Nov. 24, 1964 L. B. HOLMAN 3,158,569

GYRATORY SEPARATOR

Filed June 27, 1960 3 Sheets-Sheet 1

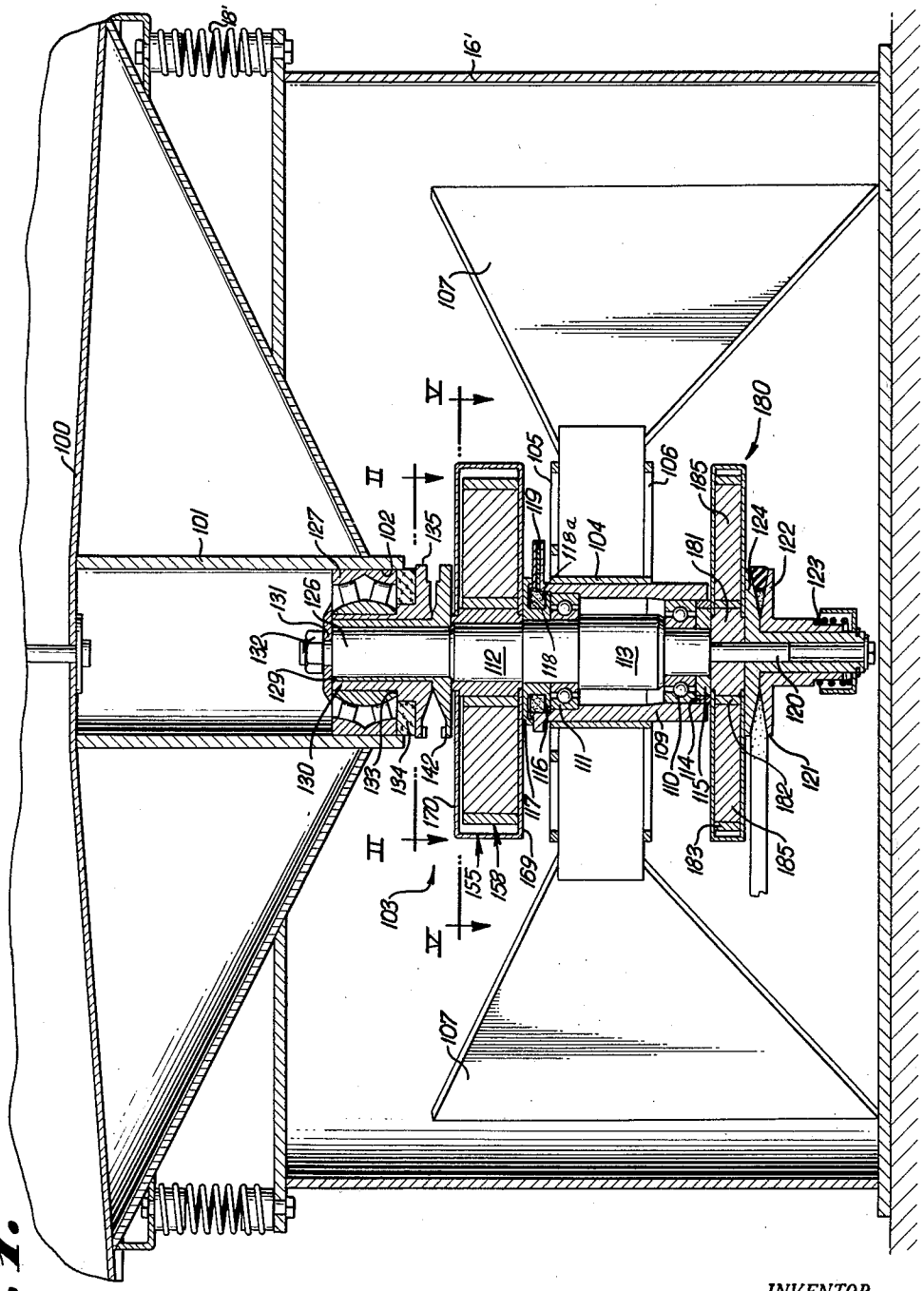


FIG. 1.

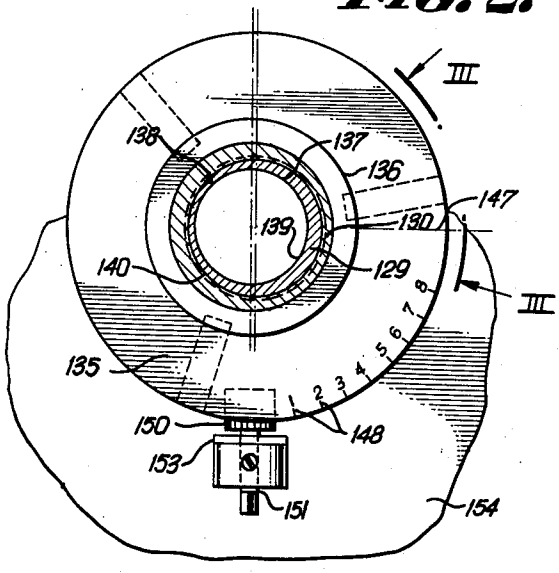
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FIG. 2.



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FIG. 4.

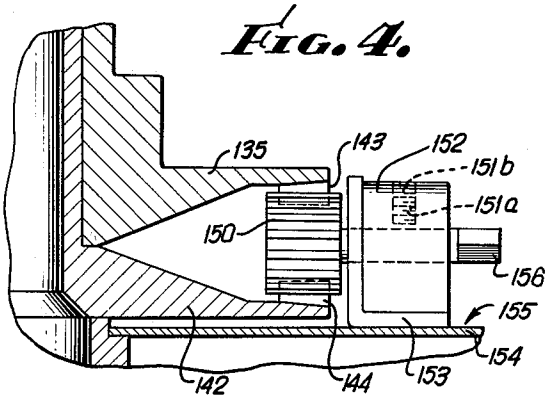


FIG. 3.

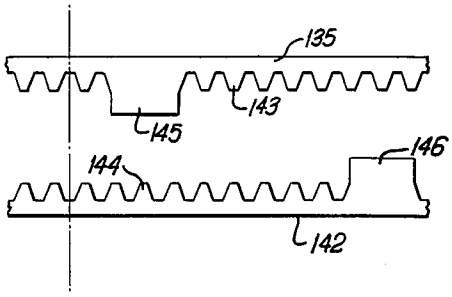


FIG. 5.

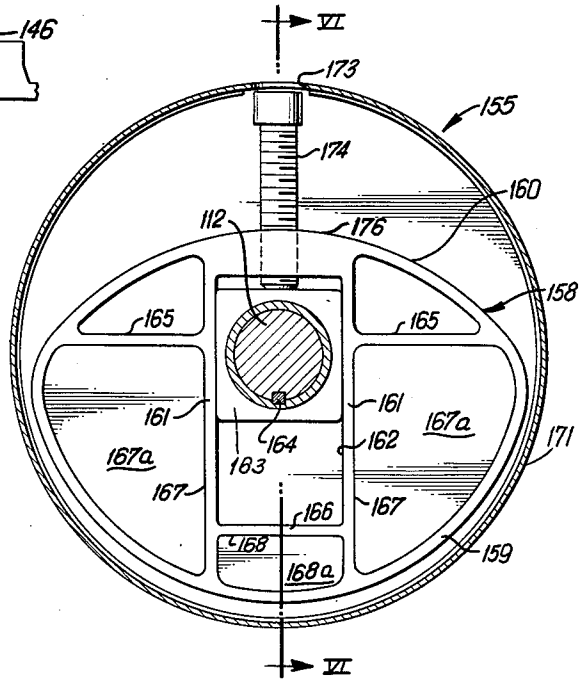
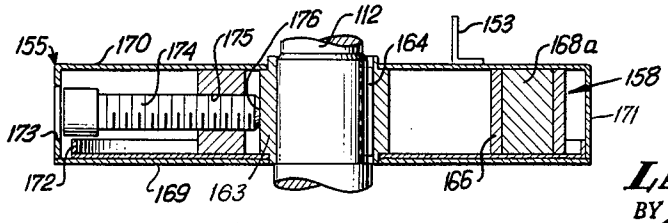


FIG. 6.



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GYRATORY SEPARATOR

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10 Claims. (Cl. 209—332)

This invention relates to a separator of gyratory type and more particularly to a gyratory separator constructed and arranged to impart a gyratory motion including horizontal, generally circular and vertical motion components to a vibratable shaking box assembly adapted to screen and separate a material introduced thereto. The gyratory separator of this invention is useful, generally speaking, in the separation of particles of material of different characteristics and of solids from liquids. More specifically, the separator has industrial use in the separation of sand and gravel, vegetables such as sizing peas, grain, purification of clays and many other materials.

The present application is directed to improvements on the gyratory separator disclosed in U.S. Letters Patent 2,950,819, issued August 30, 1960, Lee B. Holman and William T. Smith being joint inventors thereof.

The invention described in said Patent No. 2,950,819 included a gyratory separator in which a circular shaking box or sieve means of one or more box sections is resiliently and limitedly, laterally, yieldably supported by a plurality of circularly arranged spaced resilient means or coil springs from a stationary frame means. The said gyratory motion is imparted to the shaking box assembly by an eccentric connection including a self-aligning bearing which produces, in combination with the circularly arranged coil springs, a progressively tilting of the shaking box during its generally circular horizontal motion. As a result of this combination of a self-aligning bearing associated with the vibratable shaking box and the resilient support thereof, material being separated is not only rapidly screened, but non-passable material tends to flow towards the periphery of the shaking box and thence along the periphery to a discharge outlet. During the course of this flow of material, the vertical motion component imparted to the shaking box tends to upset the material facilitating effective separation and preventing clogging of the screen fabric. Means for readily varying the flow pattern of the material to adapt the separator to material of different characteristics was provided by adjustment of the amount of eccentricity provided in the eccentric connection.

Prior proposed separators of gyratory type have provided a somewhat similar flow pattern of material being separated by relatively complicated, complex constructions including eccentrically mounted weights for dynamically unbalancing the device. Such prior proposed devices were generally expensive to manufacture, subject to undue rapid wear of relative moving parts and were not readily adjustable to adapt such prior devices to materials of different characteristics.

Therefore, the primary object of this invention is to disclose and provide a separator of gyratory type, of novel construction in which the disadvantages of prior proposed separators are obviated and in which new advantages and results are achieved.

An object of this invention is to disclose and provide a gyratory separator of simple construction, of inexpensive manufacture and of convenient flexible adaptation to materials of different characteristics.

Another object of this invention is to provide a readily adjustable eccentric connection for imparting gyratory motion to a shaking box assembly wherein the eccentric connection includes telescoped eccentrically related sleeve members arranged in relative rotatable relation whereby

adjustment of eccentricity may be made without disassembly of portions of the separator.

A further object of the invention is to provide readily adjustable eccentric connecting means wherein opposed flanges of such means may be moved relative to each other by a readily accessible actuator device wherein disassembly of a part of the separator is not required.

Still another object of the invention is to provide a gyratory separator including means carried by the drive shaft for reducing transmission of vibratory components to the separator frame.

A still further object of the invention is to provide a gyratory separator wherein the means for eliminating transmission of vibratory components to the frame includes a novel arrangement and distribution of weights adapted to be readily adjusted.

A further object of the invention is to provide a gyratory separator wherein adjustable means for varying the eccentricity of the drive connection to the shaking box assembly and the readily adjustable means for eliminating transmission of vibrations to the frame provide for accurate easy adaptation of the separator to materials of various characteristics and to most effectively and efficiently tune the separator for optimum operation and separation of material.

A more specific object of this invention is to disclose and provide a gyratory separator wherein drive motor means is mounted in novel manner on a stationary frame means for modifying vibration characteristics of the shaking box assembly so as to not only vary the flow pattern of material being separated, but to vibrate said shaking box assembly at a most effective frequency.

The invention further contemplates a gyratory separator including circularly arranged resilient means supporting a shaking box assembly and a drive shaft having an eccentric adjustable drive connection to a self-aligning bearing associated with the shaking box assembly, said self-aligning bearing and drive shaft being vertically axially adjustable with respect to the shaking box assembly so as to modify the vibration characteristics of the shaking box assembly to adapt said box to materials of different characteristics.

These and many other objects and advantages of this invention will be readily apparent from the following description and drawings in which exemplary embodiments of this invention are shown.

In the drawings:

FIG. 1 is a sectional view of a separator embodying the invention, the section being taken in a vertical plane bisecting the device.

FIG. 2 is a horizontal sectional view taken in the plane indicated by line II—II of FIG. 1.

FIG. 3 is a side view taken in the plane indicated by line III—III of FIG. 2.

FIG. 4 is a reduced side view showing eccentric adjustment actuator or drive means.

FIG. 5 is a horizontal section taken in the plane indicated by line V—V of FIG. 1; and

FIG. 6 is a sectional view taken in the plane indicated by line VI—VI of FIG. 5.

In the embodiment of the invention shown in FIG. 1, only a portion of a gyratory separator is shown inasmuch as the sieve or shaking box means **17'**, resilient means **18'** and the frame means **16'** may be constructed as shown in the Patent 2,950,819 and therefore are not described herein in full detail.

The sieve means **17'** includes a transverse bottom wall **100** from which coaxially depends a cylindrical wall **101** forming a bearing housing, said housing having a bottom open end **102** into which extends the upper end of drive means generally indicated at **103**.

Drive means **103** may be mounted in a split cylindrical

wall 104 coaxial with bearing housing 101 and carried by top and bottom gusset plates 105, 106 supported from angularly spaced radially inwardly projecting frame members 107 attached to frame means 16'. The split cylindrical wall 104 permits vertical adjustment of the drive means 103 in a manner similar to that shown in Patent 2,950,819.

Drive means 103 includes a cylindrical sleeve wall 109 clamped and held by suitable means in selected vertical poistion in the split cylindrical wall 104. The internal surface of sleeve wall 109 provides longitudinally spaced seats for bottom bearing means 110 and top bearing means 111 which are mounted on drive shaft 112 at opposite sides of an enlarged shaft portion 113 thereof. The bottom bearing 110 may be retained by a suitable retainer ring 114 within which may be provided a suitable felt seal 115. The top bearing 111 may be retained in position by a retainer ring 116 and a seal cap 117 which defines a chamber 118 for a felt seal 118*a*. At one side of the top end of the sleeve wall 109 may be provided an inlet port 119 for admitting oil under pressure to the felt seal and to the bearings as an oil vapor. A reduced bottom end 120 of drive shaft 112 may carry a driven pulley 121 adapted to be connected by a pulley belt to a drive pulley carried by a motor shaft as shown in the prior embodiment. Pulley 121 may be of variable cone type and includes a pulley element 122 biased by spring 123 toward fixed pulley element 124.

Top end 126 of drive shaft 112 is coaxial with drive shaft 112 and with bearing housing 101. The top end 126 projects thorugh opening 102 and carries a self-aligning bearing means 127. Bearing means 127 is only generally indicated and it may be of the self-aligning type described in said Letters Patent, the outer race of bearing means 127 being slidable vertically on a finished internal surface of the bearing housing 101.

Eccentric means for connecting the top driveshaft end 126 to the bearing housing through the self-aligning bearing means 127 may comprise telescoped inner and outer sleeve members 129 and 130. Sleeve members 129 and 130 are coextensive at the top and may be retained on top end 126 by a suitable retaining washer 131 and a securement nut 132 therefor. The outer sleeve member 130 may be provided with an upwardly facing annular shoulder 133 upon which the inner race of the self-aligning bearing 127 may seat. A suitable seal 134 of annular form may close the opening 102 in the bearing housing 101, said seal being seated on an upwardly facing surface provided by a radially outwardly extending flange 135 integral with outer sleeve member 130.

As best seen in FIG. 2 the outer sleeve member 130 is provided with a cylindrical outer face 136 and an inner sleeve member 129 with a cylindrical internal face 139, the faces 136 and 139 being formed in eccentric relation with respect to the inner surface 138 on member 130 and the outer surface 140 on the inner member 129, the latter surfaces 138, 140 being formed about a common axis. Thus, machining of eccentric faces 136 and 139 is facilitated as later described. The internal face 139 may slidably and rotatably fit the cylindrical shaft surface 137 on top end 126 and the outer face 136 on sleeve member 130 is received between the inner race of the self-aligning bearing 127. Thus, when sleeve members 129 and 130 are rotated relative to one another the eccentric relation between the axis of shaft top end 126 and the axis of the self-aligning bearing 127 is varied. It will be understood that mating surfaces 138 and 140 may be formed in eccentric relation to an axis which may be common to the outer and inner cylindrical surfaces 136 and 139.

The inner sleeve member 129 may extend below outer sleeve member 130 and may be provided with a radially outwardly extending flange 142 which may include an annular seat 143 for the outer sleeve member 130 and peripheral portions disposed in spaced opposed relation to peripheral portions of flange 135.

In this example the opposed peripheral portions of flanges 135, 142 are provided respectively with oppositely facing teeth 143 and 144 arranged in arcuate segments, each subtending an angle of about 120°. Between said segments may be provided spacer portions 145 and 146.

The inner and outer sleeve members are preferably made and machined as a unit and assembled and used as a matched pair. The particular location of the inner sleeve member 129 with respect to the outer sleeve member 130 during boring and machine operations may be as indicated in FIGS. 2 and 3, FIG. 2 showing scribe line 147 and FIG. 3 showing the relation of teeth 143, 144 with respect to spacer portions 145, 146, the scribe line 147 being located two tooth-valleys to the left of portion 145 and ten valleys to the left of portion 146. Indicia 148 are indicated on the top face of flange 135 so that selected settings of eccentric relationship of the sleeve members may be readily made, recorded, if desired, and reset when necessary. It is important to note that both inner and outer sleeve members may be moved relatively to each other so that in one position maximum eccentricity is provided while in the diametrically opposite position minimum eccentricity is provided because of the arrangement of the eccentric surfaces 136 and 139.

The inner sleeve member 129 is not keyed or fixed to the top drive shaft end 126. Means for actuating or moving the inner and outer sleeve members in relative rotation with respect to each other and for retaining selected eccentric relation while rotated by the drive shaft 112 will now be described. The actuating means may include a pinion gear 150 (FIG. 4) having teeth meshed with teeth 143 and 144 on peripheral portions of the flanges 135, 142. Rotation of pinion gear 150 in either direction will simultaneously move the inner and outer sleeve members in relative rotation in opposite directions and will permit selective variation of the amount of eccentricity provided in the connection of the drive shaft 112 to the bearing housing 101 on the sieve means. The pinion gear 150 may be carried on a suitable pinion shaft 151 mounted in bearings carried on an actuator housing 152 secured to a mounting angle bracket 153 carried by the top wall 154 of vibration control or arrestor means 155. The outer end of shaft 151 may be provided with a polygonal end 156 adapted to be received within a suitable socket wrench or crank for turning the pinion gear 150.

Means to lock the pinion gear in selected position so that the inner and outer sleeves are maintained in the selected relative rotatable position with the desired eccentricity afforded thereby may include a threaded bore 151*a* in actuator housing and a set screw 151*b* threaded therein to contact and bear against the pinion shaft 151. The shaft 151 is thus held against rotation and the pinion gear in its engagement with the teeth holds the sleeve members in selected eccentric relation.

The vibration control means 155 provides readily adjustable means for counterbalancing components of force imposed on the drive shaft by the eccentric connection of the sieve means thereto. The control means 155 (FIG. 5) may comprise a metal frame structure having a peripheral frame member 158 including a generally semicircular portion 159 and an arcuate portion 160 having a radius much greater than the semicircular portion 159. The arcuate portion 160 and the semicircular portion 159 may be connected by a pair of parallel frame members 161 which define therebetween a diametrically extending opening 162 adapted to receive in slidable relation a mounting block 163 keyed as at 164 to drive shaft 112. The frame members 161 may be integrally formed with transversely oppositely extending frame members 165. A frame element 166 interconnects frame members 161 in spaced relation to the mounting block 163. The frame members 159, 161, 165, 166 define a plurality of side openings 167 and end opening 168 which may be filled

with a suitable dense, heavy material, such as lead, to afford weights 167*a*, 168*a* of selected mass and weight. In this example such weights 167*a*, 168*a* completely fill the openings 167 and 168 and are bonded to the frame 160.

The structure and weights within frame 158 may be contained within a bottom cover 169 and a top cover 170, said top cover 170 having top wall 155 and a peripheral flange 171 extending over an upstanding peripheral flange 172 of the bottom cover. A port 173 may be provided in flange 171 for access to and adjustment of screw bolt 174 which is provided with threaded engagement at 175 with the frame member 158 and has its inner end in abutment as at 176 with the movable slide mounting block 163. Turning of the adjusting screw bolt 174 will cause the frame member 158 to move laterally between covers 169, 170 and relative to the axis of the drive shaft 112 and thus change the location of the weights with respect to the axis. Such displacement of a rotatable mass with respect to an axis of rotation may increase or decrease vibrational force components imparted to the sieve means 17' depending upon the type of material fed to the sieve means for separation.

In order to stabilize the drive shaft 112 in its rotation so that vibrations from the sieve means are neutralized and not transmitted to the frame 16' and to the floor or support means upon which it is carried, a stabilizer 180 is provided between the lower drive shaft bearing 110 and pulley 121. The exemplary stabilizer means 180 is constructed in the same manner as control means 155, as shown in FIGS. 5 and 6, except that it is of smaller mass and size, and therefore reference to similar parts will be made only in connection with the illustration in FIG. 1. The stabilizer means 180 includes a mounting slide block 181 keyed to the lower end 120 of drive shaft 112, said slide block 181 being movable between parallel stabilizer frame members 182 formed in similar manner to the frame members 161 of the control means. Frame means 183 of the stabilizer means 180 is of the same configuration as frame means 158 and an adjustment screw bolt (not shown, but similar to bolt 174 of control means 155) is provided for moving frame means 183 and the weights 185 carried thereby into selected position with respect to the axis of the drive shaft so as to achieve the desired reduction in transmission of vibratory forces to the frame means. Normally weights 185 are disposed diametrically opposite weights 167*a*, 168*a* of the control means 155.

It should be noted in this example that the axial center of the shaking box assembly is generally non-yieldable in a vertical direction because of the eccentric connection with drive shaft 112 positioned centrally therebelow. The peripheral margins of the box assembly are vertically yieldable because of the resilient supporting coil springs. In this example, the self-aligning bearing is located below the planar zone of the coil springs and serves as a limited central pivot means for the shaking box assembly about its axis so that when the box assembly is driven through the eccentric connection a tilting motion may be produced which progresses in the direction of rotation of the box assembly. It is understood that the vertical location of the self-aligning bearing relative to the coil springs and to the center of gravity of the shaking box assembly may be varied by axial adjustment of drive means 103 in the split cylindrical wall 104 in order to modify the tilting motion.

In operation of this example of this invention, material to be separated may be introduced into the shaking box assembly in convenient well-known manner. Upon rotation of the drive shaft by energization of the drive motor, the shaking box assembly 17' will be imparted a circular gyratory motion because of the eccentric connection of the drive shaft 112 thereto and the circularly arranged coil springs will wobble or yield laterally about their vertical axes because of the eccentric motion being imparted to the box assembly. The shaking box assembly will tiltingly yield vertically at its outer periphery on coil springs, the self-aligning bearing permitting such movement, the amount and character of such tilting being dependent upon the distance between the self-aligning bearing and the center of gravity of the shaking box with the material therein. There will thus be imparted to the shaking box assembly a progressively tilting vertical motion component combined with horizontal circular motion components derived from the self-aligning bearing eccentrically connected to the drive shaft 112 and from the circularly arranged coil springs.

The circular tilting vibratory motion produced in the shaking box assembly imparts to material in the box sections a motion which causes the material to flow from the center outwardly to the peripheral edges and thence along the peripheral edges until the material reaches a discharge outlet. Material in the top box section during its movement in its path toward the periphery is caused to climb the inverted cone-shaped screen means of the shaking box and such climbing of the material is effective to facilitate rapid separation of the material. During the flow of material along the path mentioned, it will be readily apparent that the vertical motion component imparted by the combination of coil springs and self-aligning bearing causes the material to upset and thus separation is further facilitated. Upsetting the particles of material also prevents screen clogging or blinding.

Since the type of motion of the sieve means is dependent upon several factors, including the type, weight and rate of feed of material to be separated to the sieve means, resiliency of the coil springs, the eccentric throw of the driving connection to the sieve means, and the position of the weights in the vibration control means 155 and stabilizer 180, it will be apparent that adjustment of the eccentric connection and of the weights will permit the separator to be tuned so that the most effective and efficient separation is accomplished. Moreover, transmission of vibrations to the frame 16' and supporting structure can be readily prevented and eliminated. Adjustment of eccentricity is conveniently made without disassembly of part of the drive means.

It will be apparent to those skilled in the art that in the example of this invention that motion-transmitting means have been employed between a drive shaft and the axis of a resiliently supported shaking box assembly or sieve means, and that said motion-transmitting means includes an eccentric connection and a self-aligning bearing between the eccentric connection and the vibratable shaking box assembly. It will be understood that the gyratory motion imparted to the shaking box assembly is one which appears as a rapid vibration which may be of selected frequency depending upon the revolutions per minute at which the drive shaft is driven. A change in the number of revolutions per minute of the drive shaft will also tend to affect the flow pattern of the material being separated. Generally, a relatively rapid frequency of vibration is employed.

It will be understood by those skilled in the art that various modifications and changes may be made in the exemplary embodiments of this invention described above, and all such changes and modifications coming within the scope of the appended claims are embraced thereby.

I claim:

1. In combination with a gyratory separator having a drive shaft portion extending into a bearing housing, the provision of: adjustable eccentric connection means between the shaft portion and the bearing housing including an inner sleeve member turnable relative to the shaft portion, an outer sleeve member turnable relative to the bearing housing and the inner sleeve member, mating surfaces between the inner and outer sleeve members in eccentric relation to the shaft portion, external laterally extending axially spaced flanges on said sleeve member;

means extending between said flanges and cooperable therewith to selectively turn each sleeve member relative to the shaft portion to adjust eccentricity; lock means for holding said sleeve members in selected position; means connecting the lock means to the shaft portion for rotation of the sleeve members therewith.

2. In a gyratory separator having a stationary frame, sieve means resiliently supported from said frame, and a drive shaft supported by said frame between its ends, the provision of: a bearing housing connected to the sieve means; a shaft portion concentric with said drive shaft extending into said bearing housing; a self-aligning bearing means mounted in said bearing housing for said shaft portion; adjustable eccentric connecting means between said bearing means and said shaft portion and including inner and outer sleeve members independently turnable relative to each other and to said shaft portion; vibration control means rotatable with said drive shaft between said eccentric connecting means and the frame support for said drive shaft; stabilizing means carried by said drive shaft below said frame support for said shaft; and lock means carried by said vibration control means for said sleeve members to hold said sleeve members in selected position during rotation with said drive shaft; said vibration control means and said stabilizing means each having external adjustment means; whereby vibratory motion components transmitted to said sieve means may be readily varied to adjust flow pattern of material being separated.

3. In a gyratory separator having a stationary frame, and sieve means supported from said frame by spaced resilient means, the provision of: a drive means for imparting gyratory motion to said sieve means and including a bearing housing connected to said sieve means, a self-aligning bearing means mounted in said bearing housing, a drive shaft having a shaft portion received within said bearing means, means connected with said self-aligning bearing means to adjust eccentricity between the axis of said bearing means and the drive shaft, said means to adjust eccentricity comprising: sleeve means having telescoped inner and outer sleeve members provided with mating eccentric surfaces in relative rotatable relation, the inner sleeve member being freely rotatable on said drive shaft portion, said sleeve members including radially outwardly directed flanges in spaced relation, and means between said flanges to move said flanges relative to one another.

4. A separator as stated in claim 3 including a lock means for said moving means.

5. An adjustable eccentric device for use between driven and driving means including a housing and a shaft portion comprising, in combination therewith: inner and outer sleeve members provided with eccentric mating interfaces between said housing and shaft portion, said sleeve members being turnable relative to each other and to the housing and shaft portion, radially outward directed flange means on said sleeve members in opposed axial spaced relation; means engaged with and between said flange means for turning one sleeve member relative to the other sleeve member; lock means restraining said sleeve members against turning relative to each other from a selected relationship; and means connecting said lock means to said shaft portion for rotation of the sleeve members therewith.

6. A device as stated in claim 5 wherein said flange means include circumferentially arranged rack teeth.

7. A device as stated in claim 5 wherein said flange means include circumferentially arranged rack teeth; and

said flange turning means includes a pinion gear enmeshed with said rack teeth.

8. A device as stated in claim 5 wherein said lock means includes a member carried by said shaft portion and supporting said flange turning means, and a lock member engaged with said supporting member and said flange turning means.

9. In a separator having a stationary frame, sieve means resiliently supported from said frame, and a drive shaft supported by said frame, the provision of: a bearing housing connected with the sieve means; a shaft portion concentric with said drive shaft extending into said bearing housing; a bearing means mounted in said bearing housing for said shaft portion; adjustable eccentric connecting means between said bearing means and said shaft portion and including inner and outer sleeve members having eccentric mating interfaces independently turnable relative to each other, to said shaft portion, and to said housing; vibration control means rotatable with said drive shaft adjacent said eccentric connecting means; and lock means carried by said vibration control means for said sleeve members to hold said sleeve members in selected position during rotation with said drive shaft; said vibration control means having external adjustment means whereby vibratory motion components transmitted to said sieve means may be varied to adjust flow pattern of material being separated.

10. In a gyratory separator having a stationary frame, sieve means resiliently supported from said frame, and a drive shaft supported by said frame, the provision of: a bearing housing connected to the sieve means; a shaft portion concentric with said drive shaft and extending into said bearing housing; a bearing means within said bearing housing for said shaft portion; adjustable eccentric connecting means between said bearing means and said shaft portion and including inner and outer sleeve members having eccentric mating interfaces and independently turnable relative to each other and having flange means in spaced opposed relation; means engageable with said flange means for turning said sleeve members relative to each other; vibration control means rotatable with said drive shaft adjacent said flange means; and lock means carried by said vibration control means to hold said sleeve members in selected position during rotation with said drive shaft; said vibration control means and said eccentric connecting means being adjustable whereby vibratory motion components transmitted to said sieve means may be readily varied to adjust the flow pattern of the material being separated.

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