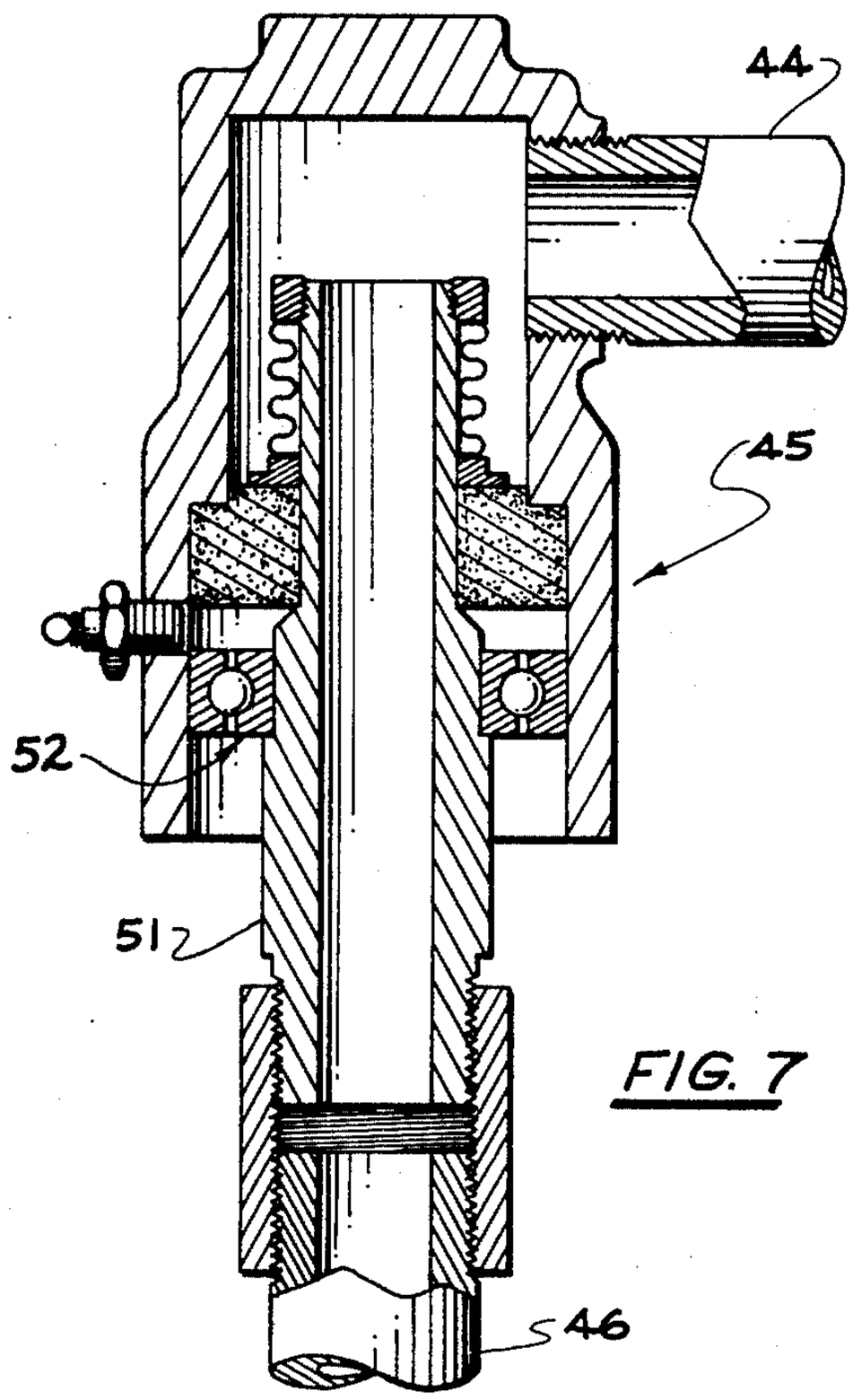

FIG. 7

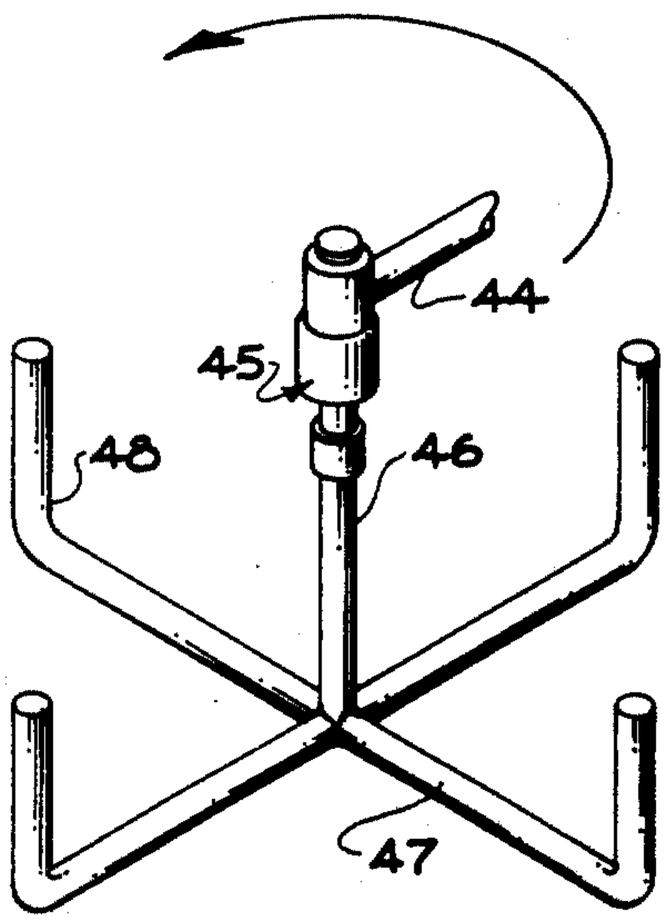

FIG. 8

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3,501,002
Patented Mar. 17, 1970

3,501,002

VIBRATORY SEPARATOR

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Int. Cl. B07b 1/50, 1/28
U.S. Cl. 209—240 11 Claims

ABSTRACT OF THE DISCLOSURE

A vibratory separator, and screening structure therefor mounted in a housing, the screening structure including a first portion having a central discharge opening therein and a second portion upstanding at near the periphery of the first portion such that material which does not flow through the second portion is delivered to the first portion near the periphery thereof. A material feed arrangement is provided adjacent the second portion of the screening structure for delivering material adjacent the inside surface of the second portion, preferably substantially tangential thereto. Means also are provided adjacent said portions of the screening structure for cleaning the same.

The present invention relates to improvements in separating devices such as vibratory screening apparatus and is particularly applicable to vibratory screen separators of high volume capacity.

Although a horizontal circular screen vibratory separating device of the type disclosed, for example, in U.S. Patents 3,035,700; 3,156,643; 3,029,946; 2,777,578; 2,753,999; 2,714,961; 2,696,302; 2,676,706 and 2,284,671 gives a great deal of flexibility in the separation of material by the selection of proper screen size and the appropriate adjustment of the vibrating device which drives it, there have been certain applications in which the vibratory screen apparatus has not been as successful as it might be.

For example, when using the conventional vibrating screen separator to remove a relatively small amount of solids from a large volume of liquid, the capacity of the separator is materially retarded by the limited surface area of the horizontal screen because there is a finite rate at which the liquid will pass through the screen, particularly in the presence of the solids, which tend to concentrate on the screen surface. In such instance, the capacity of the separator to remove the relatively small amount of solids is limited by the ability to move the solids across the screen and agglomerate the solids with larger particles so that a maximum open screen area is available to the liquid. Further, when using the vibrating screen separator to remove a relatively small amount of solids from a large volume of liquid, particularly where solids are finely divided or are semi-solids, the screen cloth also has a tendency to become bridged or clogged by the particulate or semi-solid material. This is particularly true in making a preliminary separation between water and finely divided solids in raw sewage where the sewage contains suspended grease often found in domestic household wastes. In these instances, the semi-solid grease tends to bridge and adhere to the screen cloth and gradually reduces the capacity of the cloth to discharge water.

It is, therefore, an object of this invention to provide an improved vibratory separator which employs a horizontal screen.

It is another object of this invention to provide an improved vibratory separator, which separator employs a circular screen and, when subject to vibration, is particularly adapted to the separation of large quantities of liquid material from a relatively small quantity of solid material.

It is a still further object of this invention to provide a circular screen vibratory separator having a novel arrangement which enables the separator to operate at increased capacities by increasing the screen area available with a given diameter unit.

Yet another object of the invention is to provide a vibratory separator unit which can be cleaned either while in operation or during short pauses in the operation without the necessity of dismantling the unit or removing the screen therefrom.

A further object of the invention is to provide a vibratory screening apparatus useful in the separation of mixtures of solids of different sizes as well as liquid-solid mixtures.

With the above objects in mind and other objects which may hereinafter appear, reference is directed to the drawings accompanying the specification in which:

FIGURE 1 is a vertical cross-section view of a vibratory screening apparatus of this invention having a circular configuration;

FIGURE 2 is a fragmentary plan view taken through 2—2 of FIGURE 1;

FIGURE 3 is an enlarged fragmentary, sectional view taken through 3—3 of FIGURE 4;

FIGURE 4 is an enlarged, fragmentary, sectional view of the peripheral screen mounting shown generally in FIGURE 1;

FIGURE 5 is an enlarged, fragmentary, sectional view of a portion of FIGURE 1 illustrating the center screen mounting detail;

FIGURE 6 is a fragmentary, sectional view of the upper, vertical screen mount shown in FIGURE 1;

FIGURE 7 is a detail of the rotating coupling shown in FIGURE 1 in conjunction with cleaning the screen; and

FIGURE 8 is an isolated side perspective of a cleaning means in accordance with the invention.

The above and other objects of the present invention are, in part, accomplished by a device which comprises a novel arrangement of screen, by which arrangement more screen surface area is provided, and a process and device for improving a liquid-solid separation in a vibratory screening apparatus by operating the device for its intended purpose until its capacity begins to be reduced by virtue of screen clogging and intermittently applying hot vapors, such as steam, to the screen cloth.

The vibratory separator of this invention generally comprises a housing structure; a first planar screen having an outer periphery secured to the housing structure, and a central discharge opening; a second screen; means for delivering material to be separated to the second screen adjacent its surface; the second screen being positioned above the first screen such that no portion of the second screen is in a plane parallel to the first screen and such that any of the material which does not flow through the second screen is delivered to the first screen at near the periphery thereof; means for vibrating the housing structure and the first screen to cause movement of the material from the outer periphery of the first screen toward the discharge opening for discharge of the oversize component of the material; means under the first screen for receiving the component of the material passing through the first screen; means communicating with the second screen for receiving the components of the material passing through the first screen; and means communicating with the central opening of the first screen to receive the oversize component of the material. In addition to the basic vibratory separator with the second non-planer, non-parallel screen; the present invention, in one of its aspects, makes use of a mechanism for cleaning the screens either while in operation or intermittently between periods of operation.

In a preferred embodiment of the invention, the second screen is a cylindrical screen positioned so that the axis of the cylinder formed by the screen is perpendicular

to the center of the first screen. However, any screen configuration in which the second screen is neither parallel to nor in the same plane as the first screen is within the purview of the invention so long as the discharge (i.e., material not passing through) of the second screen is the feed to the first screen. The cylindrical screen is preferred because it lends itself to inclusion in a cylindrical housing or frame and provides a maximum surface area per unit of height above the planar screen.

Another aspect of the present invention comprises means for feeding the non-planar second screen in a direction which is not perpendicular to the tangent at the surface of the screen. It has been found that a better separation of oversize and undersize material is obtained in this fashion. By undersize material, as used throughout this specification, is meant either relatively small solid particles either in a liquid or in a solid mixture and the liquid itself in a suspension.

The vibratory shaking or screening device, as shown in FIGURE 1, consists of a base frame **10** on the upper portion of which is mounted a ring of springs **11** which supports the vibratory screening device and isolates the vibrations imparted upon such device from the base frame **10**.

A vibratory unit comprising a motor **12** and upper and lower eccentric weights **13** and **14** respectively, is mounted by means of the mounting brackets **15** to a cylindrical extension **16** of the upper base **17** which is supported on the ring of springs **11** and is reinforced by gusset plates **18** which project between the springs **11**.

The relationship of the vibratory unit and the base frame **10**, as described above, may be varied by other arrangements. For example, a motor may be mounted upon the base frame **10**. A belt drive from such motor extends to and rotates the eccentric weights which are mounted on the upper base **17**.

On the upper base frame **17** is mounted a cylindrical housing structure or spacing frame **19** having a discharge duct **21** projecting therefrom and communicating with a cylindrical opening **20** in the approximate center through the sloping pan **54**.

Secured to the interior of the spacing frame **19** is a sloping receiving pan **22** which is inclined and which is isolated from the interior of the discharge duct **21** by the walls of the opening **20**. The pan **22** slopes upwardly from the lower portion of the frame **19** to a point diametrically opposite and adjacent to the upper edge of the frame **19**.

At the bottom of the frame **19** is a clamp ring **23** which secures the lower edge of the frame **19** to the upper base **17**.

The inner periphery and outer periphery of the horizontal screen **24** are secured to inner and outer tension rings **25** and **26** respectively, thus forming a rigid single unit. As best shown in FIGURE 5, the inner periphery of the horizontal screen **24** is affixed to marginal tension ring **25** by spot welding, bonding or other suitable means. As shown, the screen **24** is "sandwiched" between the tension ring **25** and the upper securing ring **55** prior to spot welding at intervals long the inner periphery. Alternatively, if the screen **24** is bonded to the tension ring **25**, the ring **55** is of the bonding medium, such as epoxy cement.

The outer periphery of the horizontal screen **24** rests upon an outer marginal tension ring **26** and is bonded, spot welded or otherwise affixed thereto. The horizontal screen **24** may be tensioned by a number of methods in a simple manner. For example, a single piece of screen material is stretched completely over the outer tension ring **26** and, while stretched, affixed in a suitable manner to the tension ring **26**. The inner tension ring **25** is then secured in place and the screen is cut to provide the center discharge opening. Upon affixing the screen **24** to tension rings **25** and **26**, the screen **24** and tension rings **25** and **26** form a single, rigid and removable unit.

The screen **24**, assembled in the tension rings **25** and **26**, is placed onto the vibratory separator unit whereby the inner marginal tension ring **25** rests upon and is secured in a suitable manner (such as by bolting) to a flange or lip **33** which projects inwardly from the upper cylindrical opening **20** (see FIGURE 5).

As best shown in FIGURE 3, a flange or lip **33** projects outwardly from the outer margin of tension ring **26**, the flange **33** being interposed between spacing frames **19** and **27** and resting upon a flange which projects outwardly from the upper periphery of the spacing frame **19**. A clamp ring **28** secures the spacing frames **19** and **27** and the interposed flange **34** of the tension ring **26**. In FIGURE 3, the outer tension ring **26** is provided with a series of openings **42**, such openings permitting the undersize liquid or other materials which pass through the adjacent vertical collar screen **29** to fall onto the receiving pan **22** and utimately be discharged through the "undersize" discharge duct **43**.

Before the collar screen **29** is assembled onto the unit, the lower periphery of the screen **29**, as illustrated in FIGURES 1 and 3, is bonded, spot welded or otherwise secured to the outer side of the vertical projection of a circular flange **30**. The horizontal projection of the circular flange **30**, with the screen attached to the outer side of the vertical projection, is attached to the tension ring **26** by inserting bolts **31** through the corresponding holes in the horizontal projection of the flange **30** and tension ring **26**, which holes are internally threaded to receive the bolts **36**. Alternatively, the holes in the tension ring **26** may be drilled completely through the ring **26** and the bolts **36** held with lock nuts.

As shown in FIGURE 6, interposed between the housing sections or spacing frames **27** and **32** is a flange **56** projecting from a circular ring **34**. Another ring clamp **35** secures the spacing frames **27** and **32** and cover **34**. The upper periphery of the cylindrical collar screen **29** is affixed by bonding, spot welding or other suitable means to the outer side of the vertical projection of a flange ring **36** in the same manner as was the lower periphery of the screen **29** as previously described. A series of bolts **37**, at pre-determined locations circularly upon the horizontal projection of the flange **36**, passes through the corresponding holes in the flange **36** and also through the circular ring **34**. Tensioning of the collar screen **29** is accomplished by the bolts **37** and tensioning nut **38** at the upper end of the bolt.

The spacing frame **27** is equipped with a feed arrangement consisting of a feed pipe **39** which enters the periphery of the spacing frame **27** in a generally tangential fashion and is connected to and projects through the collar screen **29**, the collar screen being provided with an opening at such connection corresponding to the opening of the feed pipe **39**.

As best shown in FIGURE 2, the end of the feed pipe **39** consists of a flange **40** projecting outwardly from the feed pipe **39** at an angle which is complimentary to the curvature of the collar screen **29**. The collar screen **29** overlies the projecting flange **40** of the feed pipe **39** and is covered by an overlying ring **41**. The screen **29** and ring **41** are spot welded or otherwise secured by bonding to the flange **40** which projects from the feed pipe **39**.

The vibratory separator functions to separate materials of two different sizes (or liquid from solid) through the screen **24** and the non-planar, non-parallel collar screen **29**, by virtue of the vibratory motion imparted by the vibratory unit, including upper and lower eccentric weights **13** and **14** and the tangential feed arrangement made by which the material to be separated is forcefully projected onto the horizontal screen **24** and against its adjacent collar screen **29**. As the material to be separated is fed onto the screen **24** and against the adjacent screen **29** by reason of the initial force of the tangential feed, the vibratory motion causes the material to move along the screen **24**, the oversize portion of the material being dis-

charged through the discharge opening **20**. The undersize material which passes through the collar screen **29** falls through the provided openings **42** in the tension ring **26**, as best shown in FIGURE 5, onto the receiving pan **22** and is ultimately discharged through the discharge duct **43**. Undersize material falling through the screen **24** falls onto the receiving pan **22** and is ultimately discharged through the discharge duct **43**.

The collar screen **29**, which provides a greater area over which the material to be separated may pass, thereby increasing the capacity of the separator, is particularly useful when a large volume of liquid is to be separated from a relatively small quantity of solids. In such instance, the tangential feed forcefully projects the liquid-solid material onto the screen **24**, resulting in a cyclonic movement of the material which causes the material to be forced against the side screen **29**. The major volume of liquid passes through the side screen **29** while the remaining volume passes through the horizontal screen **24** and the oversize materials being discharged through the center discharge opening **20**.

Although in most instances the additional screen area as provided for by the collar screen **29** substantially increases the capacity of a separator to separate materials, there have been certain applications in which the vibratory screening apparatus has been relatively unsuccessful.

For example, when using the vibrating screen separator to remove a relatively small amount of finely divided solids from a large volume of liquid, the screen cloth has a tendency to become bridged or clogged by the particulate materials. This is particularly true in making a preliminary separation between water and finely divided solids in raw sewage where the sewage contains suspended grease or oil often found in domestic household wastes. In these instances, the semi-solid grease tends to bridge and adhere to the screen cloth and gradually reduces the capacity of the cloth to discharge water.

This problem can be solved by the present invention which comprises a process for improving the operation of a liquid-solid separation in a vibratory screening apparatus by intermittently operating the device for its intended purpose until its capacity begins to be reduced by virtue of screen clogging or bridging, discontinuing operation and removing the bridging or clogging by applying hot vapors such as steam to the screen cloth.

This may be accomplished as illustrated in FIGURE 1 by a rotating stream jet arrangement lying above the screen **24** and parallel to the side collar screen **29**. As shown in FIGURE 9, the steam jet arrangement consists of a steam entry line **44** which feeds a rotary coupling **45** which is, in turn, attached to a vertical pipe **46** at the lower end of which are four adjacent extending arms **47**. The four lower extending arms **47** are connected to four vertical pipes **48**. The steam jets **49**, located on the vertical pipes **48** which are connected to the lower extending arms **47**, are canted in such a manner that when steam flows through the canted nozzles **49**, the reaction pressure from the steam emitted from the canted nozzles **49** causes the assembly, consisting of the four vertical pipes **48**, the vertical pipe **46** and the lower extending arms **47** to rotate in the coupling **45** so that the entire surface of the horizontal and vertical collar screen is treated with the steam during application. The fluid flowing in the lines to accomplish the cleaning need not be steam but may be any suitable solvent which will melt or dissolve the material which causes the screen clogging or bridging. Thus, under certain circumstances, hot water may be employed to effect the desired cleaning.

FIGURE 8 represents a detailed view of the rotary coupling **45** and, by way of illustration, shows the pipe **46** threadably connected to the rotating nipple **51** which is set in the lubricated bearing assembly **52** which is located in the body of the rotary coupling **45** in a manner well known in the art.

It may be observed that the circular cover **34** is provided with a circular opening of sufficient size to allow the vertical pipe **46** to pass. To assemble the rotary arm steam cleaning unit illustrated in FIGURE 1 onto separator unit, prior to placing the circular cover **34** onto the separator, the steam cleaning unit threadably detached from the rotary couple **45** must first be placed in its proper position, the circular cover subsequently placed in its proper position as previously described.

It is to be noted that the feed pipe **39** must be connected to a flexible connector (not shown) so that its vibrations are isolated from the feed system feeding material to be separated to the device. The feed pipe **39** may be located at any desired elevation along the frame **27**. It is also be noted that a plurality of feed pipes positioned around the periphery at various regularly spaced locations can be and are preferably employed. Further, although four steam arms have been illustrated, the steam cleaning apparatus may consist of a single steam arm rotating adjacent to screen **29** or it may comprise two, three, or four individual steam arms so rotating.

It is also to be noted that the screen **29** and screen **24** may be, and in many applications are, of different mesh sizes. Thus for example, when using the upper cylindrical screen **29** to concentrate raw sewage effluent for a small amount of suspended solids, the solids tend to agglomerate while passing downwardly over screen **29** so that a coarser mesh screen may be employed on the horizontal screen **24** than is employed in the vertical collar screen **29**.

It is preferred to feed material toward the upper periphery of the collar screen **29** at an angle other than perpendicular to the tangent line of the screen at the point of contact. Thus it is preferred that the material being fed to the collar screen tangentially, or as close to, tangentially as is possible. The feed means may comprise the illustrated feed pipe projecting through the annular frame, or it may be an internal mechanism not communicating with the separator screen itself which flows material against the screen **29**.

To illustrate the results obtainable with the device of this invention, it was possible to increase the capacity of a vibratory screen of 48″ outside diameter having 105 micron openings by approximately 100 percent by providing the planar screen with a collar screen having identical mesh size.

The device of this invention gave outstanding results when used in the initial or primary clarification of raw sewage containing grease and up to about 440 parts per million total suspended solids of which 70 to 80 percent comprise volatiles.

A device of the character above described having both planar and collar screen receive about 390 gallons per minute of the raw sewage, the feed being through the spacing frame as described above. The apparatus was run intermittently for 15 minute periods, was then stopped for 5 minutes during which steam was applied to collar screen **29** for approximately 3 minutes. In an extended run, the average filtrate concentration (that portion passing through screens **24** and **29**) was 194 parts per minute of total solids while the oversize material passing out through the discharge chute contained 56 percent of the initial total solids and had an actual solids concentration of about 5.0 percent with a volatile content of approximately 93 percent. The vibratory separator, according to this invention, operated for extended periods of time as a complete replacement for a primary clarifier in a sewage plant having an average input feed rate of about 390 gallons per minute.

I claim:

1. A vibratory separator comprising

a housing structure,

a first planar screen having a central discharge opening and having an outer periphery secured to said housing structure,

a second upstanding screen,

feed means for delivering material to be separated to said second screen adjacent its surface, said feed means provided a tangential feed of material to the inner surface of said second screen,

said second screen being mounted substantially adjacent the periphery of said first screen and above said first screen such that no portion of said second screen is in a plane parallel to said first screen and such that any of said material which does not flow through said second screen is delivered to said first screen at near the periphery thereof,

means for vibrating said housing structure and at least said first screen to cause movement of said material from the outer periphery of said first screen toward said discharge opening for discharge of the oversize component of said material therethrough said means for vibrating including a rotary power source and at least an eccentrically mounted weight coupled therewith,

means under said first screen for receiving the component of said material passing through said first screen,

means communicating with said second screen for receiving the component of said material passing through said second screen, and

means communicating with the central opening of said first screen to receive the oversize component of said material.

2. A vibratory separator comprising

a housing structure,

a first planar screen, secured to said housing structure and having a central discharge opening therein,

a second upstanding screen, said second screen being mounted substantially adjacent the periphery of said first screen and extending upwardly above said first screen to enable material fed to said separator which does not flow through said second screen to be delivered to said first screen near the periphery of said first screen,

feed means adjacent said second screen for delivering material to be separated to said second screen adjacent the inner surface thereof, said feed means providing a tangential feed of material to the inner surface of said second screen,

discharge means under said first screen for receiving a component of said material passing through said first screen,

means communicating with said second screen for receiving a component of material passing through said second screen,

discharge means communicating with the central opening in said first screen for receiving an oversize component of said material, and

vibratory means coupled with said housing structure for vibrating said housing structure and at least said first screen to cause movement of said material from the outer periphery of said first screen toward said discharge opening therein for discharge of said oversized component of said material, said vibratory means including a rotary power source and at least an eccentrically mounted weight coupled therewith.

3. A separator as in claim **2** wherein

said feed means includes at least one feed pipe extending through said second screen.

4. A separator as in claim **2** wherein

said first screen is substantially circular, and

said second screen is substantially cylindrical, said second screen being mounted at the periphery of said first screen.

5. A separator as in claim **4** wherein

retaining means is provided for securing said first screen to said housing structure, said retaining means having openings therein for allowing a component of said material passing through said second screen to flow to said discharge means under said first screen.

6. A separator as in claim **4** wherein

said feed means includes at least one feed pipe extending through said second screen.

7. A separator as in claim **2** wherein

said first screen includes retaining means coupling said first screen to said housing structure,

said second screen is substantially cylindrical, the bottom of said second screen is joined to the first screen near the periphery of said first screen, and

retaining means are coupled between the top of said second screen and said housing structure.

8. A vibratory separator comprising

a housing structure,

a screening structure mounted in said housing structure, said screening structure including a first portion which has a central discharge opening therein, and having a second portion upstanding at near the periphery of said first portion such that material fed to said screening structure which does not flow through said second portion is delivered to said first portion near the periphery of said first portion,

feed means extending through said second screen portion for delivering material to be separated tangentially to said second screen portion adjacent the inner surface thereof,

discharge means communicating with said screening structure for receiving components of said material passing through said first and second portions thereof,

discharge means communicating with the central opening in said first portion of said screening structure for receiving an oversize component of said material, and

vibratory means coupled with said housing structure for vibrating said housing structure and at least said first portion of said screening structure to cause movement of said material from the outer periphery of said first portion toward said discharge opening therein for discharge of said oversize component of said material, said means for vibrating including a rotary power source and at least an eccentrically mounted weight coupled therewith.

9. A separator as in claim **8** wherein

said feed means includes a feed pipe disposed with respect to said second portion of said screening structure to cause material to be fed substantially tangentially to said second portion of said screening structure.

10. A vibratory separator comprising

a housing structure,

a first substantially planar screen secured to said housing structure, said first screen having a central discharge opening therein,

discharge means communicating with said central opening in said first screen for receiving an oversize component of material being screened by said first screen,

vibratory means coupled with said housing structure for vibrating said housing structure and said first screen to cause movement of said material from the outer periphery of said first screen toward said discharge opening therein for discharge of said oversize component of said material, said vibratory means including a rotary power source and at least one eccentrically mounted weight,

screen means for receiving material to be screened and for allowing material which does not flow through said screen means to be delivered to said first screen near the periphery of said first screen, said screen means comprising a substantially cylindrical screen coupled with said housing structure and mounted above said first screen, and

feed means adjacent said screen means for delivering said material to be screened to said substantially cylin-

drical screen adjacent the inner surface thereof, said feed means providing a substantialy tangential feed of material to the inner surface of said substantially cylindrical screen to cause a cyclonic movement of said material toward said substantially planar screen.

11. A separator as in claim **10** wherein

said feed means includes at least one feed pipe extending through said substantially cylindrical screen.

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U.S. Cl. X.R.

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