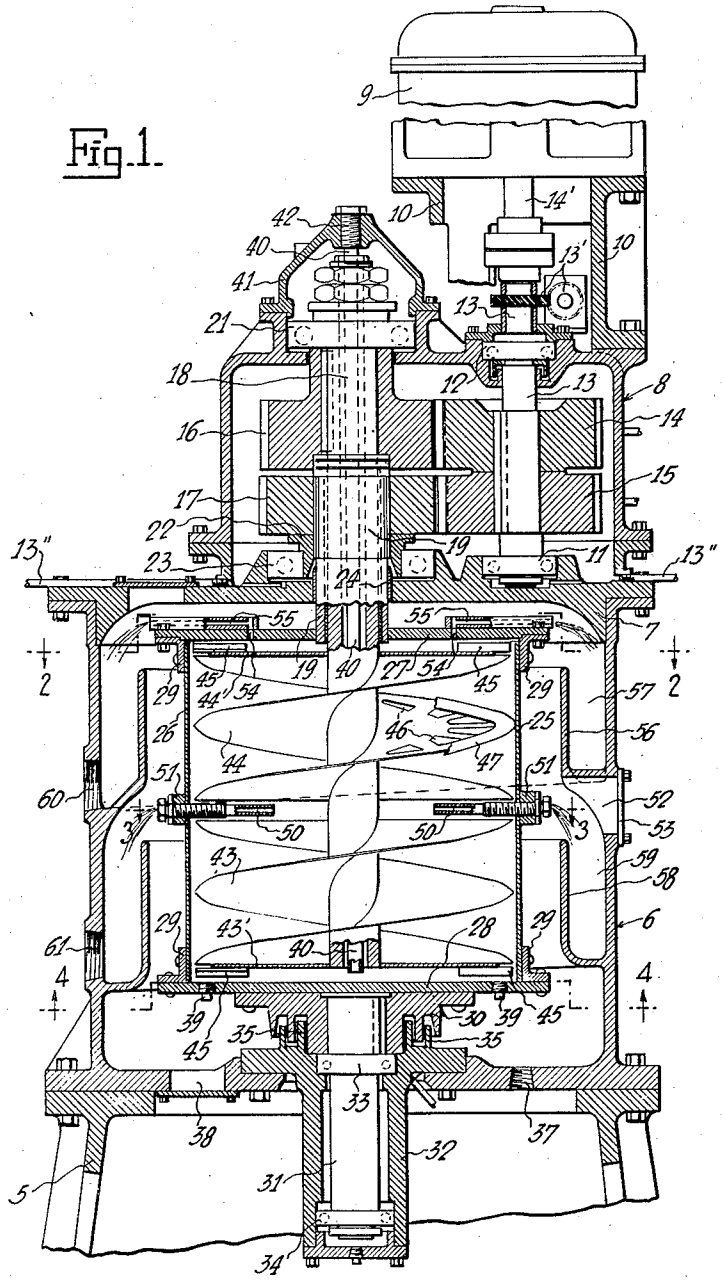
Sept. 8, 1936. W. C. LAUGHLIN 2,054,058

CENTRIFUGE

Filed April 12, 1934 3 Sheets-Sheet 1

Fig. 1.



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CENTRIFUGE

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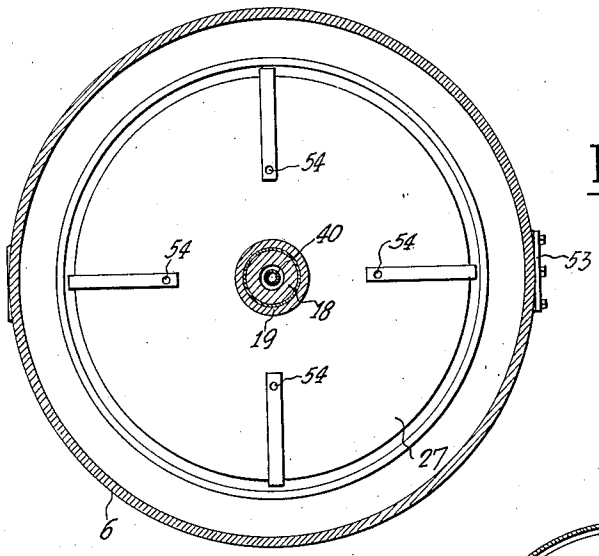


Fig. 2.

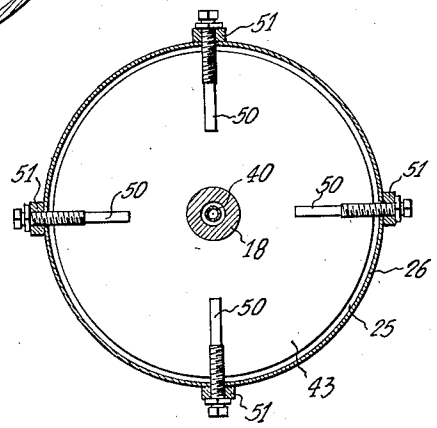


Fig. 3.

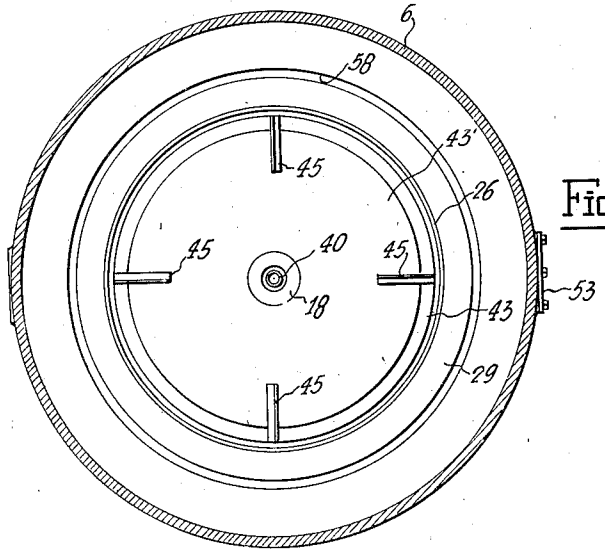


Fig. 4.

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Fig. 6.

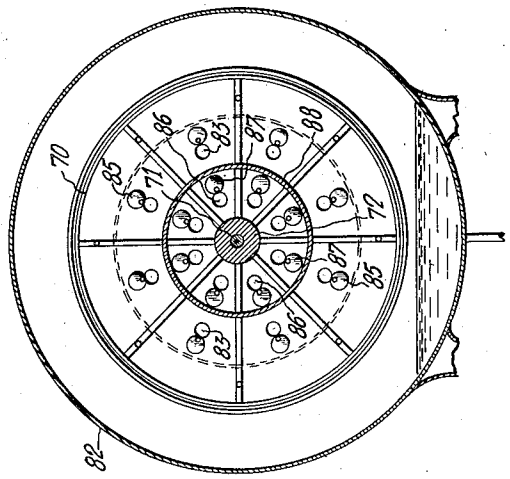
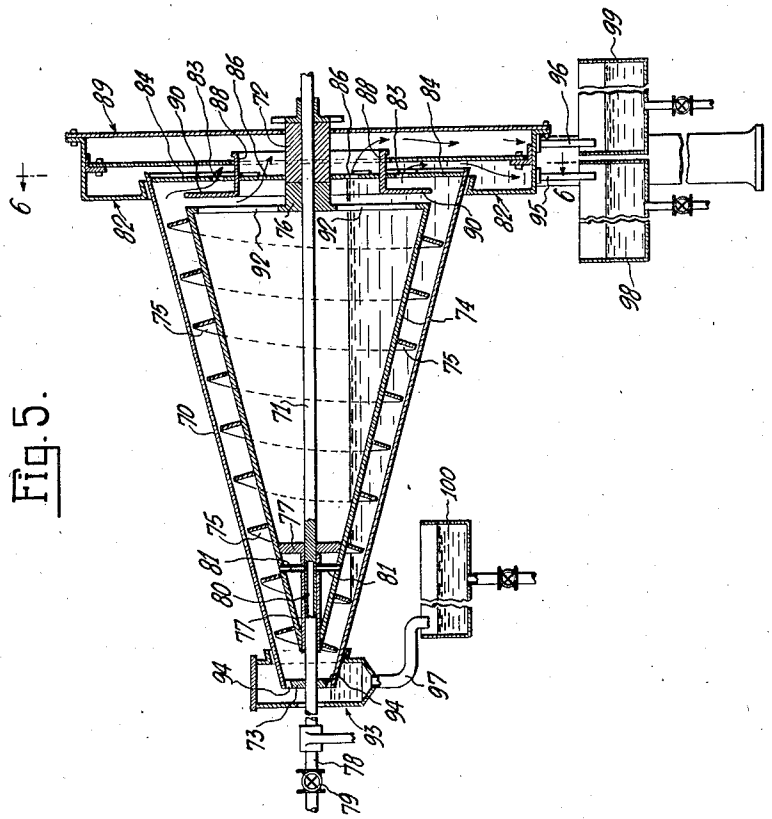


Fig. 5.



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UNITED STATES PATENT OFFICE

2,054,058

CENTRIFUGE

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Application April 12, 1934, Serial No. 720,189

4 Claims. (Cl. 233—7)

This invention relates to a novel method of and apparatus for separating a liquid mixture into fractions of different specific gravities by centrifugal action.

More particularly, the invention relates to improvements in centrifuges constructed to enable withdrawal of a relatively light fraction of a treated liquid from the centrifuge bowl at one level, at a point inwardly of the side walls of the bowl, and withdrawal of a relatively heavy or dense fraction from the bowl at another point.

A more specific feature resides in the provision of an improved centrifuge adapted to cleanly separate liquids containing finely divided solids into a heavy liquid containing most of the solids and a light liquid substantially free of solids. Preferably, provision is made for discharging the solids from the centrifuge along with the heavy fraction, but in one form disclosed herein there is provision for separately discharging the solids.

A further feature resides in providing means for enabling ready adjustment of the centrifuge for different densities of one or both of the fractions to be separated, thus providing flexibility for handling liquids of varying character.

Still another feature resides in the provision of means for preventing solid particles in the liquid from collecting in the bottom of the bowl and for aiding in carrying them to the desired point of discharge.

Another feature of the invention resides in providing an improved centrifuge of the character indicated, which shall be comparatively simple and inexpensive to manufacture, efficient in operation and durable in service.

Other features, objects and advantages of the invention will be in part apparent and in part pointed out in connection with the following detailed description of one form of centrifuge in accordance with my invention, reference being had to the accompanying drawings wherein.

Fig. 1 is a central, vertical section, partly in elevation and partly broken away, of a preferred form of centrifuge in accordance with the invention;

Figs. 2, 3 and 4 are sections taken on the lines 2—2, 3—3 and 4—4, respectively, of Fig. 1, looking in the directions of the respective arrows;

Fig. 5 is a central, vertical section of a modified form of a centrifuge, also in accordance with the invention; and

Fig. 6 is a section taken on the line 6—6 of Fig. 5, looking in the direction of the arrows.

As shown in the drawings, the centrifuge may comprise a suitable base 5 adapted to stand on the floor or other support, and a housing 6 secured to the base. The housing 6 may be provided with a cover or top 7 arranged to support an electric motor and driving connections for rotating the revolving parts of the centrifuge. For example, a gear housing 8 may be bolted or otherwise secured to convenient flanges formed on the cover 7, and a motor 9 may be supported on the gear housing through a bracket 10. Bearings 11 and 12 may be received in the cover 7 and top wall of housing 8, respectively, for mounting a shaft 13 connected to the motor shaft 14' in any suitable manner. If desired, any suitable gearing 13' may be provided for operating an oil pump (not shown), for forcing lubricant into the gear housing through pipes 13''.

Keyed to the shaft 13 there are provided gears 14 and 15 for driving gears 16 and 17, respectively keyed to main shaft 18 of the centrifuge and to a sleeve 19 journalled on this shaft. The upper end of shaft 18 may be journalled in a bearing 21, while the sleeve 19 may be journalled through a collar 22 in a bearing 23 carried by the top 7. The shaft 18 and sleeve 19 extend through the top 7 of housing 6. A suitable bushing 24, for receiving sleeve 19, may be fitted in the top 7.

Within the housing 6 there is provided a bowl 25 which may be formed of a cylindrical member 26 and end plates 27, 28 secured thereto through angle irons 29. The top end plate 27 may be attached to the lower end of sleeve 19, for instance by welding. The bottom end plate 28 may be secured to a flanged member 30 keyed to a stub shaft 31 which is mounted in bearings 33, 34 carried by a suitable housing 32. The bearing 34 serves as a thrust bearing. Upstanding flanges 35 may be provided on the top of housing 32 for cooperating with flanged member 30 in order to prevent any liquid, which may fall to the bottom of housing 6, from reaching bearings 33 and 34. A suitable outlet 37 is shown formed in the bottom of housing 6 to permit such liquid to drain therefrom, and a hand hole may also be formed in the bottom of housing 6 for reaching plugs 39 in the bottom of the bowl, when it is desired to drain liquid from the latter.

The shaft 18 is preferably formed hollow for receiving a pipe 40 which extends from above the upper end to the shaft to near the bottom of the bowl and serves as the feed inlet for liquid to be acted upon by the centrifuge. The pipe 40 may be threaded as at 42 into a suitable cap 41 on the gear housing 8.

Secured to the shaft 18 within the bowl 25

there is provided an impeller or screw comprising blades 43 and 44, preferably of generally helical or spiral shape. A flat plate 43' is preferably secured across the bottom or formed as part of the blade 43, and a similar plate 44' is preferably provided at the top of blade 44. The blades are advantageously of such diameter as to extend close to the walls of the bowl, while the plates 43' and 44' may be of somewhat smaller diameter. The plates 43' and 44' are preferably spaced a substantial distance from the end walls of the bowl, for instance as shown, and provision is made for agitating and keeping in motion the relatively heavy liquid adjacent the walls of the bowl. For this purpose, there are advantageously provided arms or fins 45, welded or otherwise attached to plates 43' and 44', and extending so that their upper and lower edges lie close to the end walls of the bowl. Any convenient number of fins may be employed. However, good results are achieved when four fins are employed at the top and four at the bottom, equally spaced around the circumference of the blades. The outer edges of the fins preferably lie close to the side walls of the bowl, while the fins may extend inwardly toward the axis of the centrifuge to about a third or so of the radius, though they may be of greater or less extent.

It may be advantageous in certain cases to construct the fins 45 so that they extend at angles to radii, or in other words so that their outer ends lead or lag with respect to their inner ends and with relation to the direction of rotation of the blades. For instance, the lower fins may extend with their outer ends lagging in order to assist the forces tending to throw solids toward the side walls of the bowl, while the upper blades, in the form illustrated, may extend with their outer ends leading in order to urge the material, which is to be discharged through outlet ports 54, toward these outlets.

Where desired, suitable perforations 46 may be provided adjacent the perimeters of the blades, and such perforations are advantageous in the upper blade 44, which is above the outlets for the light fraction, hereafter described. It is also desirable to thicken the edges of the blades, especially the upper blade, for instances as shown at 47, by means of strips folded to lie over and under the edges of the blades and secured thereto. The blades are thus strengthened and the uniform elevation of the heavier fraction is promoted.

Between the blade 43 and the blade 44 a space is provided into which extend a series of tubes 50. Four are shown, although any satisfactory number may be employed. Each of these tubes is shown threaded into a flange 51, carried by the bowl, so that the distance each tube projects into the bowl may be adjusted to the desired amount for given liquids. The relatively light liquid flows out through these tubes. According to the specific gravity of the liquid desired to be withdrawn through them, they may be moved in or out; in for lower specific gravity and out for higher specific gravity. A hand hole 52, with removable cover plate 53, is provided in housing 6 for permitting the tubes to be reached for adjustment.

It will be appreciated that if the centrifuge be operated at less than capacity, the speed of rotation of the bowl may be employed, within ascertainable limits, to vary the density characteristic of the liquid discharged through the tubes 50. For instance, by reducing the speed somewhat, more liquid will tend to flow out through tubes 50, due to reduction of the force tending to throw the liquid toward the side walls of the bowl.

Orifices 54, connected with radial passages 55, are formed at the top of the bowl and serve as outlets for the liquids of relatively heavy density. Advantageously, the orifices 54 are positioned inwardly of the inner ends of blades 45. The orifices 54 may be open at the top for venting air, but the liquid will still pass through passages 55 due to the rapid rotation of the bowl.

The housing 6 may be provided with an integral, internal flange 56 forming an annular compartment 57 for receiving the heavy fraction as discharged from the bowl, and with a similar flange 58 forming a compartment 59 for receiving the light fraction as discharged. Ports 60 and 61 permit withdrawal of the respective liquids, and suitable piping may be connected therewith to carry off the liquids as they are continuously discharged.

For the separation of many types of liquids, especially those containing solid particles, it is advantageous to drive the blades 43, 44 at a somewhat higher speed than the bowl 25, and for this purpose the gear 15 may have fewer teeth than gear 14, while the gear 17 may have more teeth than gear 16. For instance, if the shaft 18 and the blades thereon are to rotate at 900 R. P. M. and the bowl 25 is to rotate at 890 R. P. M., the gears may be readily designed to effect this speed differential. Such a speed differential aids in producing a uniform distribution of the liquids, in eliminating deposits of solids, and in carrying solids toward the heavy liquid discharge outlets in the bowl. However, the invention is not limited to any particular speed differential.

The operation of the centrifuge will be understood from the foregoing, but may be summarized here. The centrifuge is first started and then liquid to be treated is continuously admitted to the top of pipe 40 and flows downwardly therethrough, entering the bowl 25 near the bottom thereof. As the liquid is centrifuged it stratifies into a relatively dense or heavy layer adjacent the side walls of the bowl, and a relatively thin or light layer nearer the axis, and as the level of the liquids rises in the bowl an equilibrium is soon reached, whereupon the light liquid is discharged through tubes 50 into compartment 59 and the heavy liquid is discharged through orifices 54 into compartment 57. It will be seen that the heavy fraction is permitted to flow past the edges of blade 44 and onto the top of plate 44' between the fins 45, thus reaching the orifices 54. The rate of feed may be readily controlled to maintain the quantity of liquid in the bowl constant, once the machine is operating at a predetermined speed or a particular capacity.

While the present invention in its broader aspects is not confined to use with any particular materials to be treated, it has been developed and is especially useful in connection with doctor sludges produced in sweetening operations in oil refineries. Such doctor sludges commonly contain lead sulfide, caustic solution, and naphtha, in the form of an emulsion, and it becomes desirable to separate the naphtha from the other materials. When such a doctor sludge, containing the lead sulfide particles in suspension, is treated as mentioned, the relatively light naphtha is readily separated, as much as 99% of it being recovered, while by far the major part of

the lead sulfide is carried along and discharged with the caustic solution. By adjusting the tubes 50 to reduce the proportion of the naphtha cut, a naphtha fraction substantially free of lead sulfide may be produced. Additional recovery of naphtha from the heavier liquid may then be achieved by returning this liquid to the centrifuge along with additional doctor sludge, or by treating it in a separate centrifuge, or otherwise.

While the form of centrifuge shown in Figs. 1–4 has especial advantages for purposes indicated, certain of these advantages, and others, may be achieved through modified forms of construction, one of which is illustrated in Figs. 5 and 6 to which reference will now be made.

The form of machine shown somewhat diagrammatically in these latter figures may comprise a conical bowl 70 journalled on a horizontal shaft 71 through sleeves 72 and 73 at the ends of the bowl. The shaft 71 may be supported in any convenient external bearings, and the shaft and sleeve 72 may be rotated from a suitable source of power (not shown). Within the bowl 70 there may advantageously be provided a hollow conical member 74 carrying a spiral blade 75 on its outer side. The member 74 may be supported on the shaft 71 through sleeves 76 and 77 secured thereto.

Liquid to be centrifuged may conveniently be admitted to the bowl, preferably to the small end thereof, through a pipe 78, at a rate controlled by valve 79, this pipe being suitably connected with the hollow end 80 of shaft 71. A convenient number of tubes 81 extend radially from the inner end of the hollow portion 80 to the space between the bowl and member 74, for conducting the liquid into the bowl.

Surrounding the outlet or large end of the bowl 70 there is provided a housing 82 which receives the relatively heavy liquid fraction discharged from the bowl through ports 83 formed in the end wall 84 thereof. The distance of these ports from the perimeter of the bowl, at a given speed of rotation, will determine the density of the liquid withdrawn through the ports, and suitable, adjustable closure plates 85 may be provided to control the density and/or quantity of liquid discharged. For instance, the plates 85 may be mounted on set-screws which can be tightened down when the plates have beeen moved to the proper positions. However, any other convenient device may be used for this purpose.

Similar ports 86 and closure plates 87 may be provided, spaced farther from the perimeter of the bowl than ports 83, for withdrawing lighter or less dense liquid from the bowl, and the liquid thus withdrawn may be conducted by means of a circular baffle 88 into a housing 89. The baffle 88 may advantageously extend inwardly of the end wall of the bowl and be provided with a generally radial flange 90 of sufficient extent to aid in producing a clean separation of the heavy and light fractions. In other words, the baffle and flange construction aids in preventing the lighter fraction from reaching the ports 83.

Openings 92 may be provided in the large end of the member 74, for permitting this member to receive a portion of the liquid in the centrifuge, and thus enabling the stratification of the liquid fractions to take place in a relatively large volume of liquid, while at the same time the space between the cone 74 and bowl 70 may be restricted, to facilitate the desired operation of the blades 75, as will be hereafter described.

Surrounding the small end of the bowl 70 is a housing 93 for receiving solids and some liquid discharged through openings 94 in sleeve 73 by the action of the blade 75 which sweeps such materials into the small end of the bowl and discharges them at a level preferably above the liquid level in the bowl. By limiting the space between the bowl and the conical member 74, the amount of liquid carried out of the small end of the bowl may be reduced.

Suitable piping 95, 96, 97 may be provided for drawing off the several fractions from housings 82, 89 and 93 and passing them to storage reservoirs 98, 99 and 100, respectively.

In operation of this form of centrifuge, it will be understood from the foregoing that liquid to be treated is fed in through pipe 78, the bowl 70 and member 74 being revolved through suitable connections with shaft 71 and sleeve 72. A speed differential may be employed, where desired, as described in connection with Figs. 1–4. As the liquid level builds up to the desired constant, the heavy liquid will be thrown out from the axis of the bowl and will discharge continuously at the desired rate from openings 83, while the lighter fraction will discharge continuously through ports 86. The blade 75 will sweep solid particles, which tend to settle in the heavy liquid, toward the small end of the bowl and there discharge them.

Through the present construction there is thus provided a particularly simple and effective centrifuge for producing a separation of liquids into fractions of different specific gravities, and especially for separating such liquids where it is desired to cause solid particles to pass into the heavier fraction. Moreover, settling of solid particles is effectively prevented. A particularly clean separation of liquids into fractions of different densities is produced by the present centrifuge, and the construction permits a nice adjustment of the line of separation as is often desirable in handling difficult types of liquids. In addition, the machine may be readily cleaned and serviced, in addition to being simple to manufacture and economical in use.

It will be appreciated that in addition to many of the advantages of the vertical type centrifuge, which is particularly efficient in operation, provision is made in the horizontal type for a separate removal of solid particles, thus eliminating in certain cases the need for a separate settling chamber, in the event that it is desirable to remove the solid particles from the heavy liquid fraction.

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described, or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. In a centrifuge of the character described, adapted to separate a mixture of oily liquids and solids into a heavy liquid containing substantially all the solids and a light liquid, in combination, a bowl rotatable on a vertical axis and having a solid side wall and end walls, a screw within said bowl, shafting secured to opposite end walls of the bowl, a driving element co-axial with said shafting and secured to said screw, a fixed, central feed pipe opening into said bowl adjacent one end thereof, a plate carried by said driving element at the end of the screw adjacent the opposite end

of the bowl from the feed end, said plate being constructed and arranged to form a narrow passage between its edges and the side wall of the bowl, openings in the end wall of the bowl adjacent said plate for discharging heavy liquid containing solids from said passage, tubes carried by said bowl and extending into the same between the ends thereof for discharging light liquid, and fins carried by said screw adjacent the feed end of the bowl and the side wall thereof for imparting rotary motion to the liquid.

2. In a centrifuge of the character described, adapted to separate a mixture of liquids and solids into a heavy liquid and a light liquid, one of which contains most of the solids, a bowl having solid side and end walls, a screw within said bowl, shafting secured to opposite end walls of the bowl, a driving element co-axial with said shafting and secured to said screw, a fixed central stationary feed pipe opening into said bowl, two plates, one at each end of the screw, secured to said driving element, the plate opposite the feed end being constructed and arranged to form a narrow passage between its edges and the side wall of the bowl for discharging heavy liquid containing solids through said passage, tubes carried by said bowl and extending into the same between the ends thereof for discharging light liquids, and arms carried by said plates adjacent the side and end walls of the bowl for imparting rotary motion to the liquid and for assisting in removing solids which tend to settle and adhere to the walls of the bowl.

3. In a centrifuge as claimed in claim 2, the construction comprising a screw having plates extending outwardly from the driving element to adjacent the side wall of the bowl and the spaces between said plates being otherwise substantially unobstructed.

4. In a centrifuge as claimed in claim 2, wherein certain of said arms are mounted on the plate at the discharge end of the bowl between the plate and the end wall of the bowl, for imparting rotary motion to the material delivered from the screw between the edge of the plate and the side wall of the bowl.

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