

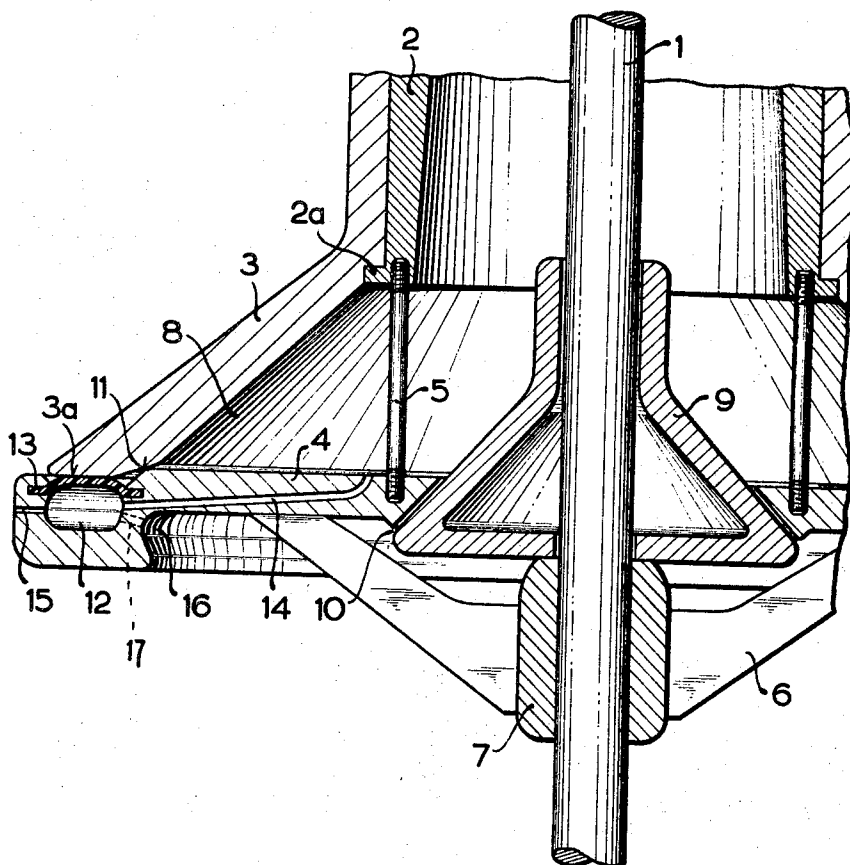
Oct. 8, 1968

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3,404,833

CENTRIFUGE

Filed Aug. 16, 1967



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3,404,833

CENTRIFUGE

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Filed Aug. 16, 1967, Ser. No. 661,502

Claims priority, application Germany, Aug. 22, 1966, M 70,652

9 Claims. (Cl. 233—20)

ABSTRACT OF THE DISCLOSURE

A centrifuge for separating a solid fraction from a liquid fraction includes a drum which is rotatable about a predetermined axis and includes a peripheral wall spaced from the axis and defining a centrifuge compartment. The wall consists of two sections which have juxtaposed end faces defining with one another a gap communicating with the compartment as well as with the exterior of the drum. One of the faces is provided with a chamber which is open to the gap. A sealing element separates the chamber from the gap. A first conduit connects the compartment with the chamber so that a portion of liquid fraction can enter from the compartment into the chamber. A second conduit connects the chamber with the ambient atmosphere and it defines a throttling orifice so that liquid fraction can escape from the chamber only at a rate which is smaller than the maximum rate at which the liquid fraction can enter the chamber through the first conduit. On rotation of the drum a predetermined pressure develops in the chamber and deflects the sealing element across the gap into contact with the other end face, thereby sealing the gap.

Background of the invention

The present invention relates to centrifuges in general, and more particularly to a centrifuge for separating a solid fraction from a liquid fraction.

It is known to provide centrifuges, which are used for separating a solid fraction from a liquid fraction, with a drum which is rotatable about a predetermined axis of rotation and whose outer peripheral wall is provided with a gap communicating with the interior centrifuge compartment of the drum. The gap is closed by a suitable sealing means and the interior can be filled with a liquid fraction containing the solid fraction therewithin. The side of the sealing member which faces away from the centrifuge compartment is subjected during rotation of the drum to a predetermined liquid pressure. When after centrifuging of a sufficient quantity of solid and liquid fraction the pressure of the solid fraction which is retained in the drum exceeds on the other side of the sealing member the predetermined pressure of the liquid acting against the sealing member, the sealing member yields and a slotted outlet for thixotropic sediment now exists. However, opening and closing of this outlet is not subject to external control so that removal of the sedimentation from the centrifuge compartment can take place not at the will of the operator, but only when the aforementioned predetermined conditions are fulfilled.

Other solutions which have been proposed are similarly inadequate because all control over the removal of the sedimentation is denied the operator.

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Summary of the invention

The present invention overcomes the aforementioned disadvantages.

More particularly, the present invention provides a centrifuge for separating a solid from a liquid fraction in which the outlet gap for escape of sediment can be opened and closed in a very simple manner.

The invention also provides a centrifuge of the aforementioned type which is suitable both for separation of a solid fraction from a liquid fraction by withdrawing the latter until the solid fraction forms a sediment in form of a thick slurry, and for initial separation of the solid fraction from the liquid fraction and subsequent drying of the solid fraction by removal of residual liquid.

In the centrifuge according to my invention opening and closing of the outlet gap occurs in automatic response of feeding and termination of feeding of the suspension into the centrifuge compartment during rotation of the centrifuge.

In accordance with one feature of my invention I provide, as pointed out above, a centrifuge which permits separation of a solid fraction from a liquid fraction. This centrifuge comprises a drum arranged to be rotatable about a predetermined axis, and the drum includes a peripheral wall which is spaced from the axis and which defines a centrifuge compartment. The wall is provided with a gap which communicates with the compartment as well as with the ambient atmosphere and through which gap liquid fraction tends to escape from the compartment. Further, the wall is provided with a chamber which opens into the gap.

Sealing means separates the chamber from the gap and is adapted to intrude into the gap for the purpose of sealing the same against escape of liquid fraction from the centrifuge compartment in response to the development of a predetermined pressure within the chamber.

First conduit means connects the compartment with the chamber so that a portion of the liquid fraction from the compartment is admitted into the chamber, and a second conduit connects the chamber with the ambient atmosphere. In accordance with the invention the second conduit means defines a throttling orifice for permitting the escape of liquid fraction from the chamber at a rate which is lower than the maximum rate of admittance of such liquid fraction through the first conduit means into the chamber. As a result of this pressure develops in the chamber when the drum is rotated about the axis, and this pressure is maintained as long as an adequate flow of liquid fraction through the first conduit means into the chamber takes place. It is this pressure which crosses the sealing means separating the chamber from the gap to intrude into the latter and to thereby seal the same against the escape of liquid fraction directly through the gap to the ambient atmosphere.

In circumstances where it is desired to first separate the solid fraction from the liquid fraction, and to subsequently dry the solid fraction by removing residual liquid therefrom, I have found it to be advantageous if the aforementioned gap is preceded by an additional gap. In other words, the additional gap would be arranged upstream of the main gap, namely in such a manner that the escaping liquid fraction must first pass through the additional gap and will only thereupon reach the main gap. The width of this additional gap is so selected

that it does not permit the passage of particles of the solid fraction therethrough and into the main gap.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

Brief description of the drawing

The single figure illustrates in a fragmentary axial section a centrifuge drum which embodies my invention.

Description of the preferred embodiments

Discussing now the drawing in detail it will be seen that I have illustrated only the lower portion of an upright centrifuge drum, and of this portion only the left-hand side. It will be understood that the configuration of the right-hand side, which is not illustrated, is mirror symmetrical so that the invention can be clearly explained by reference to the illustrated left-hand side.

Reference numeral 1 identifies an upright shaft which is rotatable about its longitudinal axis. Shaft 1 carries a centrifuge drum which is secured to the shaft for rotation therewith. The centrifuge drum comprises a peripheral wall which includes a first wall portion 2, a second wall portion 3 which is slidable in axial direction of the shaft 1 with reference to the first wall portion 2, and a third wall portion 4. The third wall portion 4 constitutes, as is of course obvious from the drawing, the bottom wall portion of the drum. The wall portion 4 is rigidly connected with the wall portion 2 by means of the bolts 5. Furthermore, the wall portion 4 is connected with a hub 7 via the members 6.

The drawing clearly illustrates that the inner cross section of the centrifuge compartment defined by the peripheral wall diverges in stepped fashion. Specifically, the inner cross section of that portion of the compartment which is defined by the wall portion 2 diverges slightly in downward direction towards the wall portion 4. That portion of the compartment which is defined by the second wall portion 3 diverges considerably in its cross section, also in the direction towards the bottom wall portion 4. By this latter expedient I obtain an enlarged space 8 which is defined between the wall portions 3 and 4.

The bottom wall portion 4 is provided with a central opening which receives a substantially conical closure member 9. It is to be noted from the drawing that a narrow annular gap 10 remains between the outer circumferential face of the member 9 and the inner peripheral face bounding the central opening in the bottom wall portion 4. As will become evident later, it is this gap 10 through which the majority of the separated liquid fraction escapes.

In the illustrated embodiment the lower end of the wall portion 2 is formed with a radial shoulder 2a which is engaged by the wall portion 3 and which thereby limits the downward movement of the latter. The construction is so selected that, when the wall portion 3 abuts against the shoulder 2a of the wall portion 2—and therefore can move no farther in the direction towards the bottom wall portion 4—an annular gap 11 of a height on the order of approximately 0.01 mm. is defined between the wall portion 3 and the bottom wall portion 4. In the illustrated embodiment, the upwardly-directed face of the bottom wall portion 4 is further provided with an annular groove or recess 12. An annular member 13, which in the illustrated embodiment consists of an elastomeric material such as rubber, overlies the upwardly-open groove and defines therewith an annular chamber 12. The member 13 is juxtaposed with the downwardly directed end face 3a of the wall portion 3 and defines

therewith an annular gap (not numbered) when the centrifuge is not in operation. It is to be noted that the gap just mentioned is not illustrated in the drawing because in the drawing it is assumed that the centrifuge is in operation and under which circumstance the just-mentioned gap does not exist. This will be explained presently.

A first channel or conduit 14 connects the chamber 12 with the compartment 8, and a second channel or conduit 15 extends radially outwardly from the chamber 12 and connects the same with the ambient atmosphere. It will be noted from the drawing that the cross sectional area of the channel 14 is greater than the cross sectional area of the channel 15.

In operation of my novel centrifuge, in which the wall portion 3 is in the illustrated position resting on the radial flange 2a of the wall portion 2, the suspension whereof the liquid fraction is to be separated from the solid fraction is introduced into the centrifuge compartment. The centrifuge rotates about the shaft 1 and, as soon as the compartment is filled sufficiently so that the suspension reaches the inlet end of the channel 14, liquid will enter through this channel into the annular chamber 12. Because liquid can enter through the channel 14 at a faster rate than it can escape through the channel 15, pressure develops in the annular chamber 12 under the influence of centrifugal force. This pressure deflects the elastomeric sealing member 13 across the gap and into sealing engagement with the face 3a of the wall portion 3. Thus, the centrifuge is closed against escape of liquid or solids at its circumference. However, a small quantity of liquid will of course continuously escape through the channel 15 out of the annular chamber 12.

During the course of centrifuging the heavier solid fraction moves radially outwardly in the centrifuge compartment and, when the liquid fraction passes through the enlarged space 8 and leaves the compartment through the gap 10, the solid fraction becomes deposited in the enlarged space 8. It goes without saying that, as the space 8 becomes substantially filled with solid fraction, the liquid fraction which heretofore was clear when issuing through the gap 10, becomes cloudy. This is an indication to the operator that the accumulated solid fraction must be removed. Of course, and even more advantageously, the necessity for having an operator control the centrifuge to obtain an indication when the accumulated solid fraction must be removed can be circumvented by a suitable automatically operating arrangement. Thus, a photocell arrangement can be used, and such an arrangement can be constructed to be actuated whenever the cloudiness of the escaping liquid fraction reaches a certain predetermined degree. Regardless of the manner in which this is accomplished, however, the further feeding of suspension into the centrifuge drum is terminated when it is observed that the escaping liquid fraction has become cloudy. Inasmuch as the drum continues to rotate the remaining suspension therein becomes separated with the liquid fraction being withdrawn through the gap 10. At this point the centrifuge chamber is emptied with the exception of the separated solid fraction in the enlarged space 8.

Because no further liquid fraction is being fed into the centrifuge compartment it is clear that the flow of liquid through the channel 14 into the annular chamber either ceases or at least becomes less than the flow of liquid out of the annular chamber through the channel 15. Thus, the pressure which heretofore existed in the annular chamber 12 disappears and the elastomeric member 13, no longer being deflected into engagement with the face 3a, withdraws out of contact with this face. This results in opening of the (unnumbered) gap between the member 13 and the face 3a and such liquid as may still be contained in the enlarged space 8 can now leave this space through the gap 11 which communicates with the gap existing between the member 13 and the face 3a. This latter removal of residual liquid is particularly advantageous with certain types of liquid fraction, for

instance synthetic plastic granulate wherein the particles may have a size of 10μ . When a suspension containing particles of this type is separated, and when the stage is reached at which the gap between the member 13 and the face 3a opens, the individual granules are tightly packed in the enlarged space 8 but contain in the interstices between the individual granules a quantity of liquid which may amount to between 70 and 80% of the contents of the space 8. It is this liquid which is removed through the gaps 11 and the one existing between the member 13 and the face 3a. While such removal takes place the granules so support one another that they are not carried along by the escaping liquid. This is facilitated by the wedge-shaped taper of the space 8 which, as the drawing shows, becomes particularly pronounced directly ahead of the gap 11.

On removal of the residual liquid the enlarged space 8 now contains dry solid fraction. To effect removal of this solid fraction the wall portion 3 is shifted axially in upward direction as seen in the drawing, that is in the direction away from the bottom wall portion 4. For this purpose a suitable device may be provided which, not constituting a part of the invention, is not specifically illustrated. Such devices will be readily apparent to those skilled in the art. Shifting of the wall portion 3 in this manner of course opens the enlarged space 8 at its periphery and during continued rotation of the centrifuge the solid fraction is ejected by centrifugal force. It goes without saying that suitable wall means will ordinarily be provided onto which the solid fraction impinges and by which it will be guided either to a collection or further processing station, or to a point at which it can be discarded.

It is clear that prior to centrifugal ejection the collected solid fraction can be subjected to one or more wash cycles, if this is considered necessary. For this purpose a wash solution is simply added into the centrifuge compartment. Such a wash solution passes through the accumulated solid fraction into the enlarged space 8, washing the same, and escapes through the gap 11 and the gap which exists between the member 13 and the face 3a.

Once the accumulated solid fraction has been centrifugally ejected the wall portion 3a is returned to its closed position, namely that illustrated in the drawing, the feeding of suspension into the centrifuge compartment is resumed, the annular chamber 12 becomes refilled and pressure develops therein, and separation of solid and liquid fractions can resume. At no time during all this is it necessary to stop the drum from rotating.

While it has been pointed out before that liquid phase is introduced into the annular chamber 12 through the channel 14 this is by no means the only way in which such introduction can be accomplished. Thus, the channel 14 can be supplemented by or replaced with another liquid-conveying arrangement. This is illustrated in the drawing where the under side of the bottom wall portion 4 will be seen to be recessed or dished. The resulting cavity is formed with a peripheral radial recess 16 which, as indicated in phantom lines, is connected with the annular chamber 12 by means of one or more bores 17. In this case the liquid phase which escapes from the centrifuge compartment through the gap 10 is flung under the influence of centrifugal force into the recess 16 from where it is ejected out of the cavity. Some of the liquid, however, penetrates from the recess 16 through the bore or bores 17 into the chamber 12. This liquid supplements that which enters the chamber 12 through the channel 14 or, if the latter has been eliminated, the liquid entering through the bores 17 in itself suffices to provide the desired pressure in the annular chamber 12.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of centrifuges differing from the types described above.

While the invention has been illustrated and described

as embodied in a centrifuge for separating a solid fraction from a liquid fraction, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. A centrifuge for separating a solid fraction from a liquid fraction and comprising, in combination, a drum rotatable about a predetermined axis and including a peripheral wall spaced from said axis and defining a centrifuge compartment, said wall being provided with a gap which communicates with said compartment and with the ambient atmosphere and through which liquid fraction tends to escape from said compartment, and with a chamber which opens into said gap; sealing means separating said chamber from said gap and adapted to intrude into said gap for sealing the same against escape of liquid fraction in response to development of a predetermined pressure within said chamber; first conduit means connecting said compartment with said chamber for admitting a portion of the liquid fraction from said compartment into said chamber; and second conduit means connecting said chamber with the ambient atmosphere, said second conduit means defining a throttling orifice for permitting escape of liquid fraction from said chamber at a rate which is lower than the maximum rate of admittance of such liquid fraction through said first conduit means, whereby said pressure develops in said chamber in response to rotation of said drum about said axis.

2. A centrifuge as defined in claim 1, wherein said second conduit means has a minimum cross-sectional area which is smaller than the minimum cross-sectional area of said first conduit means.

3. A centrifuge as defined in claim 1, wherein said peripheral wall comprises two axially aligned sections each having an annular endface facing a corresponding annular endface on the other section, said gap being defined between said endfaces and said chamber being provided in one of said endfaces.

4. A centrifuge as defined in claim 3, wherein said gap is an annular gap, and wherein said chamber is an annular chamber.

5. A centrifuge as defined in claim 4, wherein said chamber is an annular recess in said one endface; and wherein said sealing means is an elastically deflectable sealing member sealingly overlying said recess and secured to the corresponding section, and being deflectable across said gap into sealing engagement with the other of said endfaces.

6. A centrifuge as defined in claim 3; and further comprising a rotatable shaft defining said axis of rotation, one of said sections being mounted on said shaft for rotation therewith and one of said sections being mounted on said shaft for movement in axial direction of the same toward and away from the other of said sections.

7. A centrifuge as defined in claim 1; and further comprising evacuating means provided in said wall and having an inlet end communicating with said compartment for evacuating the major portion of said liquid fraction from said compartment, and an outlet end exteriorly of said compartment.

8. A centrifuge as defined in claim 7, wherein said second conduit means communicates with said evacuating means in the region of said outlet end thereof.

9. A centrifuge as defined in claim 1, wherein said solid fraction comprises particulate material and wherein said wall is provided radially inwardly of said gap with an additional gap which communicates with the first-mentioned gap and with said compartment, said additional gap having a maximum width so selected as to prevent passage of said particulate material through said additional gap and into said first-mentioned gap. 5

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