

Jan. 9, 1940.

J. L. MILTON

2,186,033

METHOD AND APPARATUS FOR TREATING FLUIDS AND SOLIDS

Original Filed Feb. 25, 1932 2 Sheets-Sheet 1

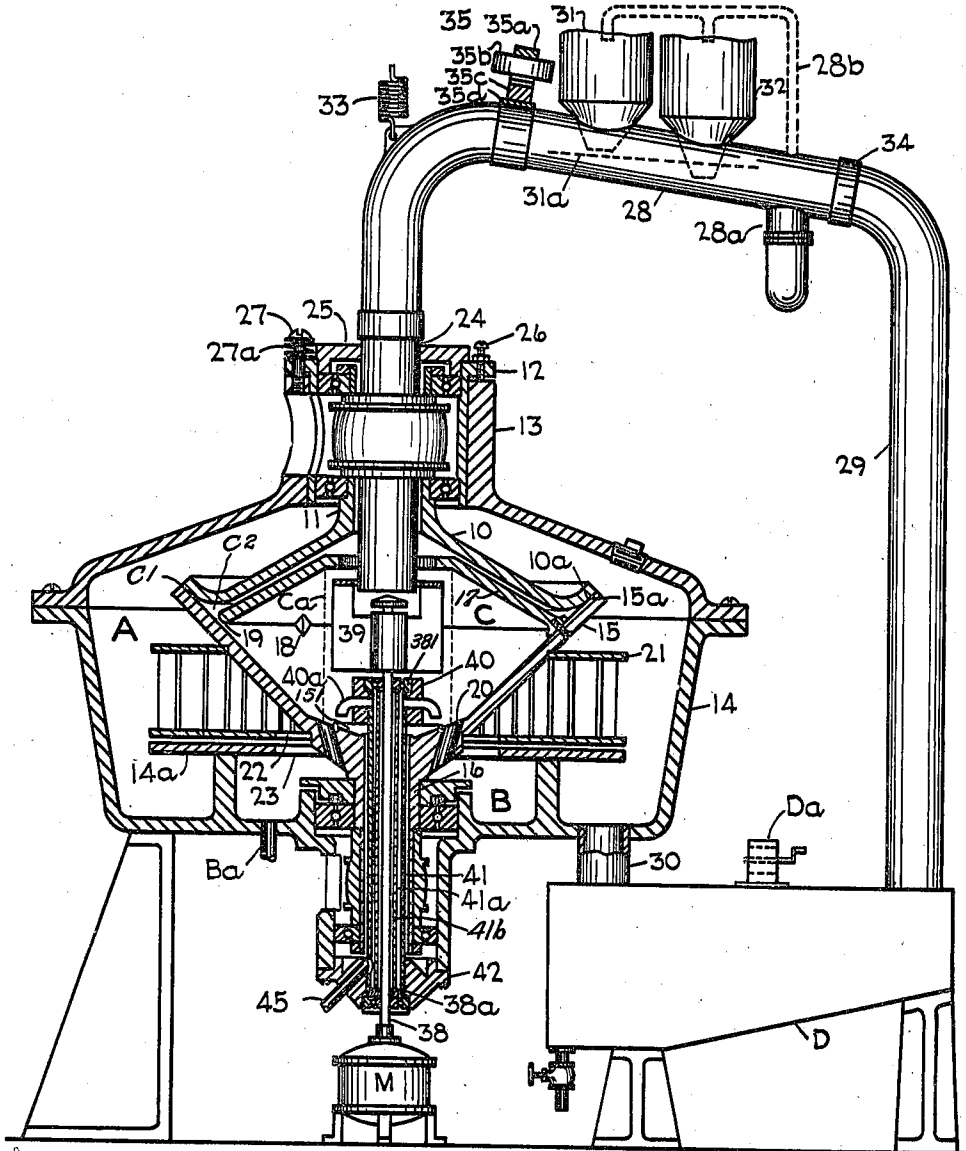


Fig. 1

Inventor

John L. Milton

Jan. 9, 1940.

J. L. MILTON

2,186,033

METHOD AND APPARATUS FOR TREATING FLUIDS AND SOLIDS

Original Filed Feb. 25, 1932 2 Sheets-Sheet 2

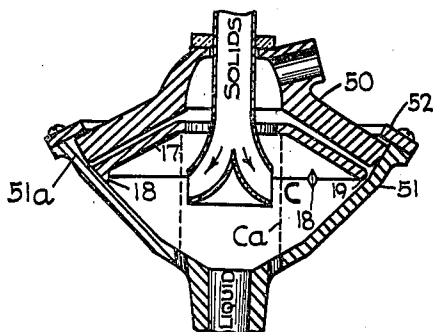


Fig. 2

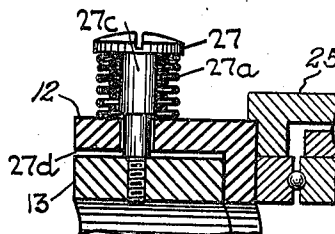


Fig. 1A

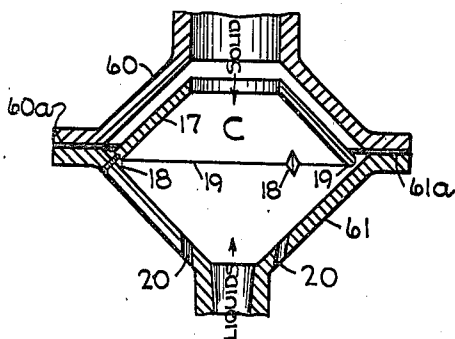


Fig. 3

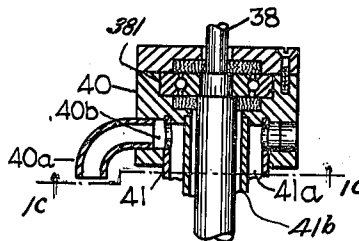


Fig. 1B

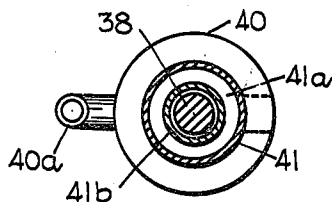


Fig. 1C.

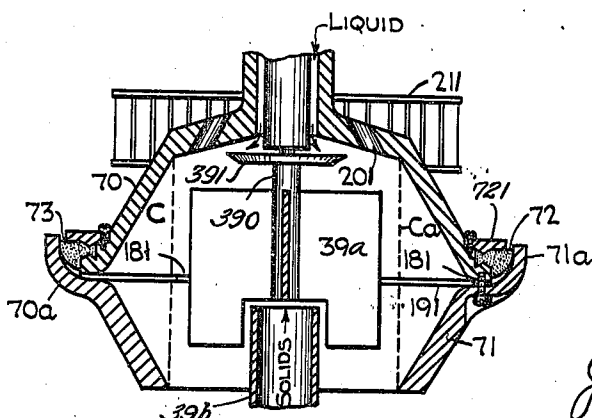


Fig. 4

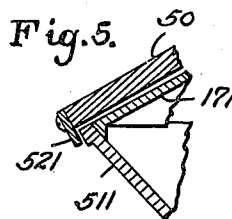


Fig. 5.

Inventor
John L. Milton.

UNITED STATES PATENT OFFICE

2,186,033

METHOD AND APPARATUS FOR TREATING
FLUIDS AND SOLIDS

John L. Milton, Louisville, Ky.

Application February 25, 1932, Serial No. 595,124
Renewed May 4, 1936

23 Claims. (Cl. 259—50)

This invention is predicated upon the principle of combining solids and fluids by centrifugal force for effecting suspensions and/or impregnation.

Production of colloids and particularly regenerated milk and synthetic cream from milk powders; dispersing barytes, magnesium carbonate, zinc oxide, litharge, calcium, magnesium oxide, et cetera, in latex or paint vehicles are representative of suspensions effected by this mill.

An object is to effect impregnation of solids with fluids, also instantaneous, absolute dispersion of solids into quiescent liquid directly through the medium of centrifugal force without beaters, agitators, et cetera, operating on or in the liquid, heretofore employed for accomplishing these objects. A further object is to homogenize the product where desirable. To this end a rotatable container or containers with axial means of ingress and peripheral means of egress for liquids and solids are provided together with means for separately delivering liquids and solids to the container or processing area as required to effect automatic continuous production.

A structure employing a single or a pair of rotatable faced bowls co-axially disposed and fashioned with closely adjacent annular angularly disposed peripheral faces, of frusto-conical form correlated and actuated to control egress of products supplies the nucleus of the mill around and to which are assembled several coordinating units all of which cooperate to process the raw materials into the finished product. The liquid and solids to be treated can be introduced to the processing area by means of stationary ducts arranged co-axially with hollow driving shafts of the bowls.

In Figure 1 of the drawings affixed to this specification and forming part thereof, a pair of faced rotatable centrifugal bowls are illustrated principally in cross-section disposed in a housing which carries concentric stationary ducts to which are attached conduits for the admission of the raw materials from delivery sources equipped with means for actuating said materials for transference.

Fig. 1A is an enlarged cross sectional view of the tensioning device shown at the left side of Fig. 1. Fig. 1B is an enlarged vertical cross sectional view of the distributor head (part 40). Fig. 1C is an enlarged horizontal cross sectional view along line 1c, Fig. 1B. Fig. 2 is a diagrammatic cross-sectional view of a pair of processing bowls to be substituted for those shown in Fig. 1. Fig. 3 is a diagrammatic cross-sectional view of a modified bowl, which can be substituted for the one shown

in Fig. 1. Fig. 4 shows a still further modification of a processing bowl, shown mainly in cross section. Fig. 5 is a modification of Fig. 2 to indicate the reverse relation of the bowl and the impedance flange.

10 is an inverted conical top bowl constructed with a hollow shaft 11 rotatably mounted in an axially adjustable sleeve 12 carried by housing 13, with which companion housing 14 completes a processing chamber A. 15 is lower conical bowl carried by hollow shaft 16 which is rotatably mounted in housing 14. 17 is an auxiliary inverted bowl entirely free from the top bowl but attached to the lower bowl and contacting only at remote spots, as at 18, thereby leaving gaps 19 for the remainder of the circumference. In the hub of bowl 15 are a plurality of diagonally disposed ducts 20 to establish communications to sub-chamber B, which is closed at the top by stationary plate 14a having a central opening 23 therein. Attached to bowl 15 is a fan rotor 21 having circumferentially disposed openings 22 and located adjacent to and in communication with the opening 23 in plate 14a so that the fan will pull air from the chamber C or container formed by the two major bowls 10 and 15 via ducts 20. Inasmuch as the peripheral faces 10a and 15a of the major bowls 10 and 15 are normally closely positioned as indicated by C1, the air drawn from the chamber C will necessarily be replaced by air drawn through the input duct 24. It will be observed that the duct 24 is concentrically located with the major bowls 10 and 15 by flanged collar 25 and serves to convey the dry solids from the feed hoppers 31, 32.

Bowl 10 is rotatably mounted on ball bearings, which ball bearings are fixedly mounted in sleeve 12. Sleeve 12 is slidably mounted for reciprocation in the cylindrical bearing in the top of housing 13. Collar 25 is fixedly secured to the upper end of sleeve 12 and also slidably engages duct 24, which duct 24 is concentrically located by the said collar. Sleeve 12 is floatingly secured to housing 13 by the tensioning device 27, which tensioning device is shown in Figure 1A. The tensioning device 27 consists of a shouldered screw 27c having a threaded end fixedly secured to the housing 13 as shown in Figure 1A. The screw 27c is also provided with a lower shouldered section having a diameter less than the hole in the flange of sleeve 12 through which the shouldered section passes. This construction and relation is clearly shown in Figure 1A. Accordingly, the sleeve 12 is free to reciprocate within the cylindrical bearing in the top of the housing 13. To limit

the upward travel of sleeve 12, the screw 27c is further provided with an upper shouldered section having a diameter larger than that of the hole in the flange of sleeve 12. Hereinafter, this will be referred to as the "up" stop. Thus, when pressure is exerted on the bowl, as hereinafter explained, the sleeve 12 moves upwardly in the cylindrical bearing in housing 13 and overpowers the springs 27a of the tensioning device.

Referring in particular to Figure 1A, it will be observed that springs 27a surround the large shouldered section and react between the head of the screw 27c and the upper face of the flange on sleeve 12. Accordingly, the sleeve 12 and bowl 10 are yieldingly forced downwardly by the springs 27a. While I have illustrated but one tensioning device in Figure 1, it is to be understood that three such devices are employed and distributed equally about the circumference of the flange of sleeve 12.

Referring now to Figure 1, it will be observed that a screw 26 is also mounted in the flange of sleeve 12. Screw 26 is employed to limit the downward travel of sleeve 12 and to accordingly adjust bowl 10 in terms of bowl 15, so as to fixedly determine the minimum clearance between the peripheral faces 10a and 15a. Hereinafter, screws 26 will be referred to as "down" stops.

From the foregoing it will be obvious that screws 26 may be adjusted to, in effect, rigidly secure sleeve 12 to the housing 13 by raising the upper face of the flange on sleeve 12 into engagement with the upper shouldered section of the screw 27c. Thus, the limiting devices control the normal space or gap between faces 10a and 15a according to the setting determined by down stops 26. These can be set so that the faces will actually contact, thereby producing in effect a single bowl which under sufficient internal pressure, produced by the action of centrifugal force on the materials under process, will cause the faces to separate or "crack" and thereby liberate or extrude the product subject to the squeezing action of springs 27a, which will incidentally produce an effective homogenizing action. It should be noted that under these conditions, the top bowl rides or floats on the materials under process. Should the "up" stops of the limiting device 27 be set to determine the gap between the faces, and the product exert pressure beyond the strength of the springs, then the up stop will temporarily determine the maximum gap.

Duct 24 is slidably mounted in collar 25 and is in communication with angularly disposed supply duct 28 which in turn is in communication with settling chamber D via vertical duct 29. D is connected to chamber A by drain duct 30. Attached to 28 is feed hopper 31 arranged to deliver solids to the floor of baffle plate 31a while hopper 32 also attached to duct 28 delivers solids to the inner bottom surface of said duct. Spring 33 is arranged to suspend one end of duct 25 while flexible coupling 34, such as rubber, suspends the other end, thereby substantially floating duct 28 and the depending input tube in order that it can readily respond to rapid vibrations produced by an A. C. vibrator motor 35 which may be constructed of a yoke 35a, coil 35b, and armature 35c carried by flat spring 35d to which the duct is attached. The rapid vibrations of the motor are employed not only to agitate the solids to enable the gas currents to carry them to their destination but to prevent

the particles from lodging in the conduit. When a completely closed system is to be employed duct 28b is connected as shown for equalizing pressure between the hoppers, which are necessarily closed, and duct 28. It is obvious that an atmosphere of a selected gas can be substituted for air. Shaft 38, which is driven by motor M carries fan rotor 39 and is mounted in the small ball bearings, the top one of which is carried in a head 40 concentrically attached to standpipe 41 which is concentrically mounted in head 42, the latter is fixed to housing 14. The standpipe is constructed in the clear of the inner walls of bowl shaft 16, while the bottom bearing is mounted in head 42 and is equipped with a suitable plug 38a to seal it from communication with the interior of the standpipe, which carries an inner pipe 41b to seal the shaft 38 and to form the liquid input duct 41a established between the two pipes 41, 41b. Head 40, Fig. 1B, carrying the upper ball bearing 381, is formed with an inner annular groove 40b in communication with duct 41a. A plurality of elbows 40a are in communication with this groove and are disposed so as to discharge liquid on the top surface of elevated ring 151 an integral part of the hub of bowl 15. As the liquid flows from the periphery of 151 it is directed in response to centrifugal force, to spread in arcuate film formation over the outwardly disposed adjacent area, which includes the inner bowl openings of ducts 20, thereby causing the gas vehicle to pass through or intermingle with said film as it proceeds on its way through said ducts from chamber A. This is provided for the removal of any entrained solid particles that were not previously removed from the gas vehicle or to cause an engagement or contact between the gas or fluid leaving the mixing chamber A with the liquid or fluid entering same through head 40a. A similar arrangement is provided in Fig. 4, where disc 391 forces a film of the incoming material over exits 20. Duct 41a connects with a liquid supply such as a pump (not shown), operated at a ratio fixed in terms of the solids supply, through duct 45 located in head 42. This whole sub-assembly being organized to convey liquid from an external source to chamber C.

Operation

In operation power is supplied to the bowl 15 preferably by a belt as indicated. After a selected speed has been attained liquid is fed in through duct 45, ascends and is discharged on to hub of said rotating bowl whereupon it is thrown out over the inner surface and ascends the inner surface of the bowl 15 unimpeded, except for normal minor resistances, until it reaches the film surface established by surfaces 10a, 15a. The top bowl 10 is then brought into rotation due to the crowding of the liquid between said surfaces. To intensify the resistance, bowl 10 is held or retarded, preferably by a belt (not shown), which is put into motion by the pulley. The other end of this belt passes over a pulley attached to the shaft of a dynamo electric machine, preferably of the direct current type, and is used as a dynamo with externally excited fields in order to effectively control the retardance of bowl 10 over a wide range of speeds. However, this can be a motor and the speed of rotation advanced, retarded or reversed in terms of bowl 15.

It should be noted that the structure provides a chamber into which the materials are fed, processed and ejected without being subjected to

agitation such as is produced by the action of beaters and agitators, or turbulence which follows subjecting liquid to the action of two correlated bowls or a bowl and an impeller operating at different speeds or in the opposite direction one to the other. Since the liquid is not agitated, although it is under rotation and in radial motion during the processing, it is sometimes herein referred to as being in a "quiescent" state.

With bowl 15 in operation, liquid is fed through ducts 45 and 41a and will ascend and build up in chamber C until it establishes a vertical cylindrical level wall Ca, the inside diameter of which is determined by ducts 20. Excess liquid will be discharged through said ducts and be forced into chamber B where it will pass out through duct Bz and returned to the supply tank (not shown). Fan 21 simultaneously withdraws air from chamber C through duct 20 into chamber B as explained supra. Fan blades 39 contribute to the egress of this air and simultaneously are employed to discharge particles into the wall of liquid, said particles being drawn in through input duct 24. The action of these blades can be regarded as a medium for transferring the solids from the gas stream to the liquid. Centrifugal force is imparted to the particles and carries them through the wall, where they are stripped of entrained removable gas, such as absorbed and/or adhering gas. The solids thus impregnated are forced on through the liquid. The particles being of heavier specific gravity tend to collect at and in the peripheral opening. It will be seen that the revolving liquid has been freed of at least certain gases and that as the particles are transferred into this rotating wall the removable air of the solids will also be eliminated, thereby continuously effecting a relatively perfect impregnation of the particles. This expression is used relatively and is not intended to convey the idea of a never ending process, rather to distinguish from the "batch" method.

To prevent turbulence incident to bowl 15 being driven at a speed varying from bowl 10, auxiliary bowl 17 is provided with the gaps 19 as explained supra. The product passes through these gaps into chamber C2 and is discharged in a dispersed and/or attenuated state from aperture C1 into the chamber A where it flows over the inner wall thereof and gravitates to the bottom from where it can be drawn from the machine through duct 30 into settling tank D. The same means provides egress for the gas.

The established gas pressure is transmitted to vertical duct 29, Da being provided for use as a vent under certain conditions. The gas currents are transmitted to diagonally disposed or inclined duct 28 into which is fed the solids via hoppers 31, 32 where unit 28 and its appurtenances are subjected to rapid vibration in order that the fines can be suspended in the gas currents and the coarse aggregates separated and permitted to respond to gravity and drop into duct 28a where they can be collected or passed through rolls or other pulverizing means and returned to the system. Floor 31a is angularly disposed to the bottom of 28 in order that lighter or more responsive solids, such as magnesium carbonate, can be simultaneously fed with heavier ones, such as zinc oxide, through individual hoppers to provide means for feeding dissimilar constituents. A screw conveyor can be substituted for the feeding method just described.

Modifications

In the modified structure shown in Fig. 2 a stationary inverted bowl 50 is substituted for bowl 10 shown in Fig. 1 which is constructed to cooperate with lower bowl 51 provided with inner bowl 17 and fashioned with face 51a disposed at a lesser angle to the axis of rotation than that employed in the former bowl, in order that centrifugal force will tend to impinge the product more vigorously against the working face than if a greater angle to the axis were selected and thereby hold the product in the bowl for a longer period where desired as when very light particles are under treatment, which would inherently be slower in responding to the centrifugal impregnating forces. This feature will also be useful for delaying the expulsion of the liquid in order to keep it in step with the conveyance of the particles to the liquid for impregnation and/or suspension, especially where an abnormally slow treatment is desired and when the rotor is operated at relatively high speeds and provides facilities for assisting in controlling or balancing the output to the input of the constituents delivered by the feeding apparatus, particularly where automatic control is involved. As a further means of impeding the outflow of the product, annular flange 52 angularly extending towards the axis of rotation of the rotor is attached to the rotor and overlaps the stator substantially as shown, however the drawing is not intended to dictate proportions or exact relations as these factors can be varied according to the behavior of the materials under process and to favor the desired results. As shown in Fig. 5, the rotor and stator can be reorganized so that the stator 50 will carry the impedance flange 52 and effect a further retarding action on the materials under process. It should be noted that numeral 511 designates the main rotating bowl, and that inverted bowl 171 is mounted thereon.

As another effective means for impeding the outflow of the product, when desirable, the bowls can be operated in opposite directions in order that the resultant forces on the product confined between the operating faces will tend to neutralization and thereby prolong the duration for forcing the solids into the liquid wall. The modified structure indicated in Fig. 3 is especially adaptable to these conditions. Bowls 60 and 61 have faces 60a and 61a which may be of the same or different area and the speed of rotation can be the same or varied.

To provide means for mixing and/or impregnating highly abrasive materials such as silica and cement with liquid without excessive damage to the mill, the structure shown in Fig. 4 can be employed. Bowl 70 is substituted for bowl 15, however inverted, while ring 71 is carried in fixed relation thereto by bowl 70 at spaced sections designated by 181. This arrangement results in arcuate gaps 191. There are no working surfaces provided at the peripheral outlet 72, which is formed between face 70a and the juxtaposed face of annular ring 73 composed of a flexible material, such as cork or rubber, which is attached at the inner periphery thereof to bowl 70 by rings 721. For material in process to escape it is necessary for it to force a gap between face 70a and ring 73. Centrifugal force tends to keep ring 73 against face 70a which effect is of special use during starting, which is preferably lower than the operating speed, when liquid is introduced in advance of the solids. Numeral 39a designates fan blades that are car-

ried by shaft 390. Shaft 390 also carries a disc 391. Suspended solids are fed through duct 39b and are forced by fan 39a into the wall of liquid Ca, while liquid is fed through the hollow shaft of the upper bowl and deposited on the disc 391, which disc is carried and rotated by shaft 390. The liquid deposited on the disc is thrown outwardly and accordingly forms an annular spray. The annular spray forms a veiling over the exit ducts 201 and functions to arrest the entrained fine particles that failed to respond to the centrifugal action of the fan. This structure and action corresponds to that described for similar parts in Fig. 1. Obviously fan 211 corresponds to 21 in Fig. 1.

Scope

Although a closed system of feeding and operating the apparatus is shown and described, it can be adapted for communication with the atmosphere in whole by omission of duct 29, or in part, by opening vent Da without departing from the essential principles.

The two bowls selected to disclose this invention have their abutting faces fitted by mutual abrasion to function as a unitary structure, however, they can be replaced by a single bowl particularly in cases where the normal gas content of the solids is to be replaced with a heavy gas and this step is to be followed by impregnation or a coating operation. It is obvious, that for this method of procedure, the solids must be delivered into the processing bowl in advance of the liquid. Further, the speed of rotation can be varied for each step, et cetera, all without departing from the disclosed fundamental principles.

I claim:

1. A process of continuously mixing dry particles with liquid having lower specific gravity comprising, continuously advancing liquid into a vessel, continuously rotating the vessel at a velocity sufficient to establish and maintain a hollow body of the liquid within the vessel, continuously delivering dry particles into the inner surface of the hollow body, and continuously discharging the particles mixed with the liquid from the vessel.

2. A process of continuously mixing dry material with a liquid having a lower specific gravity, comprising, continuously advancing a liquid into a vessel, continuously rotating the vessel at a velocity sufficient to establish and maintain a hollow body of the liquid within the vessel, continuously delivering the dry material to the inner surface of the hollow body, centrifugally moving the material through the liquid forming the hollow body, and continuously discharging the material mixed with the liquid from the vessel.

3. A process of mixing dry material with a liquid having a lower specific gravity, comprising, delivering the liquid into a vessel, rotating the vessel at a velocity sufficient to establish and maintain a hollow body of the liquid within the vessel, delivering the dry material to the inner surface of the hollow body and centrifugally moving the material through the liquid forming the hollow body.

4. A method of impregnating one material with a second material which consists in subjecting the first material to centrifugal force, while maintaining same in a quiescent state, subsequently centrifugally forcing the second material into the first materials and removing gases from both material by said centrifugal force.

5. A process of suspending dry solids in liquid, comprising, continuously advancing a stream of liquid to the inner periphery of a rotating vessel to establish and maintain a substantially quiescent cylindrical wall of said liquid, and continuously advancing a supply of dry solids adjacent the center of said vessel so as to contact the liquid in said rotating vessel and continuously discharging the product.

6. A process of suspending dry solids in liquid by centrifugal force, comprising, continuously advancing a stream of liquid to a rotating vessel while maintaining said liquid in a quiescent state, and continuously advancing a supply of solids to unite with the liquid in said rotating vessel, and continuously discharging the product from the periphery of said vessel.

7. A process of suspending dry solids in liquid by centrifugal force, comprising, continuously advancing a stream of liquid to a rotating vessel while maintaining the interiorly disposed surface of said liquid in a quiescent state, and continuously advancing a supply of solids adjacent the axis of said vessel to unite with said surface of the liquid in said rotating vessel, and continuously discharging the product.

8. A process for suspending dry solids in liquid by centrifugal force, comprising continuously advancing a stream of liquid to a rotating vessel while maintaining same in a quiescent state and continuously advancing a supply of said solids into the interior of said vessel where said solids are centrifugally forced to unite with the liquid.

9. A method of combining liquid and dry matter which consists of continuously forcing minute solids into a rotating wall of liquid by throwing minute solids from a gas stream into said rotating liquid and eliminating all the gas of said stream; continuously supplying liquid and solids to the wall continuously discharging the product while maintaining said wall at a predetermined cylindrical level.

10. A process of suspending dry solids in liquid, which consists of feeding conglomerate fine and coarse solids into a vibrating duct in which an air stream suspends and conveys said solids to and discharges same into a body of revolving liquid where said solids are suspended in said liquid.

11. A process of suspending dry solids in liquid, which consists of feeding conglomerate fine and coarse solid particles into a vibrating duct in which an air stream suspends and conveys the fine particles to a chamber circumscribed by a wall of revolving liquid where the particles are centrifugally forced from said stream into said wall.

12. A process of suspending dry solids in liquid, which consists of feeding solids onto a vibrating member in the presence of an air stream which suspends and conveys some of said solids to and into a body of revolving liquid where said solids are discharged and suspended in said liquid.

13. The method of suspending solids in liquid which comprises, conveying solids by a gas stream into a rotating body of liquid, removing the solids from the gas and depositing said solids in the liquid and passing the gas stream through a film of liquid as it leaves said body.

14. In an apparatus for effecting suspensions, comprising, a bowl mounted on an axis, means for conveying and delivering solids to the interior of the bowl, other means for conveying and delivering liquid to the interior of the bowl, a rotatable member within the bowl to operate on

said solids and means to simultaneously rotate said bowl and said rotatable member at different speeds.

15. An apparatus for forcing dry solid particles into liquid and simultaneously excluding gas, comprising, rotatable members having annular working surfaces; means for spacing said surfaces, means for rotating said rotatable members so that the working surfaces move past each other; means for separately introducing particles and said liquid into the rotatable members; pneumatic means for conducting the dry particles into said members, centrifugally radially forcing the particles into the rotating liquid and means for ejecting the product from the junction of said surfaces.

16. An apparatus for impregnating dry solids with liquid, comprising, a rotating member; independent means for introducing liquid and a pneumatic stream for introducing solids into said member; means for centrifugally forcing said solids from said stream into said liquid and means for simultaneously excluding gases from said solids.

17. An apparatus for impregnating dry solids with fluid, comprising, rotatable bowls having annular faces; means yieldingly securing said faces in closed relation to form a chamber, and provide a homogenizing element; means for rotating the bowls; means for conveying said dry solids into the rotating chamber and centrifugal means for substituting fluid for the gas in said solids.

18. An apparatus for impregnating dry solids with fluid, comprising, rotatable bowls having annular faces; means yieldingly securing said faces in closed relation to form a chamber, means for rotating the bowls; means for conveying said dry solids into the rotating chamber and centrifugal means for substituting fluid for the gas in said solids.

19. In an apparatus of the centrifugal type, a rotating bowl in three sections, two sections of which are secured together and define between them an annular chamber having a fixed outlet at the periphery of one section and adjacent the periphery of its companion section while two of

said sections define between them an annular chamber having a peripheral outlet.

20. A centrifuge for effecting a mixture of dry solids and liquid and homogenizing said mixture, comprising, a pair of bowls rotatable together as a unit; pneumatic means for supplying said solids and other means for delivering liquid into said bowls, means for centrifugally forcing said solids into said liquid and means for expelling said mixture through an homogenizing element constituting a part of each of said bowls.

21. Mixing apparatus comprising a mixing receptacle, a supply container for powdered material; means agitating said material in said supply container to effect flow therefrom; means continuously conducting said flow of powdered material from said supply container into said receptacle, a source of supply of liquid material, means effecting the flow of said liquid material, means introducing said flow of liquid into said receptacle, and means continuously mixing the materials in said receptacle.

22. Mixing apparatus comprising a mixing receptacle, a supply container for powdered material, means agitating said material in said supply container to effect flow therefrom, means continuously conducting said flow of powdered material from said supply container into said receptacle, a source of supply of liquid material; means effecting the flow of said liquid material; means introducing said flow of liquid into said receptacle; means continuously mixing the materials in said receptacle, and means continuously discharging said materials after mixing.

23. Mixing apparatus comprising a mixing receptacle, a supply container for powdered material above said receptacle, means agitating said material in said supply container to effect flow of said powdered material therefrom, means continuously conducting said flow of powdered material from said supply container into said receptacle, a source of supply of liquid material, means introducing said liquid into said receptacle, and means continuously mixing the materials in said receptacle, said receptacle having means providing a continuous overflow of the material processed therein.

JOHN L. MILTON.