April 14, 1953 F. H. SMITH 2,634,907

PROCESS AND APPARATUS FOR CENTRIFUGAL DEAERATION

Filed June 24, 1950 2 SHEETS—SHEET 1

Fig.1

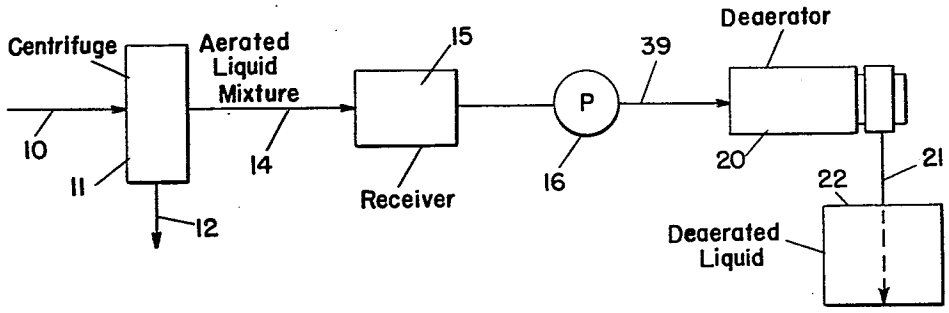
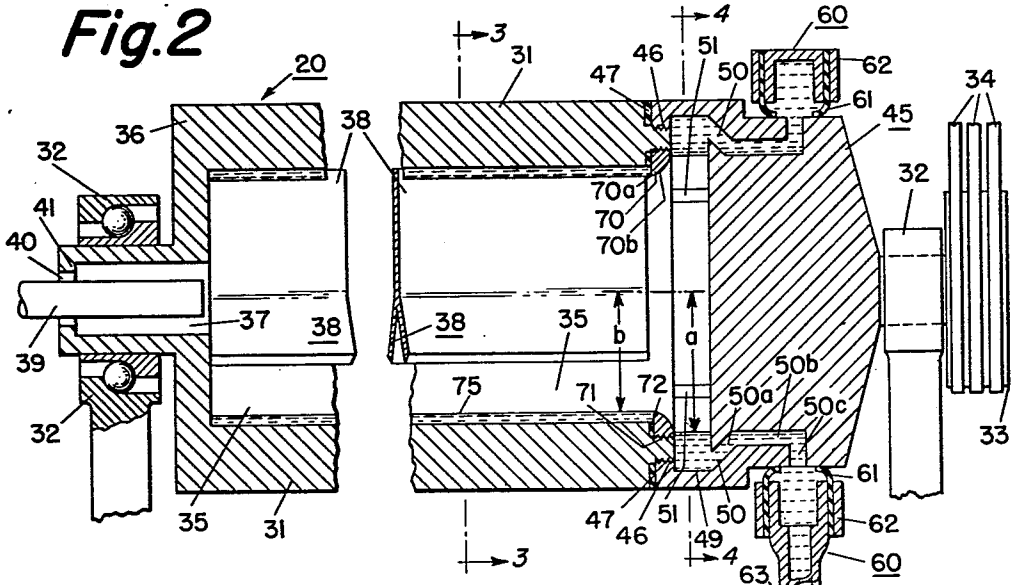


Fig.2



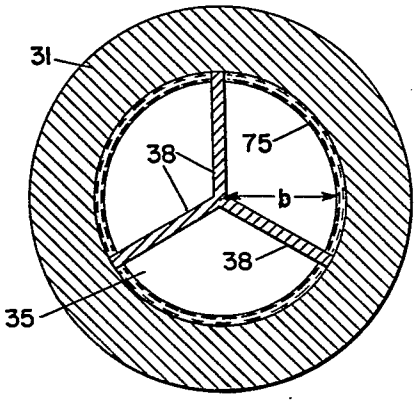


Fig.3

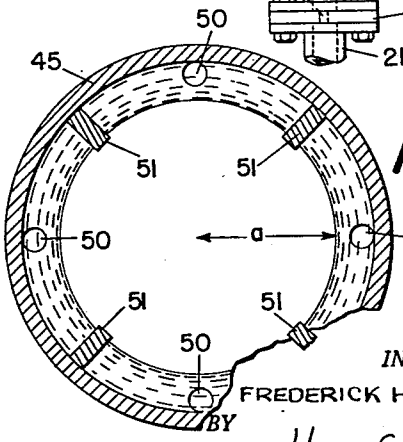


Fig.4

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PROCESS AND APPARATUS FOR CENTRIFUGAL DEAERATION

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Fig.5

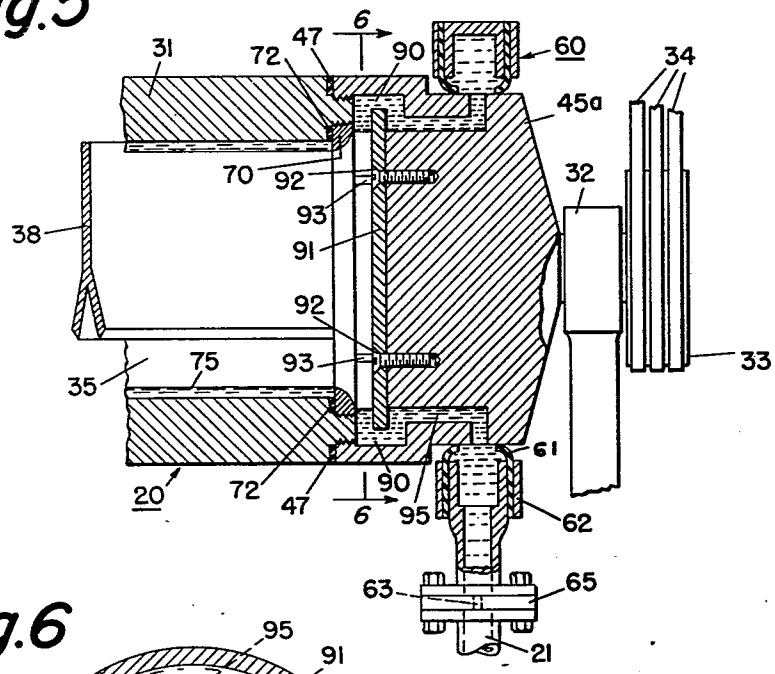


Fig.6

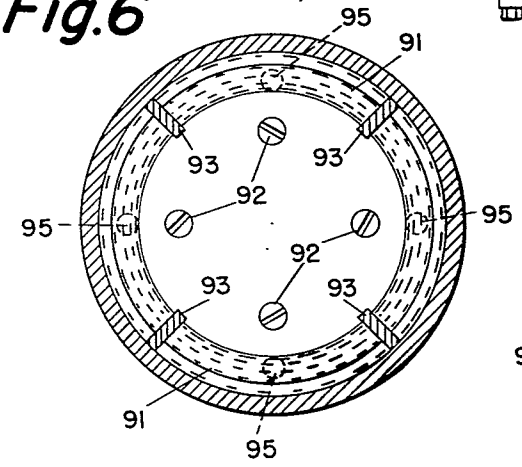
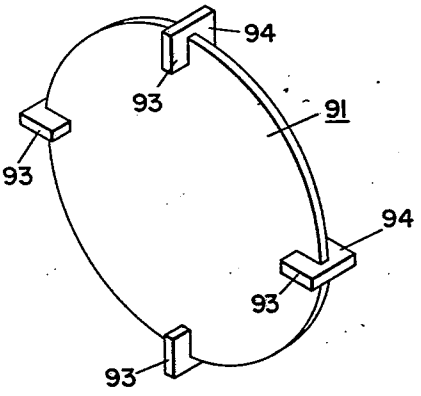


Fig.7



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UNITED STATES PATENT OFFICE

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PROCESS AND APPARATUS FOR CENTRIFUGAL DEAERATION

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Application June 24, 1950, Serial No. 170,227

14 Claims. (Cl. 233—21)

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This invention relates to centrifugal deaeration, and more particularly to a process and apparatus so designed as to effectively minimize or prevent the reincorporation of air or other gas in the deaerated material.

In many industrial processes, the production of the process material, or its purification, results in the inclusion in the body of the material of bubbles of air or other gas. In certain cases this is extremely undesirable. This is particularly true in the case of foamy liquids or of viscous liquids from which gas bubbles, such as of air, do not settle out quickly.

The general object of this invention is to provide a process and improved centrifugal apparatus into which aerated liquid is fed, and from which liquid the air or other gas entrained therein is released by centrifugal force, and from which apparatus the air and the liquid free of entrained air or other gas are continuously and separately discharged.

Another object of the invention is to provide a method and means for delivering the gas-free liquid from the centrifugal apparatus under pressure, without risk of reincorporating air into the body of the liquid.

Another object of the invention is to make such discharge pressure independent of pressures developed in the body of the rotor during the deaeration step.

Another object of the invention is to make it possible to vary at will the thickness of the liquid layer in the deaeration step, to adapt the invention to the deaeration of liquids having varying characteristics.

In order that the invention may be readily understood, reference is made to the accompanying drawings wherein,

Figure 1 is a diagrammatic representation of an arrangement of apparatus and flow of materials used in the practice of this invention,

Figure 2 is a vertical section of a centrifugal deaerator constructed in accordance with the present invention,

Figure 3 is a sectional view taken on lines 3—3 of Figure 2,

Figure 4 is a sectional view taken on lines 4—4 of Figure 2,

Figure 5 is a fragmental vertical section of a modified construction of the centrifugal deaerator shown in Figure 2,

Figure 6 is a sectional view taken on lines 6—6 of Figure 5, and

Figure 7 is a perspective view of the plate and associated wings used in the modified construction shown in Figure 5.

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Referring to Figure 1, an illustrative embodiment of the present invention is shown in conjunction with a continuous process for the manufacture of soap, such as described in Patent 2,300,749 and/or Patent 2,300,750 by Ashton T. Scott, dated November 3, 1942. In this process saponifiable fat and alkali are reacted in suitable proportions by passing same continuously through a plurality of successive mixing and separating stages. In a process of this character, as soap is separated from the aqueous phase by centrifugation, some air becomes admixed with the soap, particularly when it is delivered, after separation, into the covers of the centrifuges employed. Because of the viscosity of the soapy mass, this incorporated air is difficult to remove.

In the practice of the present invention, the fluid admixture produced by mixing water with the soap phase separated by centrifugation after the final caustic treat in accordance with said patents, is fed by line 10 to a centrifuge 11. Separated nigre flows off through line 12, and soap containing air bubbles flows off through line 14 to a tank or receiver 15. The soap at this stage is not solid but is in the form of a viscous fluid mass, due to its somewhat elevated temperature. This viscous mass is fed by pump 16 through line 39 to centrifugal deaerator 20, further details of which will be described hereinafter. The deaerator 20 continuously removes entrained air from the viscous mass of soap passing therethrough. The deaerated soap flows through line 21 to a storage tank 22. If desired, line 21 may extend down into and terminate short of the bottom of tank 22 to avoid splashing, thus insuring against the reincorporation of air in the soap as it is fed into tank 22.

A specific illustrative embodiment of the invention relating to the centrifugal deaerator construction is shown in Figures 2 to 4. The deaerator, indicated in general by numeral 20, comprises a centrifugal rotor 31, preferably cylindrical in shape, and for example about 15½" in length, mounted on either a vertical, horizontal or inclined axis, as may be desired, supported between spaced bearings 32 and driven by a pulley 33 and V-belt drive 34 connected to a suitable motor (not shown). The rotor is provided with a hollow cylindrical smooth interior chamber 35 having an internal diameter, say for example 3". The rotor 31 is closed at its liquid intake end by a head 36 having a central opening 37 through which the liquid to be deaerated is supplied by supply pipe 39. The opening 37 is preferably of a larger diameter than the diameter of supply pipe 39 so as to permit air or other gas from the

interior of rotor 31 to escape through passage 40. The opening 37 is preferably provided with an inwardly directed integral flange 41 to retain any liquid that might tend to escape from the rotor 31. A plurality of spaced radially disposed wings 38 are provided in the interior of the rotor which may be suitably retained in the interior of chamber 35 of the rotor as shown in Figure 3. The wings as shown extend the full length of the chamber 35 and serve the conventional function of bringing the feed liquid into rotation. Any other suitable means known in the art may be used to accelerate rotation of the liquid fed to the rotor. Although the wings are shown in Figure 3 as being in contact with the inner surface of the chamber 35, they may be spaced therefrom if desired, and supported within the chamber by any suitable means.

The other end of the rotor, referred to as the output end, is closed by a removable head 45 shown as internally threaded at 46 to engage with the complementary threaded end of the rotor 31. A suitable gasket 47 seals the head against possible leakage of the liquid passing therethrough. A plurality of spaced ports or passageways 50, for example two, four or other multiples of two, are provided in the outlet head 45, as shown in Figure 2, through which the deaerated liquid is led to a stationary collector 60 which surrounds the head 45 of the rotor. Between the collector 60 and the head 45 a yieldable sealing member 61, such as a "Klozure" seal sold by Garlock Packing Company, is provided which is retained by suitable plates 62. The sealing member permits discharge of liquid from the rotor 20 under pressure without leakage past the seal. The collector 60 is provided with an outlet port 63 connected to a pipe 21 which as shown is provided with a suitable orifice plate valve 65 adapted to regulate flow from the collector.

An annular channel 49 is provided in the head 45, as shown in Figure 2, having a greater diameter than the internal diameter of the rotor chamber 35. The channel 49 receives the deaerated liquid flowing from rotor chamber 35 of the rotor 20 and is connected to ports 50 as shown in Figure 2. It will be noted that the course of each port 50 is directed inwardly at 50*a* toward the axis of the rotor 20, then extends axially at 50*b* and then radially at 50*c* where it connects with the collector 60. The liquid discharged from the rotor chamber 35 will collect in channel 49 to a level, as illustrated in Figure 2, which is in line with the port course 50*b*, thereby forming a liquid trap which seals the openings to ports 50. The back pressure developed in collector 60 will keep the collector filled with liquid during operation of the rotor, and the channel 49 will also be filled with liquid to a sufficient depth to seal the openings into ports 50, and to provide sufficient pressure to overcome the back pressure in collector 60, whereby no external gas is available for reincorporation into the deaerated liquid as it is being fed through ports 50 into the collector 60.

If desired, removable annular dam 70, shown threaded at 71, and of suitable diameter, may be provided, which is retained at the exit end of the rotor chamber 35 as shown for example in Figure 2. A gasket 72 is provided to seal the dam against the rotor 20 to prevent leakage at this juncture. The inner edge 70*a* of the dam may extend radially inward beyond the interior surface of the rotor chamber, say from approximately 1/64" to 1/64", for example, about 3/32". The dam 70 will cause a layer of liquid 75 to be retained on the interior surface of the rotor chamber 35 to a predetermined depth as may be desired, depending upon the characteristics of the liquid to be deaerated, its viscosity, amount of air entrained, and the rate of feed to the rotor. The weir face 70*b* of the dam is preferably curved so as to conduct the liquid flowing thereover without splashing. A suitable number of wings 51 are also provided in the channel 49 to prevent swirling of the liquid so as to avoid entraining gas therein.

In operation, the aerated liquid containing entrained gas is fed through the feed tube 39 into rotor 20. The wings 38 immediately bring the liquid up to the speed of the rotor 20, and the liquid is spread out by centrifugal force in a relatively thin film or layer 75 of predetermined depth or the interior wall of the rotor chamber 35. Under centrifugal force the entrained air is squeezed toward the center and escapes around the feed tube 39 through opening 40.

The deaerated liquid flows into the circular channel 49, and fills it to a level that results in a continuous discharge through the ports 50 into collector 60. From the collector it flows out through pipe 21. Sufficient back pressure is maintained on the discharge from the collector, by proportioning the size of the opening 63 in the orifice plate valve 65, to keep the collector 60 full at all times, discharging under pressure developed by centrifugal force and represented by the radius *a* as shown in Figure 2. The design of the orifice 63 is such that the radius *a*, to the surface of the liquid in channel 49 is never permitted to become less than radius *b* to the surface of the liquid in the body 35 of the rotor 20, as shown in Figure 2. This is highly important, since, although centrifugal force is effective as a means of squeezing air out of the liquid, pressure engendered by an undue increase in depth of liquid under centrifugal force will tend to offset the value of such force, as a separating means, because such pressure results in a reduction in the size of the air bubbles.

Although it is undesirable to permit the thickness of the liquid layer 75 in the body of the rotor to increase in an uncontrolled manner, it may be desirable in certain cases to alter the depth of liquid as represented by radius *b*, independent of the pressures necessary for discharge, as represented by radius *a*. On extremely fluid liquids, without any provision to retain liquid in the body of the rotor, the liquid will pass extremely rapidly from the point of feed to the point of discharge. This may be undesirable, since it reduces to a minimum the time under which the liquid is subjected to centrifugal force. Provision is made, therefore, for the introduction of a dam 70 as previously described, to create a layer thickness in the body of the rotor equivalent to the height of the dam plus the natural cresting of the flow over the dam. This means a reduction in radius *b* of the same extent as the increase in the thickness of the liquid layer. Dam 70 is replaceable and can be of varying inside diameters to suit different specific requirements.

As previously stated, this invention is particularly adapted for deaerating soap produced by a continuous process such as disclosed in the above-mentioned patents. The aerated hot, fluid, very viscous soap is fed to the centrifugal deaerator, previously particularly described, for example, at a rate of 500 to 2500 lbs. per hour. The aerated soap when examined under 4 power magnification had a multitude of uniformly distributed air bubbles and had a specific gravity of 1.018. After being deaerated in the centrifugal

deaerator, previously particularly described, the soap was free of visible air bubbles under the same degree of magnification, and had a specific gravity of 1.033. The rotor 20 may be operated at varying speeds for deaerating the soap such as in the range of from 2000 to 3000 R. P. M. developing for example a centrifugal force of from 170 to 370 times gravity or more. When deaerating a particular charge of soap, fed at 2500 lbs. per hour to the rotor, at the speeds indicated, a layer of 0.05'' thickness existed in the rotor chamber 35 without using the dam 70 which was found entirely adequate for completely deaerating the soap.

The present invention may be employed for deaerating any liquid materials or any flowable materials, aqueous or solvent solutions, as well as any materials which are plastic or viscous at normal or higher temperatures. For example, the invention is useful in deaerating insulating oil used in electrical transformers. Such insulating oil is usually centrifuged to remove any water present and during such treatment air is entrained in the oil which is difficult to remove. The presence of air in the transformer oil is very undesirable because it causes oxidation and corrosion of the electric windings and metallic contacts in the transformer.

The present apparatus and method are also suitable for clarification of viscose solutions by removing gas entrained therein prior to spinning. The invention may be utilized on various other materials in plastic or liquid form such as molding plastics, synthetic resins and polymers; liquid lacquers, paints and enamels prior to putting them up in containers; fruit juices and soups prior to canning same and the like. Although the invention has been described previously for the removal of air, it is to be understood that it can be equally satisfactorily used for the removal of any gas from a liquid or plastic material which can be spread into a layer under centrifugal force in the rotor to deaerate same. The expression "deaerate" or "deaerating" is intended whenever used herein to indicate removal of air or any other gas from the materials treated.

Other modifications and changes may be made in the details of construction of the centrifugal deaerator previously described. One such modification, for example, is shown in Figures 5 to 7, wherein a channel 90 replaces the channel 49 shown in Figure 2, and a circular plate 91 is attached to the head 45a by screws 92. The diameter of the plate 91 is such as to have its outer circumference project into the channel 90 so as to divide the channel 90 into two chambers communicating at the bottom of the channel 90 as to form a liquid trap. Suitable wings 93 and 94 are provided in each of the chambers as shown in Figures 5 and 6 to prevent swirling of the liquid therein as it flows from the rotor chamber 35. The channel 90 communicates with a plurality of ports 95 which feed the deaerated liquid to the collector 60. The back pressure developed in the collector serves to maintain the level of the liquid in channel 90 at such height as to seal the inlets to ports 95 whereby no ambient gas will be re-entrained in the liquid.

It will thus be understood that the present invention provides means to continuously deaerate a flowable material or liquid having gas entrained therein by subjecting the liquid to a centrifugal force while it is in the form of a relatively thin layer from which the entrained gas can readily escape at the operating centrifugal pressure. The deaerated liquid is continuously removed from the rotor and is fed under pressure to a collector through a suitable liquid seal or trap provided in the exit head of the rotor so that no ambient gas will be re-entrained in the deaerated liquid as it is fed to the collector. Since the liquid trap is located in the rotor the liquid therein will also be subjected to centrifugal force whereby any slightly re-entrained air will be removed before it will enter the ports leading to the collector.

The centrifuge particularly described may be of any suitable materials, dimensions, size, shape and design, the particular centrifuge described being for the purposes of illustration.

The size of the orifice 63 in orifice plate 65 is a matter of choice, and is governed by the rate of feed to the centrifuge 20, so that the liquid in channel 49 or 90 is maintained at the desired height, and to prevent air from entering through the orifice or discharge pipe. It is to be understood that any other suitable means for developing the desired restriction in flow may be substituted to prevent air from leaking in such as an adjustable valve, a static head, or otherwise. It will be noted that orifice plate 65 is interchangeable with plates having different orifice sizes, so that the desired size may be easily inserted depending upon the particular material to be treated.

When the mouth of the discharge pipe 21 is brought down below the level of the liquid in tank 22 as illustrated in Figure 1, the valve or orifice or other means may be eliminated, since in such case it will not be possible for air to enter through the discharge line. This may be considered in a sense as a static head, and permits, as in the case of a static head, variation in feed without adjustment at the discharge. However, the arrangement should not be such as to develop a hydraulic leg sufficient to break the liquid seal in the rotor. It will be noted that entrance of air through channel 49 is prevented by the liquid seal.

As indicated above, dam 70 can be dispensed with in certain operations, such as when the liquid to be treated is of such viscosity and flow characteristics as to normally reside in the rotor chamber 35 for a sufficient length of time for deaeration purposes, such as in the example given above with respect to soap. Likewise, the dam 70 can be omitted when it is desired to centrifuge a more fluid liquid in a very thin film.

The material to be treated may be at any desirable temperature. Thus, if desired, it may be heated prior to treatment, such as to reduce its viscosity, or cooled prior to treatment if desired for any reason, such as to increase its viscosity, particularly if dam 70 is not used.

While wings have been described and illustrated as the accelerating means inside of the gas separating chamber 35, it will be understood that any other suitable means known in the art may be substituted. Other variations are possible.

Accordingly it is to be understood that numerous changes and modifications may be made in the apparatus and process herein disclosed which will nevertheless embody the essential principles of this invention, and it is intended to include such changes and modifications within the scope of the appended claims.

I claim:

1. The process of continuously deaerating a liquid having gas entrained therein which comprises feeding said liquid into a centrifugal zone,

forming a thin layer of the liquid in said centrifugal zone to separate gas entrained therein, and removing the deaerated liquid from said centrifugal zone through a liquid seal, subjecting the liquid in said seal to centrifugation, flowing the liquid into a substantially gas-free collecting zone to prevent reincorporation of ambient gas in the deaerated liquid and removing the deaerated liquid from said collecting zone.

2. The process of continuously deaerating liquid soap having air entrained therein which comprises feeding said liquid soap into a centrifugal zone, forming a thin layer of the liquid soap in said centrifugal zone to separate air entrained therein, and removing the deaerated liquid soap from said centrifugal zone through a liquid seal, subjecting the soap in said seal to centrifugation, flowing the soap into a substantially gas-free collecting zone to prevent reincorporation of ambient air in the deaerated soap and removing the deaerated soap from said collecting zone.

3. The process of continuously deaerating insulating oil having gas entrained therein which comprises feeding said insulating oil into a centrifugal zone, forming a thin layer of the oil in said centrifugal zone to separate gas entrained therein, and removing the oil from said centrifugal zone through a liquid seal, subjecting the oil in said seal to centrifugation, flowing the oil into a substantially gas-free collecting zone to prevent reincorporation of ambient gas in the deaerated insulating oil and removing the deaerated oil from said collecting zone.

4. The process of continuously deaerating a viscose solution having gas entrained therein which comprises feeding the viscose solution into a centrifugal zone, forming a thin layer of the viscose solution in said centrifugal zone to separate gas entained therein, and removing the viscose solution from said centrifugal zone through a liquid seal, subjecting the viscose solution in said seal to centrifugation, flowing the viscose solution into a substantially gas-free collecting zone to prevent reincorporation of ambient gas in the deaerated viscose solution and removing the deaerated viscose solution from said collecting zone.

5. The process of continuously deaerating fruit juice having gas entrained therein which comprises feeding said fruit juice into a centrifugal zone, forming a thin layer of the fruit juice in said centrifugal zone to separate gas entrained therein, and removing the deaerated juice from said centrifugal zone through a liquid seal, subjecting the fruit juice in said seal to centrifugation, flowing the fruit juice into a substantially gas-free collecting zone to prevent reincorporation of ambient gas in the deaerated fruit juice and removing the deaerated fruit juice from said collecting zone.

6. The process of continuously deaerating a liquid plastic material having gas entrained therein which comprises feeding said liquid into a centrifugal zone, forming a thin layer of the liquid in said centrifugal zone to separate gas entrained therein, and removing the deaerated liquid plastic material from said centrifugal zone through a liquid seal, subjecting the liquid plastic material in said seal to centrifugation, flowing the plastic material into a substantially gas-free collecting zone to prevent reincorporation of ambient gas in the deaerated liquid plastic material and removing the deaerated plastic material from said collecting zone.

7. The process of continuously deaerating a liquid having entrained gas which comprises continuously feeding a stream of the liquid to a centrifugal zone, forming a thin layer of the liquid in said centrifugal zone and continuously separating gas entrained therein, continuously removing the deaerated liquid from said centrifugal zone and feeding same to a gas-free collector through a liquid seal and simultaneously subjecting said deaerated liquid to centrifugation while flowing through said seal to said collector to prevent reincorporation of ambient gas in said liquid and removing the deaerated liquid from said collector.

8. The process of continuously deaerating a liquid having entrained gas which comprises continuously feeding a stream of the liquid to a centrifugal zone, forming in said centrifugal zone a thin layer having a depth up to about $\frac{12}{64}$" of the liquid and continuously separating gas entrained therein, continuously removing the deaerated liquid from said centrifugal zone and feeding same to a substantailly gas-free collector through a liquid seal and simultaneously subjecting said deaerated liquid to centrifugation while flowing through said liquid seal to said collector to prevent reincorporation of ambient gas in said liquid and removing the deaerated liquid from said collector.

9. The process of continuously deaerating liquid soap having entrained gas which comprises continuously feeding a stream of the liquid soap to a centrifugal zone, forming a layer of the liquid soap in said centrifugal zone and continuously separating gas entrained therein, continuously removing the deaerated liquid soap from said centrifugal zone and feeding same under pressure to a gas-free collector through a liquid trap and simultaneously subjecting said deaerated liquid to centrifugation while passing through said liquid trap to prevent reincorporation of ambient gas in said liquid and removing the deaerated soap from said collector.

10. A centrifugal deaerator for deaerating a liquid having entrained gas which comprises means for producing a centrifugal zone, means for continuously feeding a stream of liquid to said centrifugal zone, means for maintaining a layer of the liquid in said centrifugal zone of a predetermined depth and separating gas entrained therein, means for continuously removing the deaerated liquid from said centrifugal zone and feeding same through a liquid seal to a gas-free collecting zone and subjecting the stream of the deaerated liquid in said liquid seal to centrifugation to prevent reincorporation of ambient gas in said liquid.

11. A centrifugal deaerator for continuously deaerating a liquid having entrained gas which comprises means for producing a centrifugal zone, means for continuously feeding a stream of liquid to said centrifugal zone, means for continuously maintaining a layer of the liquid in said centrifugal zone of a predetermined depth and separating the gas entrained therein, means for continuously removing the deaerated liquid from said centrifugal zone and feeding same through a liquid seal to a gas-free collecting zone and subjecting the stream of the deaerated liquid passing through said liquid seal to centrifugation to prevent reincorporation of ambient gas in said liquid.

12. A centrifugal deaerator comprising a rotor, means for continuously feeding a liquid containing entrained gas to said rotor, means for rotating said rotor to form a layer of the liquid of

predetermined depth on the inner walls of said rotor and for separating any gas entrained therein, liquid trap means for receiving the deaerated liquid from said rotor, said trap means rotating with said rotor whereby the liquid therein is subjected to centrifugation while flowing therethrough, a stationary collector for receiving the deaerated liquid and ports communicating with said trap means to conduct the deaerated liquid to said collector.

13. A centrifugal deaerator comprising a substantially cylindrical rotor, the intake end of said rotor being closed by a head, an opening in said head for feeding to the interior of said rotor a liquid containing entrained gas, an opening in said head to permit escape of gas from said rotor, a plurality of accelerator wings extending within the interior of said rotor to impart rotation to the liquid fed to the rotor, the output end of said rotor being closed by a removable closure head, a removable dam positioned adjacent the output end of the rotor to maintain a layer of liquid of predetermined thickness on the interior surface of said rotor, a channel in said closure head having a diameter greater than the interior diameter of said rotor for receiving deaerated liquid, a stationary collector adjacent said output head for receiving the deaerated liquid, means for sealing the stationary collector against the said closure head, a plurality of ports in said closure head communicating with said channel and with said stationary collector, and

means for maintaining said channel, ports and collector filled with deaerated liquid.

14. A centrifugal deaerator comprising a substantially cylindrical rotor, the intake end of said rotor being closed by a head, an opening in said head for feeding to the interior of said rotor a liquid containing entrained gas, an opening in said head to permit escape of gas from said rotor, means in said rotor to impart rotation to the liquid fed to the rotor, the output end of said rotor being closed by a closure head, a dam positioned adjacent the output end of the rotor to maintain a layer of liquid of predetermined thickness on the interior surface of said rotor, a collector for receiving the deaerated liquid, a channel in said closure head for receiving deaerated liquid, a plurality of ports in said closure head communicating with said channel and with said stationary collector, and means for maintaining said channel, ports and collector filled with deaerated liquid.

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