March 12, 1935. C. P. TOLMAN 1,993,762

COLLOID MILL

Filed Nov. 8, 1930 3 Sheets-Sheet 1

Fig. 1.

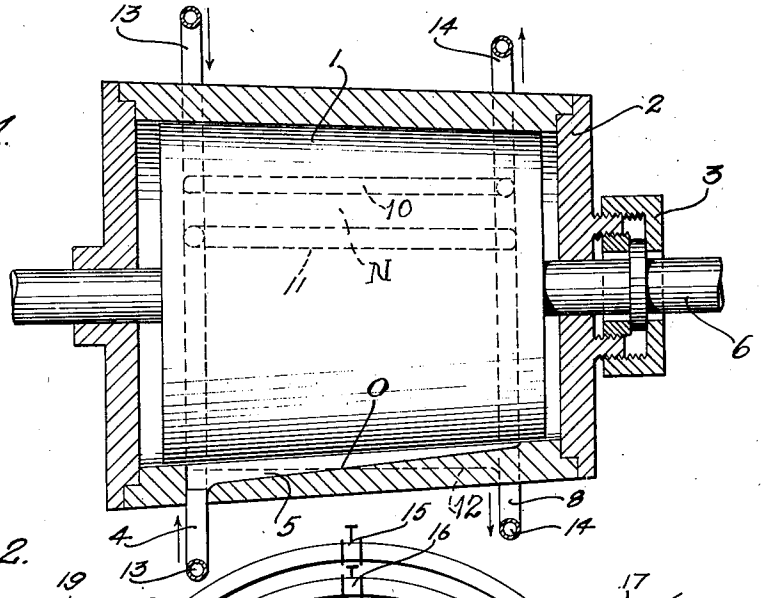



Fig. 2.

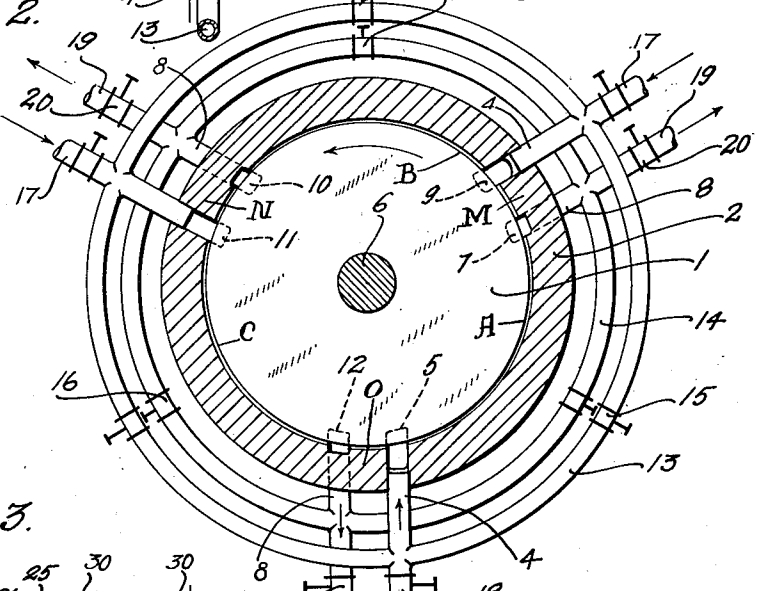
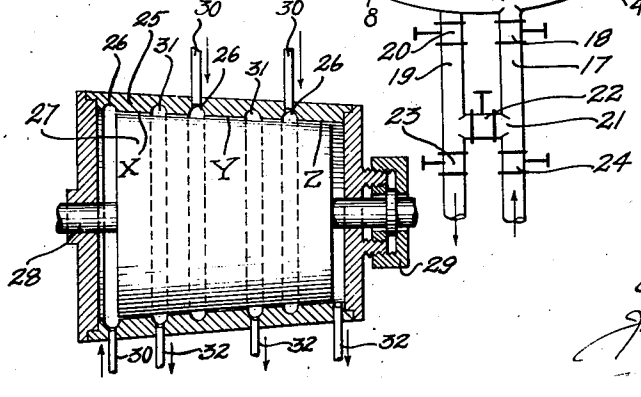



Fig. 3.




INVENTOR
Charles P. Tolman
BY
Janney Blair & Curtis
ATTORNEYS

March 12, 1935. C. P. TOLMAN 1,993,762

COLLOID MILL

Filed Nov. 8, 1930 3 Sheets-Sheet 2

Fig. 5.

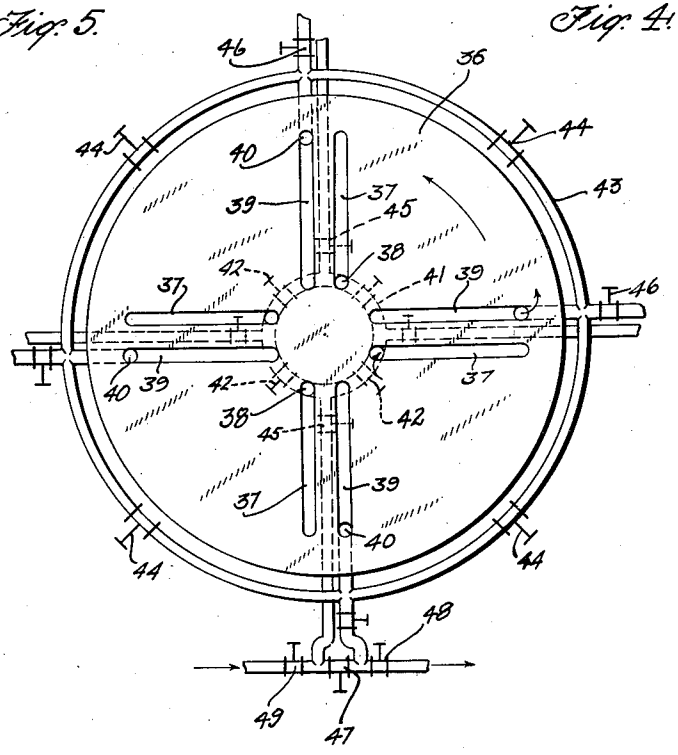



Fig. 4.

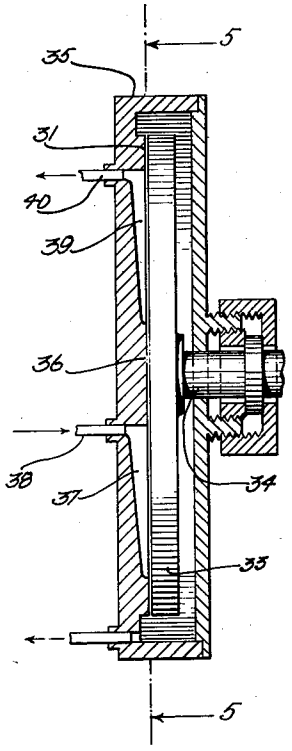



Fig. 6.

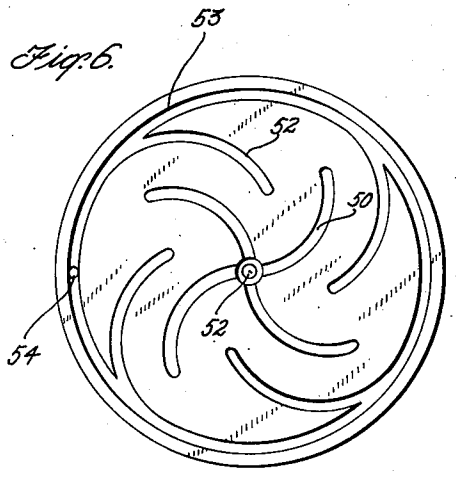
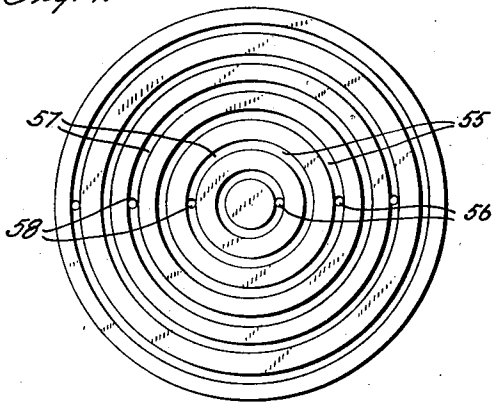



Fig. 7.




INVENTOR
Charles P. Tolman
BY
Janney Blair & Curtis
ATTORNEYS

March 12, 1935. C. P. TOLMAN 1,993,762

COLLOID MILL

Filed Nov. 8, 1930 3 Sheets-Sheet 3

Fig. 9.

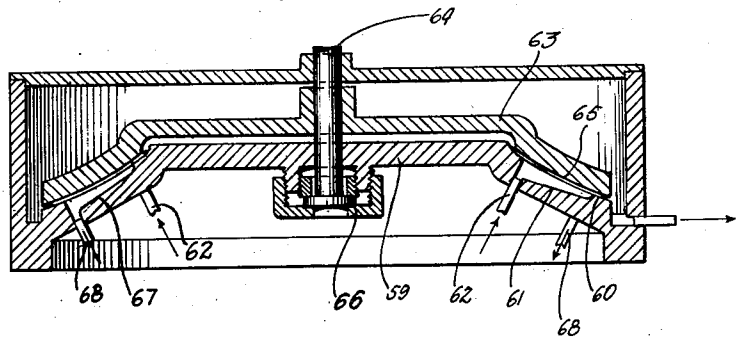
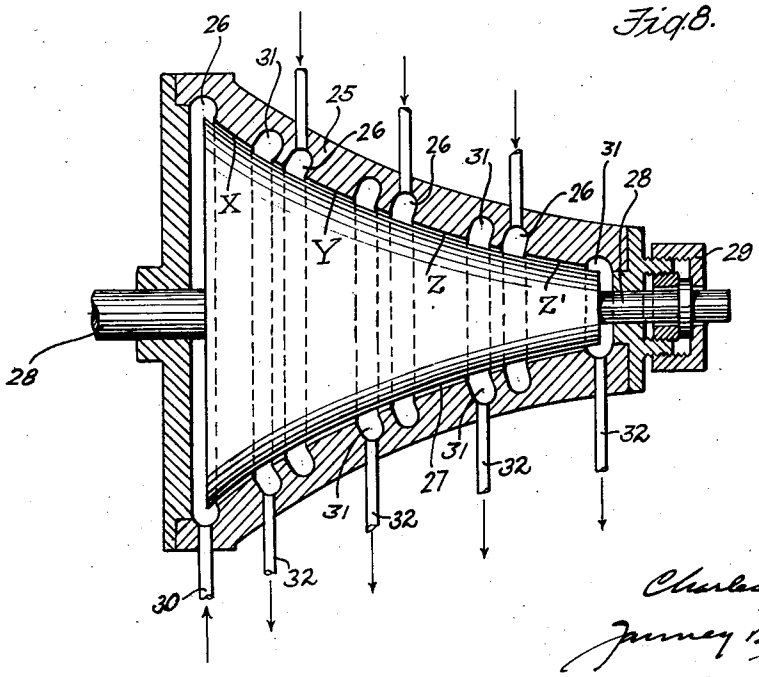



Fig. 8.




Charles P. Tolman INVENTOR

BY Blair & Curtis ATTORNEYS

Patented Mar. 12, 1935 1,993,762

# UNITED STATES PATENT OFFICE

1,993,762

## COLLOID MILL

Charles P. Tolman, Kew Gardens, N. Y., assignor, by mesne assignments, to The Noble & Wood Machine Co., Hoosick Falls, N. Y., a corporation of New York

Application November 8, 1930, Serial No. 494,250

4 Claims. (Cl. 83—13)

The present invention relates to an improvement in colloid mills. One object thereof has been to provide a mill which presents material advantages in operation over certain known types of homogenizers and dispersion machines. One factor which has tended to retard the wider use of colloid mills in industry has been the relatively small output per unit in relation to the time and energy expended. Under such conditions, it has not been economically possible to commercially exploit a number of low priced products which can be produced or advantageously treated in colloidal mills if their output can be increased sufficiently to reduce the per-unit cost of operation.

One of the reasons why devices of the prior art with which I am familiar have not been economically adaptable to the treatment or production of low cost products is the fact that their output has been restricted because the product is usually treated for a greater time and through a more extended space than is necessary to effect the desired result. For example, assuming that the purpose is to disperse a solid such as a wax in a liquid medium such as water, it is my theory that, at a given speed of operation, and under proper conditions, the desired dispersion will ordinarily be effected within a relatively short period of time and after each particle is moved or translated only a relatively short distance in the dispersion or colloid machine. It is believed that when any given particle of colloidal dimension or characteristic is moved, under the conditions existing in the colloid mill, over a distance approximately one hundred times its diameter, it will have been moved sufficiently to bring it into a dispersed state.

Accordingly, one of the objects of my invention has been to secure the dispersed or colloidal effect with a minimum displacement of the particles operated on by the moving surfaces between which the film shear takes effect. Thus, instead of applying energy and time to the further and unnecessary treatment of particles after the colloidal or dispersed condition has been achieved, I provide means for rapidly discharging said particles immediately thereafter. In this way, the output or capacity of a colloidal mill of a given size and power requirement is increased many times and the cost of the applied energy is distributed over a materially greater number of units of product.

Several illustrative embodiments of my invention are described in the following specification and illustrated in the accompanying drawings in which

Figure 1 is a view in central longitudinal section of a truncated cone type of colloid mill;

Figure 2, a transverse section thereof;

Figure 3, a view in central longitudinal section of a modified form of truncated cone type of mill;

Figure 4, a central section of a rotating disc type of mill;

Figure 5, a plan view of the effective stator surface of the mill illustrated in Figure 4;

Figure 6, a plan view of a modified form of stator;

Figure 7, a plan view of a further modified form of stator;

Figure 8, a central longitudinal section of another modification; and

Figure 9, a central longitudinal section of another modification.

Referring to the drawings, Figures 1 and 2 illustrate a type of colloid mill in which the characteristic shearing effect is produced in separate shearing gaps as A, B, and C, located between relatively moving surfaces, one of which is the outer surface of a truncated cone shaped rotor 1 and the others of which are portions of the inner surface of a similarly shaped stator in the form of a casing or housing 2. The shearing gaps or spaces between said surfaces may be regulated to any predetermined size or extent by suitable adjusting means indicated generally at 3. The material to be treated in the mill is introduced conveniently through inlets 4, one of which communicates with a longitudinally extending groove or recess 5 in the inner surface of casing 2 while the others are connected to the inlet grooves 9 and 11 respectively. The rotor member 1 is mounted on a shaft 6 driven by a motor or other suitable device, not shown. Where the direction of motion of the rotor is counterclockwise, as indicated in Figure 2, the material introduced into inlet groove 5 will move through shearing gap A and discharge at the opposite edge of said gap into a longitudinally extending outlet groove or recess 7 communicating with an outlet pipe 8. The material introduced into inlet groove 9 travels through gap B in a counter-clockwise direction and is discharged through another discharge groove 10. Similarly, material introduced through inlet groove 11 is moved through gap C and discharged through a discharge groove 12. Although in the illustrative embodiment of my invention above described, I have shown and referred to three inlet grooves 5, 9 and 11 and a corresponding number of gaps A, B and C and outlet grooves 7, 10 and 12 it is contemplated that any suitable number of inlet grooves shearing gaps and outlet grooves may be provided, whether more or less than the number herein shown and described and they may be operated simultaneously or singly at will. The outlet grooves are separated from their respective next adjacent inlet grooves in the direction of rotation of the rotor by baffles or the like M, N, O, formed by portions of the walls of the casing 2.

As indicated in Figure 2, the inlet pipes, as 4,

are connected by a conduit 13 while the outlet pipes, as 8, are similarly connected by conduit 14. Valves 15 are interposed between adjacent inlet pipes 4 and valves 16 are interposed between adjacent outlet pipes 8. Furthermore, the inlet pipes 4 and their connecting conduits 13 communicate with supply pipes 17, each provided with a valve 18. Similarly, the discharge pipes 8 and their connecting conduits 14 are provided with discharge conduits 19, each equipped with a valve 20.

In multiple operation, material to be treated is fed simultaneously through the several inlets into the corresponding shearing gaps and the completed product is continuously withdrawn either at separate discharge openings or at a single predetermined discharge opening. Where materials of different characteristics are to be dispersed to form a single product, they may be introduced separately through the several inlets or they may be introduced after being preliminarily mixed. Where materials are introduced separately, the relative amount of each thereof may be separately regulated by means of valves 18 on the inlet pipes 17. It will be understood that, when separate ingredients are introduced into the mill through the several inlets thereof, the valves 15 will be closed so that there will be no intercommunication between the material introduced at one point and that introduced at an adjacent point. Besides permitting control of the amount of any added ingredients, in proportion to other ingredients, the arrangement thus described also permits ingredients to be added in a predetermined sequence in relation to each other.

As shown in Figure 2, the outlet pipe 19 is connected to the inlet pipe 17 by means of pipe 21 provided with a valve 22. Thus, if it is desired to re-treat or re-introduce the output of any given outlet, the valve 22 is opened and the discharge from pipe 19 flows into pipe 17, either as it comes from the mill or mixed with new or different material feeding through pipe 17. With such an arrangement, it is desirable to provide an additional control valve 23 in pipe 19 and a control valve 24 in pipe 17. Obviously, this arrangement of connecting pipes or conduits and control valves may be repeated as often as desired for any given installation, and the re-treatment of treated material or the introduction of partly treated material together with untreated material may be effected not only in the type of apparatus illustrated in Figures 1 and 2 but in other types or modifications as well.

In the modifications illustrated in Figures 3 and 8 respectively, my improved mill comprises a casing 25 provided with interiorly disposed annular inlet grooves or recesses 26 and outlet grooves 31. A rotor 27 of tapered contour is mounted on a shaft 28 and driven by suitable means, such as a motor, not shown, said rotor being adjustable relatively to the interior surface of the casing 25 by suitable adjusting devices indicated at 29 and forming with portions of said surface shearing gaps X, Y, Z and Z'. In Figure 3, the inlet grooves 26 communicate with inlet pipes 30, and the outlet grooves 31 communicate with outlet pipes 32, this arrangement being repeated as often as may be desired or practicable. In operation, material to be treated is introduced through an inlet 30 into a groove 26 and is moved from its initial position longitudinally and circumferentially through a shearing gap, as X for example, until it reaches groove 31 from which it is discharged through a pipe 32. The same operation takes place in connection with each succeeding pair of said inlet and outlet grooves and their corresponding interposed shearing gaps. As indicated in connection with the description of the device illustrated in Figure 2, here also the inlet pipes 30 may be connected to feed simultaneously and the outlet pipes 32 may be connected to discharge simultaneously. Likewise, the connections of the inlet pipes may be such that different materials will be simultaneously fed for treatment in shearing gaps operating opposite different parts of the rotor, and the outlet or discharge openings may be controlled to discharge the product at any intermediate stage of its treatment, or the product may be retained in the mill or dispersing apparatus to be discharged only at or through the last discharge opening or as desired. Also, as shown in connection with Figure 2, the product from one outlet or from any group of discharge openings may be re-introduced through one or more of the inlet openings.

In the form of apparatus illustrated in Figures 4 and 5, a rotor disc 33 or the like, mounted on a shaft 34 operates within a casing 35, one face of said disc 33 being disposed in spaced relation opposite an interiorly disposed face 36 of said casing. Inlet recesses 37 open through said inwardly disposed face 36 and communicate with corresponding inlet ports 38. A series of outlet recesses 39 also open through said interiorly disposed face 36 and communicate with corresponding discharge ports 40. In Figure 5, the apparatus is shown with four inlet recesses and four outlet recesses. However, it is contemplated that the number of inlet and outlet recesses may be varied to meet different conditions arising in actual operation. The inlet pipes 38 may conveniently be connected by a circular conduit 41 provided with valves 42. The outlet pipes 40 or their extensions are conveniently connected by a circular conduit 43 provided with valves 44. In devices employing disc type rotors, as shown in Figures 4 to 7 inclusive for example, an effective shearing gap is provided between each inlet groove or recess and the next adjacent outlet or discharge recess in the direction of rotation of the disc rotor.

Control valves 45 are interposed in the feed lines or inlet pipes and control valves 46 in the discharge lines or outlet pipes. Where it is desired to return treated material to the mill for further treatment, a discharge or outlet conduit is connected to an inlet conduit, as indicated in Figure 5, with a valve 47 interposed to control the flow of material between said conduits. Control valves 48 and 49 are also placed in the discharge and feed lines respectively. The arrangement just above described may conveniently be repeated in respect to as many of the inlet and outlet conduits as may be desired.

In the modification shown in Figure 6, the face or inwardly exposed surface of the stator portion of the casing opposite the operative face of disc 33, for example, is provided with intercommunicating inlet grooves 50 to which material is supplied through a centrally disposed inlet opening 51. The treated substance or material moves from said inlet grooves through the several shearing gaps to outlet grooves 52 which communicate with a collecting groove 53 having a discharge opening 54.

In another form of device such as that illustrated in Figure 7, an annular inlet groove 55 is provided with an inlet opening 56. The material

introduced through opening 56 and groove 55 after passing through the intervening shearing gap is intercepted in an annular groove 57 having an outlet 58, said groove 57 being concentric with the inlet grove 55. In like manner, a second inlet groove 55 having an inlet opening 56 will feed material to be treated in another shearing gap and discharged through the second discharge groove 57 having a discharge opening 58, it being contemplated that the series of alternating inlet and outlet grooves with interposed shearing gaps may be repeated as frequently as desired, or to such extent as practicable in any given case. It is also contemplated that the inlet and outlet grooves indicated in Figures 6 and 7 may be connected and interconnected in such a manner as to permit control of the product to take place in substantially the same manner as that described in connection with the devices shown in Figures 2 and 5.

Figure 9 illustrates a type of colloid mill in which the operative parts are of substantially dish-shape in cross sectional contour. In this form of apparatus, a stator 59 is provided with an annular angularly disposed curved surface 60 through which are the openings of recesses, as 61, communicating with inlet pipes 62. A rotor 63 mounted on a shaft 64 is provided with an annular curved surface 65 positioned opposite the surface 60 of the stator, and is adjustable toward and away from said surface by suitable adjusting means as 66 to vary the extent of shearing gaps formed between the rotor and the several shearing surfaces of the stator. Outlet grooves or recesses 67 are also provided in the stator and communicate with outlet conduits 68. In operation, the material to be treated is introduced through pipe or pipes 62 and the corresponding grooves or recesses. It passes through shearing gaps formed between the surfaces 60 and 65 of the stator and rotor respectively and discharges through the grooves 66 and outlets 67.

From the foregoing description of various forms of colloid mill structures in which my invention may readily be embodied, it will be apparent that the described means for feeding material to and removing product from the effective zone of shear or selected portions thereof produces in effect a multiple path device, particularly when the inlet and outlet openings operatively related to the respective shearing zones or gaps are so arranged and controlled that they may be connected or disconnected at will. One advantage of a mill of this character is that the output or capacity of any given machine will be in proportion to the relative ease or difficulty with which a given material goes into colloidal suspension or dispersion. A colloid mill or dispersion machine embodying my improvements is more flexible than known types in that materials or products which are readily dispersed can be fed through in relatively greater quantities for a given expenditure of time and energy and the same machine can be used to advantage for treating a wider variety of materials than can be economically handled in known mills. Where the substance to be dispersed requires a greater time and greater expenditure of energy, the feeding or re-feeding arrangement hereinabove described will permit re-treatment of the material any desired number of times through the same machine or different parts thereof to produce the ultimate product.

I claim as my invention:

1. In a colloid mill, the combination of co-operating members having opposed film shearing surfaces, means for effecting differential film shearing movement between said surfaces, simultaneously operable material feeding inlets opening into the space between said surfaces, simultaneously operable material discharge outlets opening into said space in alternating relation to said inlets, and means for operatively connecting an outlet with an inlet to effect a feedback of treated material to a different portion of said intersurface space.

2. In a colloid mill the combination of a rotor, a plurality of spaced stator shearing surfaces operatively arranged opposite different portions of the rotor surface, an inlet opening at one side and a discharge opening at the opposite side of each of said plurality of stator shearing surfaces, said openings and said stator surfaces being position in co-operating relation to each other and to the rotor to form, during rotation of the latter, simultaneously operative shearing gaps whereby material to be dispersed in each gap enters said gap from an inlet opening and is dicharged from said gap into the next adjacent discharge opening, a stop member adjacent each discharge opening and extending across the rotor surface to deflect treated material into said opening, and individually controllable conduits operatively connected to said respective inlet and discharge openings.

3. In a colloid mill the combination of a rotor, a plurality of spaced stator shearing surfaces operatively arranged opposite different portions of the rotor surface, an inlet opening at one side and a discharge opening at the opposite side of each of said plurality of stator shearing surfaces, said openings and said stator surfaces being positioned in co-operating relation to each other and to the rotor to form, during rotation of the latter, simultaneously operative shearing gaps whereby material to be dispersed in each gap enters said gap from an inlet opening and is discharged from said gap into the next adjacent discharge opening, a stop member adjacent each discharge opening and extending across the rotor surface to deflect treated material into said opening, and means for operatively connecting a discharge opening of one shearing gap with the inlet opening of another shearing gap.

4. In a colloid mill, the combination of two cooperating members having opposed film shearing surfaces, means for effecting differential film shearing movement between said opposed surfaces, one of said members being provided with material feeding inlets and material discharge outlets opening into the space between said opposed surfaces and arranged in alternating spaced relation, said opposed shearing surfaces being positioned to form a plurality of shearing gaps arranged in succession in the direction of travel of material through said gaps during film shearing operation, and each gap being operatively positioned to receive material from one of said inlets and to discharge material into one of said outlets, and means for operatively connecting an outlet of one shearing gap with the inlet of another shearing gap.

CHARLES P. TOLMAN.