

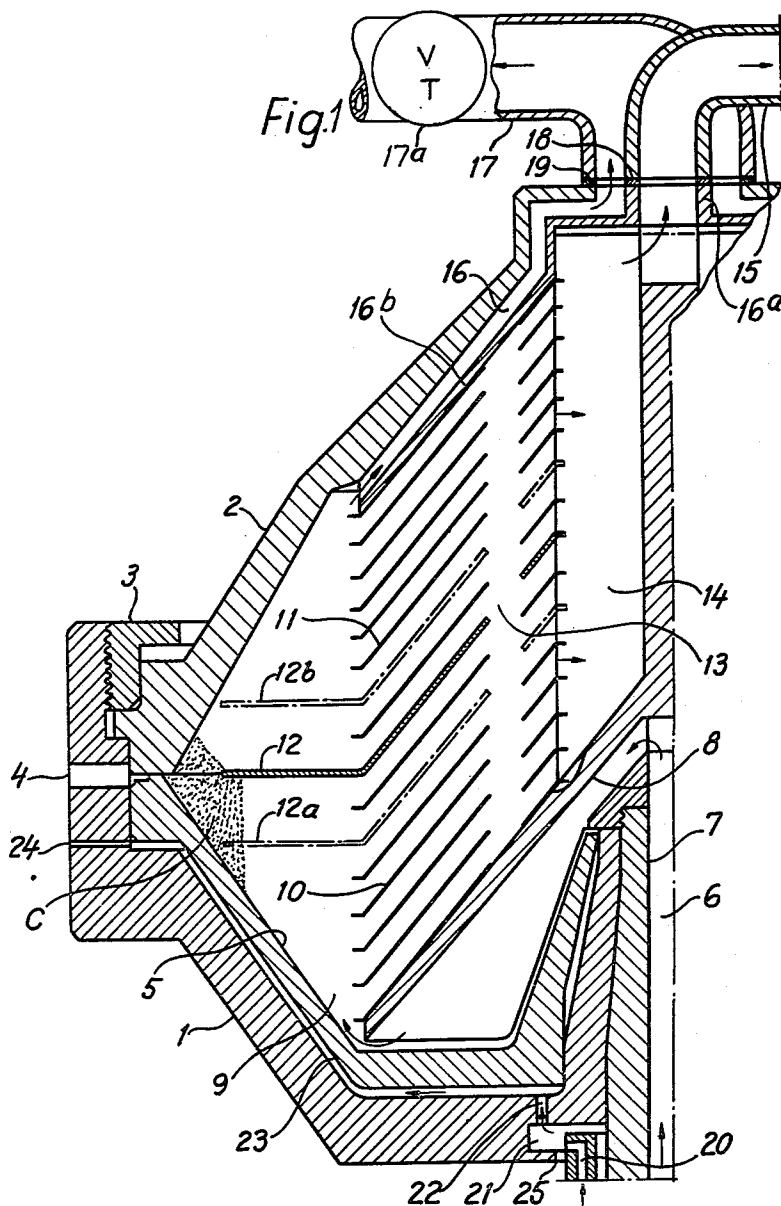
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CENTRIFUGAL SEPARATOR

3,117,928

Filed April 13, 1961

2 Sheets-Sheet 1



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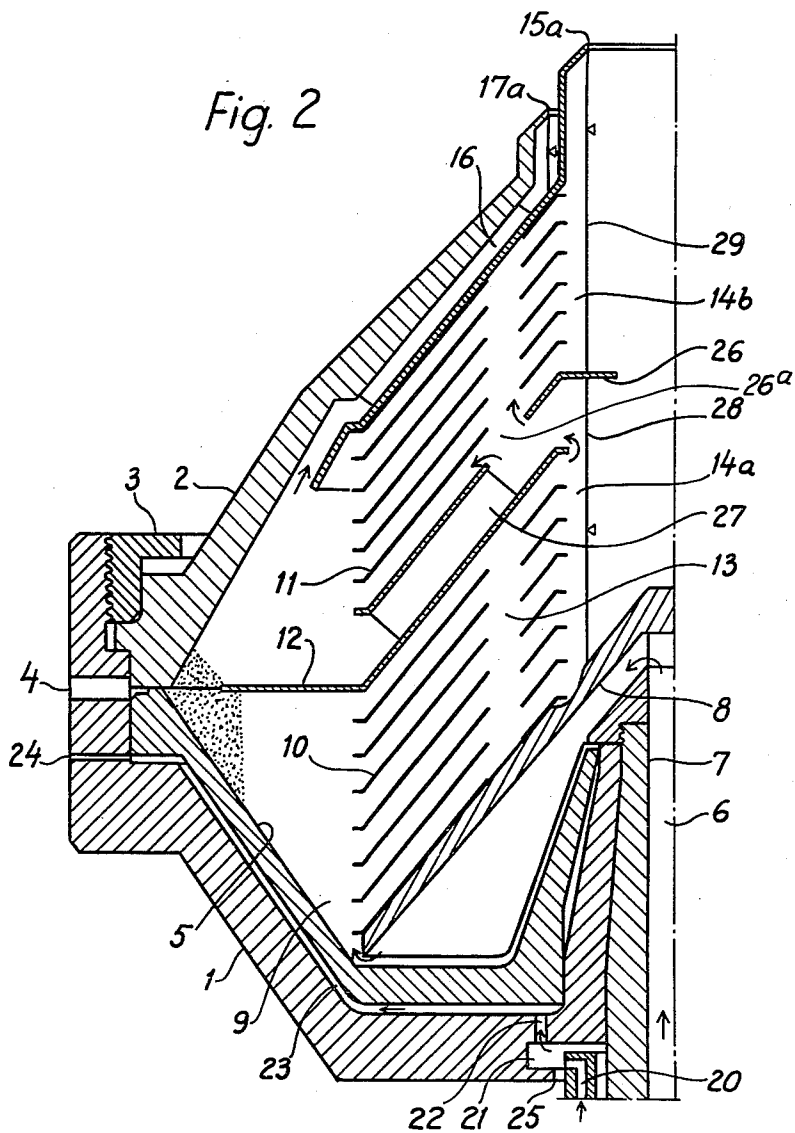
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CENTRIFUGAL SEPARATOR

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This invention relates to centrifugal separators for separating a liquid mixture containing sludge.

In the centrifugal separation of water extracts of coffee or citrus juice, for example, which are sludge-containing mixtures of liquids insoluble in each other (water and oil), it has become increasingly important to discharge the separated liquids free from sludge. For this purpose, the sludge has heretofore been separated from the liquid in a centrifuge of the so-called clarifier type, this separation being followed by centrifuging of the liquid in an other centrifuge of the so-called purifier or concentrator type to free the liquid from its oil content. In other words this practice has required the use of two different centrifuges. The centrifuge having the lower output capacity therefore limits the maximum output capacity of the centrifuging system or plant.

The present invention has for its principal object the provision of a centrifuge for carrying out both of the above-mentioned different separating operations.

A centrifuge made according to the invention comprises a hollow centrifugal rotor forming a separating chamber provided with a plurality of generally conical, axially-spaced annular discs, one of these discs extending radially outward from the rotor axis beyond the outer peripheries of the other discs and dividing these other discs into two separate disc sets. The part of the separating chamber containing the first set of discs has an inlet for admitting the unseparated mixture to the separating chamber, and the part of the separating chamber containing the second set of discs has an outlet for separated light liquid, this outlet extending from the inner edges of the discs. This second part of the separating chamber also has an outlet for separated heavy liquid, the latter outlet being spaced radially outward from the light liquid outlet. The rotor has a liquid flow passage interconnecting the two disc sets; and according to the invention, the outlet of this interconnecting passage opens into the second disc set and is located at a greater radius than the innermost edge of the discs but at a substantially smaller radius than the inlet through which the unseparated liquid mixture is admitted into the chamber containing the first disc set.

In the centrifuge of the present invention, the first disc set (that is, the set located in the part of the separating chamber having the inlet for the unseparated liquid mixture) operates as a clarifier, while the other disc set operates as a concentrator or purifier. Preferably, the two disc sets communicate at their inner edges with a common outlet chamber for separated lighter liquid, this outlet chamber extending from the inner edges of the discs to the light liquid outlet. To allow liquid to pass from one disc set to the other through the interconnecting passage, the outlets for the separated heavy liquid and separated light liquid should be so positioned radially that the boundary level between heavy and light liquid in the separating chamber will lie radially inward from the outer edge of the interconnecting passage. The position of this boundary level may be controlled in any other conventional man-

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ner, as by adjusting the back pressure in the heavy liquid outlet by means of a throttle valve.

The passage interconnecting the two disc sets may be a hole formed in the dividing disc and which leads directly from one set to the other. Alternatively, this interconnecting passage may have its outlet formed by a generally conical annular disc interposed between the dividing disc and the second disc set, the inner edge of the interposed disc being located substantially nearer the rotor axis than are the inner edges of the dividing disc and the other discs. In the latter case, liquid from the first disc set may pass around the inner edge of the dividing disc into the inlet end of the interconnecting passage and thence through the part of this passage formed between the dividing and interposed discs to the passage outlet through the interposed disc. Preferably, the discs of the two sets have passage holes located at about the same radius as the outlet end of the interconnecting passage.

To ensure that all of the heavy liquid will be forced to pass through the aforementioned interconnecting passage, the dividing disc separating the disc set sections should extend radially outward so that this outer periphery lies near the peripheral wall of the separating chamber.

This invention is described more in detail below, reference being made to the accompanying drawings, in which:

FIG. 1 is a vertical sectional view of a centrifuge embodying one form of the invention, showing only the left-hand half of the rotor; and

FIG. 2 is a view similar to FIG. 1 but showing a modified form of the invention.

While the illustrated forms of the centrifuge are of the type having a valve disc movable automatically to accumulate and then discharge the separated sludge, it will be understood that the invention is applicable as well to a nozzle centrifuge or to a sludge-accumulating centrifuge of other types.

In FIG. 1, which shows a completely closed centrifuge, reference numeral 1 designates a hollow rotor body having a cover 2 and a locking ring 3 for retaining the cover to the body 1. In the wall of the latter at its periphery are sludge discharge openings 4 which are opened and closed by an axially movable valve disc 5. Liquid to be separated is supplied through a feed channel 6 in an axial spindle 7, which supports and drives the rotor or centrifugal bowl, and enters via the distributor 8 into separation chamber 9. In this chamber are two sets of conical annular discs 10 and 11, the discs of each set being axially spaced and the two sets being separated by means of a disc 12 of greater diameter than the other discs. Like these other discs, the disc 12 has holes 13 spaced around the rotor axis for upward flow through the discs. The separated light liquid is collected from the two disc sets 10 and 11 in a central chamber 14 and discharges upwardly therefrom through a stationary pipe means 15 forming an outlet. The separated heavy liquid discharges through a channel 16 and stationary pipe means 17 forming an outlet. Inserted in the latter outlet is a throttle valve 17a by means of which the boundary level between heavy and light liquid can be adjusted to a position somewhere inside the outer edges of the holes 13. The two outlet pipes or tubes 15 and 17 are in concentric relation at their lower portions, the lower ends of which bear against packing rings 18 and 19, respectively. The latter are concentric to the rotor axis, the outer ring 19 being secured to the cover 2 around a central opening therein and inner ring 18 being secured to the upper end of a

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central tube 16a of a disc 16b which, with cover 2, forms channel 16. The stationary tubes 15 and 17 may be held in the conventional manner so that they are pressed against the respective rotating rings 18—19, thus providing sealed flow paths from chamber 14 and channel 16 to outlets 15 and 17, respectively. The valve disc 5 is kept closed (pressed against the cover 2) by means of water or other operating liquid which, through a stationary supply conduit 20, is fed to an annular chamber 21 in the rotor bottom and passes therefrom through a channel 22 into a conical chamber 23 between the underside of the valve disc 5 and the inner wall of the rotor body. The operating liquid is supplied in such a quantity that, despite escape of liquid through a small draining hole 24 in the rotor periphery, it fills the chamber 23 to a level which is controlled by an overflow outlet 25, excess of operating liquid discharging through this outlet. When the separation chamber of the centrifuge is to be at least partly emptied, the supply of the unseparated liquid through channel 6 is cut off as well as the supply of operating liquid through conduit 20, without the centrifuge being stopped. When the chamber 23 has been emptied of liquid through the drain hole 24, the valve disc 5 is pressed downwards by the content of the centrifuge, which then discharges through the openings 4. The valve disc 5 is returned to its closing position by a new supply of operating liquid from conduit 20, before the separation is resumed.

In the operation of the centrifuge, the liquid entering the separation chamber 9 passes first into the space below disc 12 where it is freed from the main part of the sludge, which moves outwardly under centrifugal force and forms a cushion C at the periphery of the chamber 9. Light liquid separated in this space discharges at the inner edges of the disc 10 into the chamber 14. The heavy liquid is prevented by the cushion C from going round the outer edge of the disc 12 but, together with unseparated light liquid, is forced to pass up into the space above the disc 12 through the holes 13 therein. Sludge accompanying the liquid mixture is separated between the discs and moves outwardly to cushion C. In the upper disc set 11, remaining light liquid is separated and is also collected in the chamber 14. Clean-separated heavy liquid discharges through the channel 16.

The disc 12 may be placed lower or higher relative to the other discs, as indicated at 12a and 12b. This makes it possible to obtain the proportion which is most appropriate between the clarifier part and the purifier part (or concentrator part) of the centrifuge, so that the centrifuge in its entirety will have as great output capacity as possible for the particular mixture to be separated.

The centrifuge of FIG. 2 has a closed inlet 6 as in FIG. 1 but has open outlets. In other respects, it substantially corresponds to the centrifuge of FIG. 1. Since it is intended in the FIG. 2 embodiment to use the disc set 10 in its entire radial extension for sludge separation, and consequently it is desired to conduct the liquid mixture freed from sludge over the inner edge of the disc 12, the latter has no through-flow holes. A disc 26 having through-flow holes 26a is provided in order to force the liquid mixture to flow radially outwards before entering the disc set 11, the inner edge of the disc 26 extending farther inward toward the rotor axis than do the inner edges of the other discs. In this way, unseparated liquid mixture is prevented from passing directly to the outlet for light liquid from the inner chamber 14a. The discs 12 and 26 are spaced from one another by means of extra high spacing ridges 27. Pure light liquid leaves the chamber 14b through an overflow outlet 15a, and pure heavy liquid leaves the same chamber by way of the channel 16 and through an overflow outlet 17a. The disc 26 separates two different liquid levels 28 and 29, which are determined on one hand by the composition and thus by the specific gravity of the liquids or liquid mixtures in those sections of the separation chamber which are separated by the

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disc 26, and on the other hand by the flow resistance in the passage between the same sections of the separation chamber.

I claim:

1. A centrifugal separator for a liquid mixture containing sludge, which comprises the combination of a hollow centrifugal rotor forming a separating chamber having a peripheral sludge accumulating space, the rotor having a peripheral sludge outlet for discharging sludge from said space, control means for controlling the discharge through said sludge outlet to accumulate a body of sludge in said space, a plurality of generally conical, axially spaced annular discs in the separating chamber, one of said discs extending outwardly from the rotor axis beyond the outer peripheries of the other discs and dividing said other discs into first and second separate sets of discs, the outer periphery of said one dividing disc being adjacent said space, the part of the separating chamber containing said first set of discs having an inlet for admitting said mixture to the chamber, said inlet opening into the separating chamber at a substantial distance outwardly from the inner edges of the discs, the part of the separating chamber containing said second set having an outlet for separated light liquid, said outlet extending from the inner edges of the discs, said second chamber part also having an outlet for separated heavy liquid, said heavy liquid outlet being spaced radially outward from said light liquid outlet and radially inward from said peripheral sludge outlet, and said one disc having a liquid flow passage interconnecting said disc sets and located at a greater radius than the innermost edges of the discs but at a smaller radius than said inlet to the chamber.

2. A separator according to claim 1, in which the inner edges of the discs surround a common outlet chamber for separated light liquid, said outlet chamber being common to both disc sets and leading to said light liquid outlet.

3. A separator according to claim 1, comprising also a stationary pipe line leading from said heavy liquid outlet and in sealing engagement with the rotor to form a sealed flow path for discharge of heavy liquid from the rotor, and a throttle valve in said pipe line.

4. A separator according to claim 1, in which said discs have passage holes.

5. A centrifugal separator for a liquid mixture containing sludge, which comprises the combination of a hollow centrifugal rotor forming a separating chamber having a peripheral sludge accumulating space, the rotor having a peripheral sludge outlet for discharging sludge from said space, control means for controlling the discharge through said sludge outlet to accumulate a body of sludge in said space, a plurality of generally conical, axially spaced annular discs in the separating chamber, one of said discs extending outwardly from the rotor axis beyond the outer peripheries of the other discs and dividing said other discs into first and second separate sets of discs, the outer periphery of said one dividing disc being adjacent said space, the part of the separating chamber containing said first set of discs having an inlet for admitting said mixture to the chamber, said inlet opening into the separating chamber at a substantial distance outwardly from the inner edges of the discs, the part of the separating chamber containing said second set having an outlet for separated light liquid, said outlet extending from the inner edges of the discs, said second chamber part also having an outlet for separated heavy liquid, said heavy liquid outlet being spaced radially outward from said light liquid outlet and radially inward from said peripheral sludge outlet, and an additional generally conical annular disc interposed between said dividing disc and said second disc set and having a passage located radially outward from the inner edges of the other discs, said passage being adapted to receive liquid passing around the inner edge of the dividing disc and deliver said liquid into the second disc set, said additional disc having its inner edge

at a substantially smaller radius than the inner edges of the other discs.

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