Jan. 6, 1970 G. R. SCHOLD 3,488,009

MEANS AND METHOD FOR DISPERSING FINELY DIVIDED SOLID PARTICLES IN A VEHICLE

Filed Aug. 19, 1966

FIG. 1

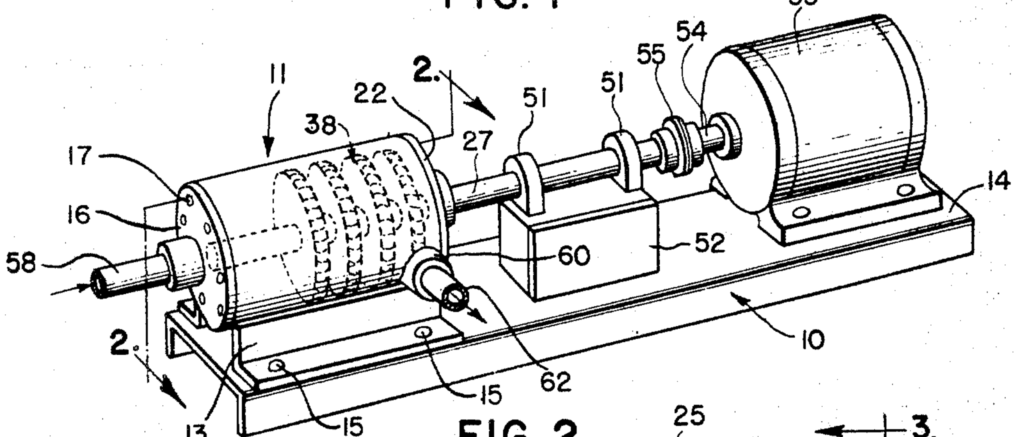


FIG. 2

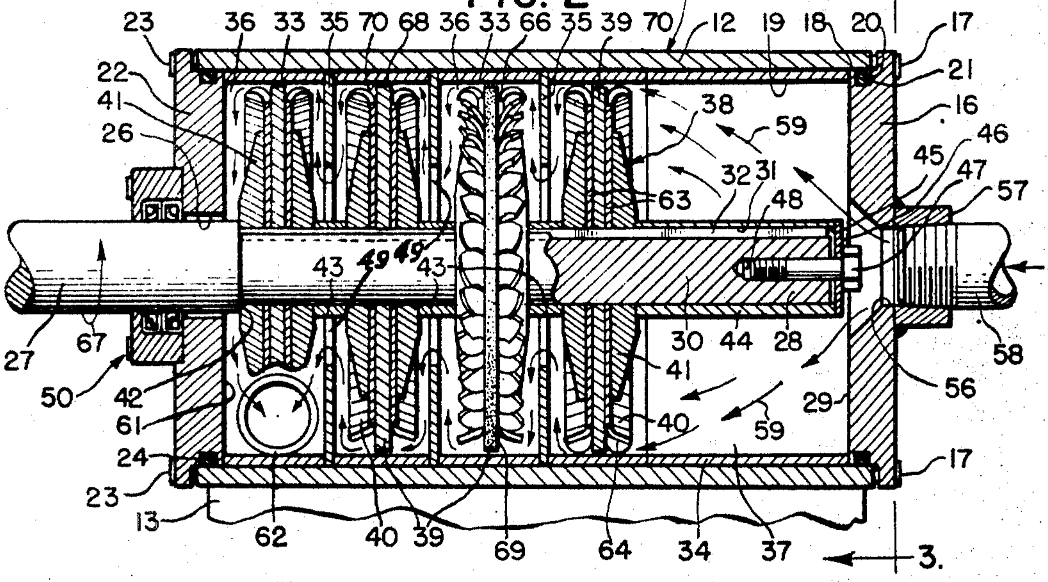


FIG. 3

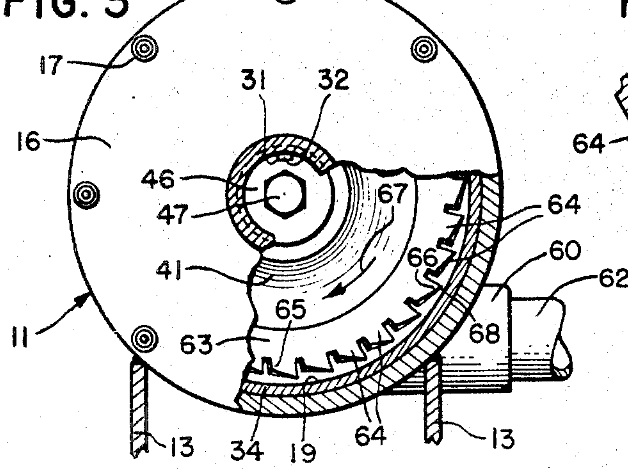
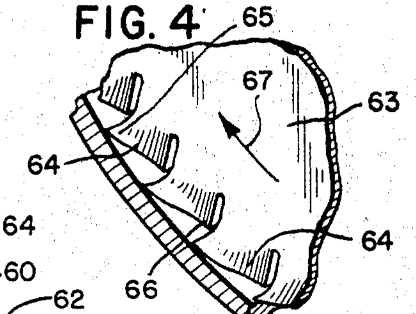


FIG. 4



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MEANS AND METHOD FOR DISPERSING FINELY DIVIDED SOLID PARTICLES IN A VEHICLE

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ABSTRACT OF THE DISCLOSURE

An apparatus for producing finely divided particles and uniformly distributing such finely divided particles in a liquid vehicle including means for causing the stream of a fluid mixture of agglomerated particles and liquid vehicle to pass through a plurality of zones where the fluid mixture is subjected to tremendously high pressures and is simultaneously agitated violently for controlled, predetermined periods of time.

This invention relates to a means and a method for uniformly dispersing finely divided particles in a liquid vehicle and more particularly, to a new and improved apparatus and method for producing finely divided particles and uniformly distributing such finely divided particles in a liquid vehicle.

In the manufacture of products such as paints, enamels, pigmented ink oils containing a solid and the like, the solid material ingredient of the product is usually introduced into a liquid vehicle in a finely divided form having a particle size as low as one micron. As pointed out in detail in U.S. Patent 3,135,474, of which the present inventor is also the inventor, such solid particles are substantially insoluble and inert with respect to the liquid vehicle and when such material in the dry form is first introduced into the liquid vehicle the particles tend to form lumps which are aggolmerations of a multitude of particles surrounded by a film of the liquid vehicles. As a result, the entire outermost surfaces of substantially all of the particles agglomerated in each lump remain dry and do not readily disperse uniformly in the liquid vehicle. As was pointed out in the aforementioned patent, this phenomena is probably due to the surface of the liquid vehicle being of such magnitude to inhibit dispersion.

Heretofore, a variety of different apparatuses and methods have been employed in an attempt to break up the agglomerated particles. However, no one apparatus and method afforded the efficiency of operation and the low installation and maintenance costs desired from such equipment. One form of mechanical apparatus heretofore commonly used to break up the agglomerated particles involved passing a fluid mixture of the liquid vehicle and agglomerated particles through conventional roller mills which usually consisted of a pair of accurately machined and highly polished and thus extremely expensive metal rollers. The metal rollers are power driven and are in line contact with each other under a relatively heavy pressure. The fluid mixture was caused to pass between the rollers and the force exerted by the rollers on the fluid mixture stream was relied upon to mechanically crush the agglomerated particles and disperse the individual particles of the agglomerates into the liquid vehicle issuing from the rollers. The shortcomings of such apparatus are numerous and major. The rate of dispersion is obviously slow and operation of the apparatus requires at least one operator to be in attendance at all times since the rollers are rapidly damaged if the mill is allowed to operate for even a short period of time without the fluid mixture flowing through the rollers. Furthermore, the power consumption and other maintenance costs as well as the initial installation cost of such roller mills are extremely high. Lastly, the operating efficiency of the apparatus left much to be desired.

Apparatus embodying applicant's invention as set forth in the aforementioned patent obviated to a great extent, all of the many shortcomings and disadvantages possessed by roller mills of the type described above. Briefly, the apparatus and method involved introducing a dispersing agent in the form of granulated, magnetically susceptible particles into the fluid mixture, agitating the resulting mass so as to cause disintegration of the agglomerates, and thereafter removing the dispersing agent particles from the fluid mixture.

Although the apparatus and method described in U.S. Patent 3,125,474 have proved to be extremely successful from both operational and commercial standpoints, the present invention contemplates the provision of an apparatus and method which afford even greater efficiency and are less costly to manufacture and utilize then applicant's patented apparatus and method. More particularly, applicant's new and improved invention is directed to an apparatus and method for uniformly distributing finely divided particles in a liquid vehicle without the need of a dispersing agent of any form whatsoever or the introduction of foreign materials of any sort into the fluid mixture of agglomerated particles and liquid vehicle. Broadly, it is an important objective of the present invention to provide an apparatus and method for uniformly dispersing finely divided particles in a liquid vehicle by causing the fluid mixture to pass through one or more zones where the fluid mixture stream is subjected to tremendously high pressures and is simultaneously agitated violently for controlled, predetermined periods of time. Briefly, the apparatus for accomplishing the primary objective of the invention includes a cylindrical drum and a rotor extending centrally and along the longitudinal axis of and within the drum. The interior space enclosed by the drum is divided into one or more longitudinally spaced chambers, each of which has axially aligned inlet and outlet openings radially spaced inward of the interior surface of the drum and encircling the rotor. Secured to the rotor and disposed within each chamber is a pair of disk-like blades having vanes formed thereon for directing the fluid mixture entering the inlet opening of the chamber radially outwardly to a zone adjacent the outer peripheries of the blades with a tremendous pressure. The zone is defined by an annular anvil surface which rotates in unison with and is axially spaced between the blades and is radially spaced relatively close to the interior surface of the drum. The anvil surface is relatively hard and roughened so that the fluid mixture flowing through the zone is agitated violently while under the tremendous pressure produced by the blade vanes and the centrifugal force acting upon the rotating mass of fluid mixture. The application of pressure on the fluid mixture simultaneously agitating the same as it passes through the high pressure zone are effective to tear or destroy the film enclosing the particles of each lump or agglomeration of a multitude of particles and, consequently, cause the agglomerated particles to break up into single, separated particles or at least into lumps of smaller size containing a smaller number of agglomerated particles. As the fluid mixture passes through the high pressure zone and is violently agitated, the temperature of the fluid mixture is raised with a resultant lowering of its viscosity. Heretofore, it was sometimes necessary to provide a boiler or the like for preheating certain fluid mixtures before introducing the same to the apparatus for dividing the agglomerated particles so as to not impose an unnecessary load on the apparatus and to facilitate the dividing process. Obviously, the provision of a boiler involved an expenditure for equipment which is not necessary to practice the present invention. Furthermore, the heat impacted to the fluid mixture as it flows through each high pressure zone facilitates the destruction of the film enclosing the agglomerated particles and the production of finely divided particles.

Another object of the present invention is to provide a simply, yet sturdily, constructed apparatus for dispersing insoluble solid particles uniformly into a liquid vehicle continuously without the necessity of utilizing a dispersing agent or the like.

A still further object is to provide adjustable means for varying the physical dimensions of the high pressure zones so as to adapt the apparatus of the invention for materials of various viscosities and/or for materials containing agglomerated particles of different sizes.

Another object is the provision of an apparatus for uniformly dispersing finely divided particles in a liquid vehicle wherein the liquid mixture of liquid vehicle and the solid material in agglomerated particle form is capable of being continuously fed to the apparatus for processing as distinguished from those apparatuses which require the liquid mixture to be introduced in predetermined quantities or batches and, consequently, a greater quantity of liquid mixture can be handled in a shorter period of time than heretofore possible.

Still another object is to provide a simple method for dispersing solid particles in a liquid vehicle without the need of employing a dispersing agent of any sort.

The foregoing and other important objects and desirable features inherent in and encompassed by the invention, together with many of the purposes and uses thereof, will become readily apparent from a reading of the ensuing description in conjunction with the annexed drawings, in which,

FIGURE 1 is a perspective view of an apparatus embodying the invention;

FIGURE 2 is a vertical sectional view taken substantially along line 2—2 of FIGURE 1;

FIGURE 3 is an end elevational view, partly in section, taken substantially along line 3—3 of FIGURE 2, portions of the structure are broken away to better illustrate the invention; and

FIGURE 4 is an enlarged, fragmentary perspective view, partly in section, of an arcuate segment of one of the blades utilized in the invention.

Referring to the drawings in detail, wherein like reference characters represent like elements throughout the various views, reference character **10** is used to generally designate a suitable sturdy support base which is preferably rectangular shaped in plan. As best shown in FIGURES 1 and 2, the dispersing apparatus, designated generaly by reference character **11**, includes a cylindrical sleeve **12** mounted on the support base **10** so that its longitudinal axis extends horizontally and longitudinally. The cylindrical sleeve **12** is rigidly mounted on the base **10** adjacent one end portion thereof by means of a pair of parallel, transversely spaced angle irons **13**, each of which has an edge of one leg rigidly secured to the cylindrical sleeve 12 as by welding or the like, and the other, horizontally disposed leg thereof suitably fastened to the flat top surface **14** of the support base **10** by means including a plurality of bolts **15**.

As best shown in FIGURE 2, a generally circular end plate **16** is used to close one end of the cylindrical sleeve **12**. A plurality of circumferentially spaced machine screws **17**, extending through suitable apertures in the end plate **16** adjacent the periphery thereof, are adapted to be threaded into the sleeve **12** so as to secure the end plate **16** to the sleeve **12**. It will be noted that the end plate **16** has a reduced diameter section **18** which projects into and slidably engages the interior surface **19** of the sleeve **12** when the end plate **16** is secured to the sleeve **12**. The reduced diameter section **18** is provided with an annular groove **20** which serves as a pocket for retaining an O-type sealing ring **21**. The end of the sleeve **12** opposite the end plate **16** is provided with an end plate **22** which has its peripheral edge portion constructed in the same manner as the end plate **16** described above. The end plate **22** is also secured and sealed to the sleeve **12** by means of machine screws **23** and a sealing ring **24**. The cylindrical sleeve **12** and the end plates **16**, **22** secured and sealed thereto define a drum-like housing **25**.

As best shown in FIGURE 2, the end plate **22** is provided with a central opening **26** through which a shaft **27** extends horizontally into and along the longitudinal axis of the sleeve **12**. The innermost end **28** of the shaft **27** terminates in a vertical plane adjacent to the inner face **29** of the end plate **16**. As clearly illustrated in FIGURE 2, substantially the entire shaft section **30** of the shaft **27** disposed within the housing **25** has a reduced diameter and such reduced diameter shaft section **30** is provided with a longitudinally extending keyway groove **31** for receiving a portion of an elongated key **32** and keyway groove **31** will be pointed out presently.

By means of a plurality of spacer rings **33** and a single filler ring **34** a number of stationary, generally circular partitions **35** are positioned within the housing **25**. Three of these partitions **35** are shown but it is to be understood that a smaller or a greater number could be utilized without departing from the spirit and scope of the invention. The spacer rings **33** and the filler ring **34** are arranged end-to-end with the peripheral edge portion of a respective partition **35** between and abutting adjacent rings. Thus, it will be appreciated that securance of the end plates **16**, **22** to respective opposite ends of the sleeve **12** in the manner hereinbefore described causes the spacing rings and filler ring **34** to firmly clamp the partitions **35** to the interior of the housing **25**. The partitions **35** partially define three chambers **36** of substantially uniform volume and a single end chamber **37** of a relatively large volume which is partially defined by the inner face **29** of the end plate **16** and the partition **35** nearest thereto.

Referring to FIGURE 2, it will be noted that each chamber **36** and the large end chamber **37** contain an assembly **38** which includes a center disc **39**, a pair of blades **40** and a pair of clamping members **41**. The center disc **39** as well as the blades **40** and clamping members **41** are each provided with a central opening therethrough of a diameter slightly larger than the diameter of the reduced diameter shaft section **18** and a keyway notch adapted to receive the key **32** therein when mounted on the shaft **27**. As clearly illustrated, the blades **40** of each assembly **38** are arranged back-to-back with the center disc interposed between and abutting the blades **40**. Each circular clamping member of each assembly **38** in turn, is in abutting engagement with a respective one of the blades **40**. When mounted on the shaft **27** one of the clamping members **41** of the assembly **38** closest to the end plate **22** abuts the shoulder **42** formed at the juncture of the reduced diameter section **30** and the shaft proper to limit axial movement in one direction. It also will be noted that the shoulder **42** axially positions the assembly **38** substantially in the center of the chamber **36**. The remainder of the assemblies **38** disposed within the chambers **36** are axially centered within such chambers **36** by means of spacer members **43** which are keyed to the reduced diameter shaft section **30** and interposed between each pair of adjacent assemblies **38**. The spacer member **43** interposed between the assembly **38** disposed within the chamber **37** and adjacent assembly **38** being of the same axial length as the other spacer members **43** positions the assembly **38** of the chamber **37** closely adjacent to the partition **35** partially defining the chamber **37**. The assemblies **38** and spacer members **43** are axially fixed to the shaft **27** by means of a clamping sleeve **44** which is adapted to be mounted on and keyed to the reduced diameter shaft section **30**. The clamping sleeve **44**, which is capable of sliding axially along the reduced diameter shaft section **30**, is positioned so as to have one end thereof abutting one of the clamping members **41** of the assembly **38** disposed within the large chamber **37**. The axial length of the clamping sleeve **44** is such that when all the assemblies **38** and respective spacer members **43** are in engagement with each other, as shown in FIGURE 2, a small end portion of the clamping sleeve **44** projects beyond the end face **45** of the reduced diameter shaft section **30**. A thrust washer **46**, having a peripheral edge portion in abutting engagement with the end of the clamping sleeve **44**, is mounted on a bolt **47**. The bolt **47**, in turn, is capable of being screwed into a threaded recess **48** opening into the end face **45** of the reduced diameter shaft section **30** in order to firmly clamp all of the assemblies **38** between the clamping sleeve **44** and the shoulder **42**. From the foregoing, it will be appreciated that the assemblies **33** are axially and rotatably fixed to the shaft **27**.

Each partition **35** is formed with a central opening **49** therethrough for accommodating the reduced diameter shaft section **30** and a respective spacer member **43**, and for providing annular fluid passageway means between adjacent chambers **36, 37**. The purpose of the annular fluid passageway means will be pointed out hereinafter in detail.

Suitable shaft sealing means, designated generally by reference character **50**, are provided for sealing the opening **26** in the end plate **22**, through which the shaft **27** extends. As shown in FIGURE 1, the shaft **27** is rotatably supported by means of a pair of axially spaced conventional bearing blocks **51** which, in turn, are mounted on a box-like standard **52** fixed to the top surface **14** of the support base **10**. Power means, in the form of an electric motor **53**, is also bolted to the top surface **14** of the support base **10**. The motor shaft **54** is drivingly connected to the outer end of the shaft **27** by means of a coupling **55**. From the foregoing, it will be appreciable that when the electric motor **53** is energized the shaft **27** and the assemblies **38** are rotated in unison.

As best shown in FIGURES 1 and 2, the end plate **16** is provided with a centrally disposed opening **56** therethrough. Encircling the opening **56** and fixed to the outer face of the end place **16** by welding is a stub **57** provided with internal pipe threads. One end of an inlet pipe **58** (partially shown) is connected to the stub **57**. The inlet pipe **58** communicates with the discharge side of a conventional motor driven variable displacement fluid pump (not shown). It is to be understood that the inlet or suction side of the fluid pump is in communication with a source (not shown) of fluid mixture of agglomerated particles in a fluid vehicle. The innermost end of the inlet opening **56** flared for discharging undispersed fluid mixture, under pressure, generally axially and radially outwardly into the large chamber **37** is indicated by the arrows **59**. The final product which consists of the fluid vehicle with the solid particles (e.g. pigment) finely divided and completely dispersed therein flows from the housing **25** in a direction generally tangential of the housing **25** through an outlet pipe fitting **60** which opens into the end chamber **36** partially defined by the inner face **61** of end plate **22**. A discharge or outlet pipe **62** (partially shown) has one end connected to the pipe fitting **60**.

The blades **40** of each assembly **38** are mirror images of each other and each blade **40** comprises a generally flat, relatively thin body **63**. The outer peripheral edge of the body **63** is provided with a plurality of circumferentially spaced, integrally formed vanes **64**. The vanes **64** of each blade **40** are formed to extend radially from the outermost edge and axially in one direction from the general plane of the body **63** with which they are integrally formed. It will be noted that an edge **65** of each vane **64** defining one circumferential extent of the vane is generally curved and the free, outer end thereof is radially spaced inwardly of the free, outer end of the edge **66** defining the opposite circumferential limit of the vane. It will also be noted that the edge **66** of each vane **64** has a radius of curvature which is considerably greater than the radius of curvature of the edge **65**. Thus, the free, outer end of the edge **65** of each vane **64** is also axially spaced a greater distance from the general plane of the body **63** than the free, outer end of the edge **66**. Consequently, when the shaft or rotor **27** is rotated in the direction of the arrow **67** as contemplated in the operation of the apparatus **11**, the edge **65** of each vane **64** leads the edge **66** thereof. Because of the vane formation described above, the disposition of the blades **40** and the rotational direction of the shaft or rotor **27**, the fluid mixture in each of the chambers **36** as well as the large chamber **37** is forcefully propelled radially outwardly. The blades **40** of each assembly **38** are also effective to simultaneously direct the fluid mixture axially toward the center disc **39** interposed therebetween. As a result, a tremendously high pressure is caused to be developed in each of the annular zones **65** partially defined by the outer peripheral edge or anvil surface **69** of a respective center disc and the annular surface portion of the interior surfaces **70** of the spacer or filler rings **33, 34** in radial alignment therewith. It will also be appreciated that the fluid pressure developed in each annular zone **68** by the pumping action of the blades **40** is augmented by centrifugal force acting on the fluid mixture mass when the apparatus is in operation. In the manufacture of the center discs **39** the anvil surfaces **69** thereof are hardened by any suitable means after being roughened by a conventional shot blasting process or the like. The purpose and significance of providing the center discs **39** with hardened and roughened anvil surfaces **69** will be pointed out hereinafter.

OPERATION

The electric motor **53** is energized causing each of the assemblies **38** to rotate in its respective chamber **36, 37** in the direction of the arrow **67**. A fluid mixture comprising the selected vehicle, such as oil, with agglomerated particles of undispersed solids therein (e.g. a pigment) is introduced into the large chamber **37** through the inlet opening **56** formed in the end plate **16**. The fluid mixture having agglomerated solid particles is pumped continuously from the variable displacement supply pump (not shown) and is discharged into the chamber **37** under a positive pressure which is slightly greater than the fluid pressure developed in the annular pressure zones **68**. Consequently, the fluid mixture, after being subjected to the high pressure of the zone **68** associated with chamber **37**, flows sequentially through each of the series of chambers **36** and the zones **68** associated therewith and is ultimately discharged from the drum-like housing **25** through the outlet pipe fitting **60**. The variable displacement supply pump (not shown) controls the rate of flow of the fluid mixture into the inlet pipe **58**. Inasmuch as the motor **53** is energized at this time, the assembly **38** disposed within the chamber **37** is rotating and causes the fluid mixture to flow radially outwardly toward the annular zone **68** associated therewith. The radial spacing or clearance between each anvil surface **69** and the radially aligned interior surface portions **70** of the spacer and filler rings **33** and **37** is approximately ten to one hundred thousandths of an inch and the rotational speed of the shaft **27** in relation to the diameter of center discs **39** is selected such that the anvil surface **68** travel at a speed of approximately 7000 feet per minute. As the fluid mixture flows serially or sequentially through each of the successive high pressure zones from the inlet opening **56** to the outlet pipe **62** the lumps of solid particles are physically torn apart and progressively reduced in size by the abrading action of the fast-moving roughened anvil surfaces **69**. The fluid mixture stream is also agitated violently to further assist in the breaking up of the lumps of agglomerated solid particles. During the time the fluid mixture is passing through each zone **68** and being violently agitated and subjected to the tearing action of the roughened anvil surface **69**, it is simultaneously under a pressure of 100 to 500 pounds per square inch which developed pressure greatly facilitates the tearing or destroying of the film enclosing the agglomerated particles of the lumps. Consequently as the fluid mixture flows from one chamber to the next adjacent chamber through the opening **49** in the partition **35** separating such chambers, the lumps contained in the fluid mixture are progressively reduced in size by lowering the number of solid particles in such lumps until the fluid mixture being emitted from the outlet pipe **62** is relatively free of lumps of agglomerated solid particles. It will be appreciated that by increasing or decreasing the number of chambers **36** provided in the housing **25**, the size of the lumps (which size is dependent on the number of agglomerated solid particles contained in the lump) present in the fluid mixture flowing from the housing **25** may be controlled as desired.

It will also be appreciated that as the fluid mixture passes through each high pressure zone **68** and is violently agitated, the temperature of the fluid mixture is raised with a resultant lowering of its viscosity. Obviously, by reducing the viscosity of the fluid mixture, the power required to operate the apparatus **11** is correspondingly reduced. Furthermore, the heat imparted to the fluid mixture as it flows through each high pressure zone facilitates the destruction of the film enclosing the agglomerated solid particles and, thus, the production of finely divided solid particles. There are indications that the heat imparted to the fluid mixture is effective to cause any water contained in the fluid mixture to suddenly and explosively burst into steam as the fluid mixture flows from the high pressure zones **68**. It is believed such minute and multiple explosions tend to destroy the films of water encasing and causing agglomerations of solid particles and thus reduce the size of the lumps. The temperature of the fluid mixture flowing through the dispersing apparatus **11** is controlled by regulating the discharge flow rate of the variable displacement supply pump. It is also to be understood that the temperature of the fluid mixture could be controlled by providing an external water jacket (not shown) about the housing **25**. Thus, the necessity of providing a separate boiler or the like for preheating certain fluid mixtures before introducing the same to apparatus **11** is eliminated.

From the foregoing, it will be appreciated that with a constant flow rate, variance of the thickness of the anvil surfaces **69** measured in an axial direction will be effective to change the dwell time the fluid mixture is in the high pressure zones **68**. Thus, by merely substituting center discs **39** having a thickness different from that illustrated in the drawings other different fluid materials may be processed in the apparatus **11**. That is, fluid materials having larger or smaller lumps of agglomerated solid particles therein than the fluid mixture illustrated.

It is also to be understood that the degree of surface coarseness of the anvil surfaces **69** can also be changed in order to modify the effectiveness of such surfaces **69** to tear up the liquid films enclosing the lumps in the fluid mixture and the degree of agitation caused by such surfaces **69** when the apparatus **11** is in operation.

The final product flowing through the outlet pipe **62** is found to consist of the liquid vehicle with its finely divided solid particles (e.g. pigment) completely dispersed therein. Unlike the process described in U.S. Patent 3,135,474 there is no necessity to be concerned as to whether the final product contains any trace of a dispersing agent therein since a dispersing agent is not employed in the present process. Furthermore, unlike the roller mills mentioned hereinbefore, the above described apparatus **11** of this invention will not be damaged in any way whatsoever if permitted to continue oprating in the event fluid mixture flow to the housing **25** ceases for any reason. Furthermore, the cost of manufacturing and operating the apparatus of U.S. Patent 3,135,474 and conventional roller mills is considerably greater than the cost of constructing and operating the apparatus **11** of the present invention.

The embodiment of the invention chosen for the pur-

poses of description and illustration herein is that preferred for achieving the objects of the invention and developing the utility thereof in the most desirable manner, due regard being had to existing factors of economy, simplicity of design and construction, production methods, and the improvements sought to be effected. It will be appreciated, therefore, that the particular structural and functional aspects emphasized herein are not intended to exclude, but rather to suggest, such other adaptations and modifications of the invention as fall within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. An apparatus for individually dispersing finely divided substantially insoluble solid particles held in agglomerated form carried in suspension by a liquid vehicle as a fluid mixture comprising, in combination, housing means substantially cylindrical in shape; a plurality of chambers formed in said housing means and arranged along the longitudinal axis thereof, each pair of adjacent chambers being partially defined and separated by a common partition disposed substantially in a plane normal to the longitudinal axis of said housing means, each of said partitions having a central, generally circular opening therethrough to provide fluid communication between the chambers separated thereby, each of said chambers further having a zone formed therein providing fluid communication therethrough; means for introducing a flow of fluid mixture into a first one of said chambers disposed adjacent one longitudinal end of said housing means and causing the fluid mixture to flow sequentially through such chambers and their respective zones; fluid mixture discharge means in fluid communication with a second one of said chambers disposed adjacent the longitudinal end of said housing means opposite said first one of said chambers, said means for introducing a flow of fluid mixture into said first one of said chambers and causing the fluid mixture to flow sequentially through said chambers and their respective zones is effective to discharge the resulting dispersion product through said discharge means; means for substantially increasing the dynamic pressure of the fluid mixture as the fluid mixture flows through each of said zones including an assembly means disposed in each of said chambers and drive means for moving all of said assembly means in unison relatively to said housing means, said drive means including a rotatable shaft extending longitudinally into said housing means from one end thereof and through said central, generally circular openings of said partitions, the rotational axis of said shaft being coincident with the longitudinal axis of said housing means, and each of said assembly means including a generally circular disc secured to said shaft, the outer peripheral edge portion of each disc being radially spaced from the generally cylindrical, intrior surface of said housing means, each of said outer peripheral edge portions and the annular interior surface portion of said housing means in radial alignment therewith partially defining a respective one of said zones, each of said assembly means further includes a pair of generally circular, plate-like blades fixed to said shaft, said blades being substantially mirror images of each other and arranged back-to-back with a respective one of said generally circular discs interposed between and in abutting engagement therewith, each of said blades of each of said assembly means having a plurality of circumferentially spaced vanes provided on the outer periphery thereof, said vanes being formed and arranged on each blade so that upon rotation of said shaft in one particular direction they are effective to direct the flow of fluid radially outwardly and axially into the zone of the chamber in which the blade is disposed and to substantially increase the dynamic pressure of the fluid mixture as it flows through such zone; and means for simultaneously agitating said fluid mixture as it flows through each of said zones including said outer peripheral edge

portion of each of said generally circular discs, the annular surface defining each of said outer peripheral edge portions being of a relatively rough character of the annular interior surface portion of said housing means in radial alignment therewith.

2. An apparatus for individually dispersing finely divided, substantially insoluble solid particles held in agglomerated form carried in suspension by a liquid vehicle as a fluid mixture comprising, in combination, a substantially cylindrical shaped housing means; a plurality of chambers formed in said housing means arranged side-by-side along the longitudinal axis of said housing means, each of said chambers being in fluid communication with the chamber adjacent thereto and further having a zone formed therein providing fluid communication therethrough; means for introducing a flow of fluid mixture into one of said chambers and causing the fluid mixture to flow sequentially through said chambers and their respective zones; means for substantially increasing the dynamic pressure of the fluid mixture as the fluid mixture flows through each of said zones; and means for simultaneously agitating said fluid mixture as it flows through each of said zones including a generally circular disc in each of said chambers, said disc being rotatable in unison and the outer peripheral edge portion of each disc being radially spaced from the generally cylindrical, interior surface of said housing means, the annular surface defining each of said outer peripheral edge portions and the annular interior surface portion of said housing means in radial alignment therewith partially defining a respective one of said zones, one of said annular surface and annular interior surface portion partially defining each zone being of a relatively rough character and the other one of said annular surface and annular interior surface portion partially defining each zone being of a relatively smooth character in comparison, said means for substantially increasing the dynamic pressure of the fluid mixture as the fluid mixture flows through each of said zones includes a generally circular, plate-like blade fixed to each of said circular discs so as to be rotatable therewith, said blade having a plurality of circumferentially spaced vanes provided on the outer periphery thereof, said vanes being formed and arranged each blade so that upon rotation of said disc in one particular direction they are effective to direct the flow of fluid mixture radially outwardly and axially into the zone of the chamber in which the blade is disposed and to substantially increase the dynamic pressure of the fluid mixture as it flows through such zone.

3. An apparatus for individually dispersing finely divided, substantially insoluble solid particles held in agglomerated form carried in suspension by a liquid vehicle as a fluid mixture comprising, in combination, a substantially cylindrically shaped housing means; a plurality of chambers formed in said housing means arranged side-by-side along the longitudinal axis of said housing means, each of said chambers being in fluid communication with the chamber adjacent thereto and further having a zone formed therein providing fluid communication therethrough; means for introducing a flow of fluid mixture into one of said chambers and causing the fluid mixture to flow sequentially through said chambers and their respective zones; means for substantially increasing the dynamic pressure of the fluid mixture as the fluid mixture flows through each of said zones; and means for simultaneously agitating said fluid mixture as it flows through each of said zones including a generally circular disc in each of said chambers, said discs being rotatable in unison and the outer peripheral edge portion of each disc being radially spaced from the generally cylindrical, interior surface of said housing means, the annular surface defining each of said outer peripheral edge portions and the annular interior surface portion of said housing means in radial alignment therewith partially defining a respective one of said zones, one of said annular surface and annular interior surface portion partially defining each zone being of a relatively rough character and the other one of said annular surface and annular interior surface portion partially defining each zone being of a relatively smooth character in comparison, said means for substantially increasing the dynamic pressure of the fluid mixture flows through each of said zones includes a pair of generally circular plate-like blades disposed in each of said chambers, said blades being substantially mirror images of each other and arranged back-to-back with a respective one of said generally circular discs interposed between and in abutting engagement therewith, each of said blades being secured to a respective circular disc and having a plurality of circumferentially spaced vanes provided on the outer periphery thereof, said vanes being formed and arranged on each blade so that upon rotation of said disc to which it is secured one particular direction they are effective to direct the flow of fluid radially outwardly and axially into the zone of the chamber in which they are disposed and to substantially increase the dynamic pressure of the fluid mixture as it flows through such zone.

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2,092,992	9/1937	Thalman	241—256
2,718,178	9/1955	Wandel	241—163 X
2,882,149	4/1959	Willems	241—157 X

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