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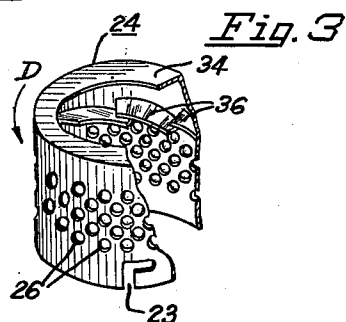
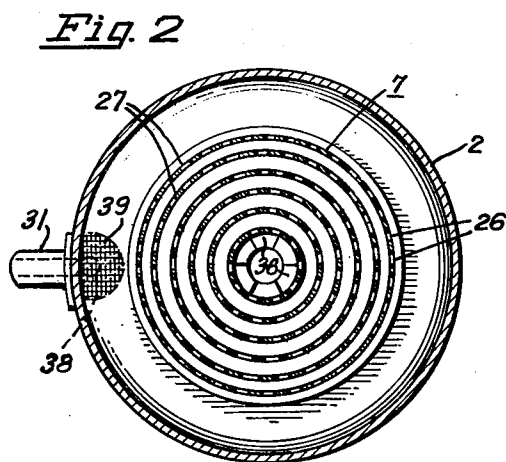
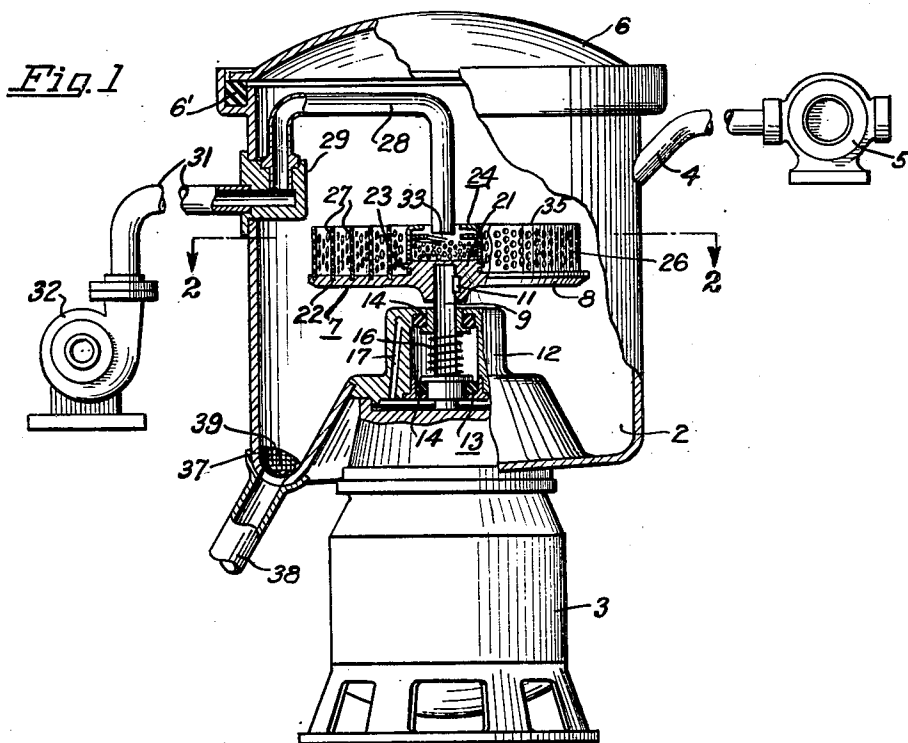
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APPARATUS AND METHOD FOR DEAERATION OF LIQUIDS

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2 Sheets-Sheet 1



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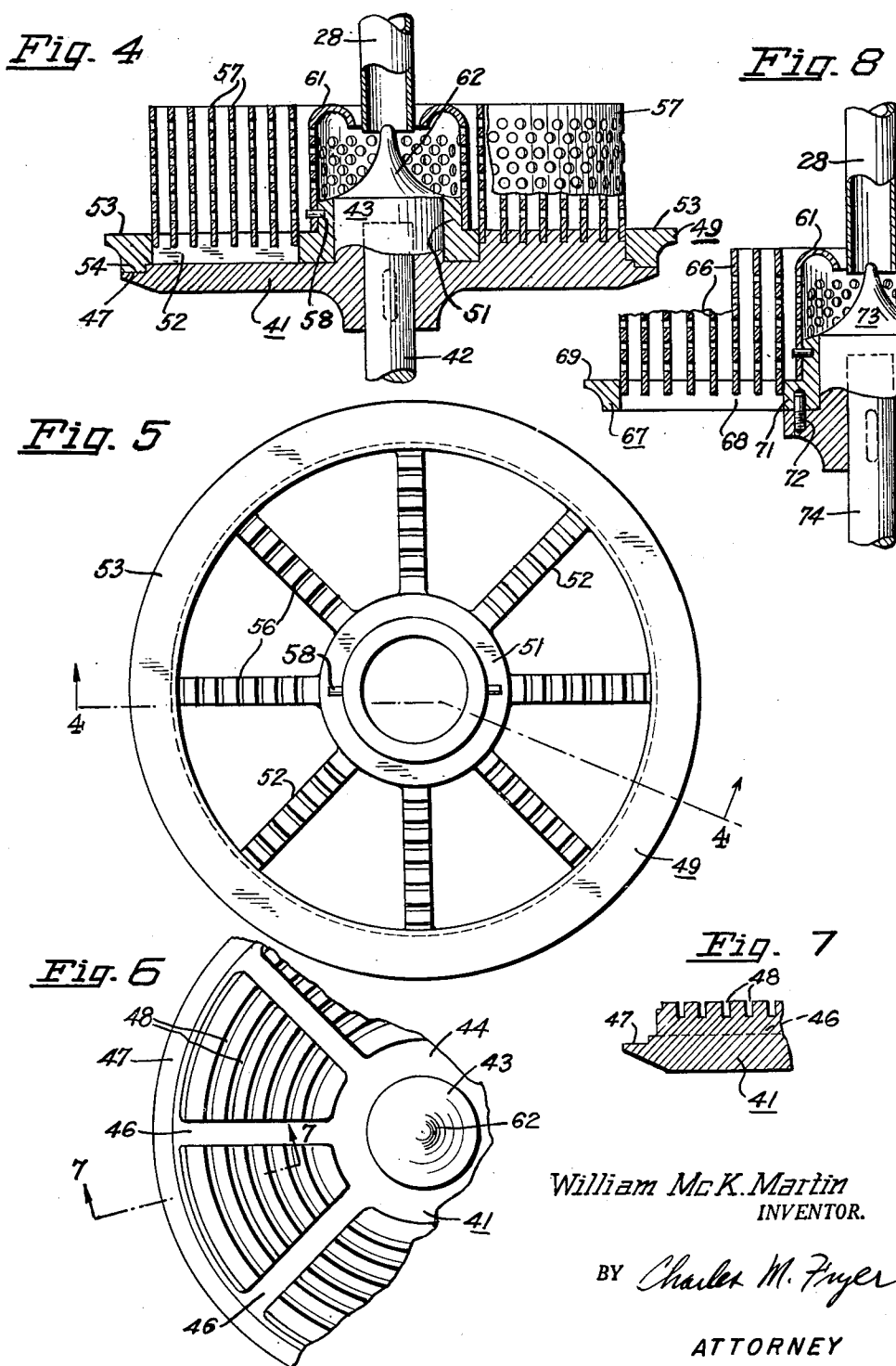
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2 Sheets-Sheet 2



## UNITED STATES PATENT OFFICE

2,507,797

APPARATUS AND METHOD FOR  
DEAERATION OF LIQUIDS

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My invention relates to deaeration, and more particularly to centrifugal deaeration of liquids.

Objects of my invention, among others, are the provision of an improved centrifugal deaerator and method of deaeration by centrifugal force, by which the liquid to be deaerated is repeatedly and continually disrupted into relatively small droplets under the action of such centrifugal force and then coalesced after each disruption, so as to allow escape of occluded or dissolved gas such as air which may exist in the liquid; which are both simple and economical; and in which the apparatus consists of relatively few working parts. Other objects of my invention will become apparent from a perusal thereof.

In general, my apparatus comprises a rotor provided with a plurality of apertured annular baffle plates which are nested in spaced relationship with respect to each other, and which are rotated as a unit under relatively high speed in an enclosed chamber maintained under vacuum. Liquid to be deaerated is introduced centrally of the rotor into the space within the innermost apertured baffle plate. As a result, the liquid is thrown outwardly under the centrifugal force effect, against the surfaces of the apertured baffle plates, which effect disruption of the liquid into droplets that become coalesced as they strike a succeeding baffle.

Because of the provision of a plurality of such baffle plates, whereby there is an inner apertured baffle plate, an outer apertured baffle plate and apertured baffle plates in spaced relationship therebetween, the described droplet formation and subsequent coalescence are repeatedly effected; and dissolved or occluded gas in the liquid is brought to the surface layer of the droplets and can thus readily escape under the vacuum effect. This action is important in exposing a fresh layer of liquid to the vacuum after each successive passage through the baffles. The dissolved or occluded gas is, thus, moved to the surface of the droplets mechanically rather than by diffusion.

Reference is now made to the drawings for a more detailed description of my invention in which:

Fig. 1 is a vertical sectional elevation of an embodiment of the apparatus of my invention, parts being broken away to illustrate more clearly the construction;

Fig. 2 is a horizontal section taken in the plane indicated by the line 2—2 in Fig. 1;

Fig. 3 is a fragmentary isometric view of the inner baffle plate which is associated with means

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to prevent liquid from climbing over said baffle plate as it is being introduced;

Fig. 4 is a fragmentary vertical sectional elevation of a modified form of rotor construction wherein the baffle plates are detachably mounted as a unit, and another form of means for preventing climbing of the liquid over the inner baffle plate is provided; the plane of the section being indicated by line 4—4 in Fig. 5;

Fig. 5 is a plan view of a detachable spider upon which the baffle plates of the modification of Fig. 4 are mounted;

Fig. 6 is a fragmentary plan view of the rotor base of the modification of Fig. 4, upon which the spider is mounted;

Fig. 7 is a fragmentary section taken in the plane indicated by line 7—7 in Fig. 6; and

Fig. 8 is a fragmentary vertical sectional elevation of a still further embodiment of rotor construction.

Referring to Figs. 1, 2 and 3, the apparatus comprises enclosed chamber 2 mounted on a suitable base 3 which also provides a housing for any suitable driving motor. Adjacent its top, chamber 2 is provided with connection means 4 for connection to a source of vacuum shown in the form of vacuum pump 5 which is adapted to maintain a relatively high vacuum within chamber 2, but which may be any other source of vacuum. A removable cover 6 is provided for the chamber, and is adapted to rest on rubber sealing gasket 6'; the vacuum maintaining the cover tight in operation of the apparatus.

A horizontally positioned rotor unit 7 is rotatably mounted within chamber 2 below vacuum connection 4, for rotation about an upright axis, and includes base plate 8 fixedly secured for rotation to motor shaft 9 by key 11. The motor shaft is journaled for rotation in a hollow boss 12 integral with the belled bottom of chamber 2, and which contains a suitable expansible seal 13 comprising the usual spaced sealing elements 14 thrust apart by the coil spring 16. A passage 17 for introduction of sealing, lubricating and cooling liquid is formed in the wall of boss 12.

Rotor base plate 8 is provided with a central hub portion 21, and a plurality of concentric grooves 22 about such hub portion. Detachably mounted on to hub portion 21 by means of bayonet-slot connection 23 is inner annular baffle plate 24 having apertures 26 in the wall thereof about its entire periphery. About inner plate 24 are a plurality of concentrically arranged spaced annular baffle plates 27 which are secured in the grooves 22 of base plate 8 by any suitable

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means, such as brazing or welding; each of the walls of baffle plates 27 being also provided with the apertures 26 about its entire periphery.

Means is provided for introducing liquid to be deaerated centrally of the rotor into the space within the inner baffle plate 24, comprising conduit 28 within chamber 2 and connected through fitting 29 in the wall of chamber 2, to a source of the liquid supply by means of piping 31 and pump 32 which is preferably a centrifugal pump but may be of any other type. Gravity feed of the liquid can also be employed. The discharge end 33 of conduit 28 is adjacent the inlet end of inner baffle plate 24 extending just inside such end; and as a result the liquid to be deaerated is fed without spillage into the receptacle which the inner baffle plate 24 provides.

In operation, the rotor is rotated at a high speed, for example, about 1800 to 3500 R. P. M.; and to prevent climbing of the liquid being introduced into the rotor over the inlet end of inner baffle plate 24, means associated with such plate is provided to obtain this result. Such means comprises inwardly extending lip or flange 34 on the inlet end of baffle plate 24, and a plurality of inclined cooperating impeller blades 36 on the inner wall of baffle plate 24 spaced below flange 34. These blades are inclined upwardly with reference to the direction of rotation of the rotor, as indicated by the direction arrow D in Fig. 3, so that as liquid tends to climb over the feed end of inner baffle plate 24 under the action of centrifugal force as the rotor is rotated, the impellers serve to prevent such climbing, and flange 34 serves to deflect whatever small amount of liquid that may be thrown past the impellers. The detachable bayonet connection of inner baffle plate 24 provides a ready means by which it may be removed for cleaning on the occasions when this may become necessary.

Apertures 26 in the baffle plates should be relatively small to effect formation of small droplets, but large enough to obviate clogging. If they are from  $\frac{1}{8}$ " to  $\frac{3}{32}$ " in diameter, this will be satisfactory for most purposes. As liquid is continually fed to the center of the rotor, it is dispersed radially outwardly through the baffle plate apertures under the action of the centrifugal force. Passage of the liquid through the apertures in the course of its outward movement causes it to be repeatedly disrupted into small droplets at each successive baffle plate; and this exposes an extremely large surface area of the liquid to the vacuum with consequent enhancement of the deaeration. The droplets coalesce as they strike a succeeding baffle plate. As a result, a fresh or new layer of the liquid is exposed to the vacuum after each passage through a baffle, and dissolved or occluded gas is brought to the surface layer of each droplet whereby it may readily escape and be drawn off by the vacuum. In this connection, it is to be noted that the end 35 of the rotor defined by the edges of the baffle plates adjacent the inlet end of the rotor, is open; or in other words, substantially the entire area covered by the path of outward movement of the liquid is open to the chamber 2. As a result, the gas which escapes from the liquid being deaerated is open to and can, consequently, be readily drawn off under the effect of the vacuum.

The liquid deaerated after it is discharged through the apertures in the outer baffle plate 27, flows to the bottom of chamber 2, which bottom is inclined to form a sump 37 connected to discharge outlet 38 over which a strainer 39 may be

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placed if so desired. My apparatus and method have been found particularly applicable for the deaerating of relatively viscous liquids such as fruit and vegetable purees, catsup and similar liquid food products which are to be canned, and which readily entrap air. However, it is to be understood that it may be employed for the deaeration of any liquid containing dissolved or occluded gas, such as fruit and vegetable juices, and oil having air or other gas entrapped or dissolved therein; and the term "deaeration" is defined to include removal of air or any other gas.

In the embodiment of Figs. 4 through 7, is illustrated another form of rotor construction which is designed to provide for ready removal of the baffle plate supporting portion of the rotor should this be necessary for replacement or repair. Also, another form of means is provided for preventing the liquid from climbing over the inlet end of the inner baffle plate, although the means described with respect to the modification of Figs. 1, 2 and 3, is preferred because it has been found to produce the best results. Otherwise the embodiment of Figs. 4 through 7 is the same as that already described, being mounted in a vacuumized chamber in the manner related.

The rotor comprises base plate 41 keyed for rotation to motor shaft 42. In the upper part of plate 41 about central hub portion 43 is an annular recess or groove 44 which communicates with a plurality of equi-spaced radially extending grooves 46 extending adjacent the periphery of plate 41 at which a peripheral recess 47 is formed. A plurality of concentric spaced grooves 48 are also formed in the top surface of rotor plate 41 between recess 44 and recess 47. The described groove or recess arrangement on rotor base plate 41 provides a means for detachably seating a baffle plate carrying spider 49 shown in Fig. 5. The spider has central hub portion 51 adapted to seat in recess 44 of base plate 41, and also radially extending spokes 52 of substantially the same width and substantially the same depth as radially extending grooves 46 so as to seat therein in driving relationship therewith; the spokes 52 being joined to rim 53 which has shoulder 54 adapted to seat in the peripheral recess 47 of rotor base plate 41.

Spokes 52 have concentric recesses 56 adapted to provide seats for the apertured annular baffle plates 57 in which the ends of such baffle plates are secured in the manner already described; the concentric grooves 48 in rotor base plate 41 being in alinement with recesses 56 when the spider is mounted on the base plate thus providing means for the reception of the portions of baffle plates 57 between spokes 52. The innermost baffle plate is detachably mounted to the hub 51 of the spider 59 by suitable bayonet connecting means 58.

For preventing climbing of liquid over the inlet of the inner baffle plate as it is being introduced into the rotor from conduit 28, such inlet end is formed with a curved downwardly extending lip or flange 61 which cooperates with a cone deflector 62; the surface of which is concave. Otherwise the operation is the same as that previously described.

In both the previously described modifications, the bottom end of the rotor opposite the liquid inlet end is closed but the inlet end is open, so that gas may readily escape under the vacuum conditions. If desired, the bottom of the rotor may be also open as is disclosed in the modification of Fig. 8 wherein the apertured baffle plates

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66 which are concentrically arranged in the manner described, are secured to the spaced arms of a rotor base which is in the form of a spider 67 having radially extending arms or spokes 68 secured to peripheral rim 69 and to a hub 71. Hub 71 is secured by means of pins 72 to deflector member 73 in turn keyed to motor shaft 74. The spokes 68 provide open spacing therebetween; and the lower ends of baffle plates 66 are secured in suitable grooves formed in such spokes, by any suitable means such as brazing or welding.

In the modification of Fig. 8, the innermost baffle plate and associated means to prevent climbing of the liquid are shown in the manner illustrated with respect to the embodiment of Figs. 4 through 7. However, they may be the same as described in the embodiment of Figs. 1 through 3. In this connection, it is to be noted that in all the modifications, the bottom portion of the rotor within the innermost baffle plate is closed, so as to form a receptacle in which the entering liquid is caught, and thus insure that there will be no escape of the liquid before the liquid is subjected to the action of the described centrifugal force and thrown outwardly.

The baffle plates and other parts of my apparatus are preferably of metal, although any other suitable material may be employed. Although in all embodiments of the invention, I have shown apertured baffle plates which are concentrically arranged and are hence independent rings, the construction may be in a form of a spiral formed from a continuous sheet of suitable perforated material which will provide a plurality of apertured annular baffle plates nested in spaced relationship with respect to each other, as is also the case with respect to the concentrically arranged plates illustrated.

I claim:

1. A centrifugal deaerator comprising a chamber having an outlet for deaerated liquid, means for connection to vacuum creating means for maintaining said chamber under vacuum, a deaerating rotor rotatably mounted in said chamber comprising a plurality of apertured annular baffle plates nested in spaced relationship with respect to each other, and means for introducing liquid to be deaerated into said rotor.

2. A centrifugal deaerator comprising a chamber having an outlet for deaerated liquid, means for connection to vacuum creating means for maintaining said chamber under vacuum, a deaerating rotor rotatably mounted in said chamber comprising a plurality of apertured annular baffle plates nested in spaced relationship with respect to each other, an end of said rotor formed by edges of said plates being open to allow escape of gas, and means for introducing liquid to be deaerated into said rotor.

3. A centrifugal deaerator comprising a chamber having an outlet for deaerated liquid, means for connection to vacuum creating means for maintaining said chamber under vacuum, a deaerating rotor rotatably mounted in said chamber comprising a plurality of apertured annular baffle plates nested in spaced relationship with respect to each other, an end of said rotor formed by edges of said plates being open to allow escape of gas, and means for introducing liquid to be deaerated centrally of the rotor into the space within the inner baffle plate.

4. A centrifugal deaerator comprising a chamber having an outlet for deaerated liquid, means for connection to vacuum creating means for maintaining said chamber under vacuum, a

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deaerating rotor rotatably mounted in said chamber comprising a plurality of apertured annular baffle plates nested in spaced relationship with respect to each other, an end of said rotor formed by edges of said plates being open to allow escape of gas, means for introducing liquid to be deaerated centrally of the rotor into the space within the inner baffle plate, and means associated with said inner baffle plate to prevent the liquid from climbing over said inner baffle plate as it is being introduced.

5. A centrifugal deaerator comprising a chamber having an outlet for deaerated liquid, means for connection to vacuum creating means for maintaining said chamber under vacuum, a deaerating rotor rotatably mounted in said chamber comprising a plurality of apertured annular baffle plates nested in spaced relationship with respect to each other, an end of said rotor formed by edges of said plates being open to allow escape of gas, means for introducing liquid to be deaerated centrally of the rotor into the space within the inner baffle plate including a liquid feed conduit having a discharge end adjacent the inlet end of said inner baffle plate, and means associated with said inner baffle plate to prevent liquid from climbing over said inlet end of said inner baffle plate as it is being introduced including an inwardly extending flange on said inlet end and impeller means on the inner wall of said inner baffle plate spaced from said flange.

6. A centrifugal deaerator comprising a chamber having an outlet for deaerated liquid, means for connection to vacuum creating means for maintaining said chamber under vacuum, a deaerating rotor rotatably mounted in said chamber comprising a plurality of apertured annular baffle plates nested in spaced relationship with respect to each other, an end of said rotor formed by edges of said plates being open to allow escape of gas, means for introducing liquid to be deaerated centrally of the rotor into the space within the inner baffle plate, means associated with said inner baffle plate to prevent the liquid from climbing over said baffle plate as it is being introduced, and means detachably mounting said inner baffle plate.

7. A centrifugal deaerator comprising a chamber having an outlet for deaerated liquid, means for connection to vacuum creating means for maintaining said chamber under vacuum, a deaerating rotor rotatably mounted in said chamber comprising a rotor base and a plurality of apertured annular baffle plates nested in spaced relationship with respect to each other and detachably mounted on said rotor base, an end of said rotor formed by edges of said plates being open to allow escape of gas, and means for introducing liquid to be deaerated centrally of the rotor into the space within the inner baffle plate.

8. A centrifugal deaerator comprising a chamber having means adjacent the top thereof for connection to vacuum creating means for maintaining said chamber under vacuum, a deaerator rotor mounted in said chamber below said vacuum connection means for rotation about an upright axis comprising an inner apertured annular baffle plate, an outer apertured annular baffle plate and a plurality of apertured annular baffle plates between said inner and said outer plates, all of said baffle plates being nested in spaced relationship with respect to each other, an end of said rotor formed by edges of said plates being open to allow escape of gas, means for introducing liquid to be deaerated centrally of the rotor

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into the space within the inner baffle plate, means associated with said inner baffle plate to prevent the liquid from climbing over said inner plate as it is being introduced, and an outlet for deaerated liquid in the bottom of said chamber.

9. The method of deaerating liquids which comprises introducing a liquid to be deaerated into a confined space maintained under vacuum, subjecting the liquid in said space to a centrifugal force effect to effect dispersal of the liquid radially outwardly, subjecting said liquid in the course of its outward movement to repeated steps of disruption into droplets, and maintaining substantially the entire area covered by the path of outward movement of said liquid open to said vacuum.

10. The method of deaerating liquids which comprises introducing a liquid to be deaerated into a confined space maintained under vacuum,

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subjecting the liquid in said space to a centrifugal force effect to effect dispersal of the liquid radially outwardly, subjecting said liquid in the course of its outward movement to repeated steps of disruption into droplets and subsequent coalescence, and maintaining substantially the entire area covered by the path of outward movement of said liquid open to said vacuum.

WILLIAM MCK. MARTIN.

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