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C. M. AMBLER

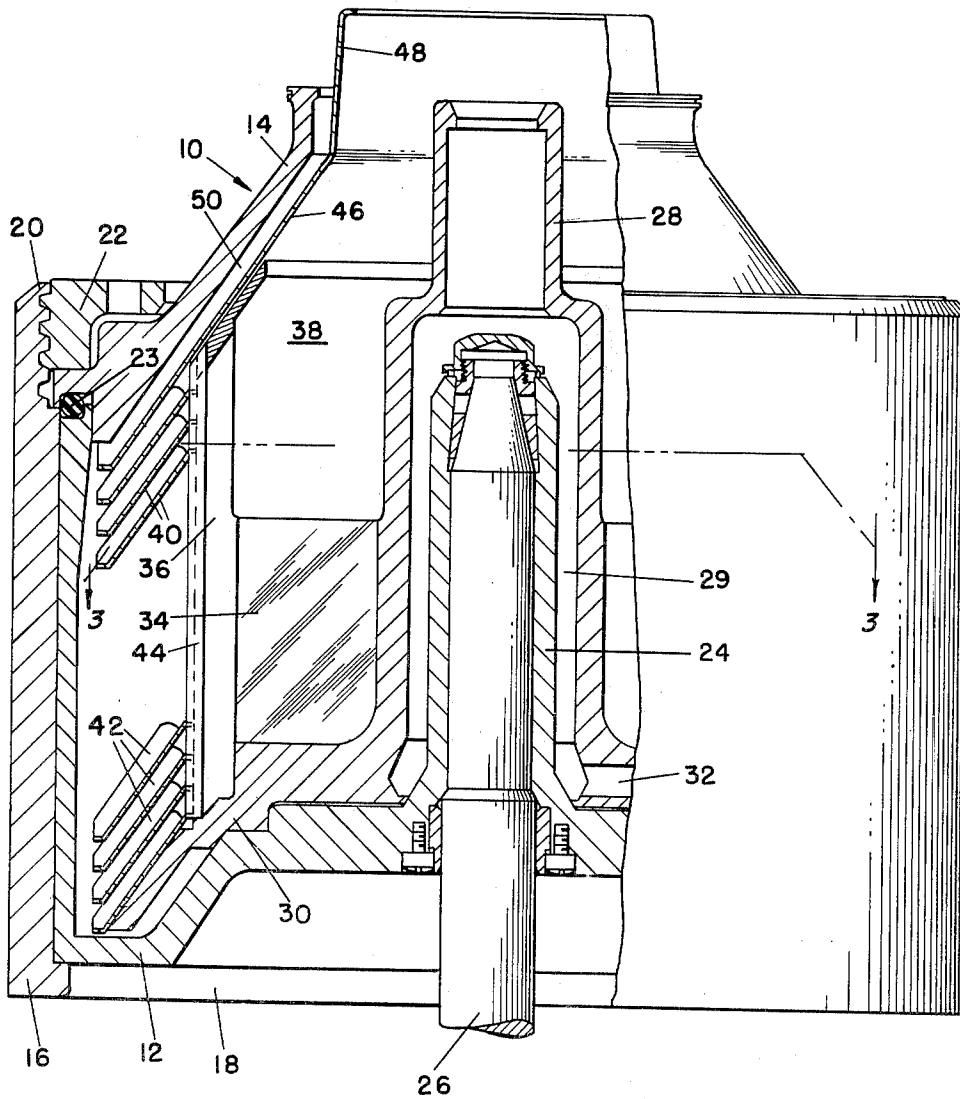
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CENTRIFUGE HAVING SELF-CLEANING SOLIDS DISCHARGE

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2 Sheets-Sheet 1

Fig. 1



INVENTOR.

CHARLES M. AMBLER

BY *Dalbert Hoopes*

ATTORNEY

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C. M. AMBLER

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Fig. 2

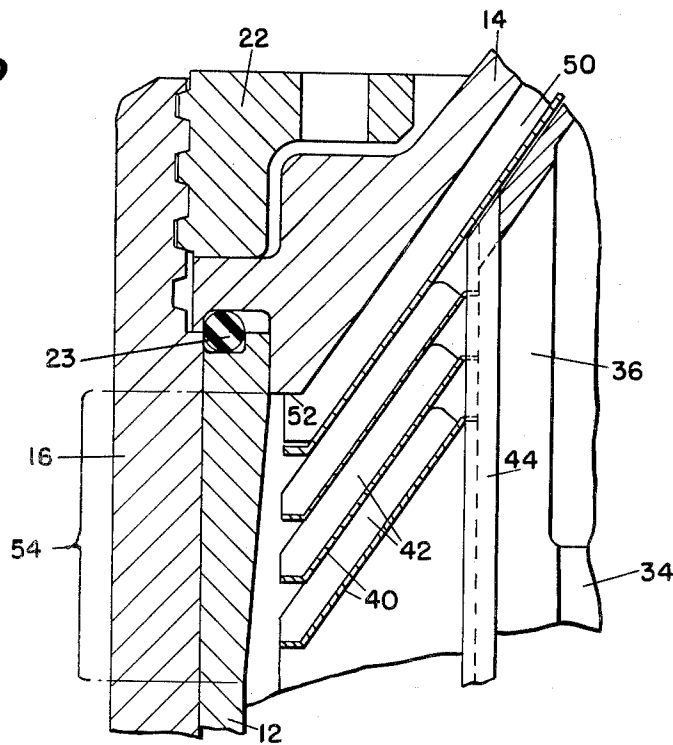
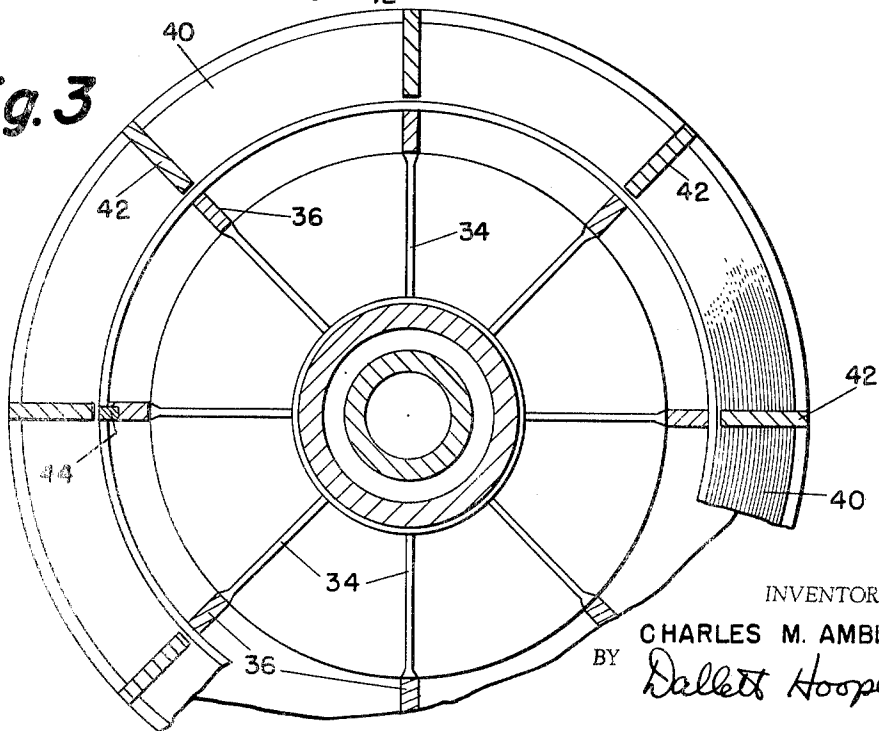


Fig. 3



INVENTOR.

CHARLES M. AMBLER

BY

Dallett Hoopes

ATTORNEY

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CENTRIFUGE HAVING SELF-CLEANING
SOLIDS DISCHARGECharles M. Ambler, Philadelphia, Pa., assignor to
Pennsalt Chemicals Corporation, a corporation of
Pennsylvania

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This invention relates to the separation of a cheese fluid from whey and heavy solids in a feed mixture. More specifically this invention relates to the separation of cheese fluid from whey and heavy solids in a centrifugal apparatus with avoidance of plugging of the heavy discharge passages of the apparatus by the bacterial residues, colloidal caseins, and other solids.

In the past it has been conventional to separate cheese fluid from whey and heavy solids in a centrifuge. Such a centrifuge has normally comprised a rotor having a vertical inside peripheral surface and a relatively abrupt inward heavy discharge passage commencing at a mouth adjacent an end of the peripheral surface. At the intersection of the surface and the passage there has been manifest a tendency for the colloidal casein and bacterial residues and other solids to collect and become impacted under the heavy centrifugal force. This tendency has been especially noticeable upon the interruption of the feed to the rotor whereupon on resuming feed additional residues have added to the build-up to plug the heavy discharge. Such plugging has required shutdown and disassembly of the apparatus for cleaning.

By the present invention provision is made for the continuous sweeping of heavy solids from adjacent the abrupt surface intersections which has been the locus of plugging. As a result with my invention such plugging is eliminated.

Further features of this invention will become apparent to persons skilled in the art as the specification proceeds and upon reference to the drawings in which:

FIGURE 1 is a side elevation partly in section of an apparatus embodying my invention;

FIGURE 2 is an enlarged fragmentary view of a portion of FIGURE 1; and

FIGURE 3 is a fragmentary sectional view taken on the line 3-3 of FIGURE 1.

Briefly, the invention is a centrifuge adapted especially for separating a cheese fluid from whey and heavy solids, including a rotor having a vertical inside peripheral surface and a relatively abrupt inward heavy discharge passage commencing at a mouth adjacent an end of the peripheral surface, and a long annular slightly tapered zone on the inside surface of the rotor intermediate the vertical surface and the inclined discharge passage. The zone extends from a point in the primary separating chamber of the centrifuge, tapering inwardly to the mouth of the passage.

Referring now to FIGURE 1, an illustrative example of a centrifuge rotor embodying the invention is broadly designated 10. It comprises a generally cup-shaped shell 12 having a generally frusto-conical top element 14. Surrounding the shell is a strengthening band 16 having at its lower end an inward flange 18 abutting against the lower end of the shell. The strengthening band 16 is formed with interior threads 20 adjacent its upper end and receives a retaining ring 22 in threaded engagement. In the abutting annular surfaces of the shell 12 and the top element 14 are formed annular grooves which in assembly receive a sealing ring 23 to seal the unit.

Centrally disposed in the shell 12 is an upstanding hub 24 with its axial bore receiving the spindle 26. The spindle is connected to a suitable power source and imparts rotary motion to the structure. Surrounding the

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hub 24 is the center tube 28 open at its upper end and spaced from the hub 24 to provide an annular passage 29 for feed material. The center tube 28 includes an outwardly flaring stepped skirt 30 having a radial bore 32 adjacent its lower end permitting passage of feed material from the annular space 29 into the primary separating chamber of the structure.

Extending radially outward from the center tube 28 are a plurality of uniformly spaced vanes 34. As shown, the vanes extend upward to a point about half way to the top of the primary separating chamber. Extending upwardly from the skirt 30 at the outer end of the vanes 34, respectively, are the support posts 36 secured at their upper ends to a frusto-conical support ring 38. For simplicity only one post 36 has been shown and some of the horizontal outlines of the ring 38 have been omitted.

Positioned outward from the posts 36 is a thin disc stack comprising a plurality of nested frusto-conical disc elements 40. Each disc element (FIG. 3) has secured thereto a plurality of spacer blocks 42 in radial alignment with the support posts 36. For purposes of maintaining balance upon reassembly, each disc element is formed with a notch on its inside edge adjacent one such spacer block, the notch being adapted to receive a key 44 projecting outward from one of the posts 36.

The frusto-conical dividing cone 46, which may be of spun metal or the like, rests on blocks 42 of the upper disc element and on the support ring 38. The dividing cone 46 is formed with an upward longitudinal extension 48 from which the cheese fluid may be skimmed. Positioned on top of the frusto-conical portion of the dividing cone are a plurality of wings 50 engaging the under surface of the top element 14 and forming between them passages for the heavy layer discharge. As is conventional the wings 50 also provide means for transferring the angular momentum of the inwardly flowing heavy layer into useful energy to help rotate the structure.

The portion of the apparatus which embodies the present invention is highlighted in FIGURE 2. In this figure it will be noted that the lower end of the top element 14 terminates in a downwardly facing annular surface 52. The surface 52 meets the wall of the shell 12 which is formed with a long annular slightly tapered zone 54 on its inside surface. The zone 54 extends from a point in the primary separating chamber of the rotor to its intersection with the horizontal surface 52 in the mouth of the heavy discharge passage. As shown, the inside surface of the shell 12 in the zone 54 tapers inwardly as the surface 52 is approached. The angle of the taper to the vertical may be about $4\frac{1}{2}^\circ$, for instance. It has been found that angles of less than about 3° do not adequately function to achieve the desired purpose. On the other hand, in order to maintain the capacity of the separating chamber, the taper is selected as gradual as possible. An upper limit is about 10° .

In the preparation of cream cheese the mix after inoculation by lactic acid bacteria and rennet is permitted to set for a time period of 24 hours or less in a flat tank. After settling, the mixture is divided into semi-solid blocks by wire combs and is then stirred at a temperature for instance between about 170° F. and 185° F. The mixture is then separated by an apparatus embodying the invention from which cheese is discharged as a light effluent and the whey as the heavy effluent. The whey, which has the appearance of a greyish water, contains colloidal casein and bacteria residues as solids. In prior art machines under the high centrifugal forces developed by a centrifuge operating at speeds of, for instance, 7600 r.p.m., there has been manifest a tendency for these solids to collect at the abrupt intersection of the vertical wall of the bowl and the downwardly facing

horizontal surface at the mouth of the heavy discharge passage. This collection has been noticeable especially after interruption of feed to the prior art machines as when switching from one stirring vat to another. After such interruption additional solids have built up on those already impacted and have completely plugged the mouth of the heavy discharge passage requiring shutdown and disassembly of the apparatus for cleaning.

With the apparatus embodying the present invention there has been no such plugging after interruption of the feed. Continuous operation has been achieved.

Exactly how the present invention operates to eliminate plugging is not known. It is believed, however, that the slightly inclined zone 54 in drawing the upwardly moving liquid inward has caused movement of the liquid adjacent the surface in the zone 54 in advance of the surface by reason of the angular momentum or inertia of the liquid due to its speed at the lowest point in the zone. This advance movement has achieved a sweeping action of the incline surface 54 and has precluded build-up of solid particles therealong up to the downwardly facing horizontal surface 52.

Whatever the action of material in the rotor, it should be noted that I have accomplished the cure of a condition which has for many years been a problem in the centrifugal separation of a cheese fluid from whey and heavy solids; namely the requirement due to heavy discharge blockage of frequent shutdowns for cleaning purposes.

It should be understood that variations of the apparatus shown are possible within the scope of the invention. The division between the shell 12 and the top element 14 need not be between zone 54 and surface 52.

Since this invention was conceived and perfected in connection with the separation of a cheese fluid from whey and heavy solids in a feed mixture, it has been described in this use. However it should be understood that the rotor embodying the invention is useful in any separation in which there is a tendency for the heavy discharge to plug at the abrupt intersection of the vertical wall and the heavy discharge passage.

A reasonable variation of the uniformly tapered zone 54 is a zone of similar length tapered in a concave arc, the chord subtending the arc having the prescribed angle with the vertical surface. The uniform taper is the preferred embodiment however.

It is therefore to be understood that the above particular description is by way of illustration and not of limitation, and that changes, omissions, additions, substitutions and/or other modifications may be made without departing from the spirit of the invention. Accordingly it is intended that the patent shall cover, by suitable expression in the claims, the various features of patentable novelty that reside in the invention.

I claim:

1. A centrifuge adapted especially for separating a cheese fluid from whey and heavy solids in a feed mixture while avoiding pluggage in the whey and heavy solids discharge comprising

(a) a rotor including a generally cup-shaped impermeable-walled shell having a vertical inside wall por-

tion and a generally frusto-conical top element having a horizontal annular undersurface and mounted on the shell, the shell and the top partly defining a primary separating chamber,

(b) means for rotating the rotor about an axis,

(c) means for feeding the mixture into the rotor,

(d) a disc stack disposed within the primary separating chamber,

(e) a frusto-conical dividing cone supported by said disc stack and spaced under the top element to define a relatively abruptly angled heavy discharge passage between the top element and the dividing cone,

(f) radial vanes within the disc stack, the vanes extending from the lower end of the primary separating chamber to a level below the top of the primary separating chamber and adapted to help accelerate the feed in the rotor to the velocity of the rotor,

(g) a long annular slightly tapered zone on the inside surface of the shell, the zone extending from immediately adjacent the vertical portion and approximately the midpoint level in the primary separating chamber of the rotor continually upward to the horizontal annular undersurface of the top element and disposed entirely radially outward of the disc stack, the shell diameter in the zone decreasing as the upper end of the shell is approached,

whereby the whey portions and heavy solids adjacent the inside surface of the rotor in moving upward in the chamber toward the heavy discharge passage are guided gradually inward of the rotor by the tapered zone, and are thereby caused to move tangentially faster than the adjacent surface.

2. The centrifuge as described in claim 1 wherein the surface of the slightly tapered zone has a generatrix of a line intersecting the axis at an angle of about 4.5°.

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