C. E. NORCROSS.

METHOD OF AND APPARATUS FOR EMULSIFICATION.

APPLICATION FILED NOV. 12, 1919.

1,338,996.

Patented May 4, 1920.

2 SHEETS—SHEET 1.

Fig 1

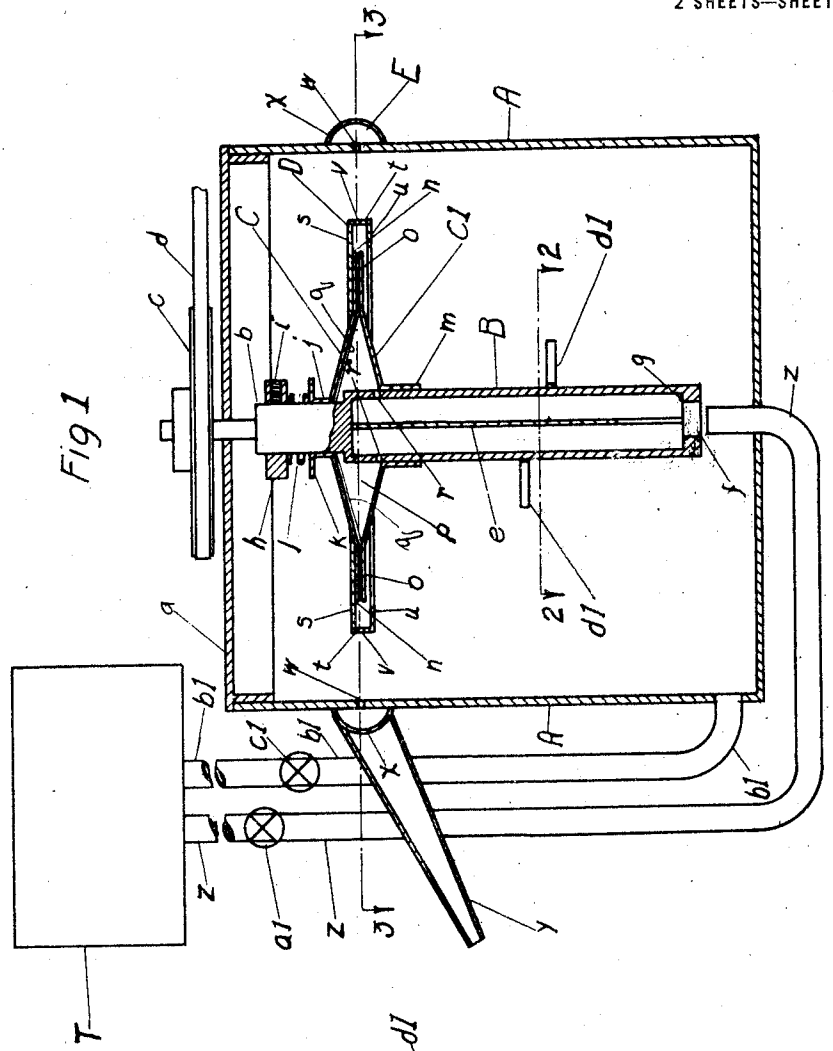
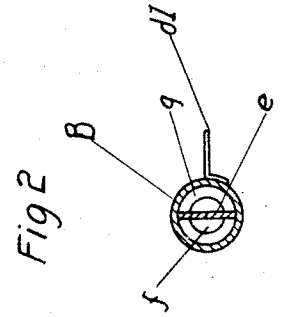


Fig 2



Inventor:
Colen E. Norcross
by Cornelius L. Ehret
his Attorney

C. E. NORCROSS.

METHOD OF AND APPARATUS FOR EMULSIFICATION.

APPLICATION FILED NOV. 12, 1919.

1,338,996. **Patented May 4, 1920.**

2 SHEETS—SHEET 2.

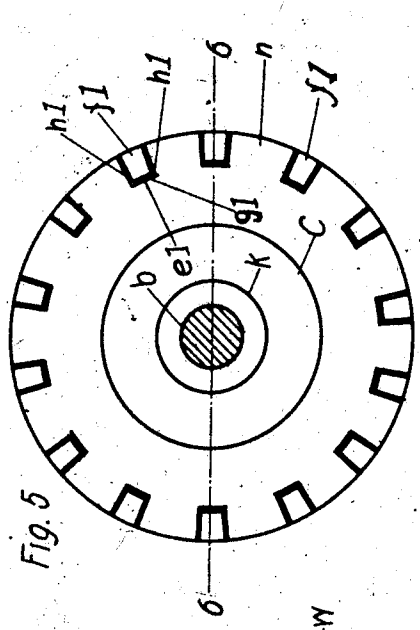


Fig. 5

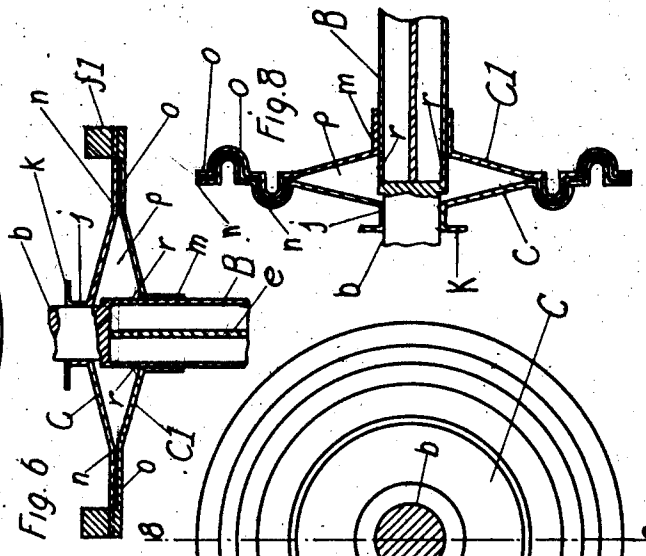


Fig. 6

Fig 7

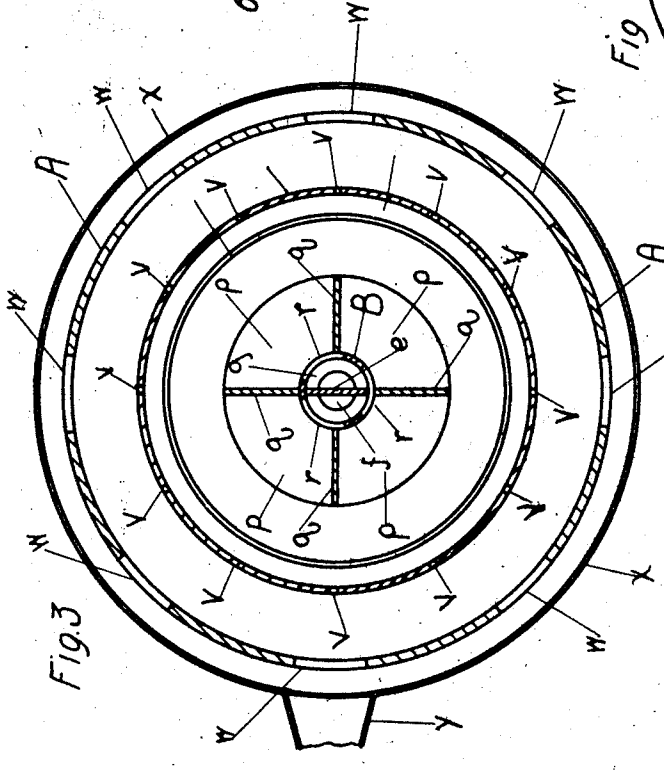


Fig. 3

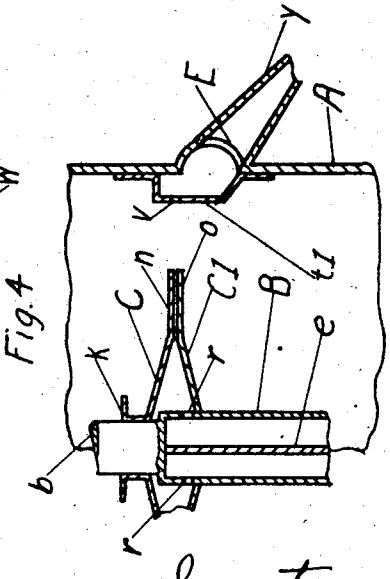


Fig. 4

Inventor:
Colben E. Norcross
by
Cornelius L. Ethret
his Attorney

UNITED STATES PATENT OFFICE.

COLLEN E. NORCROSS, OF WEST CHESTER, PENNSYLVANIA.

METHOD OF AND APPARATUS FOR EMULSIFICATION.

1,338,996. Specification of Letters Patent. Patented May 4, 1920.

Application filed November 12, 1919. Serial No. 337,599.

To all whom it may concern:

Be it known that I, COLLEN E. NORCROSS, a citizen of the United States, residing in West Chester, county of Chester, and State of Pennsylvania, have invented a new and useful Method of and Apparatus for Emulsification, of which the following is a specification.

My invention relates to a method of and apparatus for bringing materials into suspension in a liquid, or for emulsification.

My invention resides in apparatus of the character referred to wherein an annular bowl structure is employed rotatable at high speed to impart to a liquid and the material to be emulsified therewith or brought into suspension therein great centrifugal force under influence of which the mixture is caused to pass through suitable constricted passages and to suffer impact upon a wall more thoroughly and completely to induce suspension or emulsification. My invention resides also in such structure in combination with a tubular bowl by which is effected a preliminary suspending or emulsifying action.

My invention resides further in an annular bowl structure formed between disk members which may yield or be moved relatively to each other in an axial direction for varying the width of a straight or circuitous restricted annular slot or passage through which the materials are forced by centrifugal action.

My invention resides further in such annular bowl structure with which coöperates a preferably perforated wall member, either stationary or preferably rotating with the bowl member, and against which the mixture is thrown after traversing the aforesaid restricted annular slot or passage.

My invention resides further in the combination with structure above described of a stationary wall having a series of perforations substantially in alinement with the aforesaid slot or passage.

My invention resides also in a method of producing suspensions or emulsions by imparting to the mixture high rotative speed to develop sufficiently great centrifugal force to compel the mixture to pass in a thin sheet through a restricted straight or circuitous passage in which fine subdivision and intimate mixture takes place; and further, in impacting the mixture delivered in a thin sheet against a stationary or rotating surface for effecting further subdivision and intimate mixture.

My invention resides in further features of structure and method hereinafter described.

For an illustration of some of the various forms my apparatus may take, and for an understanding of my method, reference is to be had to the accompanying drawing, in which;

Figure 1 is a vertical sectional view, some parts in elevation, of apparatus embodying my invention and suitable for effecting my method

Fig. 2 is a fragmentary horizontal sectional view taken on the line 2—2 of Fig. 1.

Fig. 3 is a horizontal sectional view taken on the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary view illustrating a modification.

Fig. 5 is a plan view of a modified form of bowl structure.

Fig. 6 is a vertical sectional view taken on the line 6—6 of Fig. 5.

Fig. 7 is a top plan view of a further modification of bowl structure.

Fig. 8 is a cross sectional view on the line 8—8 of Fig. 7.

Referring to Figs. 1 to 3 inclusive, A is a vessel, as of sheet metal, provided with the cover *a* supporting the shaft *b* rotated at high speed by any suitable means, as for example, pulley *c* secured upon an extension of shaft *b* and driven by belt *d*. Secured to or integral with the shaft *b* is the tubular bowl member B, which may have one or more longitudinally extending vanes *e*. The bowl B has an admission opening or port *f* at its lower end, preferably of lesser diameter than the inner diameter of the bowl B to form a ledge or dam *g*.

Adjustable longitudinally upon the shaft *b* is the collar *h* secured to the shaft *b* at any desired longitudinal position by set screw *i*. C and C^1 are annular bowl members rotating with the shaft *b*. The member C is supported upon the shaft *b* by the sleeve *j* between whose flange *k* and the collar *h* is the spring *l* exerting downward pressure upon the member C. The member C^1 is supported upon the shaft *b* or bowl member B by its sleeve *m*. At their peripheries the members C and C^1 are provided with the substantially parallel flanges *n* and *o* between which is formed a constricted or narrow radially extending passage, prefer-

ably circumferentially continuous, the vertical width of the passage being variable by adjustment of the collar *h* by variation in the force opposing the spring *l*, and by yielding of the flanges themselves when sufficiently thin and resilient. The bowl space *p* between the members C and C¹ may be traversed by a plurality of curved or straight outwardly extending vanes *q*, Fig. 3, which may be secured to member C¹ and extend toward member C. In the upper end of the bowl member B forming communication between the interior thereof and the bowl space *p* is a plurality of holes or slots *r*.

On one of the annular bowl members, as C, may be secured the annular channel-shaped member D by its radially extending horizontal flange *s*, from which depends the vertical wall *t* having the inwardly extending flange *u*, the latter spaced from the flange *o*. In the vertical flange or wall *t* and preferably in alinement with the slit or narrow annular passage between the flanges *n* and *o* is a series of holes or slots *v*.

Preferably at the same height as the perforations *v*, there are provided through the wall of the receptacle A the holes or preferably circumferentially extending slots *w* communicating with the annular chamber E formed between the outer surface of the receptacle A and the member *x*, a delivery spout *y* communicating with the annular channel or space E so formed.

Into a tank T may be introduced the materials to be emulsified. For example, powdered evaporated milk, butter and warm water in case an emulsion or suspension simulating milk or cream, as for making ice cream, is desired. The crude mixture may be delivered from the tank T through the pipe *z*, controlled by valve a^1, and delivered in a jet into the bowl B through the port *f*. Or the mixture may be delivered from the tank T through the pipe b^1 controlled by valve c^1 into the receptacle A in which it may rise to suitable level and pass into the bowl B through port *f*. Either or both modes of delivering the material to the apparatus may be utilized, as may be desired.

Upon the exterior of the bowl member B may be secured any desired or suitable number of paddles or vanes d^1 for agitating the mixture within the receptacle A to assist in producing or maintaining the suspension or emulsion. These vanes d^1 are particularly useful in batch operation for maintaining the materials in tank A well mixed.

The operation is as follows:

The crude mixture is delivered from tank T through pipe *z*, at suitable rate determined by the setting of the valve a^1, and delivered in jet form through the port *f* into the interior of the bowl B. Or the mixture may be delivered through the pipe b^1, at a rate determined by the setting of the valve c^1, into the interior of the vessel A, from which it rises through the port *f* into the bowl B.

The mixture within member B is caused to partake of similar speed of rotation by the vane structure *e*. Because rotating at high speed, centrifugal force holds the mixture against the inner wall of the member B to any suitable thickness, such, for example, as determined by the radial width of the shelf or dam *g*, which prevents the wall of liquid from dropping out from the bowl B. With the mixture continually fed through the port *f* there is delivery of mixture through the holes or slots *r* at high velocity, causing subdivision or breaking up and more intimate mixture of the materials as they pass therethrough into the bowl cavity *p* between the annular bowl members C and C¹.

The subdivision and intimate mixture of the materials is greatly increased or enhanced by rotation at high speed within the annular bowl member, slippage being prevented by the vanes *q*, and the mixture is subjected to far greater centrifugal force than in the tubular bowl member B, and is forced through the highly restricted slit or passage between the flanges *n* and *o*, further subdividing and intimately mixing the materials, the width of the slit or passage varying automatically with varying conditions of pressure within the annular hole structure, the spring *l* yielding upwardly upon increase of pressure and returning the flanges *n* and *o* toward each other with decreasing pressure within the annular bowl member, the flanges *n* and *o*, if resilient, also yielding to pressure to increase the width of the passage between them.

The mixture leaves the passage between flanges *n* and *o* in a thin annular sheet and strikes upon the wall *t* of the member D which rotates with the annular bowl structure, this impact further subdividing and intimately mixing the materials, the mixture being retained by centrifugal force within the annular space between the flanges *s* and *u*, any excess overflowing through the annular space between flanges *u* and *o* into the interior of the receptacle A, where it may be again drawn through the port *f* and subjected to retreatment. Mixture retained within the member D is forced outwardly through the restricted passages or holes *v*, thereby undergoing further subdivision and intimate mixture followed by further impact upon the inner wall of the vessel A and in large proportion passing through the slots or openings *w* in the wall of the vessel A into the receiving channel or conduit E, from which it is delivered through the spout *y* to any suitable receptacle.

The mixture so delivered is a suspension

or emulsion which, particularly when of the materials above referred to, remains as such for a considerable length of time without serious or appreciable separation. In the manufacture of ice cream, for example, this stability is of importance in that the freezing operation need not take place so soon after emulsification, as is the case with apparatus and methods heretofore employed, so far as I am aware.

By the structure and method described the operation is continuous in that crude mixture is continuously fed from the tank T into the apparatus and the desired suspension or emulsion is continuously delivered through the spout *y*.

In lieu of rotating with the annular bowl structure, the perforated impact member *t* may be stationary, as indicated in the fragmentary view in Fig. 4 at t^1, in which case the member t^1 is supported upon the inner wall of the vessel A and extends across the channel E. In this case the mixture passing through the apertures or restricted passages *v* in member t^1 passes into channel E and is delivered by spout *y*. Some of the material delivered from the annular bowl strikes member t^1 and falls into the interior of the vessel A and undergoes retreatment by reentry through the port *f* into the bowl member B.

In Figs. 5 and 6 is indicated a modified structure of the annular bowl member. The flange *n* has formed therein substantially rectangular or similar notches e^1 upwardly through which and spaced from the edges of the notches extend the lugs f^1 integral with or carried by the flange *o* at its periphery. The restricted passage or slit between the flanges *n* and *o* is then partly barred, in the radial direction, by the lugs f^1, against which the mixture is thrown, some rising through the narrow passage or slit g^1, some through the more or less radially extending slits h^1, and the remainder through the restricted passage between flanges *n* and *o* between neighboring lugs f^1, this structure forming in effect a circuitous passage with sharp changes of direction of flow, which enhances sub-division and intimate mixture of the material undergoing treatment.

In Figs. 7 and 8 is shown a modified structure for procuring a circuitous narrow passage between the peripheral flanges upon the bowl members C and C^1. The peripheral flanges may be formed in any suitable way, as for example, in substantially straight radial portions joined by curved portions. The long restricted slit or passage so formed, particularly because of abrupt changes in direction, assists in subdivision and intimate mixture of the materials undergoing suspension or emulsification.

While I have in each instance illustrated a tubular bowl B as coöperating with the annular bowl structure, it will be understood that the employment of the tubular bowl structure is not essential, though it is preferred, particularly in batch operation. When the tubular bowl structure is omitted, the mixture to be emulsified may be fed through an axial opening in the annular bowl structure, as for example, through the sleeve *m*, which in such case may be of different diameter, generally smaller diameter.

Or a tubular member such as B may be employed which will produce inconsequential or inconsiderable action, particularly when of smaller internal diameter and when the vane structure is omitted, and when having unrestricted delivery into the annular bowl structure.

While I have herein described the continuous operation of the apparatus, it may also operate upon batches of material. In such case the pipes *z* and b^1 are omitted as well as the orifices *w*, channel E and spout *y*. The material in such case is introduced into receptacle A and passes upwardly through the port *f* and receives treatment as hereinbefore described, the material being delivered by the bowl structure and falling again into the receptacle A and undergoing retreatment until an emulsion or suspension of suitable nature is obtained, whereupon the centrifugal structure is removed with the cover *a* and the vessel A emptied and a new batch introduced into it.

What I claim is:

1. The method of bringing materials into suspension or emulsion, which consists in subjecting the materials in the presence of each other to rotation at high speed, delivering the material under the resultant centrifugal force through an extremely narrow annular passage, and impacting the annular jet of material upon a wall rotating with said material.

2. The method of bringing materials into suspension or emulsion, which consists in subjecting the materials in the presence of each other to rotation at high speed, delivering the material under the resultant centrifugal force through a narrow annular passage, impacting the annular jet of material upon a wall, and forcing the mixture through restricted orifices in said wall.

3. The method of bringing materials into suspension or emulsion, which consists in subjecting the materials in the presence of each other to rotation at high speed, delivering the material under the resultant centrifugal force through a narrow annular passage, impacting the annular jet of material upon a wall rotating with said material, and forcing the mixture through restricted orifices in said wall.

4. The method of bringing materials into

suspension or emulsion, which consists in subjecting the materials in the presence of each other to rotation at high speed, delivering the material under the resultant centrifugal force through a narrow annular passage varying in width with variations in the pressure of said rotating material, and impacting the annular jet of material upon a wall.

5. The method of bringing materials into suspension or emulsion, which consists in subjecting the materials in the presence of each other to rotation at high speed, delivering the material under the resultant centrifugal force through a narrow annular passage varying in width with variations in the pressure of said rotating material, and impacting the annular jet of material upon a wall rotating with said material.

6. Apparatus for producing suspensions or emulsions comprising annular bowl structure, and means for rotating the same at high speed, said structure having a circuitous restricted peripheral annular discharge passage.

7. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure comprising resilient members spaced from each other and movable axially with respect to each other to form a restricted annular peripheral passage of varying width.

8. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure comprising members having juxtaposed peripheral flanges, and means for adjusting said members as to their axial relation with respect to each other, said bowl structure having a restricted peripheral annular passage between said flanges.

9. Apparatus for producing suspensions or emulsions comprising a shaft, means for rotating the same at high speed, bowl structure comprising resilient annular members rotatable with said shaft, and peripheral flanges on said bowl members between which is formed a restricted peripheral annular passage.

10. Apparatus for producing suspensions or emulsions comprising a shaft, means for rotating the same at high speed, bowl structure comprising annular members rotatable with said shaft, one of said members movable longitudinally of said shaft with respect to the other, a spring opposing separation of said bowl members, and peripheral flanges on said bowl members between which is formed a restricted annular passage.

11. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, and a wall member adapted to rotate with said structure receiving the impact of liquid discharged from said passage.

12. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage whose length is great as compared with its axial width, and a perforated wall member receiving the impact of liquid discharged from said passage.

13. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure comprising members spaced from each other and yielding axially with respect to each other to form a restricted annular peripheral passage of varying width, and a wall member receiving the impact of liquid discharged from said passage.

14. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure comprising members having juxtaposed peripheral flanges yielding with respect to each other, means for adjusting said members as to their axial relation with respect to each other, said bowl structure having a restricted peripheral annular passage between said flanges, and a perforated wall member receiving the impact of liquid discharged from said passage.

15. Apparatus for producing suspensions or emulsions comprising a shaft, means for rotating the same at high speed, bowl structure comprising annular members rotatable with said shaft, one of said members movable longitudinally of said shaft with respect to the other, peripheral flanges on said bowl members between which is formed a restricted peripheral annular passage, and a wall member receiving the impact of liquid discharged from said passage.

16. Apparatus for producing suspensions or emulsions comprising a shaft, means for rotating the same at high speed, bowl structure comprising annular members rotatable with said shaft, one of said members movable longitudinally of said shaft with respect to the other, a spring opposing separation of said bowl members, peripheral flanges on said bowl members between which is formed a restricted annular passage, and a perforated wall member receiving the impact of liquid discharged from said passage.

17. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, and a

wall rotating with said structure and receiving the impact of the liquid discharged from said passage.

18. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, and a perforated wall rotating with said structure and receiving the impact of the liquid discharged from said passage.

19. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, and an open annular channel member rotating with said structure and receiving the liquid discharged from said passage.

20. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, and an open annular channel member rotating with said structure and receiving the liquid discharged from said passage, said channel member having perforations in its peripheral wall.

21. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, and a vessel inclosing said structure and having perforations in the wall thereof substantially in alinement with said passage.

22. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, a wall member receiving the impact of liquid discharged from said passage, and a vessel inclosing said structure and having perforations in the wall thereof substantially in alinement with said passage.

23. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage whose length is great as compared with its axial width, a perforated wall member receiving the impact of liquid discharged from said passage, and a vessel inclosing said structure and having perforations in the wall thereof substantially in alinement with said passage.

24. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, a wall rotating with said structure and receiving the impact of the liquid discharged from said passage, and a vessel inclosing said structure and having perforations in the wall thereof substantially in alinement with said passage.

25. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, an open annular channel member rotating with said structure and receiving the liquid discharged from said passage, and a vessel inclosing said structure and having perforations in the wall thereof substantially in alinement with said passage.

26. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, a coaxial tubular bowl member delivering into said bowl structure, and restricted orifices between said bowl member and said bowl structure.

27. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure comprising members spaced from each other and movable axially with respect to each other to form a restricted annular peripheral passage of varying axial width, and a coaxial tubular bowl member delivering into said bowl structure.

28. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, a wall rotating with said structure and receiving the impact of the liquid discharged from said passage, and a coaxial tubular bowl member delivering into said bowl structure.

29. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, an open annular channel member rotating with said structure and receiving the liquid discharged from said passage, and a coaxial tubular bowl member delivering into said bowl structure.

30. Apparatus for producing suspensions or emulsions comprising annular bowl structure, means for rotating the same at high speed, said structure having a restricted peripheral annular discharge passage, a coaxial tubular bowl member delivering into said bowl structure, a receptacle within which said bowl member is disposed, and paddle structure on the exterior of said bowl member rotating therewith.

31. Apparatus for producing suspensions

or emulsions comprising a receptacle, a tubular bowl member within said receptacle, means for rotating the same at high speed, an inlet port at one end of said bowl member, restricted outlet structure at the other end of said bowl member, and paddle structure on the exterior of said bowl member rotating therewith.

32. Apparatus for producing suspensions or emulsions comprising a plurality of annular members spaced from each other to form an annular bowl, peripheral flanges on said members between which is formed a restricted annular discharge passage, and vane structure within said bowl.

33. Apparatus for producing suspensions or emulsions comprising a plurality of annular members spaced from each other to form an annular bowl, peripheral flanges on said members between which is formed a restricted annular discharge passage, and vane structure within said bowl secured upon one of said members and extending toward the other.

34. The method of bringing materials into suspension or emulsion, which consists in agitating and mixing said materials, subjecting said materials to rotation at high speed, delivering the materials under the resultant centrifugal force through restricted orifices, again subjecting said materials to rotation at high speed, and impacting said materials under the resultant centrifugal force upon a wall.

35. The method of bringing materials into suspension or emulsion, which consists in agitating and mixing said materials, subjecting the resultant mixture to rotation at high speed and delivering them through restricted orifices, again subjecting said materials to rotation at high speed, delivering said materials through a narrow annular passage, impacting said materials upon a wall, and forcing said materials through restricted orifices in said wall.

36. The method of bringing materials into suspension or emulsion, which consists in subjecting the materials to rotation at high speed, delivering the materials under the resultant centrifugal force through a narrow annular orifice, impacting the resultant annular jet upon a wall having restricted orifices, collecting the materials passing through said orifices, and returning the remainder of the materials for retreatment with untreated materials.

37. The continuous process of bringing materials into suspension or emulsion, which consists in continuously feeding said materials, subjecting the materials to rotation at high speed, delivering said materials under the resultant centrifugal force through a relatively long narrow annular slot, impacting the resultant annular jet upon a wall rotating with said materials, forcing a part of said materials through restricted orifices in said wall under the resultant centrifugal force, collecting the remainder of said materials, and returning said collected materials for retreatment.

38. The method of bringing materials into suspension or emulsion, which consists in delivering said materials in rapid rotation and under centrifugal force through an extended narrow annular orifice, impacting the resultant annular jet against a wall and forcing said materials in rapid rotation and under centrifugal force through restricted orifices, and impacting the materials passing through said orifices under centrifugal force upon a wall.

39. Apparatus for producing suspensions or emulsions comprising annular bowl structure, said structure comprising members having juxtaposed peripheral flanges, and a channel member surrounding the periphery of said flanges comprising an upper wall secured to one flange member and parallel thereto, a second wall spaced from and perpendicular to said flanges, and a third wall parallel to and spaced from said flanges, said perpendicular wall having restricted orifices.

40. Apparatus for producing suspensions or emulsions comprising bowl structure, means for rotating the same at high speed, said structure comprising juxtaposed peripheral flanges formed of joined radially straight and curved portions.

In testimony whereof I have hereunto affixed my signature this 10th day of November, 1919.

COLLEN E. NORCROSS.