March 15, 1949. P. E. KNUDSEN ET AL 2,464,588

MACHINE FOR DISPERSING AGGLOMERATED PIGMENTS IN LIQUIDS

Filed Aug. 3, 1945 2 Sheets-Sheet 1

Fig. 1.

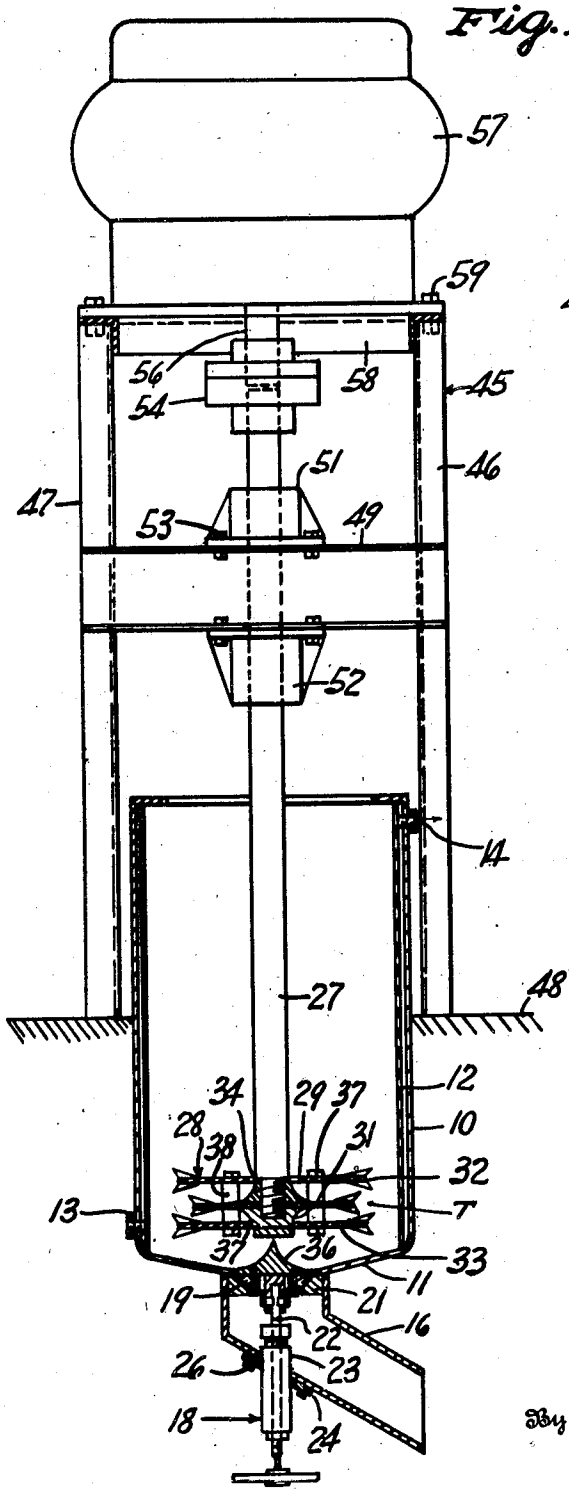


Fig. 5.

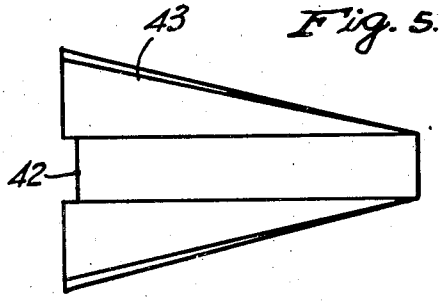


Fig. 6.

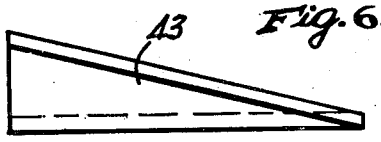
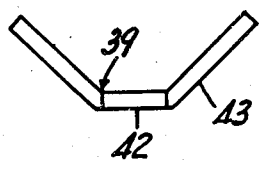


Fig. 7.



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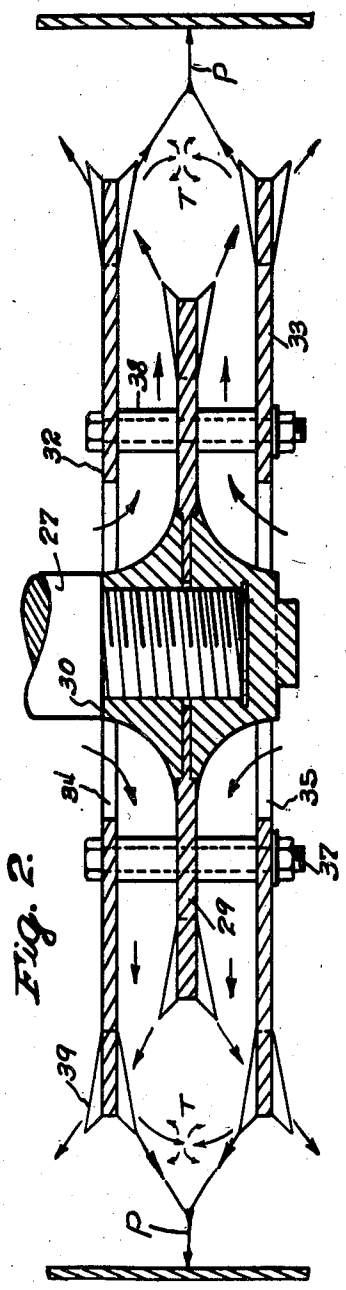


Fig. 2.

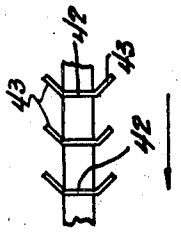


Fig. 4.

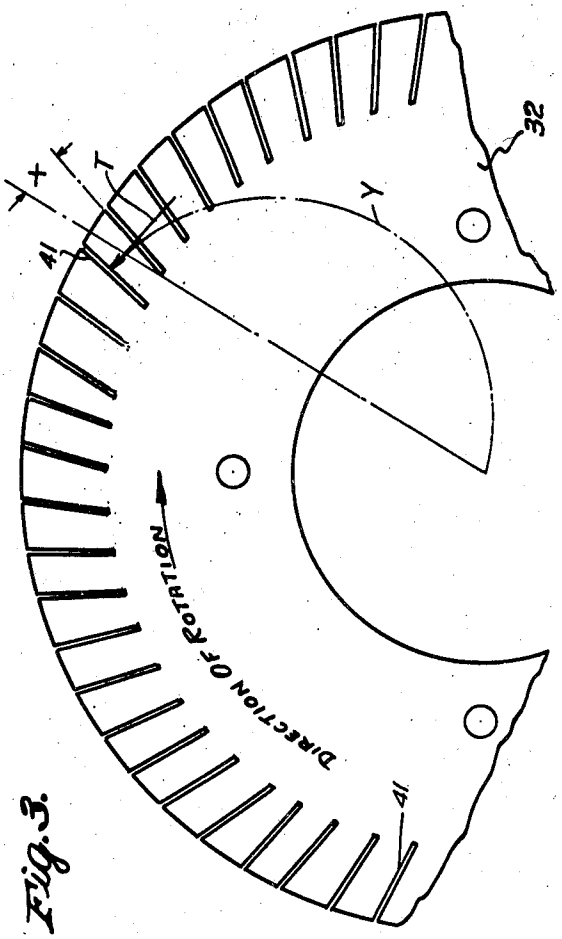


Fig. 3.

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MACHINE FOR DISPERSING AGGLOMERATED PIGMENTS IN LIQUIDS

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Application August 3, 1945, Serial No. 608,648

7 Claims. (Cl. 241—46)

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The present invention relates to apparatus for breaking up and dispersing finely divided particles and notably agglomerated pigmentary particles in a liquid medium.

One object is to reduce the number of operations and the apparatus required in the dispersion of paint pigments in oils.

A second object is to provide a simple and inexpensive apparatus whereby these various objects may be attained.

These and other objects of the invention will be apparent from consideration of the following specification and the appended claims.

Finely divided materials such as paint pigments commonly occur in the form of very minute particles, some of which by reason of forces not completely understood tend to cohere more or less firmly at points of contact to form small agglomerates. In the dispersion of such materials as paint pigments in a liquid medium such as a drying oil to form paint, it is desirable to break up these agglomerates and disperse the particles uniformly throughout the oil mixture. Various processes may be employed in effecting this result. Probably the most common involves mixing a portion of the oil of the paint with the pigments to form a paste of creamy consistency and then subjecting the paste to an intensive grinding operation in a burr stone mill of a type very similar to that heretofore employed in the grinding of flour. A second process involves grinding together pigment and oil in a ball mill in which the mixture is subjected to the prolonged beating action of the balls in the mill. A third process involves the formation of an extremely stiff paste which is subjected to a kneading action in a Banbury mixer. Several other processes which it is not believed necessary to discuss at this time have also been employed.

All of these processes, as heretofore employed, have been of low efficiency for various reasons. For example, they were comparatively slow and in most cases many hours are required in the various operations. Also, it will be apparent that large amounts of total energy were expended in many cases without performing a commensurate amount of work upon the paste mixture. For example, it will be evident that in the grinding upon a burr stone mill, much work is expended in the friction upon the stones of the mill or in merely agitating the liquid medium. Similarly, in the operation of a ball mill, a great deal of power is consumed merely in the movements of the ball elements and in the impacts of these elements upon each other or the container. This, of course,

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is all wasted effort. In the Banbury process, the paste is so exceedingly stiff that it is almost solid and a great deal of power is used. Moreover, the small batches produced on Banbury apparatus materially increases costs and decreases output.

Most of the conventional processes are also objectionable because a number of operations or separate steps are involved in the forming and milling of the paste and the subsequent incorporation of the paste after it has been formed with additional oil in order to form a finished paint. For example, when preparing a paint by the burr stone mill process, it is necessary first to agitate a desired amount of the oil (for example 25 per cent of the oil) with the pigment in order to form the preliminary paste. This may be effected by conventional agitators such as arm type agitators operating in a suitable tank or container. In this process, a partial mixture of oil and paint is effected to form a paste which can be conveniently handled by the burr stone mill. After prolonged and slow grinding, the paste can subsequently be incorporated with additional oil to form the completed paint as a separate operation by means of conventional agitator equipment. It is thus apparent that at least three operations are involved in the preparation of the paint and a different type of equipment is involved in each operation. From time to time, the apparatus requires cleaning and there is again a heavy loss because of the large number of pieces of equipment involved and also because some of the units must be taken apart and each element cleaned and scraped individually.

In accordance with the provisions of the present invention, it is proposed as one feature to effect very rapid and thorough deglomeration and dissemination of paint pigments in vehicles by provision in a container of a mass of paste of as high viscosity as is consistent with maintenance of sufficient fluidity and mobility in the paste to permit it to circulate as a liquid in the apparatus. In this viscous paste, zones of intense turbulence are generated and simultaneously the paste is circulated systematically through the zones of turbulence by streams moving away therefrom, striking the sides of the container and returning to the zones of turbulence. As a result of the high viscosity of the paste and the intense turbulence in the paste, viscous shear of great intensity is generated throughout large portions of the paste mass, thus tending strongly and efficiently to break up any pigment agglomerates. At the same time, the paste does not so approximate a solid

as to require excessive power to produce the desired turbulence.

As a further feature, the invention involves subjection of the paste to an intensive beating and wiping action by means of a multiplicity of small vane-like elements operating at high speed.

For a better understanding of the invention, reference may now be had to the accompanying drawings, in which like numerals refer to like parts throughout.

In the drawings:

Fig. 1 is a view partially in elevation and partially in section of one convenient form of apparatus by application of which the invention may be practiced.

Fig. 2 is a secondary view of an embodiment of an agitator suitable for use in the apparatus shown in Fig. 1.

Fig. 3 is a fragmentary plane view of one element of the agitator.

Fig. 4 is a fragmentary vertical view of a portion of the agitator shown in Fig. 2.

Figs. 5, 6 and 7 are detailed views of the vanes employed in the agitator.

The apparatus, as shown in Fig. 1, comprises a mixing tank or container 10 preferably in the form of a vertically disposed cylinder having a bottom 11 of inverted but flattened conical section and a lining 12 coacting with the outer cylinder to form a space for cooling or heating medium as may be required. A fluid conditioning medium is admitted to this space through conduit 13 and is withdrawn through the second conduit 14.

The container 10 is further provided with a discharge spout 16 for the discharge of the pastes or paints, discharge being controlled by means of a valve mechanism 18. This valve is of conventional design including a valve plug or washer 19 engaging a suitable valve seat 21 in the discharge spout 16. Preferably, the plug is of inverted frustoconical section so that it can be elevated to admit of the discharge of the contents of the container. The plug is carried upon a valve stem 22 extending through an appropriate gland structure 23 which provides a seal and is provided with suitable internal screw mechanism (not shown) which raises or lowers the stem when the latter is rotated. The gland may also be equipped with a flange 24 secured to the bottom portion of the spout by means of bolts 26.

An appropriate apparatus for effecting the desired flow of the paste simultaneously for producing systematic beating and shearing upon the paste in the embodiment of apparatus shown includes a shaft 27 concentrically disposed in the container and carrying at its lower extremity a system 28 of discs for breaking up and dispersing the pigments. The number of these discs may vary, a single disc being employed in some cases. However, a more efficient and powerful dispersing action may be obtained by employment of a plurality of cooperating discs. In the embodiment shown in Figs. 1 and 2, three discs are employed, the middle disc being held upon the lower extremity of the shaft by means of treaded nuts 30 and 31 which preferably are contoured to facilitate the uniform flow of the paste to be mixed between the discs. The upper disc 32 and the lower disc 33 preferably are annular, thus providing annular spaces 34 and 35 about the shaft through which the paste can obtain entrance to the spaces between the discs.

In order further to promote smooth flow of paste and to prevent accumulation of paste in

the zone below the tip of shaft 27, a plug 36 upwardly tapered preferably to an ogee or cusped section is provided. The two discs (upper and lower) are held in spaced relation with respect to the middle disc by means of through bolts 37 and spacing sleeves 38 through which the bolts extend.

Each disc is equipped with a system of vanes 39, which vanes are disposed in slots 41 best shown in Fig. 3. The spacing and arrangement of the slots may vary, but for purposes of illustration they are shown in slightly angular relation with a forward rake indicated at x with respect to the radii of the disc passing through the roots of the slots. Of course, a radial slot could be employed if so desired. The forms of these vanes may vary but for purposes of convenience, they are shown as in Fig. 7 as of sheet metal approximately trough-like in section. In this form, they are provided with a mid portion 42 and side wings 43. The side wings may have substantially any desired angular relation or slope with respect to the mid portion, but preferably are disposed to obtain optimum disseminating action upon the pigments in the oil or other liquid. In the embodiment shown, the angle is approximately 45°. The rake and slope of the vanes are desirable, inasmuch as the paste, as it flows outwardly along the surfaces of the discs, tends to travel in spiral paths in relation to the discs approximated by the line Y in Fig. 3 so that the streams impinge against the vanes in a direction very nearly normal as indicated by the tangent T with respect to the axes thereof. The paste thus striking the vanes receives maximum impact and at the same time violent turbulence in the paste is created. For example, the paste from the vanes of the middle or intermediate disc 29 flowing outwardly and upwardly or downwardly, as indicated by the arrows in Fig. 2, approximately normally against the sloped surfaces of the vanes of the discs 32 and 33 to generate a zone T of very violent turbulence best shown in Fig. 2 between and contiguous to the perimeters of the upper and lower discs. In this zone viscous shear in the mass is intense, being promoted by both the turbulence and the high viscosity of the mass. Side wings 43, as shown, are also tapered inwardly.

The vanes may be formed of sheet metal of appropriate gauge bent to the desired contour. However, it is obvious that they can be formed in other ways, for example, by casting, forging, or drawing. Vanes so formed in the rough can be machined to any desired contour and finish. The side wings 43 are shown as planes but it is also possible for them to be of appropriate curved section. It is desirable that they be so formed as to deflect the outwardly moving stratum or sheet of paste angularly with respect to the axis of the shaft 27 either upwardly or downwardly dependent upon the side of the disc upon which the stream is moving in cone-like path. In any event, the various elements should be so proportioned that the sheets or streams moving along the faces of the middle disc 29 will be deflected upwardly and outwardly as indicated by the arrows in Fig. 2 against the lower wings of the vanes of the discs 32 and 33 in the manner above described.

The paste as it leaves the lower wings of the upper vanes and the upper wings of the lower vanes is also projected outwardly in cone-like zones of high viscous shear. At an appropriate distance from the discs, the cones meet, and the convergently moving masses of paste are deflected

by each other outwardly in a radial direction in a plane P of violent turbulence, and shear to strike against the side walls of the container where they again are subjected to impact and shearing action as a result of the collision with the walls and the subsequent movement along the walls.

Manifestly, turbulent frusto conical streams of paste are also directed upwardly and outwardly from the upper faces of the vanes of the upper disc and downwardly and outwardly from the lower faces of the vanes of the lower discs. These two divergent streams cause paste to circulate systematically, the upper stream mounting upwardly along the walls of the container and sliding downwardly by gravity into the vortex to pass through the opening in the disc **32** for recirculation. Similarly, the stream from the lower disc is deflected downwardly and is returned along the bottom of the container to the opening in the lower disc **33**. Movement of the paste through the main mass assists in breaking up the agglomerates of pigment. The action is further promoted by vigorous impacts of the paste against the walls of the container and the vanes of the disintegrator head. The disintegration reaches a maximum in the zone of turbulence and intense shear T. The sheets of paste moving outwardly and striking the walls of the container to return through the openings in discs **32** and **33** assure thorough circulation through this zone.

For purposes of driving the shaft **27** appropriate apparatus is provided. This includes a stand **45** comprising a plurality of upright members **46** and **47** supported for example upon a floor **48** upon the opposite sides of the container **12**. These upright members are interconnected at intermediate points of their length by means of a cross bar **49** which supports bearings **51** and **52** secured thereto by bolts **53**. These bearings journal shaft **27**, which at its upper end is provided with a fixed clutch **54** of conventional design that provides a connection with the shaft **56** of a motor **57**. This motor is supported upon a platform structure **58** secured by means of bolts **59** to the upper extremities of the uprights **46** and **47**.

It will be apparent that a multiplicity of units, each comprising an intermediate disc of lesser diameter and contiguous larger discs having openings therein, may be carried on a single shaft. It would appear desirable that the discs of one set contiguous to the discs of the adjacent sets should be substantially spaced from the latter in order to permit free access of the paste to the openings in the discs for effective recirculation.

In the operation of the embodiment of the apparatus herein shown, variations of technique are permissible. A convenient process may involve the gradual, simultaneous addition of pigment such as paint pigment and a liquid such as linseed oil or other drying oil to the container **12** in such manner that the oil and pigment are formed into a paste substantially as they are added. It is also permissible to preform the paste prior to its introduction into the container **12**—for example, by conventional agitating apparatus. In this latter process, the conventional arm type agitation is sufficient to admix oil and liquid but is incapable, at least within any reasonable period of time, of breaking down the agglomerates in the pigments to obtain a fine dispersion.

Considerable care should be observed in the proper proportioning of the oil and the pigment to form the paste. It is desirable, after mixing of oil and pigment, to secure a relatively thick paste, for example, one having a consistency approximating that of lard or vaseline at room temperature. In this state it is capable of standing up above a surface for a substantial period of time. It can be easily dipped up on a spatula and if laid on a plate will stand up like thick whipped cream. This assures that the pigmentary agglomerates suspended in the paste when subjected to the action of the disperser herein shown will be subjected to strong shearing or tearing forces as the paste in a zone of turbulence flows through the mass or is subjected to impact and sliding movement over the various surfaces with which it collides in its movement. If the paste is too thin, shearing action will be inadequate and usually the power consumption of the apparatus, a criterion of the work of the paste will tend to fall off. If the paste is of suitable consistency for mixing, it will flow readily between the discs **29**, **32**, and **33** and will tend to pile up against the walls of the container. In so doing, it will move as frusto-conical sheets or streams away from the vanes of the various discs to produce a shearing action by its own kinetic energy as it moves outwardly. As the material piles up against the walls of the container, it will also tend, if it is of proper consistency, to flow downwardly under its own weight to form a vortex and back through the openings **34** and **35** to be recycled between the discs. Systematic flow and turnover of the material to obtain uniform mixing of all portions is thus assured.

It will be apparent that if the paste is too thick, any material piled up against the walls of the container will not adequately flow back to be recycled through the openings **34** and **35**. This will result in inadequate loading of the impeller mechanism and will manifest itself as a reduction in the power consumption of the motor. Of course, if the impeller is rotated at too rapid a rate, the vanes will merely go through the paste without adequately engaging the latter and there will again be a loss of power consumption and attendant reduction in the milling action of the apparatus. It will thus be apparent that the power consumption constitutes a good criterion to determine when paste consistency, speed of operation, etc., are at an optimum.

Usually, optimum operations are obtained when the oil constitutes approximately 9 to 25 per cent of the paste mass. However, it will be apparent that a certain degree of variation may occur dependent upon the absorbivity of the pigment, the temperature of operation and also upon the viscosity of the oil employed. It is difficult to state any precise rule for determining the ratio of pigment and oil other than by observation of the power consumption and also the flow of the paste in the container **12** to maintain proper loading. The oil may be preheated, for example, to 100° to 300° C. before it is run into the dispenser.

Mixing should be continued until the paste is of smooth and uniform texture, free of any minute agglomerates which can easily be determined by spreading a sample upon an appropriate surface. The time of mixing usually will vary dependent upon the nature of the pigments employed. Some disperse very quickly and others require a greater amount of time. Nearly all pigments can be dispersed to a degree adequate for

any commercial purposes but in a few instances, such as in the case of iron oxide, it may be desirable to employ the apparatus herein shown for purposes of carrying the dispersal down to an appropriate point after which the paste mixture is discharged and subjected to grinding in a conventional mill in order further to break up any difficultly disintegrable particles or agglomerates.

A paste, as prepared upon the apparatus herein shown, can be discharged if desired through the spout 16 and subsequently admixed with additional oil to obtain the finished paint in the usual manner upon a conventional agitating apparatus. However, it is perfectly feasible and in many instances it is preferable to add the oil directly to the paste in the container 12. In such instance, of course, care should be taken not to fill the container to such an extent that it will be overloaded when the oil is subsequently added to form the paint. During the addition of the oil, the speed of the impeller mechanism may be very substantially reduced, since the oil and the paste almost instantly diffuse into each other to give a uniform mixture. Mixing in this manner admits of use of a minimum amount of apparatus.

Assuming that paints of similar or identical composition are being formed batch-wise upon the apparatus, it will be apparent that when one batch has been discharged, the constituents of the paste of the next batch may be added immediately without subjecting the apparatus to cleaning.

The apparatus herein described is particularly effective in the dispersion of pigments in drying oils, but at least some of the apparatus features are of broader application, being useful for dispersing chocolate in liquids, paper pulp in water, etc., where it is desirable to break up and disperse more or less coherent particles of solid substances.

The forms of the invention herein shown and described are to be regarded merely as examples. It will be apparent to those skilled in the art that numerous modifications may be made therein without departure from the spirit of the invention and the scope of the appended claims.

We claim:

1. Apparatus for dispersing agglomerates of fine pigmentary particles in a liquid medium comprising a container a shaft rotatable about its longitudinal axis disposed in the container, said shaft carrying a disintegrator head comprising upper and lower discs and an intermediate disc of lesser diameter, the discs being provided with vanes at their outer peripheries, the vanes having divergent wings backwardly sloping with respect to the direction of rotation of the shaft, the vanes on the upper and lower discs being disposed beyond the outer periphery of the intermediate disc to impact the paste moving outwardly from the vanes on the intermediate disc in order to generate a zone of violent turbulence contiguous to the outer perimeters of the disc.

2. Apparatus for dispersing agglomerates of fine pigmentary particles in a liquid medium comprising a container a shaft rotatable about its longitudinal axis disposed in the container, said shaft carrying a disintegrator head comprising upper and lower discs and an intermediate disc of lesser diameter, the discs being provided with vanes at their outer peripheries, the vanes having divergent wings backwardly sloping with respect to the direction of rotation of the shaft, the vanes on the upper and lower discs being disposed beyond the outer periphery of the intermediate disc to impact the paste moving outwardly from the vanes on the intermediate disc in order to generate a zone of violent turbulence contiguous to the outer perimeters of the disc, the upper and lower discs having openings formed therein to admit the free circulation of paste into the space between discs.

3. Apparatus for dispersing agglomerates of fine pigmentary particles in a liquid medium comprising a container a shaft rotatable about its longitudinal axis disposed in the container, said shaft carrying a disintegrator head comprising upper and lower discs and an intermediate disc of lesser diameter, the discs being provided about their outer peripheries, with vanes having divergent wings backwardly sloping with respect to the direction of rotation of the shaft, the vanes on the upper and lower discs being disposed beyond the peripheries of the intermediate disc to impact, the paste moving outwardly from the vanes on the intermediate disc in order to generate a zone of violent turbulence and intense viscous shear contiguous to the outer perimeters of the disc, the vanes on the outer discs being set at an angle to the radii of the discs in a manner to impact approximately normally with respect to the paste moving outwardly along the discs.

4. Apparatus for distributing agglomerated pigmentary particles in a liquid medium and comprising a plurality of discs disposed upon a rotatable spindle two of the discs having openings formed therein contiguous to the spindle, the discs further carrying vanes of V-section with the apices of the vanes facing forwardly in the direction of rotation whereby to generate zones of turbulence contiguous to the perimeters of the discs upon rotation of the spindle, the discs being spaced with respect to each other in such manner that the zones will impinge upon each other at a point spaced outwardly from the discs.

5. Apparatus for dispersing pigmentary materials in liquids comprising a container, an axially rotatable disposed shaft in the container and being provided with a dispersing head comprising a set of three spaced discs disposed co-axially upon the shaft the discs being provided with vanes of approximately V-section, the apices of the vanes being disposed in the direction of rotation of the shaft the vanes on the intermediate disc being disposed to project conically outwardly flowing sheets of the material generated by rotation of the head in the mass against the faces of the vanes on the contiguous discs to generate zones of turbulence contiguous to the perimeters of the discs, the outer discs having openings formed therein for the circulation of liquid between the discs.

6. Apparatus for dispersing pigmentary materials in liquids comprising a container, an axially rotatable shaft disposed in the container and being provided with a dispersing head comprising a set of three spaced discs disposed co-axially upon the shaft the discs being provided with vanes of approximately V-section, the vanes facing in the direction of rotation of the shaft the vanes on the intermediate disc being disposed to project the conically outwardly flowing sheets of the material generated by the rotation of the head in the liquid against the adjacent faces of the vanes on the outer discs to generate zones of violent turbulence contiguous to the perimeters of the discs the vanes on the outer discs being further disposed to project outwardly flowing conical sheets of moving paste from the interior sur-

faces into contact in a plane before they contact the wall of the container, the outer discs having openings formed therein for the circulation of liquid between the discs.

7. Apparatus for disintegrating agglomerated pigmentary particles and disseminating the particles into a liquid medium, said apparatus comprising a vertical shaft journaled for rotation in a container for the medium and the material to be disseminated, a plurality of discs disposed coaxially in spaced relation upon the shaft and carrying vanes of approximately V-section disposed about the outer peripheries thereof with the apices of the vanes facing in the direction of rotation of the discs whereby upon rotation of the shaft the discs generate cone like sheets of moving paste, the spacing of the discs upon the shaft and with respect to each other being such that the sheets will impinge upon each other at a point spaced radially outwardly from the discs.

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