

[54] **APPARATUS FOR DISPERSING FINELY DIVIDED SOLID PARTICLES IN A LIQUID VEHICLE**

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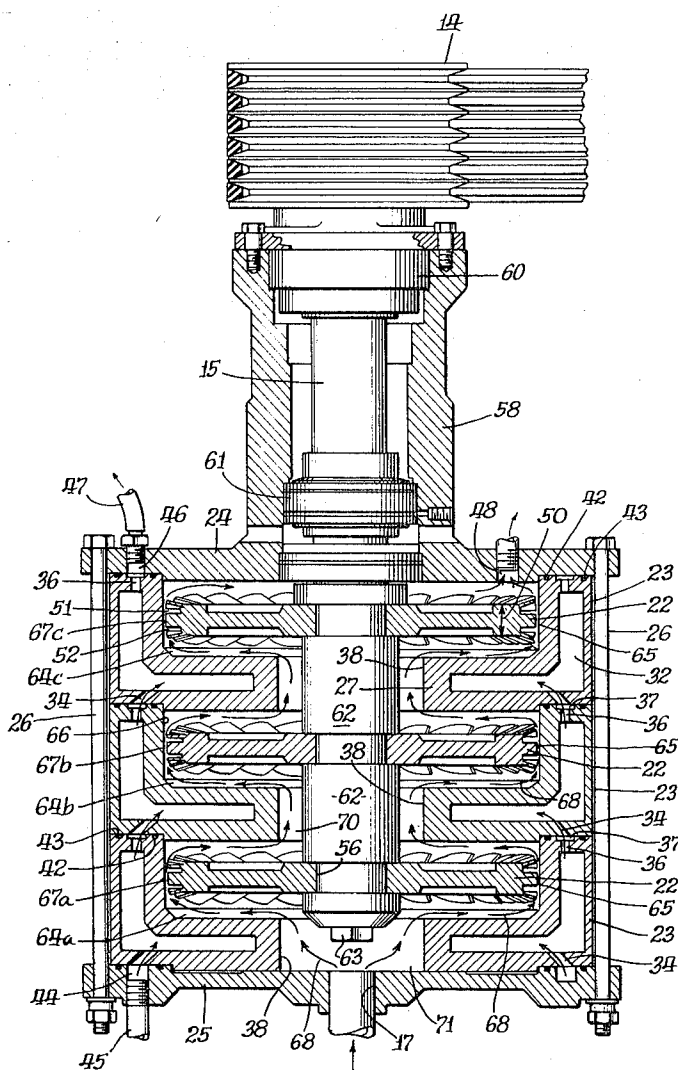
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[57] **ABSTRACT**

Apparatus for dispersing finely divided solid particles in a liquid vehicle including a mixing vessel comprising one or more dish-shaped elements which may be easily removed from each other and assembled to each other and which in their assembled relationship provide one or more chambers wherein a fluid mixture is agitated and subjected to high pressures in the process of finely dividing solid particles and effecting distribution in the liquid vehicle.

9 Claims, 8 Drawing Figures



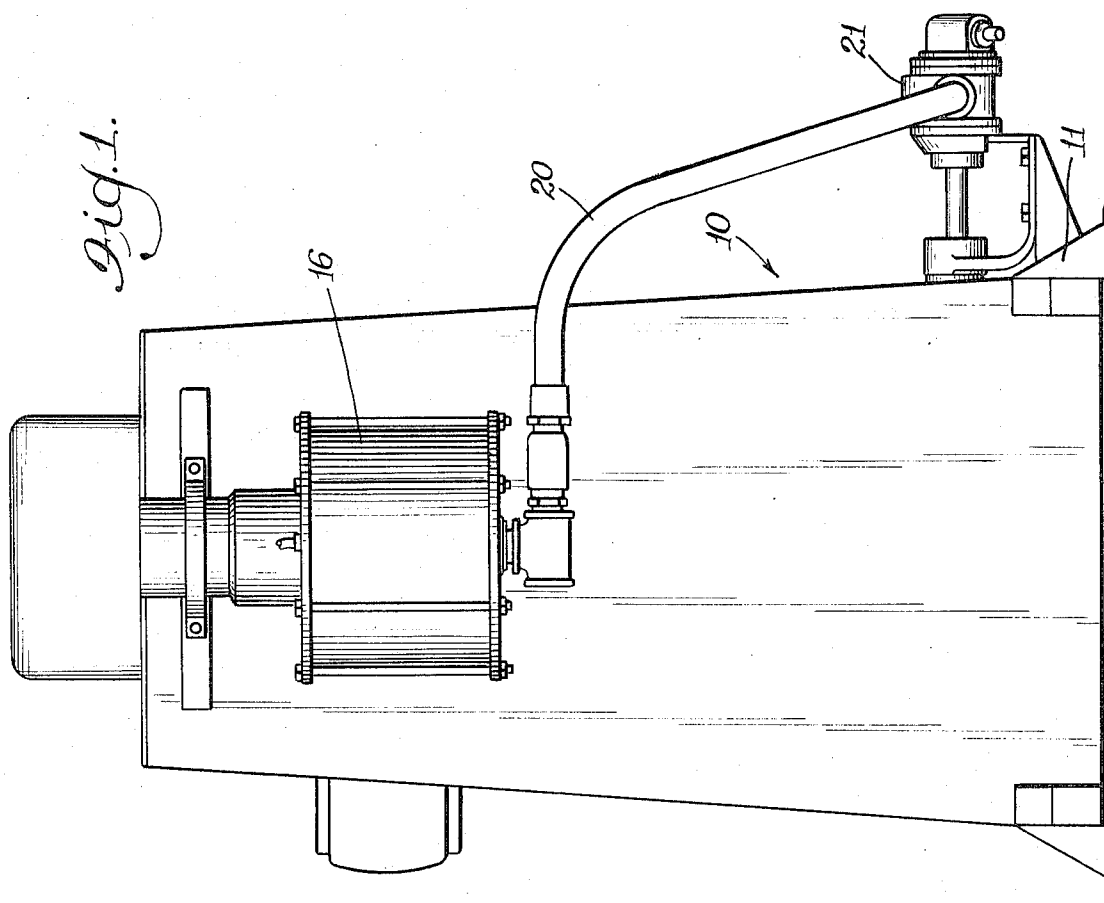
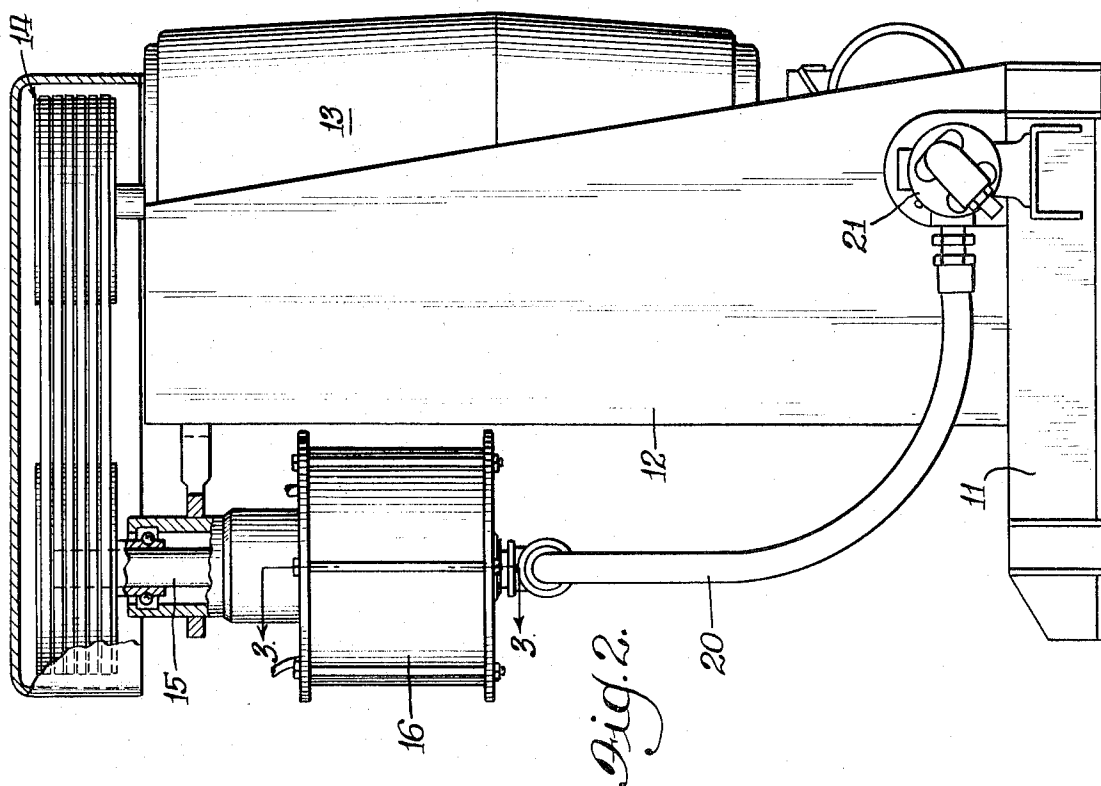
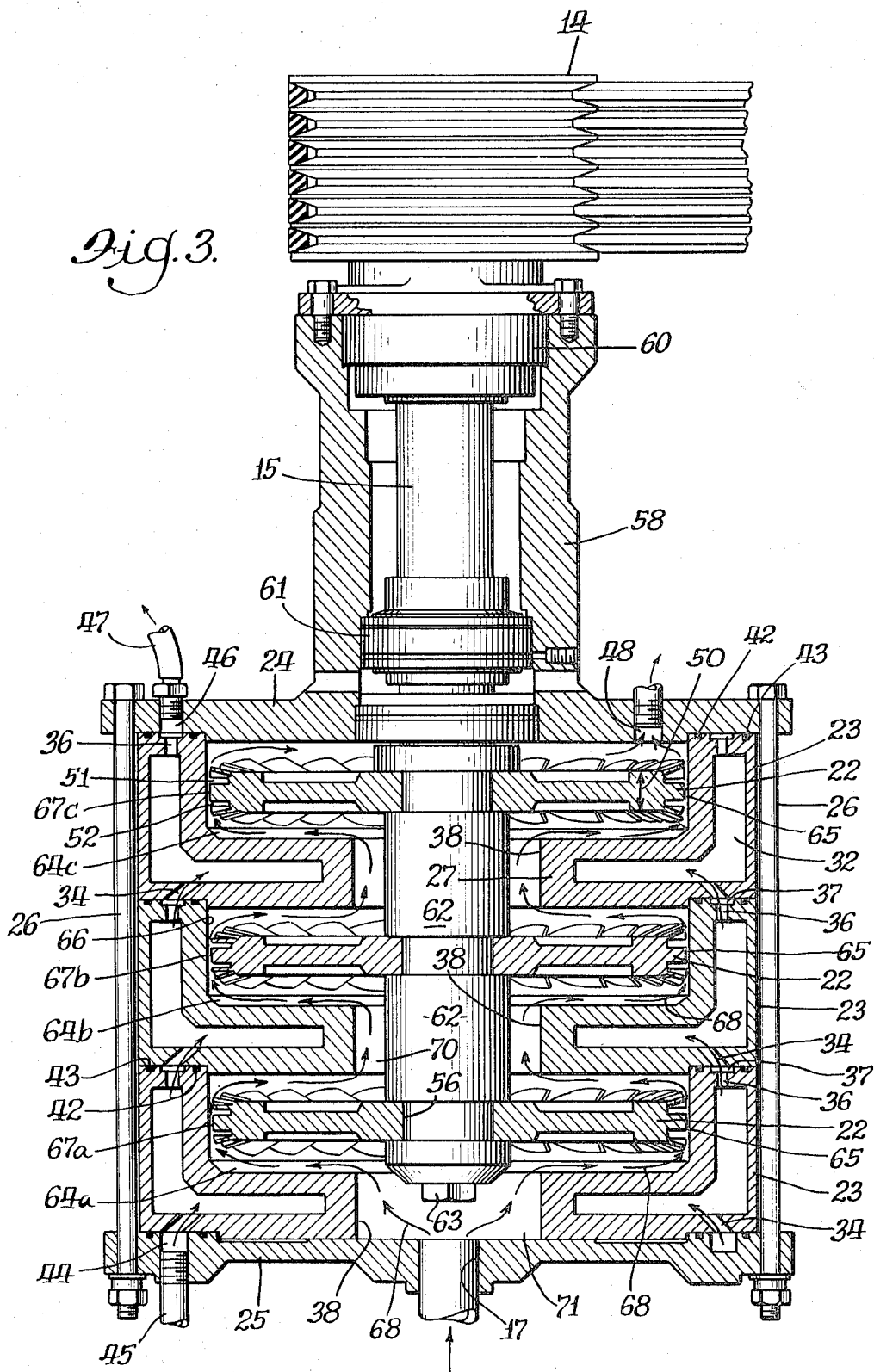
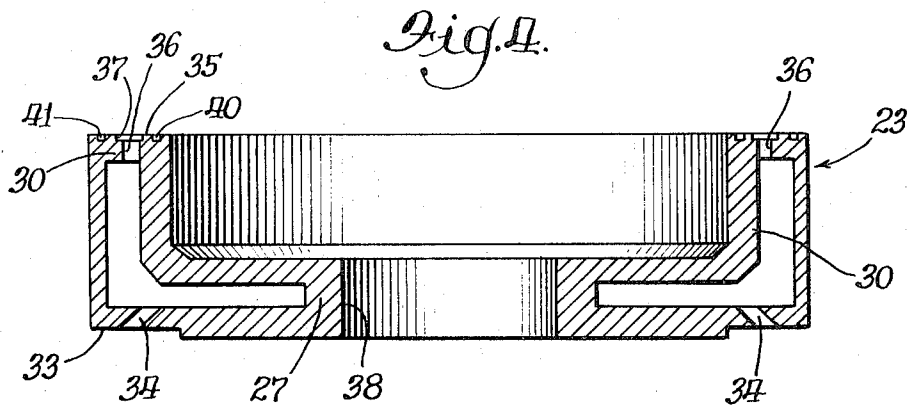
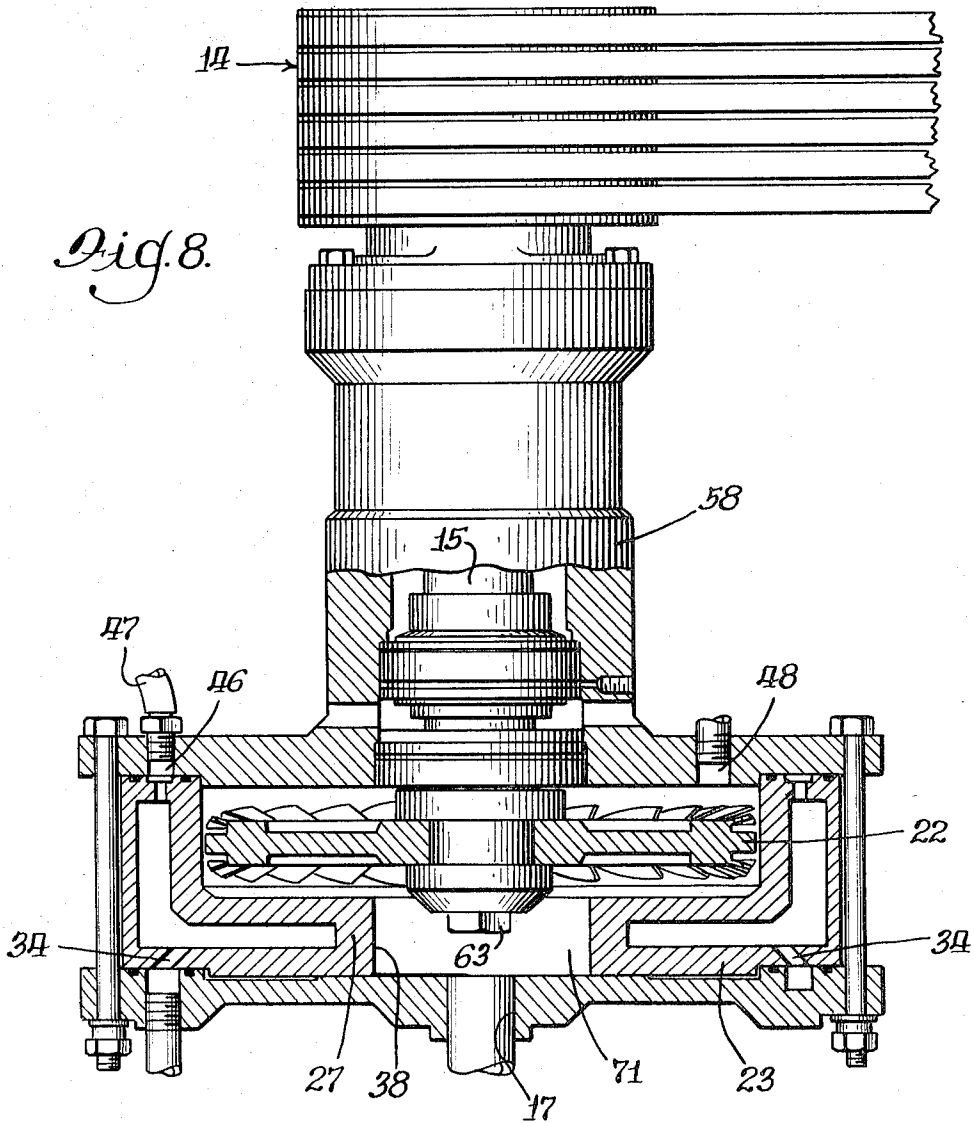
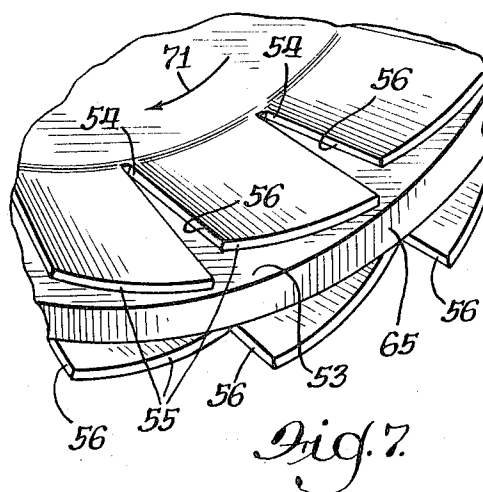
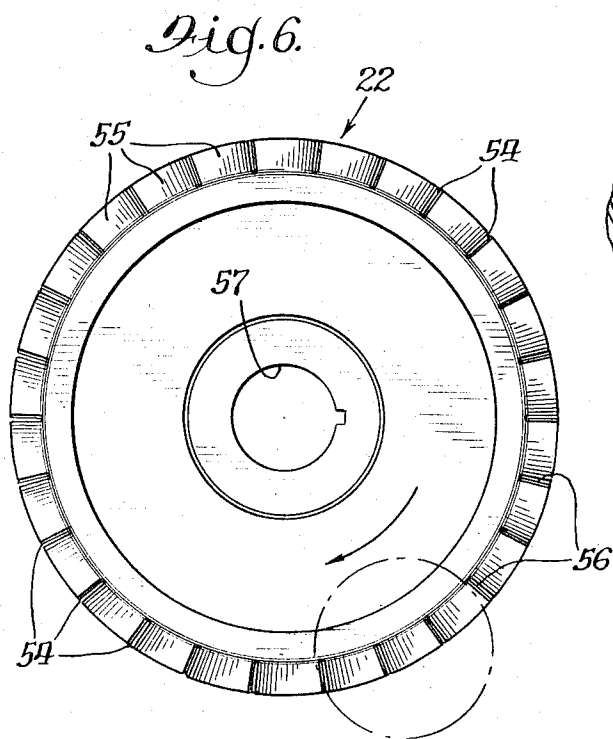
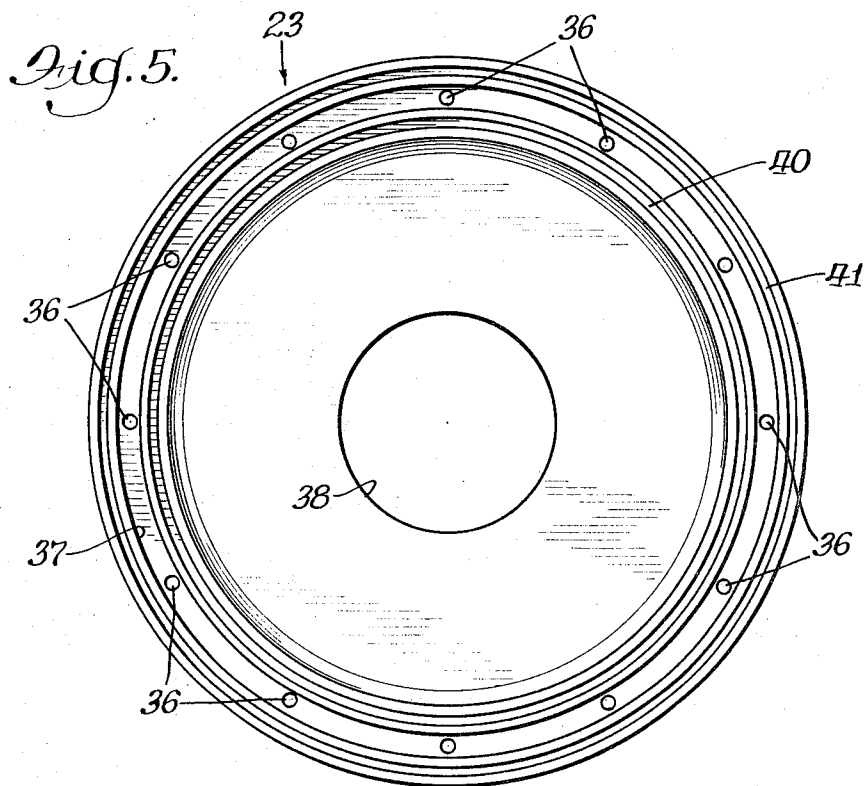


Fig. 3.







APPARATUS FOR DISPERSING FINELY DIVIDED SOLID PARTICLES IN A LIQUID VEHICLE

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for dispersing finely divided particles in a liquid vehicle.

In the manufacture of products such as paints, enamels, inks and dyes, the solid material ingredient of the product is usually introduced into the liquid vehicle in a finely divided form having a particle size as low as one micron. Such solid particles are substantially insoluble and inert with respect to the liquid vehicle and when such material is first introduced into the liquid vehicle the particles tend to form lumps which are an agglomeration of a multitude of particles surrounded by a film of the liquid vehicle. As a result, the outermost surfaces of many of the particles agglomerated in each lump remain dry and do not readily disperse uniformly in the liquid vehicle. Further background on the problems involved and the apparatus previously used in dispersing such particles in a liquid vehicle are discussed in my U.S. Pat. No. 3,488,009 for Means and Method for Dispersing Finely Divided Solid Particles in a Liquid Vehicle issued Jan. 6, 1970.

The apparatus disclosed herein is designed to perform substantially the same function as the apparatus described in my above referred to U.S. Pat. No. 3,488,009. The apparatus disclosed herein, however, is an improved structure. Just as in the apparatus of my U.S. Pat. No. 3,488,009, the apparatus herein described may be used for uniformly distributing finely divided particles in a liquid vehicle without the need of a dispersing agent. The apparatus described herein has been found particularly useful in the processing of dye materials. One of the problems that has been experienced in apparatus of this kind is that in processing certain materials such as some dyes, for example, a tremendous amount of heat is generated in the mixing vessel. A normal type of cooling jacket wherein coolant is circulated around the outside wall of the mixing vessel has been found insufficient in processing certain materials to hold down the temperature of the vessel structure within desired limits. For that reason other means had to be developed which would provide more adequate cooling.

SUMMARY OF THE INVENTION

Briefly, the apparatus described herein includes a vessel into which extends a rotatable shaft on which are mounted one or more agitator discs. The vessel is constructed to include one or more annular dish-shaped elements superimposed one upon the other. If a plurality of dish-shaped elements are used they are stacked one upon the other to thereby define annular chambers into which the agitator discs extend. If only one dish-shaped element is used, then that dish-shaped element together with an end plate defines an annular chamber into which an agitator disc extends. An inlet is provided at one end of the vessel and an outlet at the other for the fluid mixture being processed. The dish-shaped elements are individually formed with internal chambers through which heat controlling fluid usually for cooling is circulated during operation of the apparatus.

A principal object of the present invention is to provide a mixing vessel of such a construction as to allow

for a more efficient temperature control of the product being processed.

A still further object of the invention is to provide a mixing vessel including dish-shaped elements formed with internal cavities or passages for circulating temperature control fluid therethrough whereby the temperature of the mixing vessel apparatus may be easily controlled.

Another object of the invention is to provide means for constructing mixing vessels whereby different sizes of mixing vessels may be easily manufactured without changing the basic structure of the entire unit.

A further object of the invention is to provide an apparatus wherein the mixing vessel comprises a plurality of dish-shaped elements which may be easily assembled or removed from each other.

Other objects and advantages of the invention herein will become more apparent when the description is considered in connection with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view in elevation of the apparatus embodying the invention herein;

FIG. 2 is a side view in elevation of the apparatus of FIG. 1;

FIG. 3 is an enlarged view in elevation of the mixing vessel assembly, shaft and agitator discs;

FIG. 4 is a view in elevation of one of the dish-shaped elements used in the mixing vessel assembly;

FIG. 5 is a top view of the dish-shaped element of FIG. 4;

FIG. 6 is a plan view of one of the agitator discs used in the apparatus;

FIG. 7 is an enlarged view in perspective of the circled portion of the agitator disc of FIG. 6;

FIG. 8 is a view in elevation of a mixing vessel utilizing only one dish-shaped element.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings FIGS. 1 and 2 show the overall dispersing apparatus 10 including a base 11, a vertical support 12 mounted on the base 11, a motor 13 and a belt and pulley drive unit 14 mounted on the vertical support for driving a shaft 15 which extends into a vertically disposed mixing vessel assembly 16. Product to be processed is introduced into the mixing vessel 16 under pressure through an inlet 17 via a conduit 20. The conduit is connected to a pump 21 which is adapted to take a suction from a tank (not shown) containing the material to be processed. The shaft 15 which extends into the mixing vessel 16 carries one or more agitator discs 22.

The mixing vessel assembly 16 shown in FIG. 3 comprises one or more annular dish-shaped elements 23, end plates 24 and 25 disposed at each end of the vessel and a plurality of tie rods 26 extending through the end plates 24 and 25 to hold the end plates and dish-shaped elements in assembled relationship. Each annular dish-shaped element 23 is of a substantially U-shaped cross-section and has a horizontally extending base portion 27 and a wall portion 30 extending at substantially right angles to and connected to said base portion.

In order to accomplish more effective temperature control of the mixing vessel apparatus each dish-shaped element 23 is formed with an internal cavity or passage

32. This cavity or passage 32 has a horizontal portion 32a and a vertical or axially extending portion 32b generally paralleling the base portion 27 and wall portion 30 respectively. A coolant, such as water may be circulated through the cavity or passage. The lower surface of the base portion 27 has a cut-out portion 33 formed therein for receiving therein the upper end of the wall portion 30 of the next adjacent dish-shaped element. A plurality of inlet passages 34 are formed in this cut-out portion of the base portion which function as coolant inlets. It will be observed that these passages 34 are disposed at an inwardly directed angle and are effective to direct fluid into the horizontal portion of the passage as viewed in FIG. 3 for example to improve circulation throughout the element 23.

The upper surface 35 of the wall portion 30 has a plurality of circumferentially spaced outlet passages 36 and an annular fluid passage or groove 37 formed therein, the outlet passages 36 being in fluid communication with the annular groove 37 and the internal cavity 32. The upper surface 35 also has a pair of annular radially spaced seal grooves 40 and 41 formed therein for accommodating O-ring seals 42 and 43. In the assembly, the O-ring seals 42 and 43 are disposed radially on each side of the annular groove 37 to prevent leakage of fluid along the surface 35 which fits into the cut out portion 33 in the base of the adjacent dish-shaped element. Each dish-shaped element also is formed with a central opening 38 through which the shaft 15 extends in the assembly, the opening 38 being considerably larger than the diameter of spacers used to separate agitator discs on the shaft 15.

In the assembly a coolant inlet 44 is formed in the end plate 25 and is adapted to be connected to a source of coolant through conduit 45. The inlet 45, of course, communicates with the internal cavity 32 in the dish-shaped element 23 through the passages 34 formed in the base portion 27. A coolant outlet 46 is formed in the end plate 24 and is adapted to have an outlet conduit 47 connected thereto. An outlet 48 for the processed product is provided in end plate 24.

The agitator disc 22 is formed of solid metal. The agitator disc blank originally has a finished thickness at its outer periphery substantially as indicated by the dimension 50. During the manufacturing process, a pair of axially spaced peripheral grooves 51 and 52 are cut in the periphery to a desired depth. This leaves very thin blade sections formed at the outer extremities of opposed flat sides of the disc and a central core portion 53. Then a plurality of radially extending slits 54 are cut in the thin sections at each side of the disc. This leaves a plurality of circumferentially spaced segments which at that stage, of course, all lie in a plane normal to the axis of the disc. Each of these segments are then twisted to a predetermined angle out of the plane normal to the axis of the disc resulting in the vanes 55 as shown in FIGS. 3 and 8 having leading edges 56. The vanes 55 on opposite sides of the core portion 53 are twisted in opposite directions and generally an equal amount. A central opening 57 is provided in the disc to receive the shaft 15 therethrough the disc then being keyed to the shaft.

In the assembly the shaft 15 is driven by motor 13 through belt and pulley arrangement 14 and is positioned in a housing 58 by suitable upper and lower bearing means 60 and 61. The housing 58 is attached to or may be constructed integral with the end plate 24.

The shaft 15 extends into the mixing assembly and carries thereon the agitator discs 22 separated by spacers 62. The entire shaft and disc assembly are secured together by suitable means, such as a nut 63 attached to the threaded end of shaft 15.

The dish-shaped elements being adjacently disposed and stacked one upon the other provide circumferential chambers 64 (shown as 64a, 64b and 64c in FIG. 3) into which the agitator discs 22 extend. It will be observed that the outer edges of the discs 22, more specifically the outer peripheral axially extending surfaces 65 of the central core portion 53, are relatively closely spaced from the inner surface 66 of the wall portions 30 of each of the dish-shaped elements. This close spacing provides an annular pressure zone 67 (shown as 67a, 67b and 67c in FIG. 3) through which all product being processed must pass as explained in my U.S. Pat. No. 3,488,009. The spacing may vary between approximately ten and one hundred thousandths of an inch depending on the material being processed, about twenty-five thousandths of an inch having been found to be a preferable spacing when used on some products. Annular openings or passages 70 are provided by the space between the shaft spacers 62 and the enlarged central openings 38 in the dish-shaped elements. The path of flow of product through the mixing vessel assembly is indicated by arrows 68.

In view of the path of flow of the material it can readily be seen that the construction of the dish-shaped elements 23 with their internal fluid passages 32 provides a greater cooling area for the product being processed.

OPERATION

The operation which should be apparent from the above structural description can be briefly described as follows: Rotation of the shaft 15 with attached agitator discs 22 is accomplished by the belt and pulley drive 14 from the motor 13. The shaft is rotated in clockwise direction when viewed from the top down as seen in FIG. 3. The speed of the motor 13 and consequently the shaft may be controlled by a variety of means not shown herein. A fluid mixture including a liquid vehicle such as an oil together with agglomerated particles of undispersed solids such as a pigment is introduced through inlet 17 by means of the pump 21 through conduit 20. The pump 21 supplies the material continuously to chamber 71 of the mixing vessel building up a pressure up to a predetermined pressure and which is slightly higher than the pressure at the pressure zones 67. Thus the mixture under pressure is continuously forced through the chambers 64a, pressure zone 67a, chamber 64b, pressure zone 67b, chamber 64c and pressure zone 67c and the associated passages 70 between the shaft spacers 62 and the opening 38 in the dish-shaped elements to the outlet 48.

As this occurs, the lumps of solid particles are torn apart and progressively reduced in size by the abrading action of the fast moving roughened anvil surfaces 65 on the agitator discs. Agitation also occurs throughout the stream of fluid mixture which further assists in breaking up the solid particles. In passing through the mixing vessel assembly and particularly zones 67 the substantial pressures to which the fluid mixture is subjected generates a substantial amount of heat, which may vary, of course, with the particular material being processed. To control the temperature to which the

mixing vessel is subjected, temperature control fluid such as water is injected at inlet 45 and circulated through each of the dish-shaped elements 23 to the outlet 46. The fluid enters the first element 23, through passages 34, moves through the internal passageway 32 to the outlets 36 to the circular outlet groove 37 then into the fluid inlets 34 of the next adjacent dish-shaped element 23 and then successively through each of the dish-shaped elements 23 to outlet 46 in the end plate 24. Under certain circumstances it is conceivable that the circulating fluid may be run in the opposite direction, i.e. from top to bottom into outlet 46 and out the inlet 45. The fluid circulation provided by the unique internal passage construction of the dish-shaped elements has been able to achieve overall cooling of the mixing vessel assembly to a degree previously not obtainable with a simple straight cooling jacket surrounding the outside wall of the vessel.

Mixing vessels of various sizes may be constructed merely by using more or less than three dish-shaped elements 23 in the assembly. This, of course, will dictate the use of correspondingly longer or shorter shafts 15 to accommodate a greater or lesser number of agitator discs 22. Such a modified version of a mixing vessel is shown in FIG. 8. It operates in substantially the same manner as the unit shown in FIG. 3, the only difference being that only one dish-shaped element 15 and one agitator disc 22 are used.

Using dish-shaped elements 23 to construct a mixing vessel provides a tremendous manufacturing convenience in the sense that large or smaller mixing vessels may be easily constructed without changing the basic structure of the unit as a whole. Different length shafts are easily provided using a greater or lesser number of the same type agitator discs as needed.

The structure of the mixing vessel also greatly facilitates repair. If one portion is worn it is necessary to replace only a portion thereof namely one or more of the dish-shaped elements.

It will be apparent that I have advantageously provided a mixing vessel for incorporation in the apparatus described of a type which gives a great deal of flexibility in the manufacture and repair.

Furthermore, the mixing vessel is of such a construction as to include an improved temperature control means by providing greater surface area over which the temperature controlling fluid can act.

While a preferred embodiment of the invention has been specifically disclosed, it is to be understood that the invention is not limited thereto as other variations will be apparent to those skilled in the art and the invention is to be given its fullest possible interpretation within the terms of the following claims.

I claim:

1. Apparatus for dispersing solid particles held in agglomerated form and carried in suspension by a liquid vehicle as a fluid mixture comprising:

a mixing vessel having a fluid inlet at one end thereof and a fluid outlet at the other end thereof, said inlet being adapted to be operatively connected to means for introducing a fluid mixture into said inlet under pressure and moving said fluid mixture through said mixing vessel to said outlet;

said vessel comprising a plurality of annular dish-shaped elements having a substantially U-shaped cross section and stacked one upon the other, and closure means associated with said dish-shaped ele-

ments enclosing said vessel at both ends, each of said dish-shaped elements comprising a laterally extending base portion and an axially extending wall portion connected to said base portion; releasable means holding said dish-shaped elements and said closure means in assembled relationship;

said dish-shaped elements in their assembled relationship defining circumferentially extending chamber means therebetween;

means defining internal fluid cavities in each of said dish-shaped elements for conducting temperature control fluid therethrough;

communicating passage means in said dish-shaped elements connecting the internal cavities of each of said dish-shaped elements with each other;

a rotatable shaft extending into said vessel through said dish-shaped elements and adapted to be driven from a power source; and

agitator disc means mounted on said shaft and projecting radially into said chamber means.

2. The apparatus of claim 1 wherein

said communicating passage means includes a continuous annular passageway in the upper face of said dish-shaped element for communicating with inlet ports formed in the base of an adjacent dish-shaped element.

3. Apparatus for dispersing solid particles held in agglomerated form and carried in suspension by a liquid vehicle as a fluid mixture comprising:

a mixing vessel having a fluid inlet at one end thereof and a fluid outlet at the other end thereof, said inlet being adapted to be operatively connected to means for introducing a fluid mixture into said inlet under pressure and moving said fluid mixture through said mixing vessel to said outlet;

said vessel comprising a plurality of annular dish-shaped elements having a substantially U-shaped cross section and stacked one upon the other, and closure means associated with said dish-shaped elements enclosing said vessel at both ends, each of said dish-shaped elements comprising a laterally extending base portion and an axially extending wall portion connected to said base portion;

releasable means holding said dish-shaped elements and said closure means in assembled relationship;

said dish-shaped elements in their assembled relationship defining circumferentially extending chamber means therebetween;

a rotatable shaft extending into said vessel through said dish-shaped elements and adapted to be driven from a power source;

agitator disc means mounted on said shaft and projecting radially into said chamber means; and

said agitator disc means is an integral disc including a central body portion and integral radially extending blade portions disposed on each side of and axially spaced from said central body portion and vane means formed in each of said blade portions.

4. Apparatus for dispersing solid particles held in agglomerated form and carried in suspension by a liquid vehicle as a fluid mixture comprising:

a mixing vessel having a fluid inlet at one end thereof and a fluid outlet at the other end thereof, said inlet being adapted to be operatively connected to

means for introducing a fluid mixture into said inlet under pressure and moving said fluid mixture under pressure through said mixing vessel to said outlet;

said mixing vessel including at least one annular dish-shaped element having a substantially radially extending base portion and a substantially axially extending flange portion connected to said radially extending base portion and a closure member covering said dish-shaped element to define with the latter an annular chamber;

releasable means securing said dish-shaped element and said closure member in assembled relationship whereby said dish-shaped element and closure member may be easily assembled and disassembled;

a rotatable shaft extending into said vessel;

an agitator disc secured to said shaft and extending into said annular chamber, said agitator disc being an integral disc including a central body portion and integral radially extending blade portions disposed on each side of and axially spaced from said central body portion and vane means formed in each of said body portions;

means defining completely circumferentially extending internal fluid passage means in both said base portion and said flange portion of said dish-shaped element for conducting temperature control fluid therethrough; and

fluid inlet and outlet means to said internal fluid passage means.

5. Apparatus for dispersing solid particles held in agglomerated form and carried in suspension by a liquid vehicle as a fluid mixture comprising:

a mixing vessel having a fluid inlet at one end thereof and a fluid outlet at the other end thereof, said inlet being adapted to be operatively connected to means for introducing a fluid mixture into said inlet under pressure and moving said fluid mixture through said mixing vessel to said outlet;

said vessel comprising a plurality of annular dish-shaped elements stacked one upon the other and closure means associated with said dish-shaped elements enclosing said vessel at both ends;

releasable means holding said dish-shaped elements and said closure means in assembled relationship;

said dish-shaped elements in their assembled relationship defining circumferentially extending chamber means therebetween;

means defining separate completely circumferentially extending internal fluid cavities entirely within each of said dish-shaped elements for conducting temperature control fluid therethrough;

communicating passage means in said dish-shaped elements connecting the internal cavities of each of said dish-shaped cavities with each other;

a rotatable shaft extending into said vessel through said dish-shaped elements and adapted to be driven from a power source; and

agitator disc means mounted on said shaft and projecting radially into said chamber means.

6. The apparatus of claim 5 wherein, said communicating passage means includes a con-

tinuous annular passageway in the upper face of said dish-shaped element for communicating with inlet ports formed in the base of an adjacent dish-shaped element.

7. Apparatus for dispersing solid particles held in agglomerated form and carried in suspension by a liquid vehicle as a fluid mixture comprising:

a mixing vessel having a fluid inlet at one end thereof and a fluid outlet at the other end thereof, said inlet being adapted to be operatively connected to means for introducing a fluid mixture into said inlet under pressure and moving said fluid mixture through said mixing vessel to said outlet;

said vessel comprising a plurality of annular dish-shaped elements stacked one upon the other and closure means associated with said dish-shaped elements enclosing said vessel at both ends;

releasable means holding said dish-shaped elements and said closure means in assembled relationship;

said dish shaped elements in their assembled relationship defining circumferentially extending chamber means therebetween;

means defining separate completely circumferentially extending internal fluid cavities entirely within each of said dish-shaped elements for conducting temperature control fluid therethrough;

a rotatable shaft extending into said vessel through said dish-shaped elements and adapted to be driven from a power source;

agitator disc means mounted on said shaft and projecting radially into said chamber means; and

said agitator disc being an integral disc including a central body portion and integral radially extending blade portions disposed on each side of and axially spaced from said central body portion and vane means formed in each of said body portions.

8. In a closed mixing vessel apparatus for dispersing solid particles held in agglomerated form and carried in suspension by a liquid vehicle as a fluid mixture, said mixing vessel having a chamber in which an agitator disc adapted to be rotated is disposed, the combination comprising:

an integral agitator disc including a central body portion, and integral radially extending blade portions disposed on each side of and axially spaced from said central body portion and at the outer periphery of said disc; and

vane means formed in each of said blade portions.

9. The combination of claim 8 wherein, said agitator disc member is of substantial thickness being formed with top and bottom faces and includes means defining a pair of radially directed circumferentially extending slots disposed in substantially parallel relationship and formed in the periphery of said agitator disc, said slot means defining said blade portions at the outer edge of and as an integral part of said top and bottom faces, said slot means further defining said central body portion disposed between and axially spaced from said blade portions.

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