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PROCESS AND APPARATUS FOR DEAERATING VISCOUS LIQUIDS

Filed June 12, 1951

2 Sheets-Sheet 1

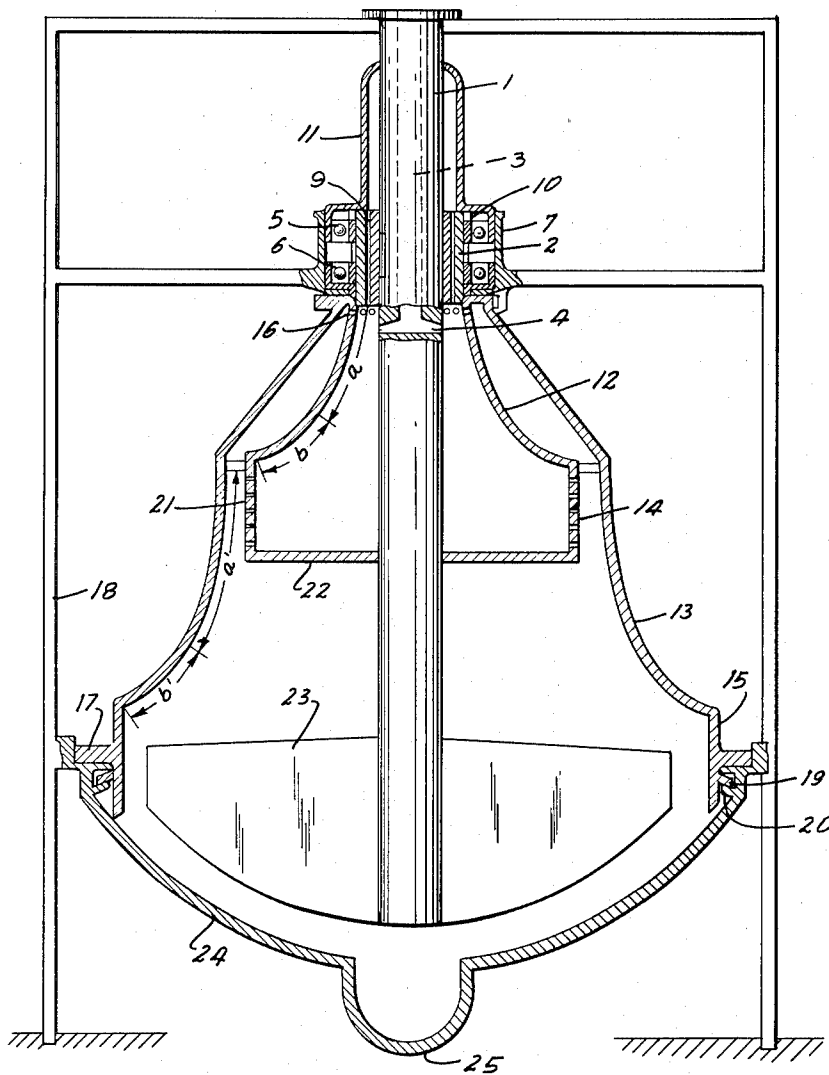


FIG. 1

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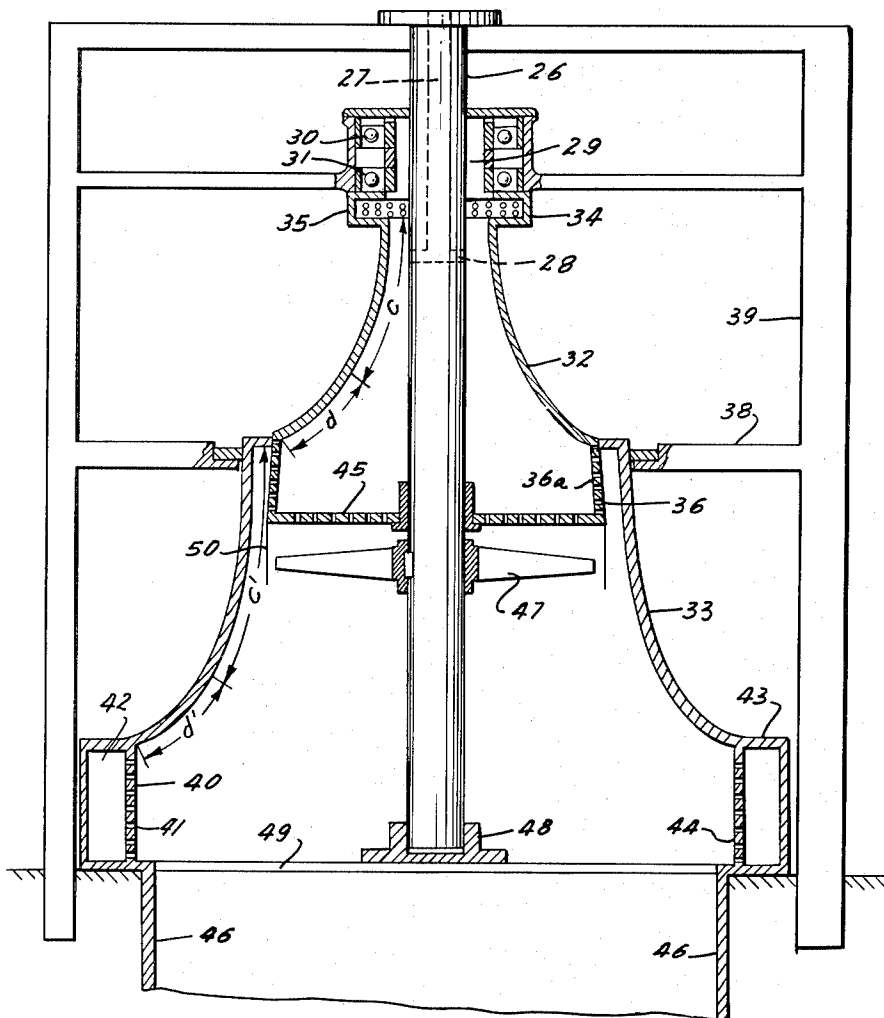


FIG. 2

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PROCESS AND APPARATUS FOR DEAERATING VISCOUS LIQUIDS

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Claims priority, application Germany June 15, 1950

19 Claims. (Cl. 183—2.5)

The present invention relates to a process and apparatus for removing entrapped gases, such as air, from viscous liquids with the aid of rotating curved surfaces.

Centrifugal deaerating processes and devices have as yet not been used to any appreciable extent in the artificial silk industry because known devices of this type have not produced a sufficient deaeration of the solutions from which the artificial threads are formed.

One of the objects of the present invention is to provide a process and device which will efficiently deaerate viscous liquids of the type which are to be found in the artificial silk industry.

Another object of the present invention is to provide a process and apparatus which guarantees the breaking of even very small gas bubbles in the liquid.

An additional object of the present apparatus of the present invention is to provide a means for effectively removing gas from the froth or foam of the liquid being deaerated.

Still a further object of the present invention is to provide a relatively simple apparatus and process for carrying out the present invention.

With the above objects in view, the present invention mainly consists of spraying a stream of the viscous liquid outwardly of a rotating shaft and by centrifugal force against the inner surface of a bell-shaped, rotating chamber so that the sprayed liquid is spread out in a thin layer on the inner wall of the chamber and moves downwardly along the same in a spiral path. The bell-shape of the chamber promotes the thinning of the layer of liquid so that air bubbles in the same are easily removed therefrom.

The bell-shaped chamber is preferably in the shape of an annular hyperbola or parabola where the liquid is first sprayed against the same, and these latter curved annular surfaces merge into an annular surface having a cross-section in the shape of an arc of a circle and connected to a conical surface having only a slight angle of inclination to the axis of rotation of the chamber. As a result of the centrifugal action to which the liquid is submitted, the air bubbles in the same are separated therefrom. If desired the curved wall of the chamber can be stepped so as to have tooth-like projections, whereby the film of liquid on the interior surface of the chamber is periodically thinned and thickened. The air bubbles move radially toward the axis of rotation of the chamber and collect on the outer surface of the film of liquid.

In the above-mentioned conical portion of the chamber there is formed a plurality of small bores passing therethrough, and the viscous liquid is sprayed through the same from the above-mentioned first chamber onto the inner wall surface of a second chamber rotating with and fixed to the first chamber. The layer of the liquid which contains air and the froth of the liquid collect on the innermost surface of the ring of liquid so that as a result the liquid flow is retarded and the thickness of the liquid increases at this conical portion of the first-mentioned chamber. The second chamber is generally shaped the same as the first chamber so that the above-mentioned

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process of separating gas from the liquid is repeated in this second chamber.

The first chamber serves to separate the principal part of the air from the liquid, and the second chamber serves to separate even the smallest gas bubbles from the viscous liquid. The above-mentioned openings in the conical portion of the first chamber have a very important function in deaeration of the liquid since all gas bubbles in the liquid which are of a greater diameter than these small openings are necessarily broken by the same as the liquid is forced therethrough by centrifugal action, so that in this way the gas separation action of the second chamber is considerably simplified. The diameter of the above-mentioned openings is carefully chosen so as to be smaller than the diameter of most of the gas bubbles.

The foam or froth can be removed from the deaerated liquid in two ways. One of these ways is to subject the interior rotating hollow space to the influence of a vacuum so as to cause the bubbles in the froth to expand and burst; and the other of these ways is to direct an air stream at a sufficiently great speed and/or at an elevated temperature through the chamber by means of a fan fixedly mounted on a rotating shaft passing through the chamber and supporting the same for rotation. The elevated temperature of the air stream causes the gas bubbles to expand and burst. In the last-mentioned type of device the deaerated viscous liquid is collected in a ring-shaped container which surrounds the lower conical part of the second rotating chamber. Where a vacuum is used, the viscous liquid is gathered in a spherically-shaped funnel which discharges into a pipe for carrying off the deaerating liquid.

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, in which:

Fig. 1 is a partially cross-sectional and partially diagrammatic view of one possible apparatus constructed in accordance with the present invention; and

Fig. 2 is a partially cross-sectional and partially diagrammatic view of another possible apparatus constructed in accordance with the present invention.

Referring to Fig. 1 of the drawings which discloses the embodiment of the invention adapted to operate in cooperation with a vacuum, there is shown an apparatus which includes a shaft 1 to which is keyed the hub 2 for rotation therewith. The hub 2 functions as a cover and as a bearing, in that it includes the ball bearings 5 and 6 whose outer rings are supported in the cylindrical part 7 which extends upwardly from the arms 8 connected to the mounting structure 13 of the device. A nut 10 fixedly mounts the roller bearings 5 and 6 on the hub 2.

The shaft 1 is formed with an axial bore 3 and with two radial bores 4 located at 180° from each other and extending from the bore 3 so that liquid may be introduced into the interior of the apparatus through these bores 3 and 4.

In order to permit air to be drawn from the interior of the device the hub 2 is formed with elongated bores 9. The air which is drawn from the interior of the device collects in the pipe 11 which simultaneously serves as a bearing cover. Any suitable vacuum pump or the like may be connected to pipe 11 for evacuating the same.

To the hub 2 are fixedly connected the two bell-shaped chambers 12 and 13 which are concentrically located with respect to each other and shaft 1. These chambers each have an annular curved part which in one portion thereof (as indicated in Fig. 1 by *a* and *a'* respectively)

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has the axial cross-section of a conic section, preferably a parabola or hyperbola, and in another portion thereof (as indicated in Fig. 1 by *b* and *b'* respectively) has an axial cross-section in the shape of an arc of a circle merging with the conic section thereof. To this latter curved part of each of the chamber walls there are connected the conical parts 14 and 15, respectively, which only have a very slight angle of inclination to the axis of rotation of the shaft and chambers. In the region of the smallest diameter of the chamber 12 there are provided the bores 16. The conical part 14 of the chamber 12 is formed with openings 21 in the wall thereof, and the chamber 12 is sealed by a floor 22.

The chamber 13 is provided in its region of largest diameter and along its outer periphery with a bearing ring 17 which is fixedly connected to chamber 13 and supported for movement on the mounting frame 18. The pressure ring 17 is lubricated by oil, and the oil deflector ring 19 directs oil from the ring 17 to the collector ring 20 from which the oil is guided away so that it cannot become mixed with the deaerated fluid.

To the lower part of the shaft 1 is fixedly connected the hollow dish-shaped body 23 which serves to subsequently subject to centrifugal action any sprayed liquid which has not been deaerated. The gap between the hollow body member 23 and the conical portion 15 of chamber 13 is determined by the diameter of the hollow body member 23. Conical portion 15 of chamber 13 is surrounded by a funnel-shaped part 24 which feeds into a discharge pipe 25.

The shaft 1 may be driven in any well known manner, such as by an electric motor mounted on the frame 18.

The above-described embodiment of the invention, which is illustrated in Fig. 1 of the drawings, operates as follows:

The liquid to be deaerated flows through the axial bore 3 of the rotating shaft 1 and is sprayed against the inner wall of chamber 12 from the radial bores 4 which communicate with the axial bore 3. Due to the fact that the liquid is sprayed in this manner against the rotating inner wall of the chamber 12, the liquid flows in spiral-shaped paths downwardly along the inner wall surface of the chamber 12. As the liquid is spread out against this wall of the curved chamber the layers thereof are thinned out, and because of their smaller mass the air bubbles in the liquid are pressed inwardly toward the free surface of the layer located nearest to the axis of chamber 12.

At the conical portion 14 of the chamber 12 the flow of the liquid is retarded so that in this region of the chamber the thickness of the layer of liquid is greater than at the upper wall portions of the chamber 12. The foam or froth of the liquid gathers on the upper and inner free surface of the liquid ring.

The thus deaerated liquid is pressed through the openings 21 of the chamber 12 and is again spread out in spiral-shaped paths along the inner wall of chamber 13 so that the above-mentioned process of air separation is repeated in chamber 13. The deaerated liquid then is collected in the funnel-shaped member 24 and can be carried off through the discharge pipe 25 from the chamber 13.

In order to remove the foam or froth, air is continually drawn off through the pipe 11, so that air is constantly flowing outwardly through the bores 16 and openings 9 to the pipe 11. In this way a partial vacuum is maintained in the chamber, and gas bubbles in the foam or froth of the deaerated liquid expand and burst so as to separate and carry off gas in this foam from the liquid therein.

The embodiment of the invention which is illustrated in Fig. 2 works with an air stream which moves in counterflow to the liquid being deaerated. The structure illustrated in Fig. 2 comprises a hanging shaft 26 provided with an axial bore 27 which communicates with the radial

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bores 28. Hub 29 is keyed to the shaft 26 for rotation therewith and includes roller bearings 30 and 31. To this hub 29, which also serves as a cover, are fixedly connected the two chambers 32 and 33 which are concentrically located with respect to each other.

The chamber 32 is expanded at its upper end and the wall 34 of this expanded portion of chamber 32 is provided with openings 35. These chambers are similar to the above-described chambers 12 and 13 in that they include annular curved portions having one part thereof (as indicated in Fig. 2 by *c* and *c'* respectively) provided with an axial cross section of a conic section, such as a hyperbola or parabola, and having another part thereof (as indicated in Fig. 2 by *d* and *d'* respectively) provided with the axial cross-section of an arc of a circle which merges with the said conic section. The chamber 33 is fixedly connected to the conical portion 36 of chamber 32 which has a slight angle of inclination to the axis of rotation of the shaft chambers, and the chamber 33 is also provided with a conical end portion 40 which also is slightly inclined to the said axis of rotation.

This conical portion 40 of chamber 33 is provided with openings 41 which open into a collection container 42 which is ring-shaped and surrounds the conical portion 40. The rotating part of this ring-shaped collection container 42 extends up to the sliding joints 43 and 44 which simultaneously serve as a bearing for the chamber 33. The remaining parts of the collection container or chamber 42 are stationary.

A fan 47 is fixedly connected to the shaft 26 for rotation therewith, and the shaft 26 has an end portion thereof located in bearing 48 which is supported on the two arms 49 which respectively are connected to the mounting structure 39. Both of the chambers 32 and 33 are supported for rotation by means of the ring-shaped bearing member 37 fixedly mounted on chamber 33 and cooperating with the arms 38 extending from the mounting structure 39. Connected to the lower part 36 of the chamber 32 is the circular, sheet metal air guide member 50 which is located about the fan 47, and the lower wall 45 of the chamber 32 is provided with perforations through which the air drawn by the fan 47 passes upwardly to the bores 35 so as to pass out of the apparatus therethrough.

The above described embodiment of the invention operates as follows:

The fluid introduced into the chamber 32 through the axial bore 27 and radial bores 28 is sprayed into the rotating hollow space and is spread out against the interior of the chamber 32 so that the layer of viscous liquid is thinned out. The liquid flowing down along the chamber 32 is retarded at the conical portion 36 thereof and at the outer surface of this retarded liquid ring there is collected the foam or froth of the liquid. The deaerated liquid passing through the openings 36a in the wall 36 is sprayed against the inner wall of chamber 33 so that the above-described air separation process is repeated. The deaerated liquid is collected in the container 42 which can only receive the deaerated part of viscous liquid through the openings 41, while the foam is collected on the outer surface of the rotating liquid ring. Air is drawn from the tube 46 by means of the fan 47 and pressed through the perforated plate 45 into the chamber 32 and outwardly therefrom through the bores 35. This air streaming through the chambers in counterflow to the liquid being deaerated in the same produces an extremely efficient removal of the foam from the deaerated liquid. The apparatus disclosed in Fig. 2 is preferably set into operation before the liquid is introduced into the same, and the flow of liquid is preferably terminated before the rotation of the apparatus shown in Fig. 2 is terminated.

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 process and apparatus

for deaerating viscous liquids differing from the types described above.

While the invention has been illustrated and described as embodied in the process and apparatus for deaerating viscous liquid by directing the liquid under the action of centrifugal force against the inner surfaces of bell-shaped containers, 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 secured by Letters Patent is:

1. A process for deaerating viscous liquids, comprising the steps of subjecting a stream of the liquid to centrifugal force; spreading the liquid thus subjected to centrifugal force against a conoidal annular tubular surface; then spreading the liquid thus spread against said conoidal annular surface against a second annular tubular surface having a cross-section in the shape of an arc of a circle; finally spreading the liquid thus forced by centrifugal action against said second annular surface against a third annular slightly conical tubular surface; and guiding against the inner side of the thus spread out liquid located against said surfaces a stream of air at a relatively high speed and at a temperature above that of the temperature surrounding said liquid.

2. A process for deaerating viscous liquids, comprising the steps of subjecting a stream of the liquid to centrifugal force; spreading the liquid thus subjected to centrifugal force against a conoidal annular tubular surface; then spreading the liquid thus spread against said conoidal annular surface against a second annular tubular surface having a cross-section in the shape of an arc of a circle; finally spreading the liquid thus forced by centrifugal action against said second annular surface against a third annular slightly conical tubular surface; guiding against the inner side of the thus spread out liquid located against said surfaces a stream of air at a relatively high speed and at a temperature above that of the temperature surrounding said liquid; and directing the thus deaerated liquid to a collecting chamber.

3. A process for deaerating viscous liquids, comprising the steps of subjecting a stream of the liquid to centrifugal force; passing the liquid thus subjected to centrifugal force through a plurality of openings which are of a smaller diameter than most of the gas bubbles in the liquid so as to break the same; then spreading the liquid thus subjected to centrifugal force and passed through said openings against a conoidal annular tubular surface; then spreading the liquid thus spread against said conoidal annular surface against a second annular tubular surface having a cross-section in the shape of an arc of a circle; finally spreading the liquid thus forced by centrifugal action against said second annular surface against a third annular slightly conical tubular surface; guiding against the inner side of the thus spread out liquid located against said surfaces a stream of air at a relatively high speed and at a temperature above that of the temperature surrounding said liquid; and directing the thus deaerated liquid to a collecting chamber.

4. Apparatus for deaerating viscous liquids, comprising, in combination, a first tubular rotatably mounted chamber having a conoidal, annular wall extending from a small end portion of said chamber to an opposite larger end portion thereof, the larger of said end portions having an axial cross section in the shape of an arc of a

circle; conduit means communicating with the interior of said first chamber at said small end portion thereof for directing liquid against the inner surface of said small end portion of said first chamber; a second tubular chamber having a conoidal, annular wall and being fixed to and at least partially located about said first chamber for rotation therewith, said first and second chambers being concentrically mounted with respect to each other and communicating with each other, whereby, when a liquid is directed by said conduit means against the inner surface of said first rotating chamber, the liquid is thinned out and passes from said first chamber to said second chamber to be further thinned out so as to remove any gas in the liquid therefrom.

5. Apparatus for deaerating viscous liquids, comprising, in combination, rotatably mounted shaft; a first tubular chamber having a conoidal, annular wall and being fixedly mounted on said shaft for rotation therewith, said chamber having opposite end portions of different sizes, the larger of said end portions having an axial cross section in the shape of an arc of a circle; conduit means communicating with the interior of said first chamber at the smaller of said end portions thereof for directing liquid against the inner surface of said smaller end portion; a second tubular chamber having a conoidal, annular wall and being fixed to and at least partially located about said first chamber for rotation therewith, said first and second chambers being concentrically mounted with respect to each other and communicating with each other, whereby, when a liquid is directed by said conduit means against the inner surface of said first rotating chamber, the liquid is thinned out and passes from said first chamber to said second chamber to be further thinned out so as to remove the gas in the liquid therefrom.

6. Apparatus for deaerating viscous liquids, comprising, in combination, a rotatably mounted shaft; a first tubular chamber having a conoidal, annular wall and being fixedly mounted on said shaft for rotation therewith, said chamber having opposite end portions of different sizes, the larger of said end portions having an axial cross section in the shape of an arc or a circle; conduit means communicating with the interior of said first chamber at the smaller of said end portions thereof for directing liquid against the inner surface of said smaller end portions; a second tubular chamber having a conoidal, annular wall and being fixed to and at least partially located about said first chamber for rotation therewith, said first and second chambers being concentrically mounted with respect to each other and communicating with each other, whereby, when a liquid is directed by said conduit means against the inner surface of said first rotating chamber, the liquid is thinned out and passes from said first chamber to said second chamber to be further thinned out so as to remove any gas in the liquid therefrom; and bearing ring means operatively connected to the outer surface of said second chamber for supporting the same for rotation with said first chamber and shaft.

7. Apparatus for deaerating viscous liquids, a comprising in combination, a rotatably mounted shaft; a first tubular chamber having a conoidal annular wall and being fixedly mounted on said shaft for rotation therewith; conduit means communicating with the interior of said first chamber for directing liquid thereto; a second tubular chamber having a conoidal, annular wall and being fixed to and at least partially located about said first chamber for rotation therewith, said first and second chambers being concentrically mounted with respect to each other, whereby, when a liquid is directed by said conduit means against the inner surface of said first rotating chamber, the liquid is thinned out and passes from said first chamber to said second chamber to be further thinned out so as to remove any gas in the liquid therefrom; bearing ring means operatively connected to the outer surface of said second chamber for supporting the same for rotation with said first chamber and shaft; and

a ring-shaped collection chamber located about and communicating with said second chamber adjacent the lower end thereof for collecting deaerated liquid therefrom.

8. Apparatus for deaerating viscous liquids, comprising in combination, a rotatably mounted shaft; a first tubular chamber having a conoidal annular wall and being fixedly mounted on said shaft for rotation therewith; conduit means communicating with the interior of said first chamber for directing liquid thereto; a second tubular chamber having a conoidal annular wall and being fixed to and at least partially located about said first chamber for rotation therewith, said first and second chambers being concentrically mounted with respect to each other, whereby, when a liquid is directed by said conduit means against the inner surface of said first rotating chamber, the liquid is thinned out and passes from said first chamber to said second chamber to be further thinned out so as to remove any gas in the liquid therefrom; bearing ring means operatively connected to the outer surface of said second chamber for supporting the same for rotation with said first chamber and shaft; and a ring-shaped collection chamber located about and communicating with said second chamber adjacent the lower end thereof for collecting deaerated liquid therefrom, said collection chamber having a stationary upper wall located in bearing engagement with said second chamber so that the latter may rotate with respect to the former.

9. Apparatus for deaerating viscous liquids, comprising in combination, a rotatably mounted shaft; a first tubular chamber having a conoidal, annular wall and being fixedly mounted on said shaft for rotation therewith; conduit means communicating with the interior of said first chamber for directing liquid thereto; a second tubular chamber having a conoidal, annular wall and being fixed to and at least partially located about said first chamber for rotation therewith, said first and second chambers being concentrically mounted with respect to each other, whereby, when a liquid is directed by said conduit means against the inner surface of said first rotating chamber, the liquid is thinned out and passes from said first chamber to said second chamber to be further thinned out so as to remove any gas in the liquid therefrom; bearing ring means operatively connected to the outer surface of said second chamber for supporting the same for rotation with said first chamber and shaft; a ring-shaped collection chamber located about and communicating with said second chamber adjacent the lower end thereof for collecting deaerated liquid therefrom, said collection chamber having a stationary upper wall located in bearing engagement with said second chamber so that the latter may rotate with respect to the former; and fan means fixedly mounted on said shaft for rotation therewith for directing a stream of air through the interior of said first and second chambers.

10. Apparatus for deaerating liquids, comprising, in combination, an elongated rotatably mounted shaft formed with passage ways for directing liquid in the passage ways outwardly of the shaft upon rotation thereof; a first tubular bell-shaped chamber fixedly mounted on said shaft for rotation therewith and having one end portion smaller than an opposite end portion thereof and located about said passage ways; a second tubular bell-shaped chamber fixedly connected to and extending at least partially about said first bell-shaped chamber for rotation therewith, said shaft and first and second chambers all being concentrically mounted with respect to each other for rotation together about a common axis and said second chamber communicating with said first chamber so as to receive liquid therefrom, each of said chambers having a conoidal annular surface portion, a second annular surface portion merging with said conoidal annular surface portion and having an axial cross section in the shape of an arc of a circle, and a third annular surface portion having sides which are slightly inclined to said common axis and extending from said second annular

surface portion, said conoidal annular surface portion of said first chamber being located at said one end portion thereof and said conoidal annular surface portion of said second chamber being located opposite said third surface portion of said first chamber, extending away from said conoidal and second surface portions of said first chamber and merging at an end distant from said third surface portion of said first chamber into said second surface portion of said second chamber, whereby liquids introduced into the first rotating chamber from said passageways in said shaft will be thinned out in the same and passed therefrom to the second rotating chamber to be further thinned therein.

11. Apparatus for deaerating liquids, comprising, in combination, an elongated rotatably mounted shaft formed with passageways for directing liquid in the passage ways outwardly of the shaft upon rotation thereof; a first substantially closed, bell-shaped chamber fixedly mounted on said shaft for rotation therewith and having one end portion smaller than an opposite end portion thereof and located about said passage ways, said first chamber being formed with a plurality of perforations at an end portion thereof opposite to said one end portion; a second bell-shaped chamber fixedly connected to and extending at least partially about said first bell-shaped chamber for rotation therewith, said shaft and first and second chambers all being concentrically mounted with respect to each other for rotation together about a common axis and said second chamber communicating with said first chamber through said perforations so as to receive liquid therefrom, each of said chambers having a conoidal annular tubular surface portion, a second annular tubular surface portion merging with said conoidal annular surface portion and having an axial cross section in the shape of an arc of a circle and a third annular conical tubular surface portion having sides which are slightly inclined to said common axis and extending from said second annular surface portion, said conoidal annular surface portion of said first chamber being located at said one end portion thereof and said conoidal annular surface portion of said second chamber being located opposite the said third surface portion of said first chamber, extending away from said conoidal and second surface portions of said first chamber, and merging at an end distant from said third surface portion of said first chamber into said second surface portion of said second chamber, whereby liquid introduced into the first rotating chamber from said passage ways in said shaft will be thinned out in the same and passed therefrom to the second rotating chamber to be further thinned therein.

12. Apparatus for deaerating liquids comprising, in combination, an elongated rotatably mounted shaft formed with passage ways adjacent one end portion thereof for directing liquid in the passage ways outwardly of the shaft upon rotation thereof, a first substantially closed, bell-shaped chamber fixedly mounted on said shaft for rotation therewith and having one end portion smaller than an opposite end portion thereof and located about said passage ways, said first chamber being formed with a plurality of perforations at an end portion thereof opposite said one end portion; a second bell-shaped chamber fixedly connected to and extending at least partially about said first bell-shaped chamber for rotation therewith, said shaft and first and second chambers all being concentrically mounted with respect to each other for rotation together about a common axis and said second chamber communicating with said first chamber through said perforations so as to receive liquid therefrom, each of said chambers having a conoidal annular tubular surface portion, a second annular tubular surface portion merging with said conoidal annular surface portion and having an axial cross section in the shape of an arc of a circle, and a third annular conical tubular surface portion having sides which are slightly inclined

to said common axis and extending from said second annular surface portion, said conoidal annular surface portion of said first chamber being located at said one end portion thereof and said conoidal annular surface portion of said second chamber being located opposite said third surface portion of said first chamber, extending away from said conoidal and second surface portions of said first chamber and merging at an end distant from said third surface portion of said first chamber into said second surface portion of said second chamber, whereby liquid introduced into the first rotating chamber from said passage ways in said shaft will be thinned out in the same and passed therefrom to the second rotating chamber to be further thinned therein; and collection means operatively connected to said second chamber for receiving deaerated liquid therefrom.

13. Apparatus for deaerating liquids comprising, in combination, an elongated rotatably mounted shaft formed with passageways adjacent one end portion thereof for directing liquid in the passage ways outwardly of the shaft upon rotation thereof; a first substantially closed, bell-shaped chamber fixedly mounted on said shaft for rotation therewith and having one end portion smaller than an opposite end portion thereof and located about said passage ways, said first chamber being formed with a plurality of perforations at an end portion thereof opposite said one end portion; a second bell-shaped chamber fixedly connected to and extending at least partially about said first bell-shaped chamber for rotation therewith, said shaft and first and second chambers all being concentrically mounted with respect to each other for rotation together about a common axis and said second chamber communicating with said first chamber through said perforations so as to receive liquid therefrom, each of said chambers having a conoidal annular tubular surface portion provided with an axial cross section in the shape of a parabola, a second annular tubular surface portion merging with said conoidal annular surface portion and having an axial cross section in the shape of an arc of a circle, and a third annular conical tubular surface portion having sides which are slightly inclined to said common axis and extending from said second annular surface portion, said conoidal annular surface portion of said first chamber being located at said one end portion thereof and said conoidal annular surface portion of said second chamber being located opposite said third surface portion of said first chamber, extending away from said conoidal and second surface portions of said first chamber and merging at an end distant from said third surface portion of said first chamber into said second surface portion of said second chamber, whereby liquid introduced into the first rotating chamber from said passage ways in said shaft will be thinned out in the same and passed therefrom to the second rotating chamber to be further thinned therein; and collection means operatively connected to said second chamber for receiving deaerated liquid therefrom.

14. Apparatus for deaerating liquids comprising, in combination, an elongated rotatably mounted shaft formed with passageways adjacent one end portion thereof for directing liquid in the passage ways outwardly of the shaft upon rotation thereof; first substantially closed, bell-shaped chamber fixedly mounted on said shaft for rotation therewith and having one end portion smaller than an opposite end portion thereof and located about said passage ways, said first chamber being formed with a plurality of perforations at an end portion thereof opposite said one end portion; a second bell-shaped chamber fixedly connected to and extending at least partially about said first bell-shaped chamber for rotation therewith, said shaft and first and second chambers all being concentrically mounted with respect to each other for rotation together about a common axis and said second chamber communicating with said first cham-

ber through said perforations so as to receive liquid therefrom, each of said chambers having a conoidal annular tubular surface portion provided with an axial cross section in the shape of a hyperbola, a second annular tubular surface portion merging with said conoidal annular surface portion and having an axial cross section in the shape of an arc of a circle, and a third annular conical tubular surface portion having sides which are slightly inclined to said common axis and extending from said second annular surface portion, said conoidal annular surface portion of said first chamber being located at said one end portion thereof and said conoidal annular surface portion of said second chamber being located opposite said third surface portion of said first chamber, extending away from said conoidal and second surface portions of said first chamber and merging at an end distant from said third surface portion of said first chamber into said second surface portion of said second chamber, whereby liquid introduced into the first rotating chamber from said passage ways in said shaft will be thinned out in the same and passed therefrom to the second rotating chamber to be further thinned therein; and collection means operatively connected to said second chamber for receiving deaerated liquid therefrom.

15. Apparatus for deaerating liquid comprising, in combination, an elongated rotatably mounted shaft formed with passage ways adjacent one end portion thereof for directing liquid in the passage ways outwardly of the shaft upon rotation thereof; a first substantially closed, bell-shaped chamber fixedly mounted on said shaft for rotation therewith and having one end portion smaller than an opposite end portion thereof and located about said passage ways, said first chamber being formed with a plurality of perforations at an end portion thereof opposite said one end portion; a second bell-shaped chamber fixedly connected to and extending at least partially about said first bell-shaped chamber for rotation therewith, said shaft and first and second chambers all being concentrically mounted with respect to each other for rotation together about a common axis and said second chamber communicating with said first chamber through said perforations so as to receive liquid therefrom, each of said chambers having a conoidal annular tubular surface portion, a second annular tubular surface portion merging with said conoidal annular surface portion and having an axial cross section in the shape of an arc of a circle, and a third annular conical tubular surface portion having sides which are slightly inclined to said common axis and extending from said second annular surface portion, said conoidal annular surface portion of said first chamber being located at said one end portion thereof and said conoidal annular surface portion of said second chamber being located opposite said third surface portion of said first chamber, extending away from said conoidal and second surface portions of said first chamber and merging at an end distant from said third surface portion of said first chamber into said second surface portion of said second chamber, whereby liquid introduced into the first rotating chamber from said passage ways in said shaft will be thinned out in the same and passed therefrom to the second rotating chamber to be further thinned therein; collection means operatively connected to said second chamber for receiving deaerated liquid therefrom; and vacuum means operatively connected to the interior of said chambers for causing gas bubbles therein to expand and break.

16. Apparatus for deaerating liquids, comprising in combination, an elongated rotatably mounted shaft formed with passage ways adjacent one end portion thereof for directing liquid in the passage ways outwardly of the shaft upon rotation thereof; a first substantially closed, bell-shaped chamber fixedly mounted on said shaft for rotation therewith and having one end

portion smaller than an opposite end portion thereof and located about said passage ways, said first chamber being formed with a plurality of perforations at an end portion thereof opposite to said one end portion; a second bell-shaped chamber fixedly connected to and extending at least partially about said first bell-shaped chamber for rotation therewith, said shaft and first and second chambers all being concentrically mounted with respect to each other for rotation together about a common axis and said second chamber communicating with said first chamber through said perforations so as to receive liquid therefrom, each of said chambers having a conoidal annular tubular surface, a second annular tubular surface merging with said conoidal annular surface and having a cross-section in the shape of an arc of a circle, and a third annular conical tubular surface having sides which are slightly inclined to said common axis and extending from said second annular surface, whereby liquid introduced into the first rotating chamber from said passage ways in said shaft will be thinned out in the same and pass therefrom to the second rotating chamber to be further thinned therein; collection means operatively connected to said second chamber for receiving deaerating liquid therefrom; and fan means fixedly mounted on said shaft for rotation therewith and for guiding a stream of air through said chambers in counter-flow to liquid passing therethrough.

17. In an apparatus for deaerating liquids, in combination, a support; a chamber having a vertical central axis and being mounted, for rotation about its central axis, on said support, said chamber having an upper annular tubular wall portion located about said central axis and gradually increasing in diameter from the top of said upper wall portion to the bottom thereof, at least part of said upper wall portion having an axial cross-section in the shape of an arc of a circle and a lower annular wall portion connected to said bottom of said upper wall portion and extending downwardly therefrom, said lower wall portion being formed with a plurality of perforations passing therethrough; and conduit means communicating with the interior of said chamber adjacent to said top of said upper annular wall portion thereof for delivering liquid to be deaerated to the inner surface of said upper wall portion of said chamber on the interior thereof, whereby, when said chamber is rotated, liquid to be deaerated will be moved by centrifugal force along the inner surface of said

chamber and will flow downwardly to said lower wall portion thereof to be forced out through said perforations.

18. In an apparatus for deaerating liquids, in combination, a support; a chamber having a vertical central axis and being mounted, for rotation about its central axis, on said support, said chamber having an upper annular tubular wall portion located about said central axis and gradually increasing in diameter from the top of said upper wall portion to the bottom thereof and a lower annular wall portion connected to said bottom of said upper wall portion and extending downwardly therefrom, said lower wall portion being formed with a plurality of perforations passing therethrough; and a shaft extending along said central axis of said chamber in the interior thereof and being mounted on said support for rotation about said central axis, said shaft being formed with an elongated passageway having an outlet adjacent to said top of said upper annular wall portion of said chamber to deliver liquid to be deaerated to the inner surface of said upper wall portion of said chamber on the interior thereof, whereby, when said chamber is rotated, liquid to be deaerated will be moved by centrifugal force along the inner surface of said chamber and will flow downwardly to said lower wall portion thereof to be forced out through said perforations.

19. A process for deaerating viscous liquids, comprising the steps of subjecting a stream of the liquid to centrifugal force; forming a tube of film of the liquid thus subjected to centrifugal force; and flaring the tube of film of liquid outwardly from its axis to increase its diameter and to decrease the wall thickness thereof.

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