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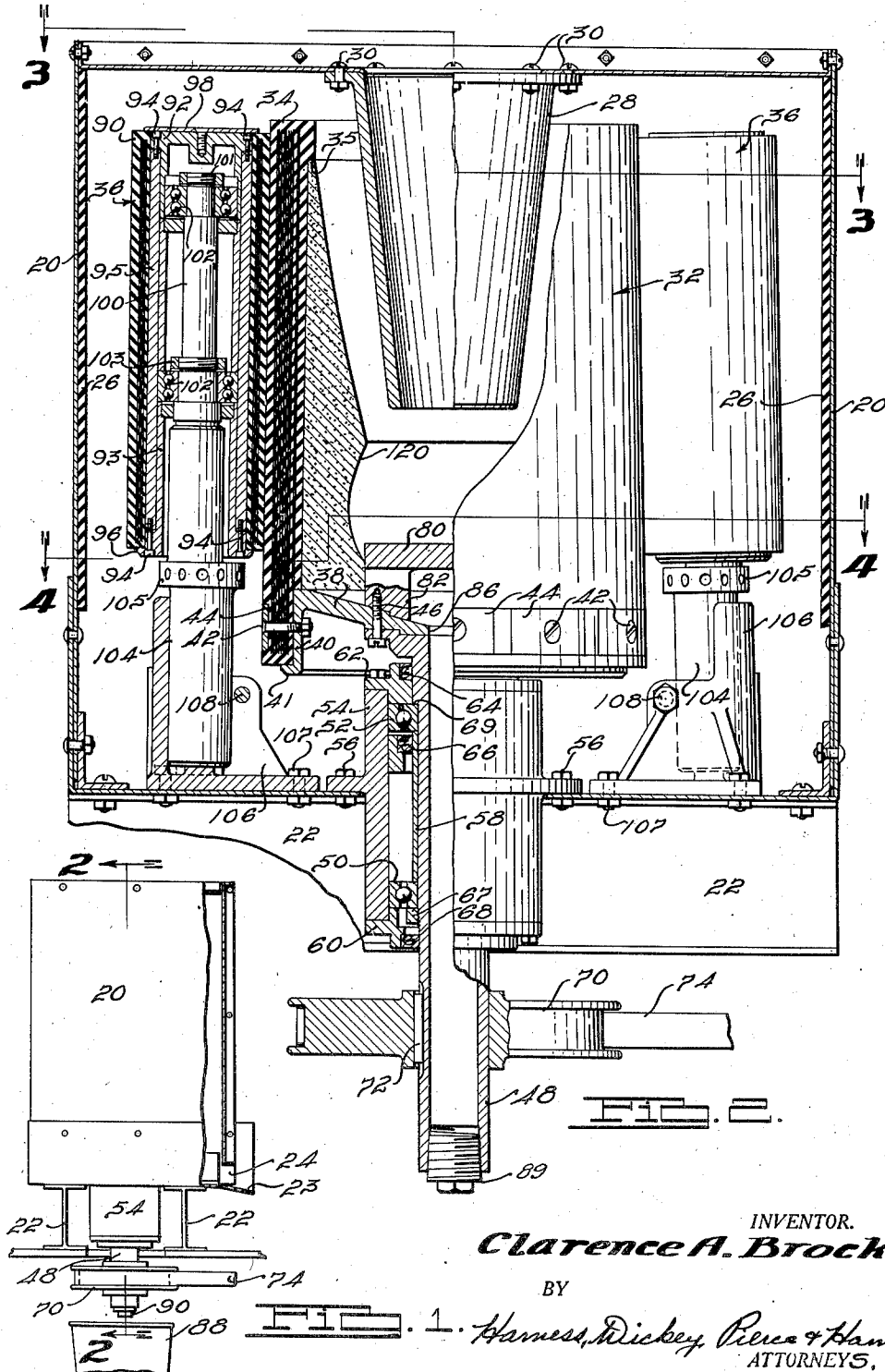
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2,136,540

SEPARATING MACHINE

Filed Aug. 23, 1935

5 Sheets-Sheet 1



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2,136,540

SEPARATING MACHINE

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FIG. 3.

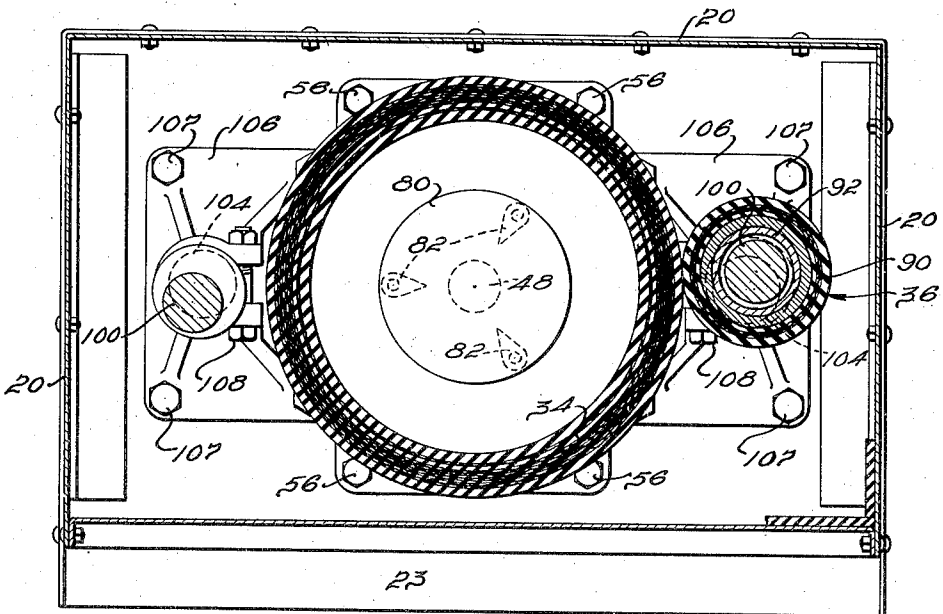
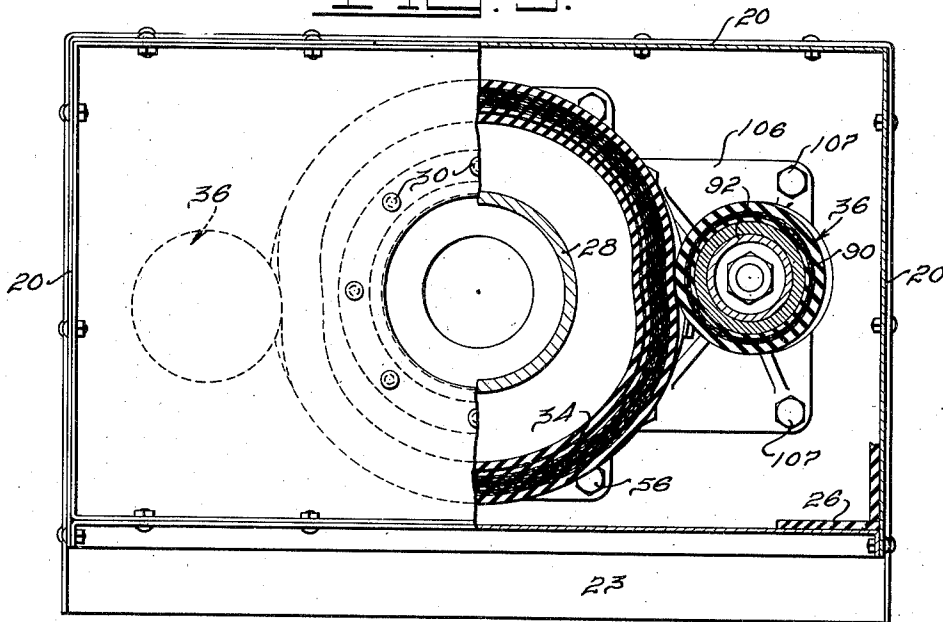


FIG. 4.

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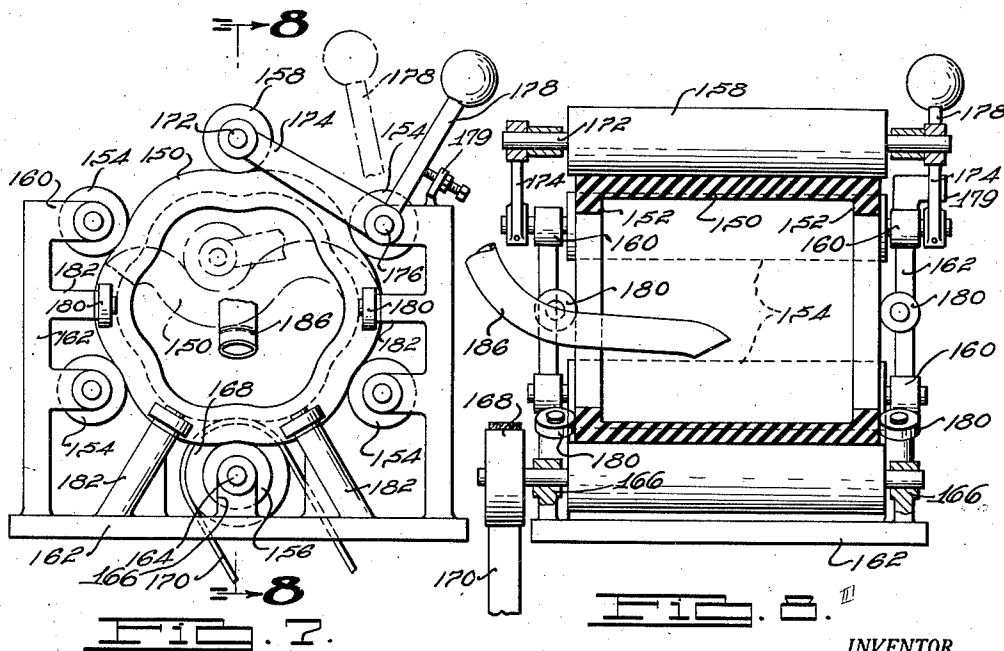
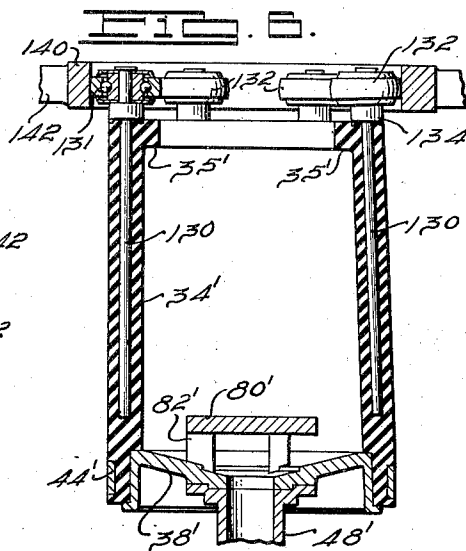
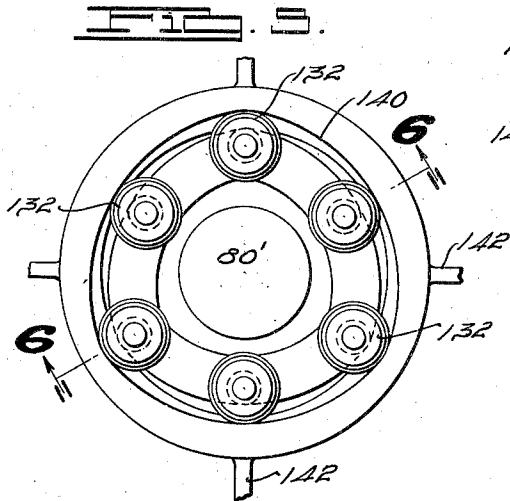
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5 Sheets-Sheet 3



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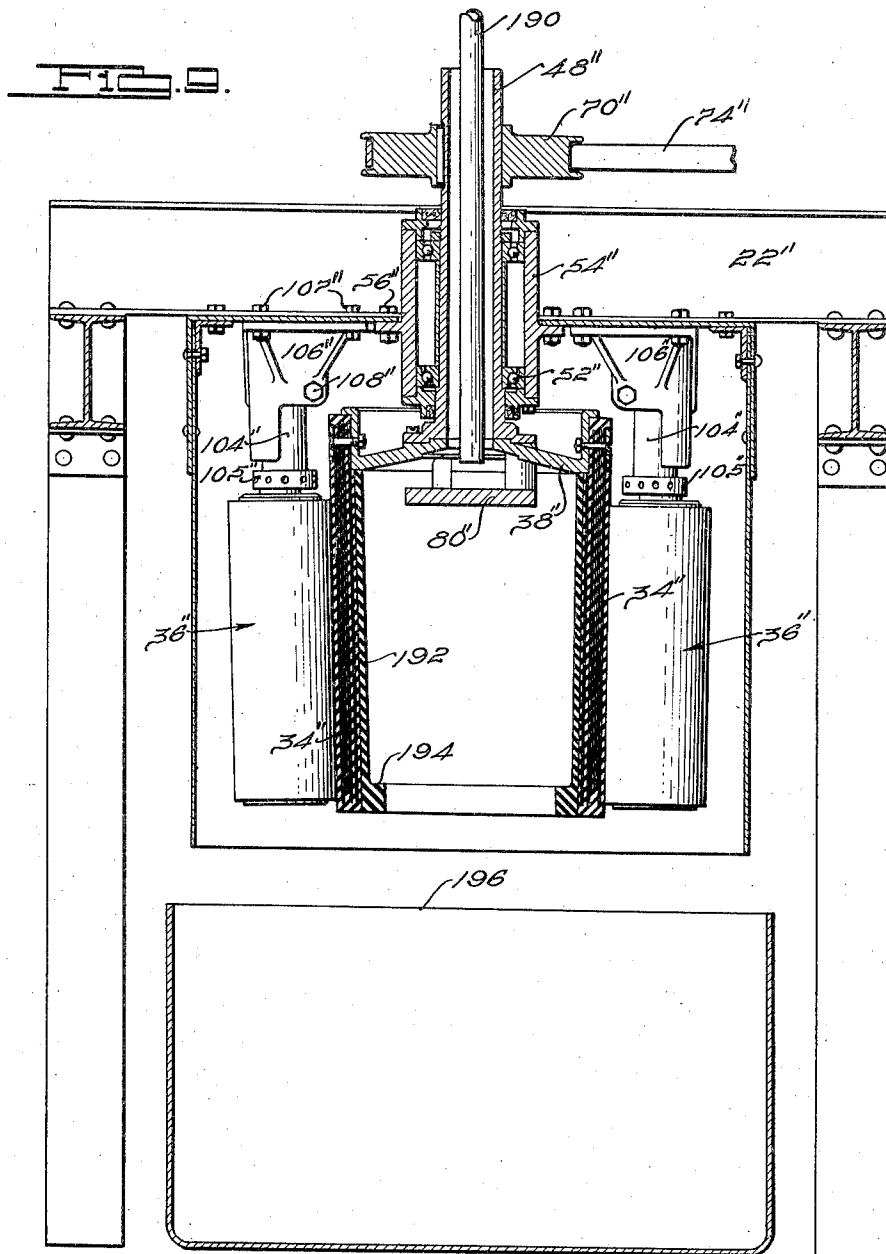
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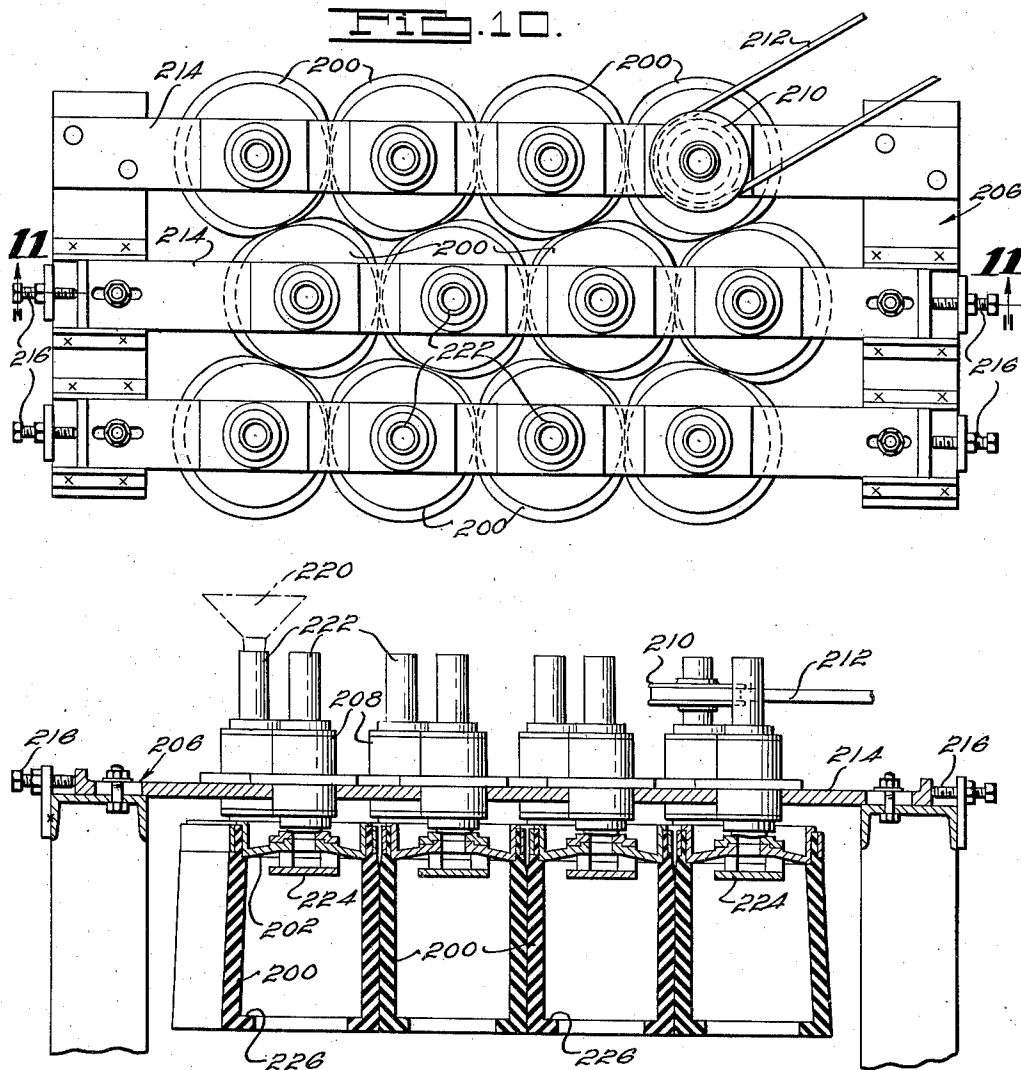
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5 Sheets-Sheet 5



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2,136,540

SEPARATING MACHINE

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11 Claims. (Cl. 233—3)

This invention relates to centrifugal separators and, while it is applicable to a wide range of uses wherever finely divided particles of different specific gravities are mixed together and it is desired to separate them according to their specific gravities, it has been designed particularly for the separation of gold and other metals from the material in which such metals are found in natural deposits. Accordingly, for ease and clearness of description in the following specification and claims, the use of the present invention will be specifically referred to only in connection with the separation of gold from the material in which it is found in natural deposits, it being understood that such reference will be made in an illustrative rather than a limiting sense.

As is well understood in the art of gold mining, gold may be found in "pay dirt" and which pay dirt usually consists of sand or gravel through which free particles of gold may be present, or it may be found embedded in rock or rock-like formations. It will be understood that the gold may be separated from pay dirt by the use of the present invention directly after the pay dirt has been subjected to the conventional screening operations to remove the boulders and pebbles, but where the gold is found embedded in rock the rock must be subjected to the usual pulverizing operations before the gold particles are subject to separation therefrom by the use of the present invention.

With the above in mind, it will be understood that principal objects of the present invention include the provision of a centrifugally operated separator which is efficient in operation, embodies durable and relatively few parts and may be readily and economically manufactured, adjusted, assembled and repaired.

Other objects of the present invention include the provision of a centrifugally operated separator embodying a rotating separating wall or surface, in combination with improved means for deforming or working the separating wall to thereby work the material being operated upon and facilitate the depositing of the heavier particles in the material upon the wall; in which the separating wall is approximately cylindrical in shape and is supported upon a relatively rigid base member and the deforming means act progressively in degree from the supporting base to the top of the cylinder; in which the separating wall structure is formed of a rubber and fabric composition which is self-sustaining but is deformable by the action of the deforming

means; in which the deforming means comprises cylindrical members, adjustably and rotatably mounted, and in continuous engagement approximately throughout their length with the separating wall; in which the deforming rolls are driven by their engagement with the externally driven separating wall; in which the surfaces of the deforming rolls are tilted at an angle to the cooperating surface of the separating wall when in non-deformed state so that the deforming action increases successively from the supported end of the wall to the unsupported end of the wall; and in which the unsupported, or discharge end, of the separating wall is provided with an inwardly extending annular shoulder to retain the separated out particles within the separating wall.

Further objects of the present invention include the provision of a centrifugally operated separator of the above stated character, in which the rotating separating wall and cooperating rotating deforming rolls are housed within an enclosure; in which the material to be separated is deposited into the separating cylinder from the top of the machine and is received upon a rotating table, which rotates with the separating wall; in which the refuse material or gangue passes out of the separating cylinder at the open end thereof; and in which the machine enclosure is provided with suitable discharge openings to discharge the gangue.

Further objects of the present invention include the provision of a centrifugally operated separator embodying a separating cylinder having a wall upon which the material to be concentrated is adapted to be deposited, and embodying a plurality of deforming members carried by the separating wall and disposed to cooperate with stationarily mounted cam mechanism to progressively deform and work the separating wall to thereby loosen the bulk material being worked upon and facilitate the centrifugal separation of the concentrate; in which the operating cylinder is supported at one end and is unsupported at the other, and the deforming members are carried and extend from the unsupported end; and in which the deforming means comprises rollers having shafts embedded in the deforming wall and which extend from one end of the separating cylinder for cooperation with a stationarily mounted cam track.

Further objects of the present invention include the provision of a centrifugally operated separator embodying a separating cylinder hav-

ing flexible walls, and one or more rolls for driving the cylinder and for deforming the wall to thereby keep the bulk material being worked upon in a loose condition to thereby facilitate the separation; in which one or more additional deforming means are provided for supplementing the action of the driving deforming roll or rolls; and in which one or more deforming means are provided which may be manually adjusted to deform the wall to an abnormal extent to facilitate the scaling from the separating wall of a collected mass of concentrate.

It is a further object of the present invention to provide a centrifugally operated separator of the type having a vertical axis of rotation, and in which the material to be operated upon is deposited at the upper end of a rotating separating cylinder, and the gangue is discharged at the open lower end of such cylinder.

It is a further object of the present invention to provide, in a centrifugally operated ore separator, a replaceable separating wall liner which may be inserted within a rotating, separating cylinder and retained in place therein.

It is a further object of the present invention to provide a multiple type, centrifugally operated ore separator embodying a plurality of rotating separating cylinders; in which the respective cylinders are in peripheral engagement so that a mutual driving action is effected between such cylinders; in which the mounting for the cylinders is such that the peripheral engagement thereof effects a deforming or working of the cylinder walls; and in which the relative positions of the respective cylinders are adjustable to take up wear and change the degree of deformation.

With the above and other objects in view, which appear in the following description and in the appended claims, illustrative embodiments of the present invention are shown in the accompanying drawings, throughout the several views of which corresponding reference characters are used to designate corresponding parts, and in which:

Fig. 1 is an external view in elevation with certain of the parts broken away, of one embodiment of the present invention;

Fig. 2 is a view in front elevation, partly in section, taken along the line 2—2 of Fig. 1;

Fig. 3 is a view in horizontal section taken along the line 3—3 of Fig. 2;

Fig. 4 is a view in horizontal section taken along the line 4—4 of Fig. 2;

Fig. 5 is a view in horizontal section of a second embodiment of the present invention;

Fig. 6 is a view in vertical central section of said second embodiment taken along the line 6—6 of Fig. 5;

Fig. 7 is a view in end elevation of a third embodiment of the present invention;

Fig. 8 is a view in vertical central section taken along the line 8—8 of Fig. 7;

Fig. 9 is a view in vertical section of a fourth embodiment of the present invention;

Fig. 10 is a top plan view of a fifth embodiment of the present invention; and

Fig. 11 is a view taken along the line 11—11 of Fig. 10.

In the form illustrated in Figs. 1 to 4 inclusive, one embodiment of the present invention comprises generally an outer casing, the top of which is partially enclosed, but is provided with an opening from which a funnel depends and through which the material to be separated is introduced,

and a partially enclosed base having a plurality of openings through which the refuse material or gangue is discharged. The side walls of the casing are closed. A rotatable separating cylinder, having its axis vertically disposed, is disposed within the casing, and is supported at its lower end upon a rigid base which is provided with a shaft having suitable bearings in the casing base.

The upper end of the separating cylinder is open, but is provided with an annular flange which extends inwardly somewhat from the side thereof, to insure that all of the concentrate separated out from the bulk material is retained within the cylinder and that none of it passes out of the top of the cylinder with the refuse material or gangue.

The separating cylinder is formed of resilient material, preferably a composition rubber and fabric, thick enough to be of a self-supporting character but resilient enough to be deformable by each of a series of deforming rolls, which are disposed in peripheral engagement therewith at spaced points around the cylinder.

Each of the deforming rolls comprises generally a mandrel having a somewhat resilient casing, preferably made of the same material as the walls of the separating cylinder, and rotatably supported upon a normally fixed eccentric shaft or spindle. The eccentric shaft is normally secured against rotation in a bracket extending upwardly from the face of the machine base, but may be released and rotated to vary the axial spacing between the associated roll and the separating cylinder either to vary the degree of deformation of separating cylinder or to compensate for wear. Preferably, the rolls are in continuous engagement throughout their length with the outside of the wall of the separating cylinder, and are driven by such engagement in response to the rotation of the separating cylinder, thus dispensing with the need of additional driving mechanism for the deforming rolls.

A feature of the present invention is the arrangement of the deforming mechanism to provide a successively increasing deformation from the base of the separating cylinder to the top of it. The base of the cylinder, as previously mentioned, is secured to the relatively rigid supporting and rotating base, and by reducing the deformation at such lower end to a minimum, the life of the separating cylinder has been found to be substantially prolonged. The reduced deformation in this part of the cylinder provides a sufficient working of the deposited material to insure it being maintained in a loose state. As the top of the separating cylinder is approached, the deformation is increased. This increase does not adversely affect the supporting cylinder, since it occurs at a part of the wall which is at some distance from the rigid supporting base. Moreover, it has been found that as the top of the separating cylinder is approached, the tendency of the bulk to pack and harden, by the centrifugal action, is increased, so that a substantially greater deformation at such upper part is required. In the form illustrated in Figs. 1 to 4, inclusive, the progressive deformation is effected by tilting the axes of the separating cylinder and of the deforming rolls with respect to each other, the separating cylinder axis being vertical and the deforming roll axes being slightly off vertical.

In the operation of this embodiment, the material to be operated upon, which may be either wet or dry, is deposited through the funnel at

the top of the casing, and is received upon a table or stool carried upon and rotating with the separating cylinder base. Upon being deposited upon the rotating table, such material is thrown outwardly by centrifugal force against the walls of the separating cylinder. The heavier particles of the material are forced outwardly, and the lighter gangue particles are retained nearer the axis of the cylinder, as will be understood. As the separation progresses, the accumulated bulk material is flattened out and caused to climb up the walls of the cylinder, finally reaching the top thereof, at which point the gangue or refuse material is discharged through the open upper end of the cylinder and falls through the casing and is discharged through the opening in the base of it. The inwardly extending annular shoulder at the top of the separating wall prevents the escape of the concentrated heavier particles.

Throughout the separating action, the rotation of the separating cylinder effects a corresponding rotation of the deforming rolls, a plurality of which, as previously stated, are distributed around the former. These deforming rolls effect an inward and outward flexing of the resilient separating cylinder wall, thus effecting a working and loosening of the bulk material forced against such walls by the centrifugal action. This deforming or working action, which is progressive from a minimum at the base of the cylinder to a maximum at the top of the cylinder, keeps the material in a relatively loose and free condition, facilitating the outward movement of the heavier particles therethrough to the separating wall. It has also been found that this progressive working of the bulk material maintains the bulk material at a much deeper angle within the cylinder than the angle of repose of the bulk material. In this way, an undue collection of the bulk material at the base of the cylinder is prevented.

The separating action thus described is conducted continuously, in accordance with the preferred practice of the present invention, until such time as it may be expected that the concentrate will be deposited upon the separating wall to a desired or to substantially no greater thickness of the previously mentioned annular flange at the upper end of the cylinder. At this time, in further accordance with the present invention and where gold is being separated, quicksilver is introduced through the funnel and forced, by the centrifugal action, through the mass of deposited material where it meets with and amalgamates with the separated ore. Upon stopping the rotation of the separating cylinder, the quicksilver, carrying with it the separated ore, runs downwardly by gravity along the side walls of the separating cylinder, along the centrally sloping space of the cylinder, and out through an opening provided through the cylinder shaft, where it may be collected in any suitable receptacle.

In accordance with a second embodiment of the present invention illustrated in Figs. 5 and 6, the independently supported deforming rolls described in connection with the first embodiment are replaced by a corresponding series of deforming rollers, the axle shafts of which are rigid and embedded and supported by the walls of the separating cylinder. The deforming rollers extend upwardly from the upper or discharge end of the separating cylinder and are disposed to be acted upon and successively moved radially inwardly of the cylinder by a stationarily

mounted cam track, causing a like movement of their axle shafts and, consequently, a like movement of the walls of the separating cylinder at the open end thereof. In all other respects the construction and operation of this embodiment of the invention may be as described in connection with the first embodiment.

In accordance with a third embodiment of the present invention shown in Figs. 7 and 8, the separating cylinder is disposed with its axis horizontal, and the material to be separated is introduced at the axial center thereof by an inwardly extending supply pipe or spout. The cylinder is driven by a deforming roll having its axis parallel with that of the cylinder, and which is driven from a suitable external source. Preferably, and as illustrated, a series of additional deforming rolls are provided around the periphery of the cylinder to supplement the action of the main driving and deforming roll. One or more of such additional deforming rolls may be adjustable, to permit a manual or other movement thereof inwardly to an abnormal extent, thus causing an abnormal inward flexing of the cylinder walls, to assist in the scaling off of the deposited concentrate.

In accordance with a fourth illustrated embodiment of the present invention illustrated in Fig. 9, the construction is generally the same as described in connection with the first embodiment, with the exception that the material is initially directed on to the wall of the separating cylinder at the upper end thereof, and is discharged at the lower end thereof. As illustrated also, a replaceable, flexible liner is inserted into the cylinder. As will appear more fully hereinafter, this replaceable, flexible liner may also be advantageously used in connection with the other embodiments.

In connection with a fifth embodiment of the present invention illustrated in Figs. 10 and 11, a multiple type separating machine is provided, embodying a plurality of simultaneously driven separating cylinders. Preferably, and as illustrated, the respective cylinders are in peripheral engagement, so that by driving one of them, the entire group rotates synchronously. Preferably, the axial spacing between the several cylinders is such that their mutual engagement results in the previously described deformation of the walls thereof, thus working the walls of the cylinders as they rotate. In order that the axes of the separating cylinders may be parallel to each other, for simplicity and economy in manufacture and operation, it is preferred to construct the cylinders so that the diameters thereof are greater at their lower ends than at their upper ends, so that the deforming action is progressive from one end to the other, as described in connection with the first embodiment. Conveniently, and as illustrated, the relative positions of the respective cylinders are adjustable to take up wear, and to also modify the deforming action.

Considering the above mentioned elements in more detail in referring particularly to Figs. 1 through 4, the casing 20, which may be conveniently formed of sheet metal, is supported on a pair of I sections 22. Three of the side walls of casing 20 are continuous. The fourth side wall is cut away adjacent the base and, with the outwardly extending lip 23 of the casing base, forms a discharge chute 24. The chute 24 permits the gangue discharged over the top of the separating cylinder, as later described, to pass out of the casing. The top of casing 20 is enclosed except

for a central opening in which a funnel 28 is secured by the bolts 30. Funnel 28 extends downwardly within the casing 20 a substantial distance. The side walls of casing 20 are preferably lined with a resilient wear resisting member 26 formed of rubber or like material, and readily replaceable.

The separating cylinder 32 comprises generally the continuous cylindrical wall 34, which is resilient, and is preferably formed of a composition rubber and fabric, of sufficient thickness that the wall is self-supporting, but is deformable by the action of the deforming rolls 36. The wall 34 is supported upon a rigid base plate 38, the peripheral edge of which is provided with a rim which presents a vertical supporting surface 40 and a lip 41. The wall 34 is secured to the base 38 by bolts 42 and clamping plates 44. The fabric portion of the wall 34 is preferably provided with a relatively thick coating or layer of resilient rubber on both sides to take the actual wear of the material being worked upon on its inner face and the deforming rolls on its outer face, and in order that these layers of rubber will not affect the proper connection between the wall 34 and the base 38, they are cut away, as illustrated, over the area of contact of the wall 34 and the base and over the area of contact of the clamping plates 44 and the wall 34. This also permits the clamping plates to be arranged in flush relation with respect to the outer surface of the wall 34, which is of advantage in certain cases.

The base plate 38 is rigidly secured by a plurality of studs such as 46 upon the upper and outwardly flared end of a hollow shaft 48. The shaft 48 in turn is rotatably supported by the radial and thrust ball bearing units 50 and 52 within a boss-like housing 54 rigidly secured by the studs 56 within a corresponding opening formed in the base of the casing 20. The ball bearing units are retained in position by the spacing sleeve 58 and the end plates 60 and 62. The threaded collar 67 and shoulder 69 on shaft 48 secure the latter against vertical movement in the housing 54. Suitable seals, such as 64, 66 and 68, are provided to prevent the escape of lubricant from within the housing 54. A pulley 70 is secured by key 72 upon the lower end of shaft 48, and may be driven from a suitable source (not shown) through the belting 74. It will be evident that rotation of shaft 48 correspondingly rotates base plate 38 and the separating cylinder 32. This rotation preferably occurs at a constant rate, although a variable rate may be used if desired, and it will be understood that the rate of rotation is determined by the character of the bulk material being worked upon.

The bulk material to be worked upon is introduced through the funnel 28 and initially deposited upon a table or stool 80, which has a substantially plane upper surface and a plurality of depending legs 82 which space it from and through which it is secured upon the upper surface of the base plate 38 by the previously mentioned studs 46. The legs 82 are disposed in suitably placed relation around table 80, leaving spaces between them, through which the concentrate is drained off at the conclusion of a separating operation. As will be evident, the ore drained off between the legs 82 passes downwardly through the opening 86 formed in base plate 38, and through the hollow shaft 48, where it may be collected in any suitable receptacle such as 88 (Fig. 1). Suitable means are preferably

provided for normally closing the lower end of the shaft 48 and operable to open it to the flow of material through it, a removable plug 89 being shown as illustrative of such means.

Each of the deforming rolls 36, one or more of which are distributed around the separator 34, two being shown by way of illustration, preferably includes a resilient outer surface or sleeve 90, which may be formed of the same type of rubber fabric composition as the separating wall 34. Each sleeve 90 is fitted over a cored-out mandrel 92, and secured in place thereon by studs 94. Each sleeve 90 is fixed longitudinally of its corresponding mandrel 92 by the outwardly extending lower shoulders 96 of the latter, and by the plate 98 which is secured at the upper end thereof. Each mandrel 92 is rotatably supported upon a shaft or spindle 100 by means of a pair of spaced ball bearing units 102. Each spindle 100, in turn, is secured upon or formed integrally in eccentric relation with a cylindrical standard 104, which is rotatably adjustably secured to the base of the casing 20 within a split bracket 106. A tightening stud 108 is provided to clamp or release the standard 104 in the split bracket 106, whereby to rigidly secure the standard 104 therein or to permit rotation thereof. As will be evident, rotation of standard 104 moves the associated deforming roll 36 closer to or farther from the separating wall 34, thus correspondingly increasing or decreasing the deforming effect thereof, and permitting compensation for wear occurring between the sleeves 90 and wall 34 to be made. It will also be noted that each of the deforming rolls 36 is independently adjustable.

As previously mentioned, in accordance with the present invention, the deforming action of the deforming rolls 36 is progressive from the base of the separating wall to the upper end thereof, and this relation is preferably effected by having the axis of the separating wall and of the deforming rolls at an angle to each other. In the form illustrated, the outer surface of the separating wall 34 is normally cylindrical, its axis is vertically disposed, and the axes of the deforming rolls are tilted somewhat from the vertical. The positioning of each deforming roll is preferably such that at the lowest point of engagement between the corresponding sleeves 90 and the separating wall 34, the deforming action is at a minimum. Due to the tilt, however, a maximum deforming action is effected at the point of highest engagement between each deforming roll 36 and the separating wall 34, which deforming action increases successively between such minimum and maximum limits.

Considering the operation as a whole of the embodiment shown in Figs. 1 through 4, rotation of separating wall 34 through pulley 70 and belt 74 causes a corresponding rotation of the deforming rolls 36, which, as shown in Fig. 3, continuously flexes or deforms inwardly the portion of wall 34 successively brought into cooperation therewith, the deforming action being successive from the base of the wall to the top thereof, as illustrated by the relative views, Fig. 3 and Fig. 4. Material deposited through the funnel 28 falls by gravity and is deposited upon the rotating table 80, from which it is thrown by centrifugal force outwardly against the separating wall 34. As will be understood, the particles to be separated out, being heavier than the bulk of the material, is moved through the material and is deposited against the inner surface of the wall 34, while the refuse material is retained nearer

the center of the separating cylinder. As the deposited material accumulates, it is gradually forced upwardly around the wall 34, and ultimately is discharged over the upper open end thereof, and falls by gravity to the base of the casing 20, from which it is discharged through the previously described opening 24. In operation, the material within the cylinder assumes an outline somewhat as indicated by the line 120, which outline is on an angle substantially greater, with respect to a horizontal plane, than the normal angle of repose of the aggregate.

The deforming of the wall 34 keeps the aggregate material in a relatively loose condition, facilitating the passage of the heavy particles therein through it. The deforming action being decreased progressively as the base of the cylinder is reached, causes substantially no flexing of the wall 34 at the point of connection thereof to the base plate 38. With this construction, a rigid plate 38 may be used without causing undue wear of the side walls 34. Normally, the tendency of the aggregate material to become solid and packed increases when the top of the cylinder is approached, but in accordance with the present arrangement, this tendency is compensated for and overcome to a material extent by the progressively increasing deforming action as the top of the cylinder is approached.

As previously stated, the separating action is conducted continuously, that portion separated out from the bulk material gradually accumulating upon the inner face of the wall 34, the inner shoulder 35 at the top thereof acting to prevent such concentrate from passing on over the top and open end.

After a period of operation in which it may be expected that concentrate will have been deposited upon the side walls 34 to substantially the thickness of the shoulder 35, further feed of bulk material is discontinued, the device is brought to rest, the plug 90 removed, and the concentrate washed or otherwise discharged through the shaft 48. Where such concentrate is gold particles, after the feed of bulk material has been discontinued and before rotation of the device is discontinued, a predetermined quantity of quicksilver may be introduced through the funnel 28 and upon the table 30, from which it is thrown by centrifugal force outwardly through the aggregate or bulk material and into contact with the separated particles, with which, as will be understood, it amalgamates. Upon the stopping of the machine, the amalgam flows downwardly along the side wall 34, along the downwardly sloping upper surface of base plate 38, and down through the hollow shaft 48, from which, upon removal of the plug 89, it may be collected in the previously mentioned vessel 88.

In accordance with the modified embodiment of the present invention illustrated in Figs. 5 and 6, and in which parts the same as in the previous views are indicated by the same numerals except such numerals bear a prime mark, a plurality of rods 130 are suitably non-rotatably embedded within the wall 34' of the separating cylinder and preferably extend from the top substantially down to the base of the latter. A roller 132 is rotatably secured at the upper and outwardly extending end of each rod 130 and is suitably spaced from the upper edge of wall 34' by a cooperating sleeve 134. The rollers 132 ride in a suitable cam track 140, which may be stationarily secured to the machine frame in any suitable manner, as through the outwardly ex-

tending legs 142 thereof. As will be understood from an inspection of Fig. 5, the rotation of the cylinder wall 34', carrying with it the rollers 132, effects a movement of the latter within cam track 140. Cam track 140 is shaped as shown to cause an inward radial movement of rollers 132 in response to the rotation of wall 34', and the centrifugal force acting on the wall 34' and the material therein maintains contact between the rollers 132 and track 140 and serves to move the rollers outwardly after having been moved inwardly by the cam track. This inward and outward movement of rollers effects a radial deforming of the wall 34' in a manner similar to and for the same purpose as described in connection with the apparatus shown in Figs. 1 through 4. The rods 130, being extended as mentioned, substantially to the base of wall 34, prevent collapsing of the latter and cause the deforming action to increase from the base to the top of the wall, as described in connection with the first embodiment. In all other respects, the construction and operation of the embodiment shown in Figs. 5 and 6 may be as described in connection with Figs. 1 through 4, and further description thereof is therefore considered unnecessary.

In accordance with the modification shown in Figs. 7 and 8, the separating cylinder is disposed with its axis horizontal instead of vertical, and, in addition, the driving relation between the deforming roll mechanism and the cylinder is reversed. Referring to Figs. 7 and 8, the cylinder 150, preferably formed of a continuous piece of resilient composition fabric and rubber as described in connection with the first embodiment, and having the inwardly turned end flanges 152 which correspond in function to the shoulder 35 of Fig. 1, is supported with its axis horizontal between a plurality of deforming rolls 154, a driving deforming roll 156, and an adjustable deforming roll 158. The respective rolls 154, 156 and 158 are so positioned, as will be understood, that the wall 150 is deformed thereby to approximately the shape shown in Fig. 7, and also serve to support and confine the cylinder 150. It may be noted, however, that the degree of deformation of the separating cylinder in Fig. 7 is exaggerated to more clearly illustrate the same, and this is also true in most of the other views.

Each of the idler rolls 154 is freely rotatable within bosses 160 secured to, or formed integrally with, the machine frame 162. The shaft 164 of driving roll 156, of which there may be a plurality, is suitably supported in bosses 166 and carries a driving pulley 168, which may be driven from any suitable external source (not shown) as through the belting 170. The adjustable roll 158 is rotatably secured by a pin 172 upon the outer end of a crank arm 174, which is rotatably supported upon the same shaft 176 which also supports one of the idler rolls 154. The lever 178, rigidly connected to the crank 174, is provided with an adjustable stop 179 which determines the normal position of the adjusting roll 158. As will be evident, the crank 174 and arm 178 are freely rotatable in a counter clockwise direction as viewed in Fig. 7, from the illustrated full line position to the dotted line position, in which an abnormal distortion of the side wall 150 is produced. This abnormal distortion of wall 150 is effective, as will be understood, to scale off from the latter the deposited and separated gold or other particles, thus facilitating removal thereof from the cylinder at the com-

pletion of a separating operation. The adjusting stud 179 may also be adjusted to provide a different degree of deforming action during normal operation by the adjustable roll 158 than by the others of the deforming rolls.

The cylinder 150 is fixed in position longitudinally of the machine by a series of idler rolls 180 suitably and rotatably supported upon bosses 182 secured to the machine frame, and which bear against the opposite ends thereof.

In operation, the aggregate or bulk material is introduced through the spout 186, which extends inwardly to substantially the axial center of the cylinder 150 which is rotating at the time and falls upon the inner wall thereof. The centrifugal force of the rotation throws the heavier particles outwardly against the wall, retaining the lighter bulk refuse material nearer the center of the cylinder. In the course of the operation, the heavier particles accumulate against the side wall and are prevented from being thrown outwardly from the end thereof by the shoulders 152. The lighter refuse material, however, is continuously discharged from the opposite open ends of cylinder 150. The deforming rolls 154, 156 and 158 act as previously described to flex wall 150, maintaining the bulk in a relatively loose condition and thus facilitating the outward movement of the heavier ore particles therethrough.

At the conclusion of a separating operation, the adjustable roll 158 may be moved inwardly to the dotted line position, thus abnormally flexing wall 150 and scaling off the collected material.

In accordance with the modification of the present invention, illustrated in Fig. 9, in which parts similar to those shown in Figs. 1 to 4, inclusive, are indicated by the same numerals but bearing a double prime mark, the separating cylinder is disposed with its axis vertical, the bulk material is fed from the top of the cylinder, but, as distinguished from the embodiment of Figs. 1 through 4, the bulk material is initially directed into the upper end of the cylinder, and the waste material is discharged through the open lower end of the cylinder. The construction of the cylinder 34'', the deforming rolls 36'', and the driving mechanism for wall 34'', comprising the base plate 38'' and the hollow shaft 48'', are preferably constructed and arranged as described in connection with Figs. 1 through 4, but are disposed in inverted positions. Further description of these elements is, accordingly, considered unnecessary. As further shown in Fig. 9, the spout 190, through which the aggregate or bulk material is introduced to the cylinder 34'', extends into the open upper end of shaft 48'', and preferably also extends downwardly therein substantially to the lower end thereof to prevent the aggregate from being collected on the side walls of shaft 48'' and clogging the machine. The table 80'', supported upon the base plate 38'' in the manner described in connection with Figs. 1 through 4, is disposed to receive the aggregate upon its upper surface, from which it is thrown against the walls of cylinder 34'' in the previously described manner.

A further feature of the embodiment shown in Fig. 9, resides in the use of the removable inner sleeve 192, which may be replaced in event of wear. The lower end of the sleeve 192 is provided with the inwardly extending annular shoulder 194, which functions to retain the separated out particles and prevent them from falling downwardly from the lower opened end of the cylinder 34''.

The sleeve 192 is slidably fitted into cylinder 34'', and during operation of the machine is retained therein by the adhesion between the walls of the two members, particularly as amplified by the centrifugal force acting on the sleeve and the material contained within it, which tends to stretch it radially. Upon stopping the machine, however, it may be readily removed and replaced if desired. It will be evident that the replaceable inner sleeve 192 may also be used to advantage in connection with the embodiment shown in Figs. 1 through 4, and, with suitable modification, may also be used with the modification shown in Figs. 5 through 8.

In the operation of the embodiment shown in Fig. 9, the aggregate is fed through spout 190, falls upon the table 80'', and is there thrown by centrifugal force against the walls of sleeve 192, the heavier particles working outwardly directly against the walls, as described in connection with the previous embodiments. As the material accumulates, it is gradually forced downwardly in cylinder 34'', and the refuse material falls freely through the open lower end of cylinder 34'', after which it may be collected in the illustrative receptacle 196. The deforming rolls 36'' act upon cylinder 34'' in the manner and for the purpose described in connection with Figs. 1 through 4.

The embodiment of the present invention shown in Figs. 10 and 11 provides a multiple type separating machine, embodying a plurality of individual separating cylinders, the mounting for which is such that a single driving force may be used to drive the entire group, and also such that the cylinders act to mutually deform each other, thus dispensing with additional deforming mechanism.

Referring to Figs. 10 and 11, a plurality of separating cylinders 200, each of which is constructed of self-supporting but yieldable material such as the composition rubber and fabric described in connection with Figs. 1 through 4, are supported with their axes vertical, upon base plates 202, which may correspond to and be constructed in all respects as described in connection with base plates 38 of Figs. 1 through 4. Each of the base plates 202 is also rotatably supported within the machine frame 206, through bosses 208, which may correspond in all respects to the housing 54 of Figs. 1 through 4.

As best shown in Fig. 10, the respective cylinders 200 are arranged in rows in staggered relation, and are positioned so that they are in peripheral engagement with each other. With this arrangement, the continuous rotation of a single one of the cylinders 200 through the cooperating pulley 210 and belting 212, drives all of the other cylinders 200 through the peripheral friction between them.

The radial spacing between the respective cylinders 200 is also such that the engagement between them effects a mutual deforming, for the purpose and preferably to substantially the extent described in connection with the other embodiments. Preferably, and as illustrated, each of the cylinders 200 is of slightly tapering construction, so that, being mounted with their axes parallel to each other, the deforming effected between them progresses from a minimum at the base thereof to a maximum at the lower or discharge end thereof, in substantially the manner described in connection with Figs. 1 through 4 and 9.

One or more of the supports 214 upon which the cylinders 200 are secured, are adjustable

longitudinally of the machine frame 206, by the adjusting studs 216, to thereby change the standard relationship between the cylinders and correspondingly adjust the degree of deformation provided. This same adjustment provides a means for compensating for wear between cooperating cylinders 200.

In operation, the material is introduced into each of the cylinders 200 through funnels 220 positioned above and extending downwardly into the hollow shafts 222, and is received upon the tables 224, which are associated with the respective cylinders in the manner described in connection with the table 80 in Fig. 9. The separation of the heavy particles and the discharge of the refuse material occurs as described in connection with Fig. 9, the heavier particles being collected on the side walls of the cylinders 200, and being retained therein by the shoulders 226, and the lighter refuse material falling freely through the lower open end of each cylinder.

Although only a limited number of specific embodiments of the present invention have been shown and described, it will be understood by those skilled in the art that formal changes may be made in the specific embodiments shown and described without departing from the spirit and substance of the broad invention, the scope of which is commensurate with the appended claims.

What is claimed is:

1. In a centrifugal separator for separating material into relatively light and heavy components, the combination of a longitudinally extending cylinder having a flexible but self-supporting wall, means adapting said cylinder to be driven in rotation, one or more longitudinally extending flexing members past which said cylinder may rotate, and means supporting said flexing members in direct engagement with said cylinder from a point near one end of said cylinder to a point near the other end thereof and at such spacing from the cylinder axis that said members flex said wall throughout said area of engagement during the rotation of said cylinder, said wall being radially unconfined except by said flexing members throughout the area engaged by said flexing members.

2. In a centrifugal separator for separating material into relatively light and heavy components, the combination of a longitudinally extending cylinder having a rigid base and a radially unconfined self-supporting but flexible wall secured to and extending from said base, means adapting said cylinder to be driven in rotation, and means for flexing the wall of said cylinder during the rotation thereof comprising one or more members arranged to apply a direct flexing force to said wall from a point near one end of said cylinder to a point near the other end thereof.

3. In a centrifugal separator for separating material into relatively light and heavy components, the combination of a longitudinally extending cylinder having a rigid base and a radially unconfined self-supporting but flexible wall secured to and extending from said base, means adapting said cylinder to be driven in rotation, one or more flexing members past which said cylinder may rotate, and means supporting said flexing members in direct engagement with said cylinder from a point near one end of said cylinder to a point near the other end thereof and at such spacing from the cylinder axis that said members flex said wall throughout said area

of engagement during the rotation of said cylinder.

4. In a centrifugal separator for separating material into relatively light and heavy components, the combination of a longitudinally extending cylinder having a rigid base and a radially unconfined self-supporting but flexible wall secured to and extending from said base, means adapting said cylinder to be driven in rotation, and means for flexing the wall of said cylinder during the rotation thereof comprising one or more members arranged to apply a direct flexing force to said wall from a point near one end of said cylinder to a point near the other end thereof, said base having a material opening therein, and a distributing table disposed adjacent said opening upon which said material may be deposited.

5. In a centrifugal separator for separating material into relatively light and heavy components, the combination of a longitudinally extending cylinder having a rigid base and a radially unconfined self-supporting but flexible wall secured to and extending from said base, means adapting said cylinder to be driven in rotation, and means for flexing the wall of said cylinder during the rotation thereof comprising one or more members arranged to apply a direct flexing force to said wall from a point near one end of said cylinder to a point near the other end thereof, said flexing action being of progressively increased degree from a point near said base to a point near the other end of said cylinder.

6. In a centrifugal separator for separating material into relatively light and heavy components, the combination of a vertically disposed rotatable longitudinally extending cylinder having a rigid base and a radially unconfined self-supporting but flexible wall secured to and extending upwardly from said base, means secured to said base for adapting said cylinder to be driven in rotation, a plurality of rotatable flexing members past which said cylinder may rotate, means supporting said flexing members in direct engagement with said cylinder from a point near one end of said cylinder to a point near the other end thereof and at such spacing from the cylinder axis that said members flex said wall throughout said area of engagement during the rotation of the cylinder, said base having a material discharge opening therein, and a distributing table supported above said base over said opening upon which said material may be deposited.

7. In a centrifugal separator for separating material into relatively light and heavy components, the combination of a vertically disposed rotatable longitudinally extending cylinder having a rigid base and a radially unconfined self-supporting but flexible wall secured to and extending downwardly from said base, means secured to said base for adapting said cylinder to be driven in rotation, a plurality of rotatable flexing members past which said cylinder may rotate, means supporting said flexing members in direct engagement with said cylinder from a point near one end of said cylinder to a point near the other end thereof and at such spacing from the cylinder axis that said members flex said wall throughout said area of engagement during the rotation of the cylinder, said base having a material receiving opening therein, and a distributing table supported below said base in registry with said opening upon which said material introduced through said opening may be deposited.

8. In a centrifugal separator for separating material into relatively light and heavy components, the combination of a rotatable longitudinally extending cylinder having a flexible but self-supporting wall, a member positioned in peripheral engagement with said wall for driving said cylinder in rotation, said member being so spaced from the axis of said cylinder that said member flexes said wall during the rotation of the cylinder, and means for driving said member.

9. In a centrifugal separator for separating material into relatively light and heavy components, the combination of a plurality of separating cylinders each having flexible but self-supporting walls, means for supporting said cylinders so that the walls thereof are in peripheral engagement with each other, the spacing between the axes of said cylinders being such that said cylinder walls mutually flex each other during the rotation of the cylinders, and means for causing rotation of said cylinders.

10. In a centrifugal separator for separating material into relatively light and heavy components, the combination of a plurality of separating cylinders each having flexible but self-

supporting walls, means for supporting said cylinders so that the walls thereof are in peripheral engagement with each other, the spacing between the axes of said cylinders being such that said cylinder walls mutually flex each other during the rotation of the cylinders, and means for driving one of said cylinders, said driven cylinder acting to drive another of said cylinders through said peripheral wall engagement.

11. In a centrifugal separator for separating material into relatively light and heavy components, the combination of a plurality of separating cylinders each having flexible but self-supporting walls and each being of greater radius at one end than at the other end, means for supporting said cylinders with the axes thereof generally parallel and with the walls thereof in lateral peripheral engagement with each other and with the relatively large and the relatively small ends of said cylinders correspondingly positioned, the spacing between the cylinder axes being such that the cylinder walls mutually flex each other during the rotation of the cylinders, and means for causing rotation of the cylinders.

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