Aug. 2, 1938. H. O. LINDGREN 2,125,453

ANTIFROTH DISCHARGING MEANS FOR CENTRIFUGAL SEPARATORS

Filed March 12, 1935 2 Sheets-Sheet 1

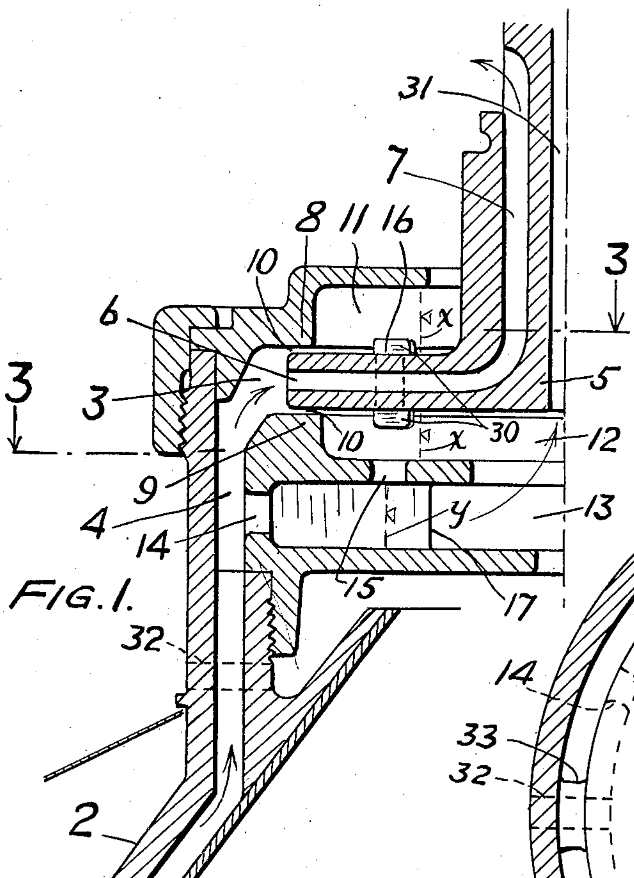

FIG. 1.

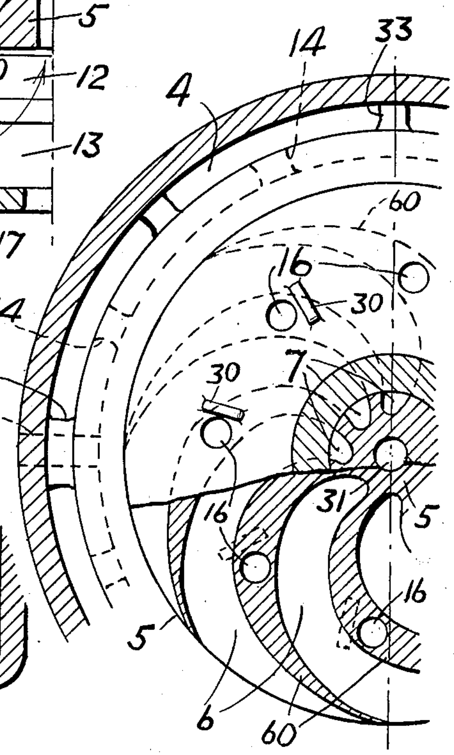

FIG. 3.

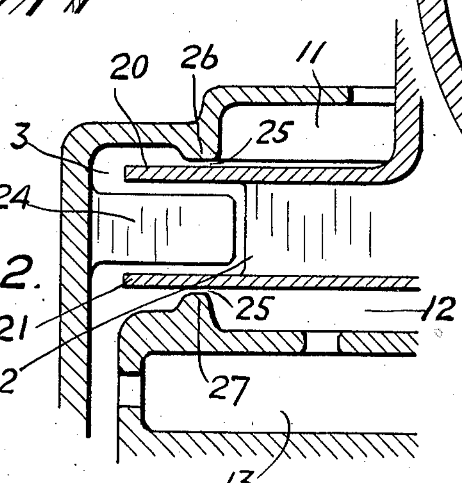

FIG. 2.

INVENTOR
Hans Olof Lindgren
BY
Busser and Harding
ATTORNEYS.

WITNESS:
Robt R. Kitchel.

Aug. 2, 1938. H. O. LINDGREN 2,125,453

ANTIFROTH DISCHARGING MEANS FOR CENTRIFUGAL SEPARATORS

Filed March 12, 1935 2 Sheets-Sheet 2

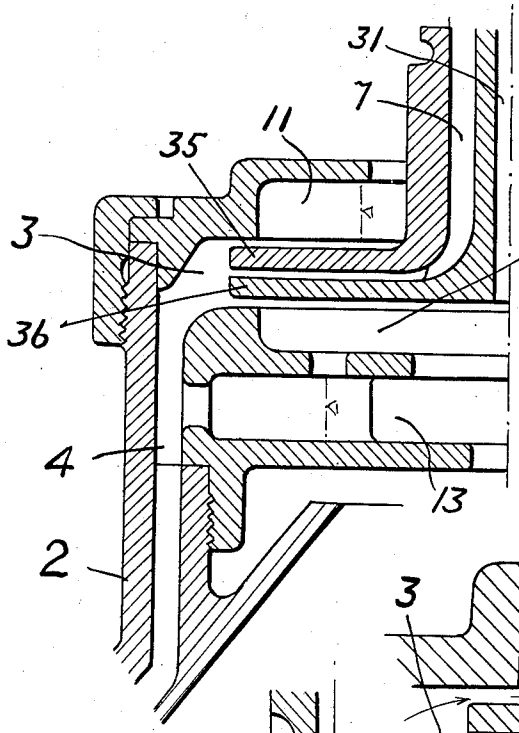

FIG. 4.

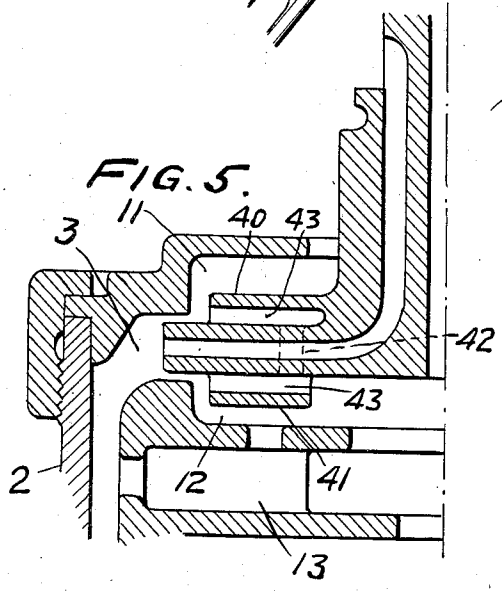

FIG. 5.

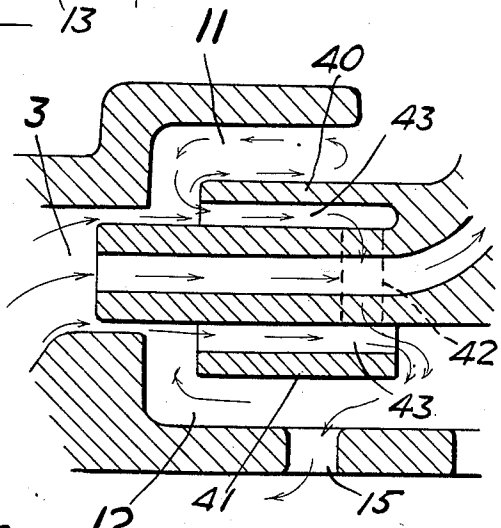

FIG. 6.

WITNESS:

INVENTOR

Hans Olof Lindgren

BY

Busser and Harding

ATTORNEYS.

Patented Aug. 2, 1938 2,125,453

UNITED STATES PATENT OFFICE

2,125,453

ANTIFROTH DISCHARGING MEANS FOR CENTRIFUGAL SEPARATORS

Hans Olof Lindgren, Appelviken, Sweden, assignor to The De Laval Separator Company, New York, N. Y., a corporation of New Jersey

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11 Claims. (Cl. 233—22)

It is known to use in centrifugal separators discharge devices or "skimmers" which project into the rotating mass of liquid and by means of which the liquid can be taken out under pressure from the centrifugal bowl. In connection with the treatment of liquids which are not to any substantial degree unfavorably influenced by the admixing of air, considerable latitude is allowed in selecting an operative construction. It is, for instance, practicable to utilize a tube, projecting into the liquid, the orifice of which is directed towards the tangential movement of the liquid. But in the treatment of liquids in which the admixing of air causes a formation of froth, as for instance milk, a device of this type is not efficient, as strong whirls are formed at the tube which cause great quantities of air to be intimately mixed with the liquid. With the object of preventing these whirl-movements it has been known to use a disc-shaped skimmer provided with channels opening at the circumference of the disc. The rotating mass of liquid encloses the circumference and covers part of the disc adjacent its periphery, for the purpose of preventing air from being mixed with the liquid streaming into the disc through the aforementioned channels. The disc should be positioned in a special chamber rotating with the bowl and communicating with the separating chamber. If the discharge or skimmer device is intended to take out skimmilk from the bowl, the special chamber must be arranged to communicate with the separating chamber in the neighborhood of the periphery of the bowl. Experience has shown, however, that even with this device it is very difficult to discharge the liquid in a frothless state. Irregular flows of liquid are caused at the free level of the liquid in the special chamber in which the skimmer device is positioned, as the inner part of the rotating mass of liquid is on the one side influenced by the frictional forces from the stationary skimming device and on the other side by similar forces from the rapidly rotating wall of the chamber. On the inner liquid surface, which is in contact with the air, forces are also at play, originating from the air, which here of course has a rather irregular movement. In order to obtain a complete absence of froth it has proved necessary to work with great overlapping of the skimming device by the liquid, that is, to work with a thick layer of liquid inside the outer edge of the skimming device. Owing to the great speed at which a centrifuge rotates, a measure of this kind is undesirable, as it causes a considerable power consumption.

The present invention relates to an arrangement by means of which a frothless discharge can be secured that is not open to the objections specified. A characteristic feature of the invention is that adjacent both surfaces of the skimming device more or less near their outer edges an inwardly directed flow of liquid is maintained, the velocity of which is sufficiently great to prevent the air from being conveyed from the inner surface of the liquid into the special chamber from which the skimming device removes liquid.

In the accompanying drawings, which illustrate four of different possible embodiments of the invention—

Fig. 1 is a vertical sectional view of the upper part of a centrifugal bowl and of the associated construction for skimming and froth prevention.

Fig. 2 is a similar view of a modification.

Fig. 3 is a fragmentary section on line 3—3 of Fig. 1.

Fig. 4 is a vertical sectional view, similar to Figs. 1 and 2, of another modification.

Fig. 5 is a vertical sectional view, similar to Figs. 1, 2 and 3, of still another modification.

Fig. 6 is an enlarged vertical sectional view of a part of Fig. 5.

Referring first to Fig. 1: Communicating with the peripheral part or sludge chamber of the centrifugal bowl **2** is an outflow channel **4** discharging into an annular chamber **3** into which the peripheral part of the skimming device extends. The skimming device may comprise a disc-shaped element **5** which may be similar in construction to a turbine wheel; that is, it may be provided with channels **6** formed by wings **60** (see Fig. 3) arranged more or less tangentially. These channels converge to a central channel, or system of channels, **7**, from the exit ends of which the skimmed liquid is discharged into the usual collecting vessel (not shown). The skimmer, for a short distance from its periphery inward, is positioned, measured vertically, close to the members **8** and **9** (which are secured to rotate with the bowl and form between them the chamber **3**), leaving throttled passages **10** which connect chamber **3** with chambers **11** and **12**. Chamber **11** is formed between member **8** and the skimmer **5**. Chamber **12** is formed between the skimmer **5** and member **9**. Beneath chamber **12** is a froth extinguishing chamber **13**.

Foamless milk is brought through the channels 4 into the chamber 3, whence it is discharged under pressure by the skimmer 5. The degree of overlapping of the outer edge of the skimmer by the liquid in chamber 3 determines the counterpressure which can be applied in the discharge channels 7. If the discharging liquid must overcome a great resistance the inner surface of the body of liquid in chamber 3 may be at such distance inward from the outer edge of the skimmer that transport of air from the surface of the liquid to the outer edge of the skimmer cannot occur. By reason of the throttled passages 10 between chamber 3 and chambers 11 and 12, there is maintained an inwardly directed flow which is comparatively small in volume but comparatively great in velocity.

Provision must of course be made for maintaining the desired circulation of liquid. The simplest arrangement would be to allow the liquid entering chambers 11 and 12 to escape from the bowl and be collected in a special collecting vessel—possibly that for the separated light liquid, e. g. cream. If complete absence of froth is not required and the inward rate of flow can be maintained sufficiently low, such an arrangement is permissible. When substantially complete absence of froth is desired or required, the inward velocity of the liquid must necessarily be kept so high that special provision must be made to establish circulation in the bowl. To effect this the skimmer 5 is provided with channels 16, which may be formed in the wings 60 (see Fig. 3) and connect chambers 11 and 12, while openings 15 connect chamber 12 and the froth extinguishing chamber 13 and openings 14 connect chamber 13 and channels 4. Chamber 13 is provided with radially extending conveyor wings 17.

Chambers 11 and 12 are not provided with conveying wings.

Owing to the braking action of the skimmer, which may be increased, if desired, by providing it with wings 30, the liquid in chambers 11 and 12 will rotate at a speed lower than the speed of rotation of the bowl. The liquid in these chambers will be intimately mixed with air, for reasons hereinbefore explained, so that its specific gravity is lower than that of the heavier separated liquid, e. g., skimmilk. Such lower specific gravity and the reduced tangential speed cause the inner level of the liquid, indicated by the line x, in chambers 11 and 12 to be inside the level of the liquid in the separating chamber of the bowl, the position of which determines the pressure in the channels 4. All of the wings 17 in the froth extinguishing chamber 13 rotate with the bowl and there is thus no tendency therein to froth formation; the tendency being to separate air from the frothy milk entering through openings 15. Suitable means should be provided for the removal of the separated air from the froth extinguishing chamber 13, as, for example, a central channel 31, between chamber 13 and a space outside the bowl. The full conveying in the chamber 13 and the high specific gravity of the liquid therein cause its inner surface, indicated by the line y, to be more distant from the center of the bowl than the inner surface of the liquid indicated by line x, in chambers 11 and 12, thereby allowing flow of liquid from chamber 12 into chamber 13.

Other means for effecting the necessary circulation of liquid may be adopted. Thus special skimming devices at the skimmer 5 and operating in the chambers 11 and 12 may conduct liquid therefrom into the froth extinguishing chamber 13, as hereinafter described.

The skimming device is shown and described as arranged in a chamber which communicates with the peripheral part of the body, and therefore handles the heavier separated component. The lighter separated component may be discharged in any suitable way, as, for example, through one or more outlets 32 extending through the bowl wall and one or more of the centralizing ribs 33; or such lighter separated component, also or instead, may be discharged by means of a second skimming device, which need not be shown and described, since the arrangement need merely substantially duplicate that described for discharging the heavier separated component.

The skimmer need not be of the type hereinbefore described. It may be constructed in any suitable manner, as shown, for example, in Fig. 2. In this modification, the skimmer comprises two spaced apart discs 20 and 21, which extend into the annular chamber 3. Enclosed between these discs are spiral vanes or wings 22, forming between them channels directed toward the tangential direction of the flow of liquid. Inside chamber 3 is a number of wings 24 fixed to the bowl wall. The spiral shaped channels formed by the wings 22 do not extend to the peripheries of the discs 20 and 21. Their outer edges terminate at a considerably shorter radial distance from the center of the bowl. The conveyor wings 24 extend inward almost to the mouths of the channels formed by wings 22. The object of this arrangement is to obtain as low a tangential speed as possible of the discharging liquid at the entrance openings of the skimming channels. It is not sufficient merely to locate these openings at a considerable distance within the peripheries of discs 20 and 21. The liquid flowing inward toward these channels tends to retain its energy and, therefore, on its way inward it tends to increase its tangential speed. The effect of the conveyor wings 24 is to prevent the liquid from increasing its angular speed and thus reduce the tangential speed to the same value as the tangential speed of the part of the bowl at the same radius, and thereby, by returning to the bowl a large part of the energy due to the difference in tangential speed, reduce the power required to drive it.

The arrangement shown in Figure 2 may be combined with throttled openings 25 between the skimming discs 20 and 21 and the rotating walls 26 and 27 of the bowl, these openings communicating with chambers 11 and 12 and corresponding to openings 10 of Fig. 1, which chambers collect liquid flowing inward through the throttles and discharge it into the froth extinguishing chamber 13.

Fig. 4 shows another modification in which two discs 35 and 36 forming a skimmer are spaced so close together that the reduction of rotary velocity is caused by friction and wings (such as 60) are not required between them.

I have hereinbefore referred to the feasibility of providing special skimming devices operating in chambers 11 and 12 for conducting liquid therefrom into the froth extinguishing chamber. Figs. 5 and 6 illustrate such a possible arrangement. The skimming device 5 may be the same as that shown in Fig. 1. Extending into chambers 11 and 12 are disc-shaped members 40 and 41 forming between them and the skimming device spaces that at their outer ends open into chambers 11 and 12 and that are connected one with

the other at their inner ends by channels **42** formed, like channels **16**, in the skimming device. At its inner end, as well as at its outer end, the lower space communicates with chamber **12**. In both spaces are radial wings **43** which may extend throughout the radial dimensions of the spaces. These wings prevent rotation of the liquid in these spaces and hence eliminate any centrifugal force. The liquid can therefore flow freely toward the center. As the entrance to these spaces is nearer to the center than the entrances to channels **6**, any frothy milk will be deflected into these spaces and will eventually reach the froth eliminating chamber **13**. In Fig. 6 arrows show the direction of circulation.

What I claim and desire to protect by Letters Patent is:

1. A centrifugal separating machine comprising a revoluble outer chamber adapted to contain a body of separated liquid and from which such liquid is intended to be removed, a relatively stationary skimming device extending into said chamber and adapted to overlap the body of liquid therein, two inner revoluble chambers one above and one below the skimming device and into which is adapted to flow liquid not removed by the skimming device, means providing restricted liquid outflow passages between the inner chambers and the outer chamber including communicating means for liquid between such two inner chambers.

2. A centrifugal separating machine comprising a revoluble outer chamber adapted to contain a body of separated liquid and from which such liquid is intended to be removed, a relatively stationary skimming device extending into said chamber and adapted to overlap the body of liquid therein, two inner revoluble chambers one above and one below the skimming device and into which is adapted to flow liquid not removed by the skimming device, means providing restricted liquid outflow passages between the inner chambers and the outer chamber including channels formed in the skimming device to allow flow of liquid from one inner chamber to the other.

3. A centrifugal separating machine comprising a revoluble outer chamber adapted to contain a body of separated liquid and from which such liquid is intended to be removed, a relatively stationary skimming device extending into said chamber and adapted to overlap the body of liquid therein, two inner revoluble chambers one above and one below the skimming device, means providing restricted liquid outflow passages between the outer chamber and the inner chambers, a froth extinguishing chamber communicating with one of the inner chambers, relatively stationary discs extending into said inner chambers and providing liquid flow spaces between them and the skimming device and inwardly through which liquid is adapted to flow, and wings substantially preventing rotation of liquid in said spaces.

4. A centrifugal separating machine comprising a centrifugal bowl, a stationary skimming device, an enclosure for the skimming device, said enclosure being revoluble with the bowl and the peripheral part of which is adapted to receive separated liquid, the skimming device being disc-shaped and having a peripheral inlet adapted to penetrate the body of separated liquid in the enclosure, said enclosure being contracted adjacent the entire peripheral part of the skimming device to an extent sufficient, in operation, to generate and maintain adjacent the peripheral part of the skimming device, and outside the inner level of liquid in the enclosure, an inwardly directed flow of liquid sufficiently strong to prevent air from being conducted from the inner surface of the liquid to the peripheral inlet of the skimming device.

5. A centrifugal separating machine in accordance with claim 4 wherein the skimming device comprises liquid receiving means and discs on opposite sides of the liquid receiving means, and wings in and revoluble with said enclosure extending into the space between said discs and terminating near said liquid receiving means.

6. A centrifugal separating machine comprising a centrifugal bowl, an enclosure revoluble with the bowl and adapted to contain a body of separated liquid, said enclosure comprising an outer peripheral portion in communication with the interior of the bowl and adapted to receive from the bowl separated liquid, and an inner portion, a relatively stationary disc-shaped skimming device having a peripheral inlet and extending through the inner portion of the enclosure and adapted to penetrate the body of liquid in the enclosure, and means, including an annular part of the wall of the enclosure in cooperation with an annular part of the skimmer adapted to restrict the flow of liquid between the inner and outer portions of the enclosure so that a limited volume of separated liquid will, in operation, flow inwardly into the inner part of the enclosure at high velocity and thereby prevent air from being conducted from the inner surface of the liquid in the enclosure to the peripheral inlet of the skimming device.

7. A centrifugal separating machine comprising a centrifugal bowl, walls forming an enclosure communicating with the interior of the bowl and adapted to contain a body of separated liquid and from which liquid is intended to be removed, a relatively stationary disc-shaped skimming device within the enclosure having a peripheral inlet part adapted to penetrate said body of liquid, said walls being widely spaced from the major part of the skimmer but closely approximating the outer surface of the skimmer adjacent its peripheral part to thereby divide the enclosure into outer and inner portions and afford between them restricted passages for flow of liquid at high velocity from the outer portion of the enclosure to the inner portion thereof and thereby prevent air from passing from the inner surface of the liquid to the inlet of the skimming device.

8. A centrifugal separating machine comprising a revoluble enclosure adapted to contain a body of separated liquid and from which such liquid is intended to be removed, a relatively stationary disc-shaped skimming device with a peripheral inlet extending into said enclosure and adapted to overlap said body of liquid and discharge liquid therefrom, means to generate and maintain adjacent the peripheral part of said skimming device an inwardly directed flow of liquid outside the skimming device sufficiently strong to prevent air from being conducted from the inner surface of the liquid to the skimming device, a froth extinguishing chamber, and means affording communication between the inner portion of said enclosure and said chamber and between said chamber and the peripheral portion of the enclosure.

9. A centrifugal separating machine comprising a revoluble enclosure having an outer portion adapted to receive a body of separated liquid and from which such liquid is intended to be removed, a relatively stationary skimming device extending

through the inner portion of said enclosure and adapted to overlap said body of liquid and discharge liquid therefrom, means providing a restricted passage between the outer and inner portions of the enclosure, a revoluble froth extinguishing chamber, means affording communication between said froth extinguishing chamber and the outer and inner portions of the enclosure, and conveyor wings in the froth extinguishing chamber.

10. A centrifugal separating machine comprising a revoluble enclosure adapted to contain a body of separated liquid and from which such liquid is intended to be removed, a relatively stationary disc-shaped skimming device with a peripheral inlet extending into said enclosure and adapted to overlap said body of liquid and discharge liquid therefrom, means to generate and maintain adjacent the peripheral part of said skimming device an inwardly directed flow of liquid outside the skimming device sufficiently strong to prevent air from being conducted from the inner surface of the liquid to the skimming device, and means to separate, from the liquid that has flowed inwardly outside the skimming device, air entrained therein and to return the air-free liquid to the outer peripheral portion of the enclosure.

11. A centrifugal separating machine comprising a revoluble enclosure adapted to contain a body of separated liquid and from which such liquid is intended to be removed, a relatively stationary disc-shaped skimming device with a peripheral inlet extending into said enclosure and adapted to overlap said body of liquid and discharge liquid therefrom, means to generate and maintain adjacent the peripheral part of said skimming device an inwardly directed flow of liquid outside the skimming device sufficiently strong to prevent air from being conducted from the inner surface of the liquid to the skimming device, said skimming device comprising two spaced apart discs and wings confined between the discs and shaped to provide liquid receiving channels whose outer ends are at a substantial distance inside the peripheries of the discs, and wings in the peripheral part of said enclosure rotatable with the bowl and extending inward between the peripheral parts of the discs.

HANS OLOF LINDGREN.