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METHOD AND APPARATUS FOR CENTRIFUGAL SEPARATION

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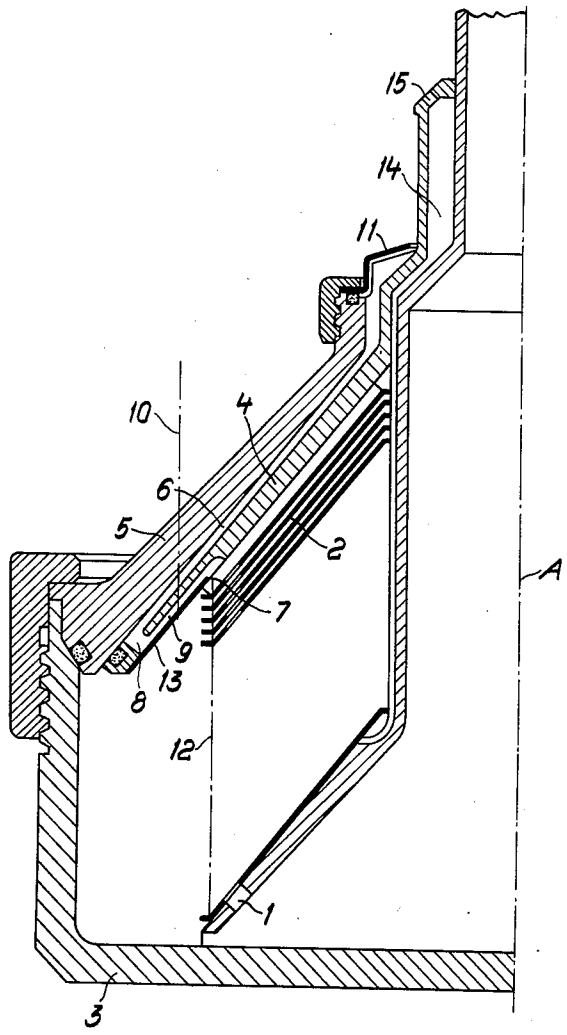

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METHOD AND APPARATUS FOR CENTRIFUGAL SEPARATION

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2 Claims. (Cl. 233—29)

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This invention relates to the centrifugal separation of a mixture of two liquids, and more particularly to an improved method and apparatus for this purpose by which the boundary surface between the two liquid components in the centrifugal separating chamber can be fixed.

In the centrifugal separation of a mixture of two liquids having different specific gravities, for example, oil and water, the two liquids are generally discharged continuously and separately over respective level outlets in the region of the rotation axis of the bowl. When it is desired to separate the heavier liquid as completely as possible from the lighter one, the centrifugal bowl must work at the maximum separating efficiency, and for this purpose the outlet levels must be so arranged that the boundary surface between the lighter and the heavier liquid in the bowl is positioned at the greatest possible diameter. In order to insure high separating efficiency of the bowl, the latter is generally provided with a set of conical discs between which thin liquid layers are formed, the separation of the liquid components of different specific gravities taking place in these layers. In addition to separating the liquid mixture into two fluid components, it is generally also desired to remove heavier solids from the liquids. The solids are also separated from the liquids and deposited at the outer wall of the bowl as a sludge layer.

In order to utilize the set of discs as efficiently as possible, the boundary surface between the liquids should be positioned close to the transition zone between the conical parts of the discs and the usual outer reenforcement flanges. However, the boundary surface is often displaced during operation, owing to fluctuations in the specific gravities of the liquids. Especially in the case of liquids which are difficult to separate and contain small and light impurities, experience has shown that, when the boundary surface is displaced outwardly and is even very slightly outside the flanges of the discs, the separation of solid impurities decreases suddenly. However, it is also undesirable for the boundary surface to be displaced inwardly and reach the conical portions of the discs, because this would entail a reduction of the separating efficiency of the bowl. It is therefore very important that the boundary surface be maintained at a certain radius during operation, and in any case it should not be displaced outside or inside the outer flange area of the discs.

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A principal object of the invention is to provide an improved centrifugal method and apparatus wherein the above-mentioned boundary surface can be maintained in the desired fixed position during the separating operation.

According to the invention, the boundary surface between the separated liquids in the bowl is held at a given radius by discharging the heavier liquid component from the separating chamber through a channel (or a system of channels), the inlet orifice of which forms a level outlet on the radius where the boundary surface is to be situated, and which extends first outwardly toward the outer wall of the bowl and then inwardly as far as the normal outlet for the heavier component. In that part of the discharge channel which is outside the level output, a second boundary surface is formed which lies outside the boundary surface in the discs and which may be displaced within certain limits under the influence of fluctuations in the specific gravities of the liquids. The boundary surface in the set of discs will therefore, according to the invention, have a predetermined fixed position which is independent of any fluctuations in the specific gravities of the liquid, whereas the displacements of the boundary surface in the channel for the heavier liquid will be dependent upon fluctuations in the specific gravities. This movable boundary surface may be regulated in the ordinary manner by means of exchangeable regulating discs having different outlet diameters, or by adjusting a valve in one of the discharge pipes when airtight centrifuges are used.

For a better understanding of the invention, reference may be had to the accompanying drawing, in which the single illustration is a vertical sectional view of a preferred form of centrifugal bowl made according to the invention.

Referring to the drawing, the liquid to be separated is fed through holes 1 into a set of discs 2 in the separating chamber of a centrifugal bowl 3. The uppermost disc of the set is a top disc 4 which extends somewhat outside the other discs and forms a liquid seal in the ordinary manner. Between the top disc 4 and the shell or top 5 of the bowl is a discharge channel or a

system of discharge channels 6 for the heavier liquid component. The inlet orifice of each channel 6 is not, as in ordinary constructions, positioned at the radius (from the rotation axis A of the separating chamber) to which the top disc 4 extends. On the contrary, each channel 6 returns inwardly from its outermost portion 8 and has its inlet orifice located inside the discs at the radius at which the boundary surface is to be fixed. The inlet orifice of each channel 6 forms a level overflow 7 for the heavier liquid component. Between the level overflow 7 and the outermost part 8 of the channel, a boundary layer 10 is formed in the channel part 9 during the separating operation, the radial position of the boundary surface 10 being dependent upon the differences between the specific gravities of the liquids. This boundary layer 10 is displaced inwardly or outwardly as the specific gravity of one or both liquids undergoes a change. In order to compensate for any considerable fluctuations in the specific gravities, a removable and exchangeable regulating device or disc 11 is provided at the outlet orifice of each channel 6, this outlet orifice being located inwardly from the boundary surface 12 in the separating chamber.

In the illustrated form of the invention, the level overflow 7, which determines the radial position of the boundary surface 12 in the set of discs, is defined partly by a recessed portion of the top disc forming the channel part 9, and partly by a frusto-conical shield or plate 13 secured to the peripheral portion of the top disc and covering the channel part 9. Thus, the radial dimension of the plate 13 determines the radial position of the level overflow 7 for the heavier liquid; and the top disc 4, the bowl top 5 and the plate 13 constitute means defining the level overflow outlet 7 and the passage 9—6 for leading the heavier component first outwardly from the overflow 7 and then inwardly for final discharge over the disc 11. The lighter liquid separated between the discs flows inwardly to passages 14 within the neck of the top disc 4 and is discharged from these passages through openings 15.

The new construction makes it possible to fix the boundary surface 12 in the set of discs, so that it remains at the radius of the level overflow 7 independently of fluctuations, within certain limits, in the specific gravities of the liquids.

In the use of conventional centrifuges, depending upon the factors determining the radial position of the boundary level or surface between the relatively heavy and light separated liquids (such as the specific gravity as well as the viscosity and temperature of the liquids and the throughput rate of the separator), a regulating disc, such as the disc 11, with a certain discharge diameter must be chosen, which determines the discharge of one of the separated liquid components from the centrifugal separator. However, as these factors cannot be held very constant during the centrifugal separation, but vary readily, the boundary level is easily displaced so that it lies, for instance, outside the peripheral flanges of the conical discs. When separating lubricating oil, for example, containing water and extremely fine carbon particles, which for the most part form the lubricating oil sludge, these particles are caught by an oil stream ascending outside the disc set and are reintroduced into the oil and discharged with the latter from the separator, if the boundary level is displaced outside the disc flanges. Accordingly, in such a case the sludge separation is easily reduced to less than one-half or one-third of the normal separation occurring when the boundary level is inside the disc flanges.

An important advantage of the present invention resides in the fact that it always insures that sludge outside the disc set has no opportunity to contaminate the liquid which has already been purified between the discs. A separator made and operated according to the invention is relatively insensitive to variations in the specific gravity of the liquids and to other variations occurring during the separating operation. In other words, such a separator has a fairly wide regulation range, so that it is no longer necessary, as has heretofore been the case, to make a careful choice of the regulation disc (such as the disc 11), since the same disc can be used within a relatively large range of variations of the liquids' specific gravities without impairing the separating efficiency.

I claim:

1. In the centrifugal separation of a mixture of liquids of different specific gravities by centrifuging the mixture in a rotary separating chamber to separate it into relatively heavy and light liquids, the method which comprises dividing the mixture in said chamber into a series of superimposed thin layers each having its outer edge directly overlying the outer edge of the next lower layer, thereby facilitating centrifugal separation of said heavy and light liquids in the chamber, discharging the heavy liquid from the chamber over a level overflow positioned at the boundary surface between the separated liquids in said layers, said surface and overflow being at a smaller radius than said edges from the chamber rotation axis, whereby the edges of said layers extend uniformly into the body of heavy liquid outside said surface to form a liquid seal at the outer portion of each layer, leading the heavy liquid from said overflow outwardly away from said axis and said overflow to a region located outwardly from said boundary surface, then leading the heavy liquid from said region toward said axis for final discharge at a region located inwardly from said boundary surface, thereby establishing outside said level overflow a second boundary surface which is displaceable radially upon fluctuations in the specific gravities of said liquids, while maintaining said first boundary surface substantially fixed, and adjusting the radial position of said second boundary surface by varying the location of said inwardly located region relative to the chamber rotation axis.

2. In an apparatus for centrifugally separating a mixture of liquids of different specific gravities, a centrifugal bowl having a separating chamber and a set of superimposed conical discs in said chamber, the discs forming thin interspaces in which the mixture is separated into relatively heavy and light liquids, means in the bowl defining a level overflow outlet from the chamber located at the same radial distance from the rotation axis of the chamber as the outer portions of said discs, said outlet lying at the boundary surface between the separated liquids, each disc having its outer edge directly overlying the outer edge of the next lower disc and at a substantially greater radius than the maximum radius of said outlet, whereby said outer portions of the discs extend uniformly into and are sealed by the body of separated heavy liquid lying outside said surface, said means also defining a

heavy liquid discharge passage leading first outwardly away from said level overflow outlet and then inwardly toward said axis.

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