Oct. 18, 1932. E. COWLES 1,883,597

METHOD AND APPARATUS FOR DISSEMINATING SOLIDS IN LIQUIDS

Filed Dec. 27, 1930 6 Sheets-Sheet 1

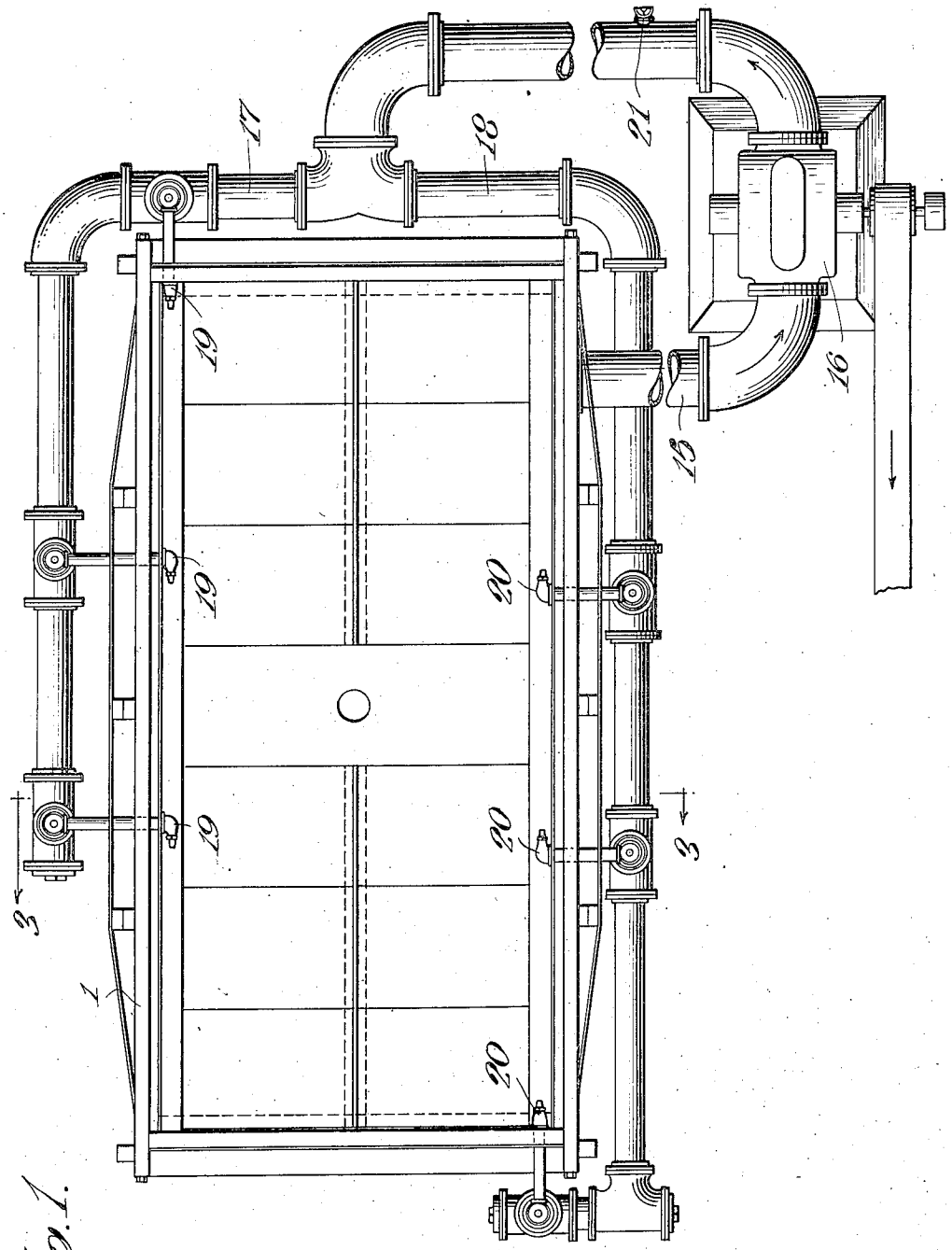


Fig. 1.

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Fig. 2.

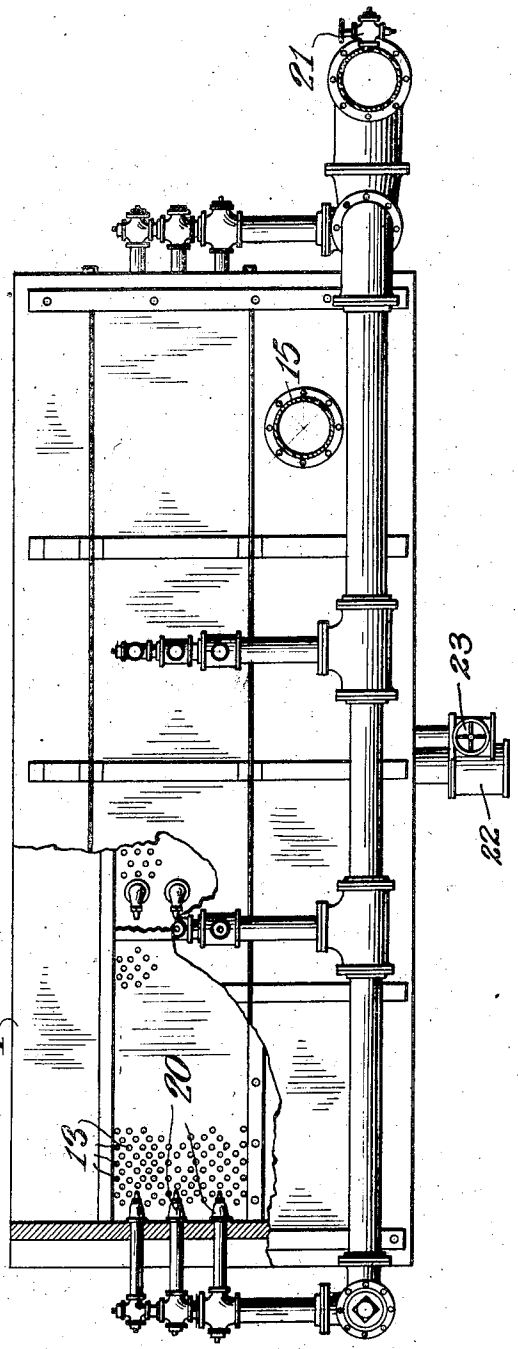
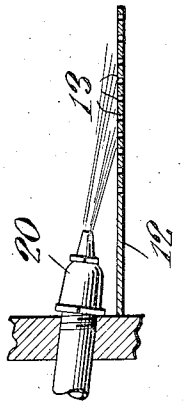


Fig. 5.



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Fig. 3.

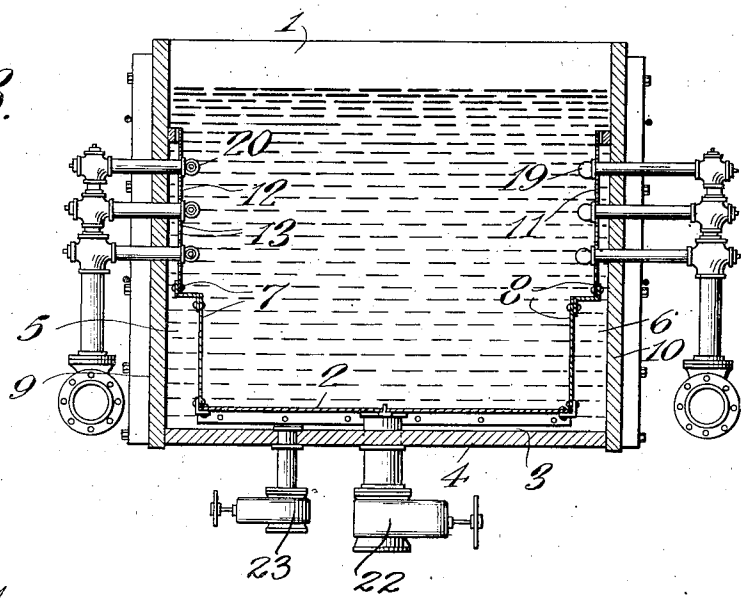
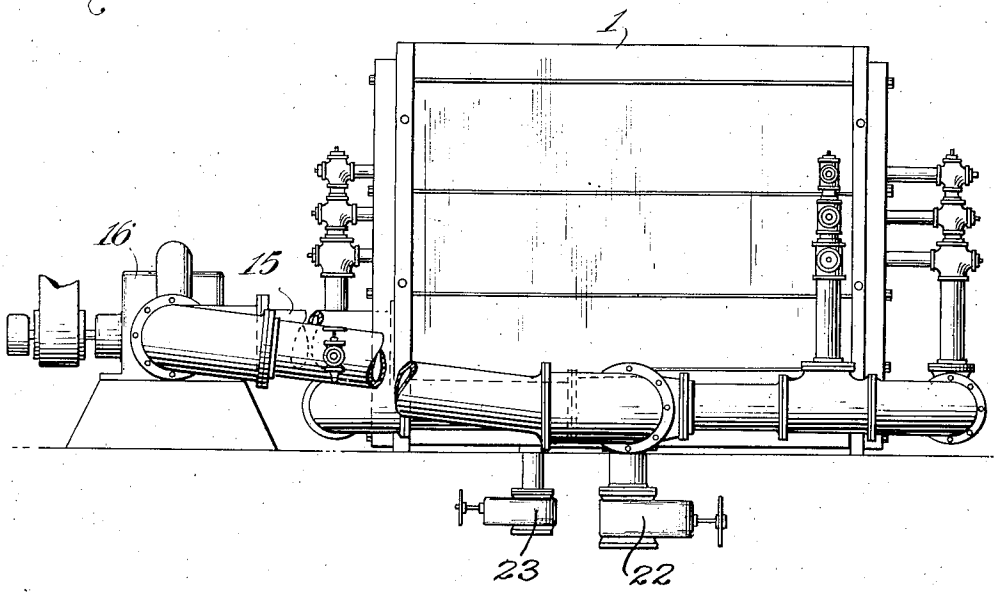


Fig. 4.



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METHOD AND APPARATUS FOR DISSEMINATING SOLIDS IN LIQUIDS

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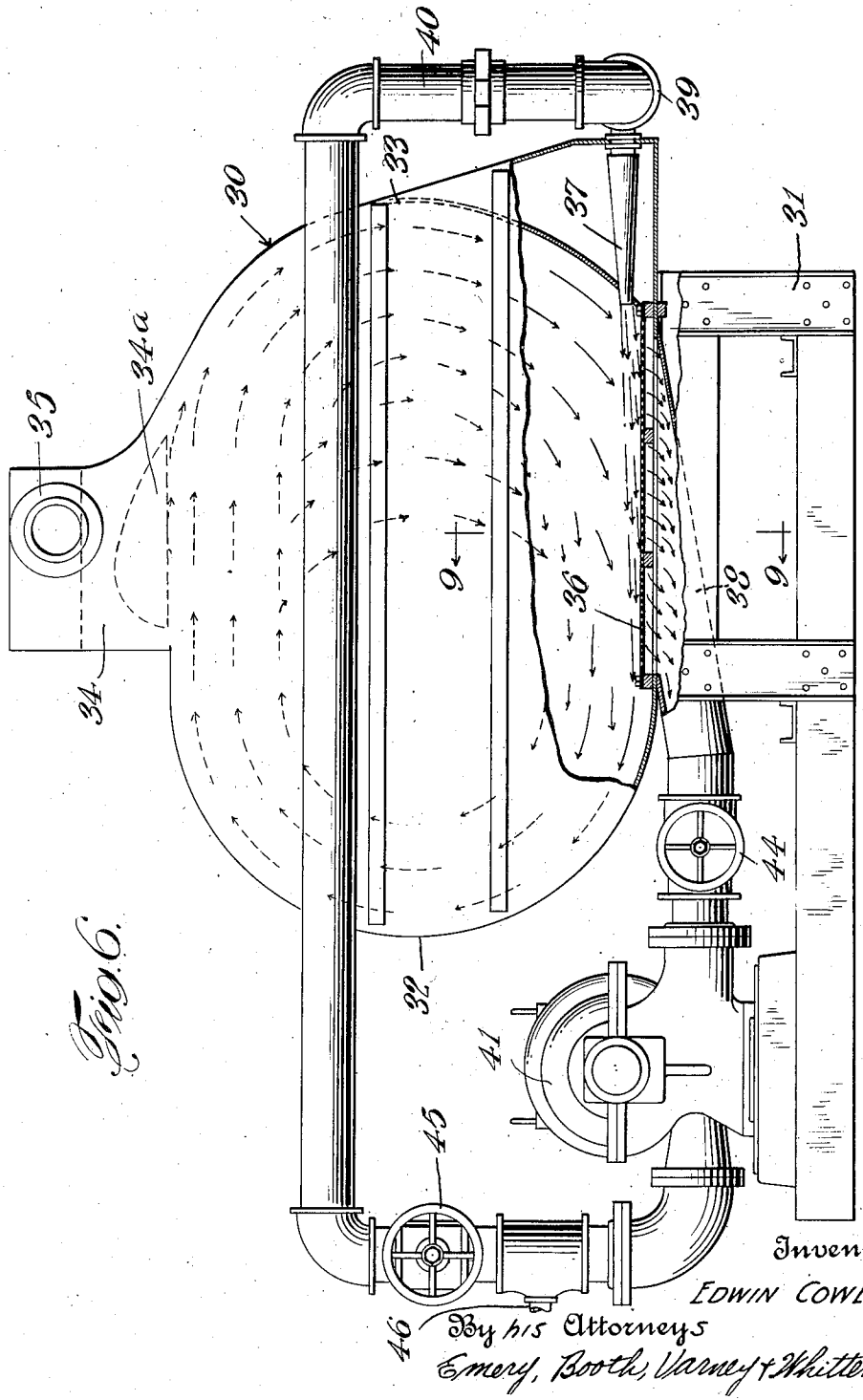


Fig. 6.

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METHOD AND APPARATUS FOR DISSEMINATING SOLIDS IN LIQUIDS

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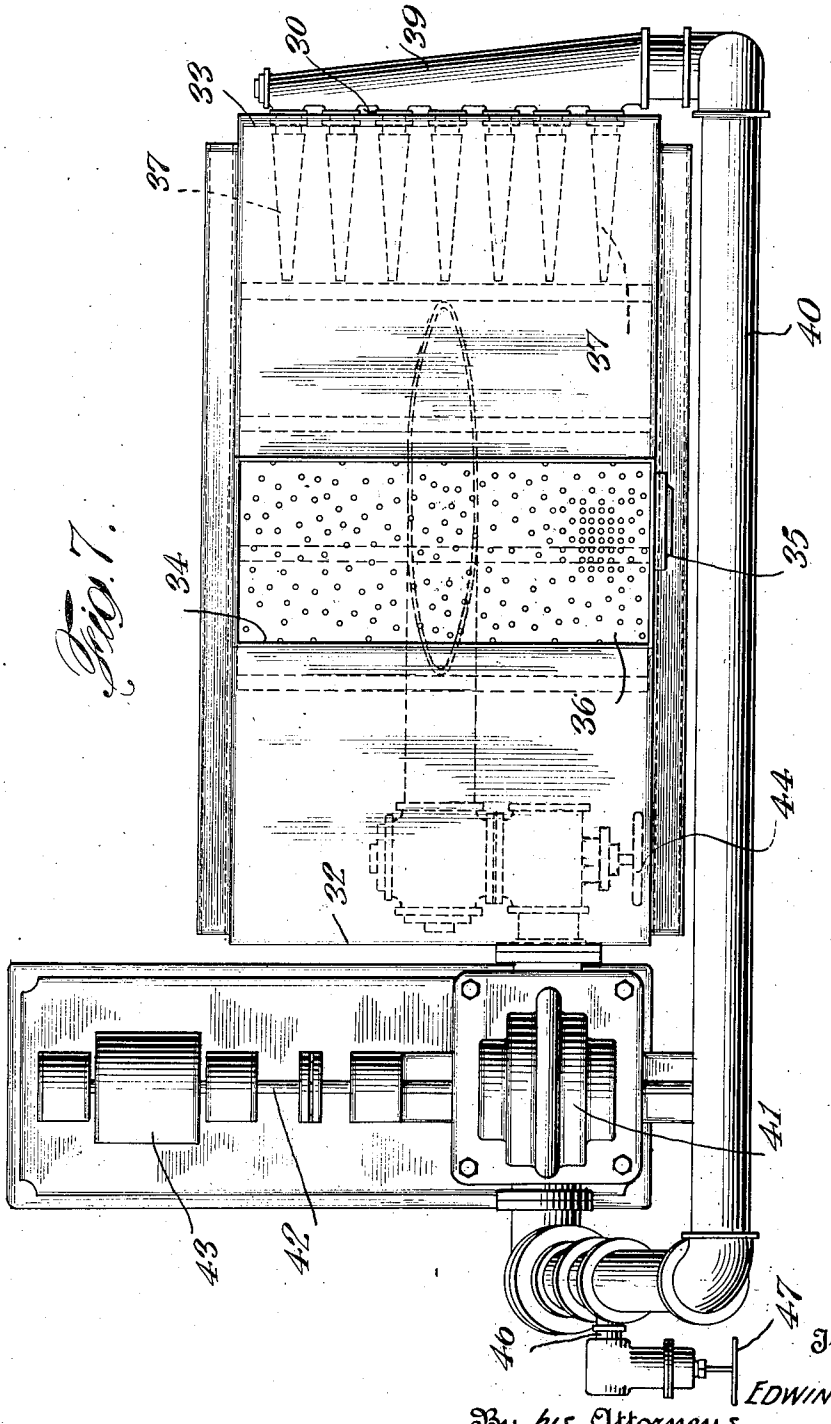


Fig. 7.

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METHOD AND APPARATUS FOR DISSEMINATING SOLIDS IN LIQUIDS

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Fig. 9.

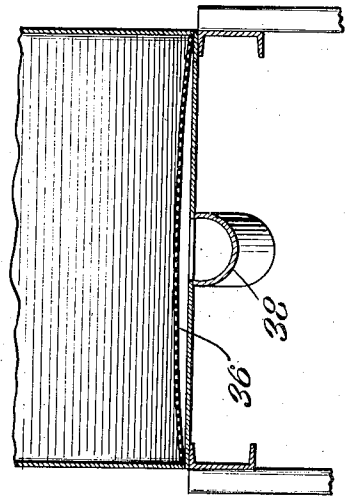
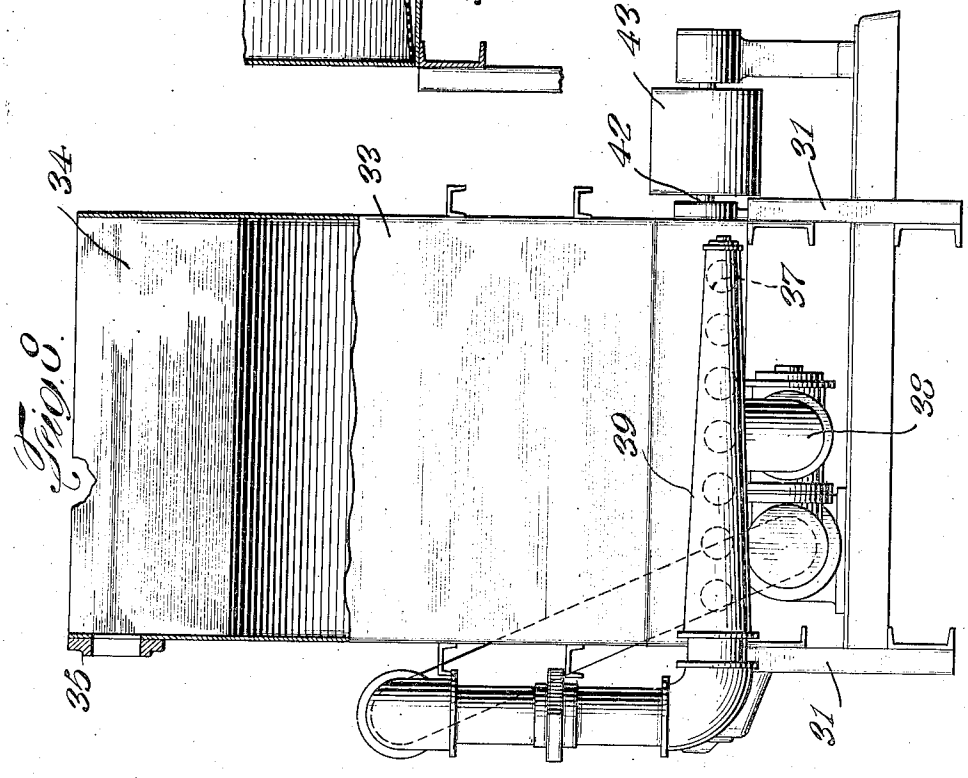


Fig. 8.



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Patented Oct. 18, 1932 1,883,597

UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR DISSEMINATING SOLIDS IN LIQUIDS

Application filed December 27, 1930. Serial No. 505,054.

This invention relates to method of and apparatus for disseminating substances in liquids, as, for example, for disintegrating, dispersing and maintaining in suspension divisible insoluble solids and for breaking up and putting into solution solids which are soluble. The object of the invention is to provide a new method of disseminating solids in liquids and improved apparatus therefor.

This application is a continuation in part of my previous application, Serial Number 432,343 filed March 1, 1930.

According to the present method, a jet—or a plurality of jets—is directed into a mass of liquid and solid material in a vessel. The liquid for this jet may be supplied from an external source or may be supplied by withdrawing liquid from the vessel, with or without selected portions of the solid material, and returning the same to the vessel under pressure through one or more nozzles. The jet is directed against and through the undisseminated solids whereby the destructive tearing and disintegrating action of solids shot against solids is added to the disruptive, shearing effect of the high velocity fluid from the jet rapidly traveling into and past the fluid and material in the vessel which has relatively much slower movement. The jet will have such a speed relative to the speed of the liquid through which it passes as to tear particles into smaller pieces or to remove the very tenacious film of saturated liquid adhering to soluble particles. In the latter case this permits direct contact of the surface of the particles with weaker solutions of the liquid thereby greatly accelerating the rate of dissolution.

In some instances the jet action and the impact action are assisted by a secondary impact action in which the jets are directed substantially tangentially or somewhat obliquely toward and across a fixed and preferably roughened plate. If the plate is perforated this may constitute the roughening, and if the perforated plate is used for an outlet it will be swept clear at all times by the jet of liquid directed across it. It would not be the case if the jet were directed straight against the plate.

It is important when the plate is used for the impact of particles from the jet or when it is to be kept clear by the jet that the end of the nozzle from which the jet issues should be placed near the plate, because the force of the jet is soon dissipated in the body of the liquid in the vessel and if the nozzle is remote from the plate the desired effects may be completely lost. This is particularly true when relatively large quantities of solid material are to be handled at one time.

In treating solid materials which are of about the same specific density (when wet with liquid) as the liquid itself, a horizontal circulation may be employed. The side or eddy currents will bring all of the material into the path of the jets. Wood pulp, old papers and rags are of this nature and may be thus treated. With horizontal circulation it is possible to separate relatively heavier or lighter particles out of the mass by gravity if a relatively quiet zone is maintained at the center of the vessel and above or below the zone of turbulence so that the particles once separated will not be again stirred up. The heavier particles will drop to the bottom and the lighter particles which float strongly will rise and remain at the surface where they may be removed.

In disseminating solids which are of a different specific gravity from the liquid, a vertical circulation may be employed. This will tend constantly to remove heavy materials from the bottom and immerse lighter materials which tend to float on top. In producing a vertical circulation the jet may be directed in a generally horizontal direction so it will continually sweep the bottom clean.

This method is convenient for grading material since the finely divided or dissolved portions may be withdrawn completely from the apparatus at intervals or continuously, leaving the coarser particles to be reduced further or to be removed separately. A saving in power is realized by the partial withdrawal (known as the continuous process as distinguished from the batch process where all of the material and liquid is retained throughout the entire period of working) because work is not required to be done on the particles

which have already reached their desired state of fineness.

It is obvious that liquid must be withdrawn from the vessel to accommodate the liquid which is being constantly added by the jets. If the liquid which is withdrawn is conducted to the pump, provision may be made for preventing undesirable material from reaching the pump. In some cases the material withdrawn to the pump may be taken from a relatively quiet zone within the vessel from which the larger particles are excluded by gravity; in some cases the material may be withdrawn through a screen; and in other cases part of the material containing larger particles may be withdrawn to the pump to be returned, and another part containing finer or dissolved particles may be completely withdrawn from the system, fresh liquid together with fresh solid, if desired, being added to compensate for the loss.

In order that the nature and objects of the invention may be readily understood, two embodiments of apparatus suitable for practicing the invention will now be described, reference being made to the accompanying drawings wherein:

Fig. 1 is a top plan view of apparatus for producing circulation in horizontal planes;

Fig. 2 is a side elevation, part of the container being broken away;

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 1;

Fig. 4 is an end elevation;

Fig. 5 is a detail view showing the nozzle and screen;

Fig. 6 is a side elevation, parts being broken away to show in section, of apparatus for producing circulation in vertical planes;

Fig. 7 is a top plan view;

Fig. 8 is an end elevation; and

Fig. 9 is a partial vertical section taken on the line 9—9 of Fig. 6.

In the first form of the invention shown in Figs. 1 to 5 inclusive wherein horizontal circulation is produced, the container 1, preferably oblong in a horizontal plane, may be of any desired or convenient size, depending on the quantity and quality of the material which it is desired to treat. The said container is provided with a false bottom 2, forming a chamber 3 between said false bottom and the real bottom 4. Communicating with the bottom chamber 3 are a plurality of chambers 5 and 6 formed by false sides 7 and 8 which are suitably spaced from the real sides 9 and 10 of the container.

Located in the false sides 7 and 8 are a plurality of screens 11 and 12 which may conveniently be provided by forming perforations 13 of the desired size and shape in the said false sides. Thus, the said perforations 13 form the only means of egress of solid and liquid material from the container to the chambers 3, 5 and 6.

Connected to the chamber 5 is a conduit 15 leading to the intake side of pump 16. The said pump may be driven from any suitable source of power through belt or gear connections or may be driven by direct connection to an electric motor, for example.

Connected to the discharge side of the pump are a plurality of conduits 17 and 18 leading to nozzles 19 and 20 through which high velocity jets of liquid are discharged into the container. As will be observed, the nozzles are arranged at intervals along the screens and are so directed as to cause the jets discharged therefrom to sweep across the entire area of the screen with considerable force. It is also to be noted that the nozzles are located immediately adjacent the holes in the plate in order that the velocity of the jet will not lose its force in the liquid before it impinges on the screen. As illustrated in Fig. 5, the nozzles are so arranged as to direct the jets toward the screen at a slight angle (approximately five degrees here), whereby a rubbing action of the solid particles against the screen may be obtained. If more vigorous rubbing action with the screen or plate is desired the angle of incidence may be increased, or if less rubbing action is required the jets may be disposed approximately parallel to the screen.

There may be any desired number of nozzles 19 and 20. In the present embodiment, as shown in Fig. 3, the nozzles are placed at about the mid-height of the vessel so as to produce a horizontal flow which is most pronounced near the mid-height of the vessel leaving relatively quieter zones above and below the mid-zone. Referring to Fig. 1 it will be observed that the circulation is in an oblong path which leaves an elongated and relatively quiet zone at the center of the vessel. This quiet central zone is conducive to the separation of particles which are noticeably heavier or lighter than the principal material being treated. For example, if paper stock is charged and contains metallic particles they will sink to the bottom of the vessel into the relatively quiet zone maintained thereat and may be withdrawn either intermittently or continuously through the valve controlled draw-off connection 22 opening through the false bottom 2. A valve controlled drain connection 23 is provided in the real bottom 4 of the vessel for emptying the same or for drawing off sludge and mud.

If any material floats strongly to the surface it may be removed in any convenient manner.

In order that finished material (either solid material in the desired state of fineness or dissolved material) may be removed from further action, an outlet, for example the conduit 21 connected to the discharge side of the pump is provided, the same preferably being constricted in size and having a valve for

controlling the flow therethrough. Any suitable means may be provided for supplying additional liquid and material.

As an example of the practical operation of the method and apparatus described herein, its use for the manufacture of pulp suitable for use in paper making may be briefly referred to. In making paper, the raw material such as wood pulp, waste paper or rags, is ordinarily subjected to a disintegrating process carried on in a machine known as a beater engine in which the individual fibers are separated one from another and are reduced to a size suitable for use in a paper making machine. According to the present process, raw material, as for example, waste paper, is fed to the container which has previously been supplied with liquid. The combined effect of the high velocity jets and of the rubbing action against the perforated screen plates serves to rapidly disintegrate the material so that as the individual fibers are released, those of the desired size, depending upon the variable factors maintained, are permitted to pass through the perforations in the screens and thus flow through the pump.

As soon as the fiber liberation attains a sufficiently rapid rate, and the desired concentration has been reached, the finished material may be removed from the machine by bleeding off through the conduit 21. Additional liquid and solid material may be added as required either continuously or intermittently.

In Figs. 6 to 9 inclusive an example of the vertical type machine is shown. This is useful where the material to be treated has a substantially different specific gravity from the liquid in which it is to be worked. In this case the solid material sinks to the bottom if it is heavier than the liquid or rises to the surface if it is lighter, in either case effectively removing itself from the zone of action if placed in the horizontal type machine illustrated herein, even when the jets are disposed near the bottom and top respectively of the liquid.

With the vertical circulation type of machine the heavier materials are constantly lifted from the bottom of the vessel and the material which tends to float is constantly submerged by the flow of liquid in vertical planes.

The apparatus illustrated is intended principally for heavier material which tends to settle to the bottom of the vessel. Specifically it comprises a container 30 mounted upon a supporting frame 31. The container is preferably oval in vertical section, having rounded ends 32, 33 curving gently into the top and bottom walls of the container. The top is partially closed so as to limit the upward flow of material in the container and to provide a relatively quieter zone within the vertically extended top opening 34 from which relatively fine or dissolved material may be withdrawn with liquid through the top outlet 35. To assist in maintaining the liquid in a quiet state within the inlet opening, the same may be provided at its bottom end with a baffle 34*a*, the bottom surface of which is approximately aligned with the upper oval surface of the container.

Through the top opening the solid material, and if desired the liquid also are charged into the container. The liquid is shown as filling the vessel to a level with the outlet 35 but if this is not to be used for withdrawal, the level need not be as high even as the bottom of the inlet opening. In fact, it is one of the advantages of the present vertical circulation type of apparatus that it will work successfully even with a wide variation in level of the liquid in the container.

The bottom of the container, in case relatively heavy material is being treated may be directly swept by a jet or jets from nozzles 37. If the plate is to be used for receiving the impact of material it may be suitably roughened and when, as in the present case, it is employed for at least part of the outflow of fluid from the container it may be formed as a perforated and substantially flat plate 36. As in the other type of machines the rubbing action on the plate 36 may be increased by inclining the nozzles obliquely toward the plate. By this arrangement of nozzles the plate is swept clean so as to serve its intended purpose as an outlet and the material is constantly lifted and mingled with the liquid in the container. Also the flow of fluid in the vessel is sufficiently rapid to cause material which tends to float to be submerged and carried across the bottom surface of the container into the jets.

The bottom in transverse section, as shown in Fig. 9, is slightly raised at the center to permit flow of fluid between it and the outlet conduit 38. As shown in Fig. 6, the outlet conduit may be forwardly in the same direction as that in which the fluid flows within the container so as to produce a smooth outflow of liquid from the container.

As best shown in Fig. 7, the nozzles 37 are supplied with liquid from a header 39 connected by a supply pipe 40 to a pump 41. The pump may be driven in any convenient manner as through a belt pulley 43 secured to the pump shaft 42. The outlet conduit 38 is connected to the pump intake and may be regulated by a valve 44. The supply pipe 40 may be regulated by a valve 45.

Liquid with dissolved or finely divided suspended material may be withdrawn from time to time from the outlet pipe 46 provided with a valve 47. The velocity of the jets best suited for use in connection with the disintegration of any specific material can best be determined by experiment. In

general, if the material is highly resistant to disintegration, relatively high velocities will be found most effective, while lower velocities are effective for materials which are less resistant. Thus, in preparing material for use in paper making, it is found that rags are more resistant to disintegration than wood pulp and require the use of higher jet velocity. For some purposes velocities as low as 1000 ft. per minute are sufficient although for other purposes velocities as great as 5000 ft. per minute or more are advisable.

In those cases where the screens are used for outlets and are so located that they are continuously swept by the jets the larger solid particles are caused to move along the screens, but because of the velocity of the jets, are prevented from accumulating and clogging the openings thereof. Preferably the total area of the openings in said screen or screens is sufficiently large so that the velocity of the liquid flowing through the openings is relatively low as compared with the velocity of the jets.

As the disintegrating action proceeds the suspended solids gradually become reduced to a size which permits them to pass through the openings in the screen, the particular size of the particles which will pass through being determined by the size and shape of the openings, by the velocity of the jets, and by the angle of incidence between the jet and the screen. Thus, in general, the larger the opening the larger the particle which will be permitted to pass therethrough; the higher the velocity of the jets, the smaller the particles which will be permitted to pass therethrough; and the greater the angle of incidence the larger the particle which will be permitted to pass therethrough. But the angle of incidence must not be made too great for in that case the particles would be driven into and wedged in the openings.

Thus the size of the openings in the screen is not the sole controlling factor in determining the size of the particle which pass therethrough, and indeed, it is observed in practice that because of the sweeping action of the jets across the screen, the size of the particles which pass therethrough is considerably smaller than the size of the openings.

Thus by proper selection of these varied factors, the size of the particles which will pass through the screen openings to the pump may be restricted to any desired maximum size, the particles of larger size ordinarily remaining in the container to be subjected to disintegrating action by the jets.

If desired, however, material may be withdrawn from the quiet zone as well as from the zone of agitation, or instead of from the zone of agitation, and when so withdrawn may either be returned to the pump or be completely removed from the system.

It is sometimes advisable in order to increase the speed of action on the materials, to heat the contents of the container. When this is the case a steam coil or other suitable heating means may be provided at some convenient point such as the bottom of the container, and sufficient heat may be applied to maintain the desired temperature.

The embodiments of apparatus which have been illustrated are preferred for some kinds of work but for other kinds of work other embodiments of apparatus may prove more suitable. In each case the apparatus will be selected or modified to suit the requirements.

The method likewise is subject to modification for a similar purpose. It is to be understood, therefore, that the invention is not to be regarded as limited except by the prior art and the scope of the subjoined claims.

I claim as my invention:

1. The method of disseminating solid material in a liquid which comprises placing the materal in a liquid medium in a container provided with a perforated bottom, directing one or more jets of liquid at close range across said bottom to keep the material from clogging therein and to create a circulation in vertical planes, withdrawing liquid and partly disseminated solid material through said bottom, and withdrawing liquid and disseminated material from a relatively quiet zone maintained in the container.

2. The method of disseminating solid material in a liquid which comprises placing the material in a liquid medium in a container, directing one or more jets of liquid against the mass of liquid and undisseminated solids in the container to cause the solids to be disseminated and to cause a circulation of liquid and material in vertical planes in the container, and withdrawing liquid and disseminated material from within a quiet zone at the top portion of the container.

3. The method of disseminating solid material in a liquid which comprises placing the material in a liquid medium in a container provided with a perforated outlet plate, creating a circulation in vertical planes to cause the liquid and material to sweep directly across the apertured outlet plate to forcibly and continuously keep material in circulation whether tending to float or to settle to the bottom of the liquid and to keep the plate openings cleared, and withdrawing liquid and disseminated material to be returned to said container against the material disposed therein.

4. The method of disseminating solid material in a liquid which comprises placing the material in a liquid medium in a container, directing one or more jets of liquid against the mass of liquid and undisseminated solids in the container to cause the solids to be disseminated and to cause a circulation of liquid and material in vertical

planes in the container, and withdrawing liquid and disseminated material from the top portion of the container.

5. The method of disseminating solid material in a liquid which comprises placing the material in a liquid medium in a container provided with apertures in the bottom thereof and directing a jet of liquid at close range approximately tangentially across said apertured bottom while withdrawing liquid through said apertured bottom.

6. The method of disseminating solid material in a liquid which comprises placing the material in a liquid medium in a container provided with outlet apertures in a plate therein and directing a jet of liquid across and obliquely toward said apertured plate while withdrawing liquid through said apertures, whereby substantially all of the liquid and material in said container are circulated in a closed path in vertical planes in said container to bring said material in rapid succession past said apertures and into the path of said jets.

7. The method of disseminating solid material in a liquid which comprises placing the material in a liquid medium in a container provided with a roughened bottom plate, directing a jet of liquid obliquely toward and across said bottom plate, and withdrawing liquid and disseminated material from said container through a screen swept by the flowing stream of liquid caused by the action of said jets.

8. The method of disseminating solids in liquids which comprises placing in a liquid within a vessel, solid materials of approximately the same specific gravity as the liquid, playing jets upon the material within the liquid to reduce it to a finely divided condition, creating a horizontal zone of turbulence within the vessel but maintaining zones of relative quiet within the zone of turbulence and at the side thereof, whereby particles of a different specific gravity are separated by gravity, withdrawing liquid and the material from within the zone of turbulence, and withdrawing the gravity separated material from the quiet zone.

9. The method of disseminating solids in liquids which comprises creating a horizontal zone of turbulence in a mixed liquid and solid mass at a space above the bottom of a vessel, maintaining a zone of relative quiet within the horizontal zone of turbulence and a zone of quiet at the bottom of the vessel, whereby heavy particles are separated out and dropped to the bottom, and removing said precipitated solids from the bottom.

10. The method of disseminating solids in liquids which comprises injecting one or more jets of liquid into a mass of liquid and solid material to create a zone of turbulence, withdrawing liquid substance from a relatively quiet zone beyond the zone of turbulence, and also withdrawing liquid substance from the zone of turbulence and returning it in said jets.

11. The method of disseminating solids in liquids which comprises injecting one or more jets of liquid into a mass of the liquid and material to create a zone of turbulence, withdrawing liquid substance from a relatively quiet zone beyond the zone of turbulence, and also withdrawing liquid substance from the zone of turbulence.

12. The method of disseminating solid material in a liquid which comprises injecting a jet of liquid directly across a perforated plate from a nozzle disposed near the perforations located within a mass of liquid and undisseminated solid material contained in a vessel, and withdrawing liquid and disseminated material through the perforated plate.

13. The method of disseminating solid material in a liquid which comprises injecting a jet of liquid across a perforated plate located within a mass of liquid and undisseminated solid material contained in a vessel, withdrawing portions of liquid and disseminated solid material through the perforated plate, and returning the withdrawn material in the liquid jet.

14. The method of disseminating solid material in a liquid which comprises injecting a jet of liquid across a perforated plate located within a mass of liquid and undisseminated solid material contained in a vessel, and withdrawing portions of liquid and disseminated solid material through the perforated plate.

15. The method of disseminating solid material in a liquid which comprises injecting a jet of liquid into a mass consisting partly of liquid and partly of undisseminated solid material confined in a vessel, withdrawing liquid containing some of the disseminated solid material but retaining the larger and undisseminated particles of solid material in the vessel and returning the withdrawn liquid mass and injecting it in the jet against the mass of liquid and undisseminated solid material left in the vessel.

16. The method of disseminating solid material in a liquid which comprises injecting a jet of liquid into a mass consisting partly of liquid and partly of undisseminated solid material confined in a vessel, withdrawing liquid containing some of the disseminated solid material but retaining the larger and undisseminated particles of solid material in the vessel, returning some of the withdrawn liquid mass to the vessel in said jets against the mass of liquid and undisseminated solid material, and withdrawing some of the liquid and disintegrated solids from further action.

17. Apparatus for disseminating solids in liquid comprising in combination, an oblong vessel for containing a mass of liquid and undisseminated solid material, perforated

plates in the sides thereof aligned with the major axis of the vessel, nozzles directed along said plates in opposite directions on opposite sides of the vessel to create a circulation in horizontal planes, solid side walls spaced from the perforated sides of the vessel, an outlet in the side for withdrawing liquid and disseminated material, and an outlet in the bottom for withdrawing material therefrom.

18. Apparatus for disseminating a solid in a liquid, comprising in combination, a vessel for containing a mass of liquid and undisseminated solid material, a perforated outlet plate disposed in a side of the vessel, one or more nozzles aligned with said plate for directing jets across the same, and means for withdrawing through said plate liquid bearing some of the material.

19. Apparatus for disseminating solids in liquids comprising in combination, a vessel for containing a mass of liquid and undisseminated solid material, an outlet disposed in the side of the vessel and spaced from the bottom, one or more nozzles for directing jets of liquid along the sides of said vessel and creating a rapid circulation in horizontal planes in the zone of said outlet but leaving relatively quiet zones within the zone of rapid circulation and at the side therefor for permitting particles to separate out by gravity, means for withdrawing liquid and disseminated material through said outlet, and means for separately withdrawing the particles separated out by gravity.

20. Apparatus for disseminating solids in liquids comprising in combination, a vessel for containing a mass of liquid and undisseminated solid material, a roughened plate disposed in the side of the vessel, one or more nozzles for directing jets of liquid along and across said plates to create a disintegrating action, said jets also creating a rapid circulation in horizontal planes but leaving a relatively quiet zone within the zone of rapid circulation, means for withdrawing liquid and material from said zone of rapid circulation, and means for withdrawing liquid and material from said quiet zone.

21. Apparatus for disseminating a solid in liquid, comprising in combination, an oblong vessel provided with outlet apertures at the bottom thereof, one or more nozzles directed substantially parallel to said bottom for forcing jets at high velocity thereacross, said jets causing a circulation in oblong vertical planes, an outlet conduit beneath said apertured bottom, and means for supplying said nozzles with liquid and for withdrawing liquid and material through said outlet.

22. Apparatus for disseminating a solid in liquid comprising in combination, a vessel, a perforated outlet plate in the bottom thereof, a nozzle disposed directly adjacent one edge of said plate to direct a jet thereacross to disintegrate material and to produce a forced circulation in vertical planes whereby the outlet plate is swept clear of larger particles and all of said material whether tending to float or to sink is kept in suspension and circulation.

23. Apparatus for disseminating a solid in liquid comprising in combination, a vessel, a perforated outlet along a wall thereof, one or more nozzles disposed directly adjacent one edge of said plate to direct jets thereacross to disintegrate material and to produce a forced circulation in vertical planes whereby the outlet plate is swept clear and all of said material whether tending to float or to sink is kept in suspension and circulation, a zone located outside said zone of forced circulation, and means for withdrawing liquid and material from said zone.

24. Apparatus for disseminating solids in liquids, comprising in combination, a vessel for containing a mass of liquid and undisseminated solid material, a roughened plate disposed in a wall of the vessel, one or more nozzles for directing jets of liquid along and across said plates to create a disintegrating action, said jets also creating a rapid circulation in vertical planes but leaving a relatively quiet zone within the vessel, means for withdrawing liquid and material from said zone of rapid circulation, and means for withdrawing liquid and material from said quiet zone.

25. Apparatus for disseminating a solid in liquid, comprising in combination, a vessel, a perforated outlet plate therein, a nozzle disposed directly adjacent one edge of said plate to direct a jet thereacross to disintegrate material and to produce a forced circulation in vertical planes whereby the outlet plate is swept clear of larger particles and all of said material whether tending to float or to sink is kept in suspension and circulation.

26. Apparatus for disseminating a solid in liquid, comprising in combination, a vessel, an outlet therein, one or more nozzles disposed directly adjacent said outlet to keep it clear of larger particles while permitting smaller particles to pass and to produce a forced circulation in vertical planes whereby the outlet is kept clear of larger particles and all of said material whether tending to float or to sink is kept in suspension and circulation, said nozzles being disposed horizontally for directing jets along and across the bottom of the vessel.

27. Apparatus for disseminating a solid in a liquid, comprising in combination, a vessel containing a mass of liquid and undisseminated solid material, a perforated outlet plate therein, nozzles for directing jets of liquid across said plate, and means for withdrawing liquid and material through said plate.

28. Apparatus as set forth in claim 27 in which means are provided for withdrawing some liquid and disseminated material completely out of the system.

29. Apparatus for disseminating solid material in a liquid which comprises in combination, a vessel containing liquid and solid material, a plurality of nozzles directing jets of liquid into the mass of material within said vessel, and a space connected with the zone of violent agitation produced by said jets but maintaining a quiet body of liquid, and means for withdrawing liquid and disseminated solid material from the quiet body within said space.

In testimony whereof, I have signed my name to this specification this 22nd day of December, 1930.

EDWIN COWLES.