April 8, 1941. H. V. KAPP 2,237,603

APPARATUS FOR AND METHOD OF CLASSIFYING OR SEPARATING FLUID-BORNE MATERIALS

Filed Aug. 9, 1937 4 Sheets-Sheet 1

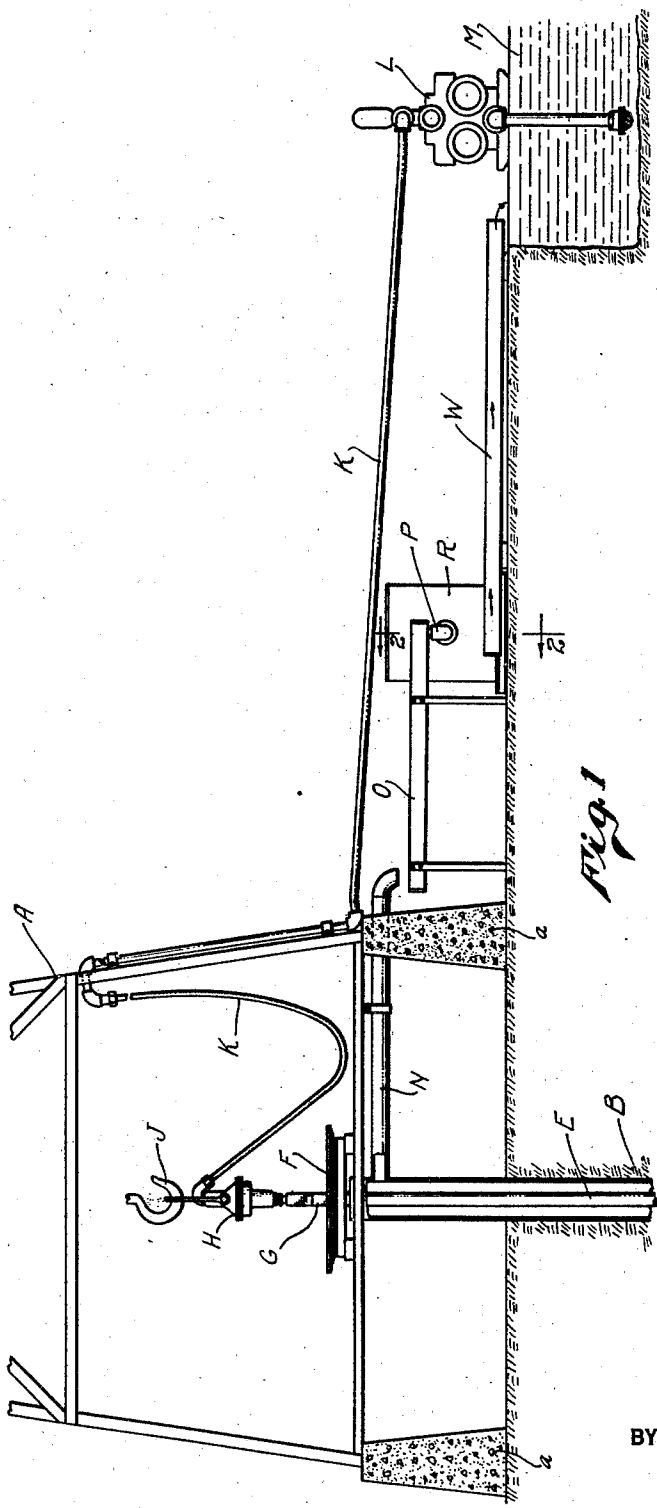


Fig. 1

Harold V. Kapp,
INVENTOR;

BY

ATTORNEY.

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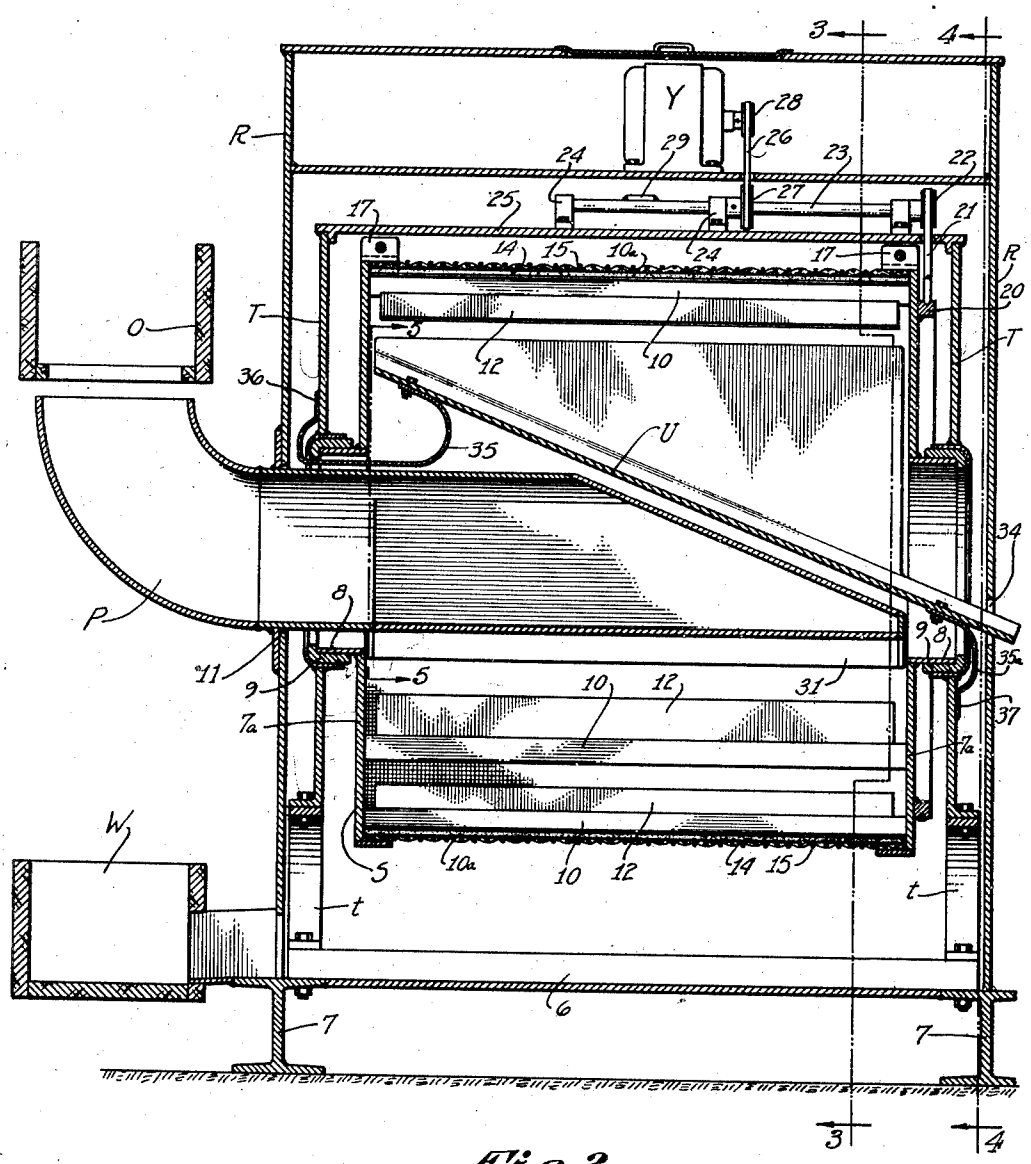


Fig. 2

Harold V. Kapp
INVENTOR.

BY Raymond & Raymond
ATTORNEY.

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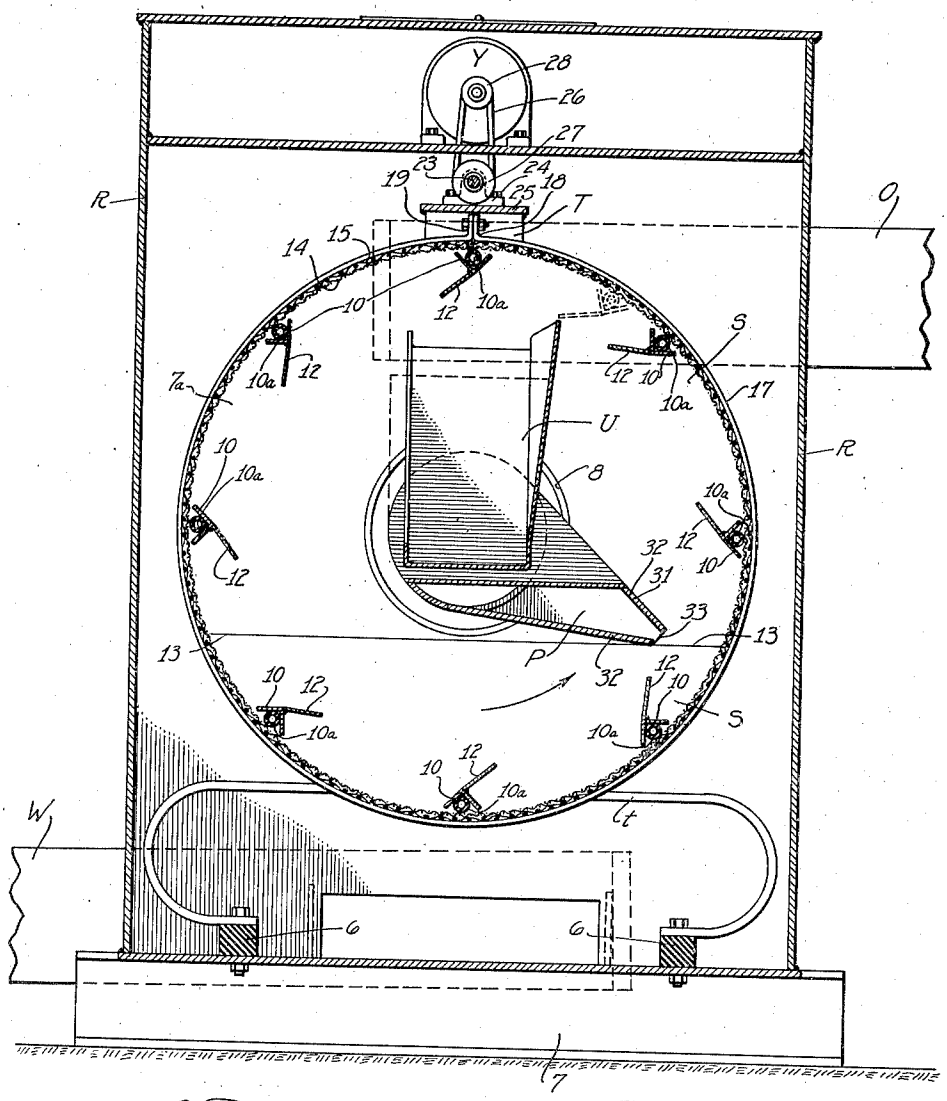


Fig. 3

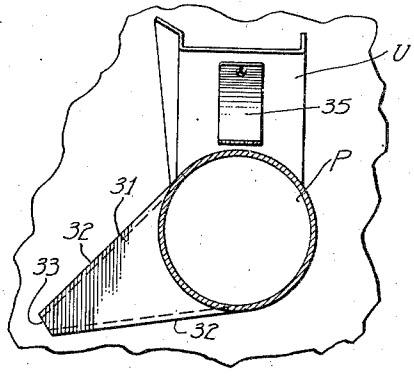


Fig. 5

Harold V. Kapp,
INVENTOR.

BY Raymond Jacobs Blakeslee,
ATTORNEY.

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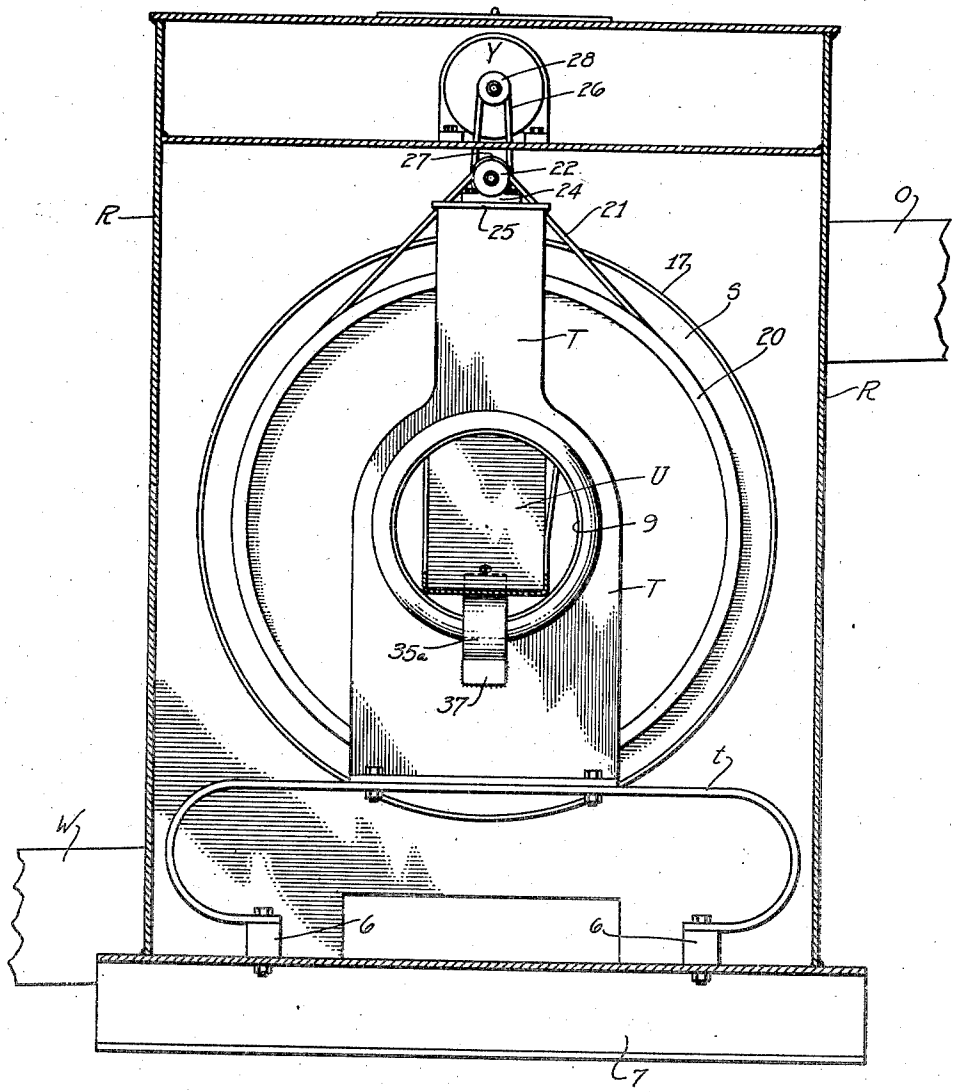


Fig. 4

Harold V. Kapp,
INVENTOR.

BY Raymond Ives & McKelvey,
ATTORNEY.

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UNITED STATES PATENT OFFICE

2,237,603

APPARATUS FOR AND METHOD OF CLASSIFYING OR SEPARATING FLUID-BORNE MATERIALS

Harold V. Kapp, Long Beach, Calif.

Application August 9, 1937, Serial No. 158,022

7 Claims. (Cl. 210—199)

This invention relates to classifiers or separators, and its use is directed at the classifying and separating of varied materials and substances, although a more particular use of the invention, as will appear from the following specification and drawings, pertains to the conditioning of what is known as hydraulic "mud" or drilling "mud" used in the hydraulic-rotary method of drilling oil wells. In order to effect and maintain such conditioning, a recurrent classifying and separation takes place in the use of the apparatus and carrying on of the method or procedure which will utilize the invention, whereby the proper make-up and consistency of the drilling "mud" or fluid or semi-fluid drilling material is maintained. To those ends a classifying takes place which produces a relative separation of the sand and gravel and large or solid portions of the circulatory stream and the portion of the stream which is properly classified and used and which comprises the "mud" content of the stream. In drilling deep oil wells, this circulatory stream is maintained in its circulatory action downwardly and through the drilling string and the drill stem and drill bit at the lower end thereof, and then upwardly within the well hole or the casing therein, where it is directed to a pit for further circulatory use. In the course of drilling, the formation attacked by the drill bit is broken up into what is known as detritus, which contains chips and sand and gravel, as well as pulverized earth. It is this sand and gravel which is of no use to the circulatory system and is removed by the classifying action in the use of this invention. It is quite common to provide a specially selected and adapted "mud" as a base for the drilling fluid, and particular "muds" of various qualities and specifications are commercially supplied for this purpose. Increments of such base "mud" may be added from time to time to the circulatory system, and, of course, the same commingles with the pulverulent earth which results from the action of the bit as aforesaid. The sand and gravel, however, are of no utility in the drilling operation, and, in fact, are an obstruction and impediment thereto, and accumulation thereof in the developing well hole is objectionable and the earliest possible removal and separation thereof from the circulatory stream is to be desired and the present invention accomplishes it effectively. Of course, the "mud" is of vital importance to the drilling of the well hole, it serving to coat the surface of the well hole and maintain its integrity and to seal off from the well hole otherwise invading water or gas or both. In other words, the "mud" "plasters" the hole and acts as a sealing medium. It also serves as a lubricant in drilling operations and in and by itself acts in the elevation of the detritus.

In utilizing the present invention, the circulatory fluid as it leaves the upper end of the well hole or casing therein, is passed to a classifier or separator organization, which effectively and efficiently separates the "mud" per se from the gravel and sand and coarser particles and chips, such "mud" passing to the "mud" pit for re-circulation. The other materials or substances are discharged from the classifier or separator and thus the circulatory stream is purged and freed therefrom, maintaining a proper circulatory fluid for performance as above indicated.

It is important to bear in mind that drilling mud is of a colloidal or viscous character, and this requires particular treatment to recover it for further drilling procedure. To that end a properly meshed screen member is provided, and this preferably constitutes the wall of a structure which receives the drilling fluid with the detritus after its flow from the well or the casing therein. The hydrostatic head thus presses upon the colloidal "mud" content which proceeds to the screen under the influence of gravity, and the screen is of such formation and mesh dimensions that the colloidal structure is broken down, which occurs under the vibration of the screen member which destroys the colloidal pattern, and the "fines" or portions of the disrupted colloidal structure are pressed through the screen member by the hydrostatic pressure. To these ends, a 100-mesh screen I have found to be satisfactory practically, but somewhat of a variation from this mesh is still within the spirit of the invention. Concurrently with this procedure leading to the recovery of the mud which reorganizes as content of the following fluid, in colloidal pattern and structure, means are provided for withdrawing and discharging the detritus, such as sand and gravel and lumped masses, which latter are discharged from the apparatus and suitably disposed of.

With the above and other objects in view, the invention consists in the novel and useful provision, formation, combination, association and interrelation of parts, members and features, and performances, all as hereinafter described, shown in the drawings and finally pointed out in claims.

In the drawings:

Fig. 1 is a fragmentary and more or less con-

ventional showing of the lower portion of a drilling rig and derrick set above the well hole and by suitably applied power within which derrick the drilling string is rotated in the customary or any suitable manner. Fig. 1 also indicates the location and interrelation with the other features of the classifier or separator, which in accordance with the present invention is introduced within the circulatory system.

Fig. 2 is an enlarged detail vertical sectional view taken upon the line 2—2, Fig. 1, through the classifier or separator organization and looking in the direction of the appended arrows.

Fig. 3 is a further mainly vertical sectional view taken upon the planes of the section line 3—3, Fig. 2, and looking in the direction of the appended arrows.

Fig. 4 is a vertical sectional view taken on the line 4—4, Fig. 2, looking in the direction of the appended arrows.

Fig. 5 is a detail vertical sectional view taken upon the line 5—5, Fig. 2, and looking in the direction of the appended arrows.

Corresponding parts in all the figures are designated by the same reference characters.

Referring with particularity to the drawings, Fig. 1 indicates at A the lower portion of an oil well rig derrick mounted upon suitable bases *a* above a well hole in process of drilling in which the penetrated earth formation is shown at B, the penetration being carried on by drill bit C attached to drill stem D, which in turn is attached to the lower end of a jointed drilling string E, comprising a plurality of "joints" or drill pipe sections connected together, preferably in stands of three or four "joints," by "collars" and couplings or tool joints between the various stands. Both the collars and tool joints serve in coupling capacity, but the tool joints are utilized to connect up a plurality of drilling pipe "joints" which are in turn connected by collars.

At F is shown a so-called rotary table, for which a suitable source of power is applied, so that it may turn a "kelly" or squared member G cooperating with the rotary table and through the joint rotation of which the rotation of the drilling string and bit are effected. The drilling string is swivelly suspended by a swivel H, which in turn is suspended by a main hook J, and the draw works of the rig likewise provide for the raising and lowering of the swivel and drilling string in the operation of drilling and in making up and breaking up the string as required from time to time.

The circulatory system for providing and applying drilling fluid includes piping K extending to and communicating with the interior of the drilling string, and serviced by a pump L disposed at a pit M, wherein the re-conditioned or properly constituted drilling fluid is stored. Laterally from the casing above the upper end of the well hole extends a discharge pipe N, the discharge end of which deposits the upwardly moving drilling fluid in one end of a trough O from which it is depositeed into or flows into a distributor member P, ranging within a housing or casing R and from which distributor member P the discharge of drilling fluid received through the pipe N and trough O is suitably directed for separation and classifying in accordance with the use of the invention.

So far, and up to and excluding the distributor P, the parts and features mentioned are in the main conventional and do not enter in any specific detail into the considerations or field of the present invention.

Referring now particularly to Fig. 2, there is shown therein a provision and arrangement of parts and features which utilizes the discharge of the distributor P for classifying and separating purposes. The distributor discharges into a circular drum S which is mounted to rotate in end supports or uprights T, which are mounted within the housing R adjacent opposite ends thereof and preferably upon resilient supports *t* which are preferably strips of spring metal with the end portions bent and returned under the main portion and suitably mounted as at 6 upon the base portion 7 of the housing R, such housing having suitable I-beam or other supports 7 resting upon the ground. The drum S comprises circular end plates 7ª or more strictly annular end plates which are mounted upon tubular journal members 8 which turn in bushings 9, fitted within the end standards T and providing for rotation of the drum S so mounted. The drum further comprises a plurality of spaced longitudinal members 10 which specifically may be lengths of angle iron which range lengthwise of the drum and are butt-welded at their ends against the annular end members 7ª. There is thus produced a drum frame endwise of which ranges the distributor P which enters one end of the housing R as at 11 and then passes through the annular bearing 8 at that end.

Springing from the apex portion of each of the angle iron drum frame members 10, but laterally therefrom with a slight synclinal relation between it and one member of the respective angle iron, is an elevator member 12 which ranges lengthwise of the drum with such respective angle iron, and, in the rotation of the drum in the direction indicated by the arrow in Fig. 3 or counterclockwise as viewing the structure in Fig. 3, serves to pocket and pick up coarser content of the fluid which stands in the drum substantially at a level indicated by the transverse plane spanning the drum along the longitudinal lines 13 (Fig. 3) some distance beneath a horizontal plane cutting the axis of the drum. The fluid in the drum cannot stand higher than such transverse plane indicated by the line between the numerals 13 because it discharges from the drum when it reaches the level of the annular bearings 8.

Inside the angle of the members of the drum frame angle members 10 is provided in each instance a length of rubber tubing 10*a* extending similarly lengthwise of the drum; and over these rubber tubing lengths are applied cylindrical screens 14 and 15 which are superimposed one upon the other, a screen of coarser mesh outside and of finer mesh inside. The inner or finer mesh screen is preferably of approximately 100 mesh to the linear inch or 10,000 to the square inch, and the mesh of the coarser outer screen is not critical, it serving mainly as a foraminous frame for the inner screen which serves to determine the particle size of the "mud" deposited from the lower reaches of this foraminous drum member into a trough W which conducts it in the direction of the arrows in Fig. 1 to the pit M. These screen members 14 and 15 are held in place by annular clamps or bands 17 mounted at opposite ends of the drum structure and of sufficient width to effectively hold the marginal portions of the superimposed screens in position and in assemblage. End portions of both of said clamps, as at 18, are outwardly turned and pulled together as at 19, and by suitably proportioning these an-

nular clamp members an effective compressive fit against the screens may be effected.

In order to rotate the drum S, I provide at one end thereof a large belt annulus **20** which receives a belt **21** likewise passed about a pulley **22** mounted at one end of a drive shaft **23** rotatably mounted in journals **24** disposed upon a transverse member **25** spanning the interior of the housing R and resting upon the upper ends of the standards T. A belt **26** is trained about a pulley **27** upon this drive shaft **23** and about the further pulley **28** upon the armature shaft of a chambered motor Y which provides power for rotation of the drum S. The shaft **23** carries a laterally projecting weight **29** which serves to produce an irregularity in the rotation of the shaft **23** and contribute a jarring or jolting effect which enters into the rotation of the drum S, thus serving to render more effective the action of the screen members **14** and **15** in the discharge therefrom of the "mud."

The distributor member P is fixedly mounted within one end wall of the housing R, as at **11**, passing, as above stated, through the annular bearing **8** at that end of the drum member S. It ranges substantially completely lengthwise of the drum and its cross-sectional formation is well illustrated in Fig. 5 in detail as being in the main circular, and completely circular down to the zone of entrance of the drum member S somewhat beyond which its circular formation is interrupted and flattened and inclined at the top and provided with a rearward extension **31** having converging walls **32**, top and bottom, which terminate slightly spaced apart as at **33** for discharge from the distributor into the drum member.

As above stated, the sand and coarser particle discharge takes place by means of the discharge trough U which is disposed above the distributor P and ranges downwardly and to the right of the drum structure and housing structure as the apparatus is viewed in Fig. 2. The elevators **12**, as above mentioned, in the upward course of travel of the drum structure, pick up the coarser material, sand, gravel and chips, etc., and their inclination with respect to the channel iron members is such that the sand and gravel and the like pocketed by them is freed and discharged by gravity trough U, thereby to be discharged at the right hand side of the housing R, as indicated in Fig. 2, through a suitable opening **34** in the right-hand end member of the housing. This discharge continues until the passage of each elevator member over the discharge trough U has taken place, whereupon in the course of travel of the elevators they plunge into the standing fluid beneath the planar line **13** in Fig. 3 and select and impound the said coarser bodies in the fluid and lift them and discharge them as heretofore stated. The selected or desired "mud" or drilling fluid discharges through the screens **14** and **15** in the lowermost course of travel of the drum member, and, as stated, enters the trough W which conveys it to the pit M under the hydrostatic pressure of the fluid beneath such line **13**.

The discharge trough U is preferably mounted upon curved spring members **35** and **35a** respectively, the former of which is at the left-hand end of the drum and passes through one annular journal **8** and is attached to the adjacent standard T, as at **36**; the other spring member **35a** at the lower end portion of the discharge trough U similarly passing through the other annular journal **8** and secured to the other standard T, as at **37**.

The operation and method of use and procedure of and accompanying the use of the apparatus and performance of the method involved in the invention as embodied, as an example, in the matter heretofore described and illustrated in the drawings, which, of course, is only one possible form of such embodiment and practice falling within the invention, will be clear from the foregoing description taken in connection with said accompanying drawings. In accordance with usual practice, the pump L is operated to maintain a circulatory stream of drilling fluid down through the drilling string and upwardly within the well hole or casing therein, and thence the fluid passes to the classifier or separator where it is first received by the distributer P through the rearwardly directed orifice **33** by which it is discharged into the drum member S, the final portion of the liquid or fluid or semi-fluid mass finding its way out as "mud" through the screens **14** and **15** and being directed to the pit M for re-use; and the coarser or undesirable particles being raised by the elevators **12** and thus withdrawn from the fluid and "mud" which are to be discharged for re-use, and are carried upward and deposited in the discharge trough U, thereby to be directed to a suitable discharge point from which same may be removed or allowed to accumulate as waste material.

The operation of the apparatus is continuous and uninterrupted and self-maintaining, the jarred or jolted rotation of the drum member S serving to prevent any adhesions or stoppages within the drum, and the elevators **12** serving not only to lift and discharge the undesirable coarser material but to agitate the fluid beneath the planar line **13** and promote an effective screening action and ultimate discharge of the desired "mud." Furthermore, the drum member S is self-cleaning in that as it rotates it will discharge by gravity in the upper courses of its rotation any adhesions to the screens **14** and **15** and this is, of course, again promoted by the jolting or jarring rotation of the drum member.

Features of marked importance attaching to the invention consist in carrying on the screening out of the "mud" under an hydraulic head, which serves to promote an effective screening action; and, furthermore, or additionally or separately considered, the use of elevators which positively withdraw the undesirable coarser particles from the fluid and likewise in their passage through the fluid, serve to agitate it. Of course, the fluid flows downwardly with the discharged "mud," but it is at that stage freed of the sand and gravel which is incapable of passing through the screen **14** and is separately discharged through the trough U.

It being obvious that many changes and variations and modifications may be made in departure from the foregoing description and the matter pictured in the drawings without departing from the true spirit of the invention, I do not desire to be understood as in any sense being limited in the consideration of my invention to any such shown or described details which are in no manner essential to the broad spirit of the invention.

Having thus disclosed my invention, I claim and desire to secure by Letters Patent:

1. In a system for continuously classifying fluid-borne materials by separation and hydrostatic pressure, an apparatus including a casing,

a drum mounted for rotation on a horizontal axis in said casing, said drum including solid end walls each having an axial opening and a foraminous circumferential wall secured to said end walls and whose interstices are such as to trap a quantity of fluid-borne fine and oversize material to a level below the said openings of the end walls to provide a hydrostatic head for forcing the fluid and classified material through the interstices of said circumferential wall, supply means extending into said drum through one of said axial openings in one of said end walls, a waste trough for oversize material transversely inclined across the interior of the drum and discharging through the opening in the other of said end walls, a plurality of elevator blades supported at the inner face of said circumferential wall to lift oversize material upwardly for precipitation into said trough, a fluid outlet in the casing below the drum, resilient supports in the casing for the drum, and means for imparting a rotary vibrating movement to the drum.

2. In a system for continuously supplying the drill bit of a hydraulic drilling apparatus with reclaimed fluid mud, an apparatus for continuously classifying the detritus and mud by separation and hydrostatic pressure, said apparatus including a casing, a drum provided with solid end walls having axial openings and mounted for rotation on a horizontal axis in said casing, an apertured circumferential wall consisting of an outer coarse screen member of relatively heavy structure and an inner fine screen member resting on the coarse screen member and of relatively light structure and whose openings are such as to trap a quantity of fluid mud and detritus to a level below the openings of the end walls to provide a hydrostatic head for forcing the mud through said fine screen openings, said screen members being secured to said end walls, a detritus waste trough transversely inclined across the interior of the drum and discharging through the opening in one of said end walls, a plurality of elevator blades carried by the inner wall of the drum to lift detritus upwardly for precipitation into said trough, a reclaimed mud outlet in the casing below the drum, resilient supports in the casing for the drum, and means for imparting a rotary vibrating movement to the drum.

3. In an apparatus for separating the liquid discharged from the drilling of oil wells into usable mud and unusable detritus, a cylindrical screen drum having terminal end plates, journaling means for rotatably supporting said cylindrical screen drum with its axis substantially horizontal and comprising springs for resiliently supporting said screen drum, inlet means passing through one of said terminal end plates for admitting liquid into said drum, a drive shaft, eccentric load means eccentrically mounted on said shaft and adapted under rotation of said shaft to apply eccentric force thereto, motive means for driving said shaft, driven means carried on said drum for transmitting motion thereto, and flexible means passing over said shaft and passing part way around said driven means and adapted to transmit rotary and vibratory motion from said shaft to said screen drum.

4. In an apparatus for separating the liquid discharged from the drilling of oil wells into usable mud and unusable detritus, a cylindrical screen drum having terminal end plates, journaling means for rotatably supporting said cylindrical screen drum with its axis substantially horizontal, inlet means passing through one of said terminal end plates for admitting liquid into said drum, means for rotatably driving said drum, a plurality of elevator strip members comprising long angle structural mounting elements having a facing angle of approximately a right angle, means for securing said structural elements to said said terminal base plates with the open face of said facing angle facing the inner periphery of said drum, mounting means received within said facing angle, the screen periphery of said drum being supported on said mounting means in contact therewith, and a discharge trough for receiving and discharging outside said drum detritus picked up and dropped from said strip members at the highest point in their travel as said drum rotates.

5. An apparatus according to claim 4, said mounting means comprising long resilient rods mounted in the facing angle of said angle elements.

6. An apparatus according to claim 4, each of said elevator strip members further comprising a plate extending inwardly into said drum obliquely to the radius thereof and substantially beyond the apex of said angle element, for engaging detritus.

7. In an apparatus for separating the liquid discharged from the drilling of oil wells into usable mud and unusable detritus, a cylindrical screen drum having terminal base plates, journaling means for rotatably supporting said cylindrical screen drum with its axis substantially horizontal, a cylindrical inlet conduit mounted substantially axially of said drum and passing through one of said terminal base plates and having its inner end terminated in a plane surface which slopes obliquely with reference to the horizontal plane which includes the axis of said cylindrical conduit and which plane surface is substantially perpendicular to the vertical plane which includes said axis, a lateral discharge spout formed on the side of said conduit for delivering liquid to the interior of said drum, elevator members carried on the inner peripheral surface of said drum for picking up detritus from the liquid in the bottom of said drum, and a discharge trough for receiving and discharging outside said drum detritus picked up and dropped by said elevator members at the highest point in their travel as said drum rotates.

HAROLD V. KAPP.