United States Patent

[11] 3,543,932

[72] Inventor **Edward L. Rastatter**
New York, New York

[21] Appl. No. **694,712**
[22] Filed **Dec. 29, 1967**
[45] Patented **Dec. 1, 1970**

[73] Assignee **Nichols Engineering & Research Corporation**
New York, New York
a corporation of Delaware

[54] **VORTEX CHAMBER REJECT CONTROL**
3 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **209/211;** 210/512
[51] **Int. Cl.** **B04c 5/28**
[50] **Field of Search** 209/211, 144; 55/191, 204, 205, 52; 210/512

[56] **References Cited**

UNITED STATES PATENTS

2,530,181	11/1950	Schilling	209/211
2,717,536	9/1955	Clark	210/512X
2,816,490	12/1957	Boadway	209/211X
2,927,693	3/1960	Freeman	209/211
3,019,895	2/1962	Loevenstein	209/158X
2,671,560	3/1954	Fontein	209/211
3,421,622	1/1969	Wurtman	209/211

Primary Examiner—Frank W. Lutter
Attorney—Ward, Mc Elhannon, Brooks and Fitzpatrick

ABSTRACT: Reject outlets from one or more vortex type separating chambers are connected to a common manifold through generally unrestricted conduits. Controlled pressure in the common manifold regulates the liquid reject rate from the vortex chambers. Pressure may be, and preferably is, maintained and controlled by the addition of dilution water to the upstream end of the manifold. A single large orifice which may be adjustable is located at the downstream end of this manifold.

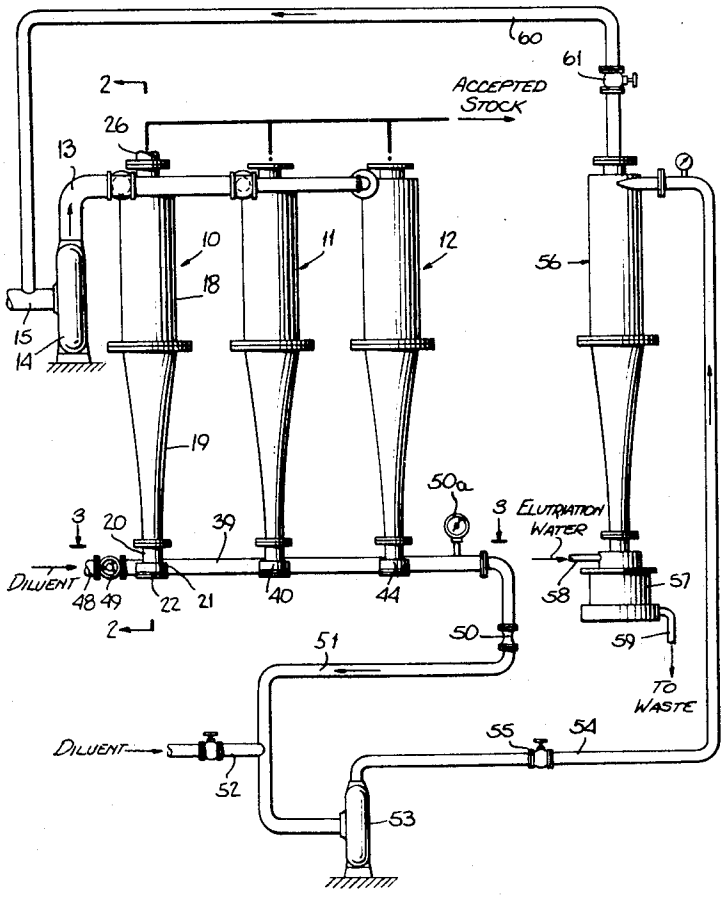
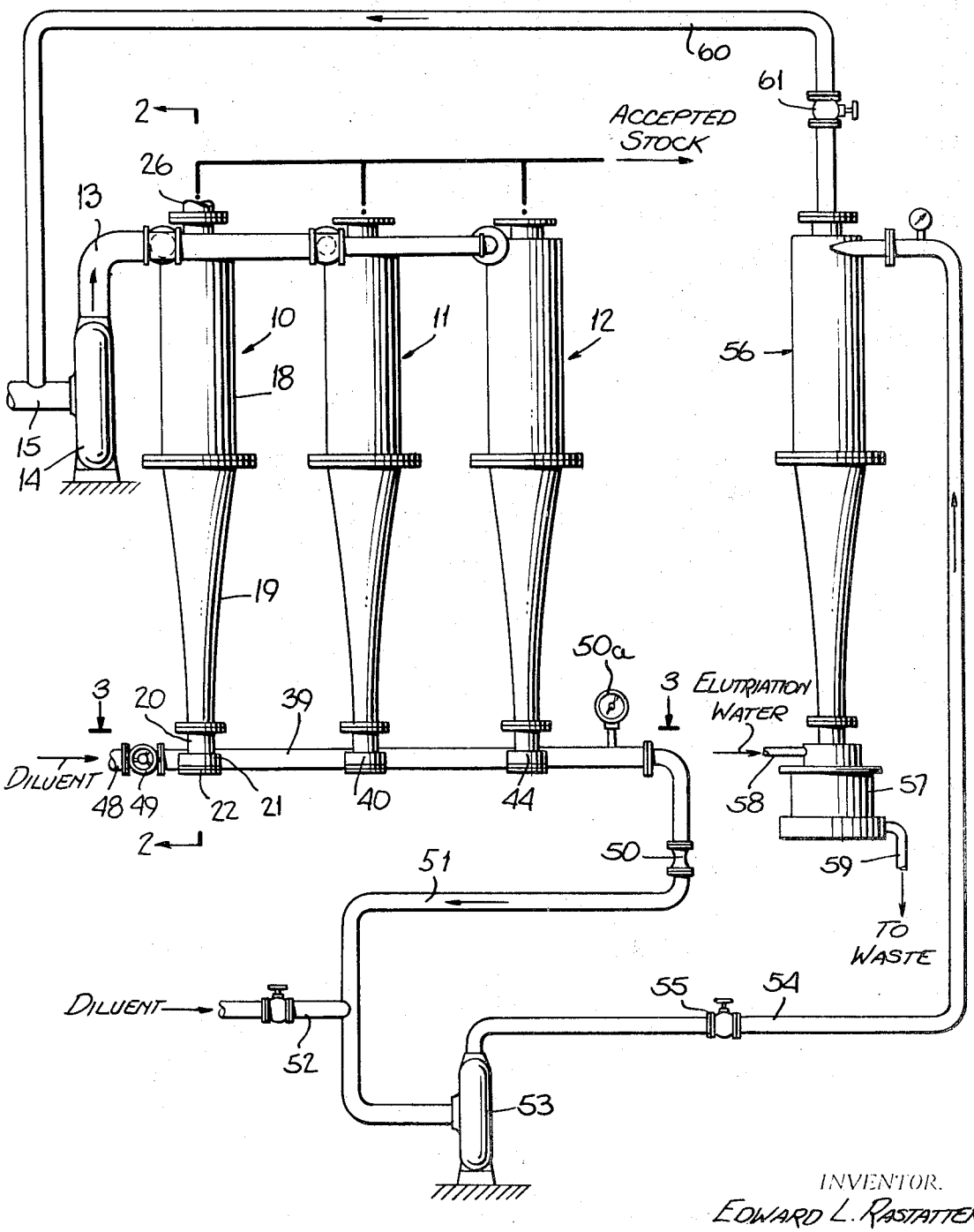


Fig. 1.



INVENTOR.
EDWARD L. RASTATTER

BY

Ward, Hanlon, McElhannon, Brooks & Fitzpatrick
ATTORNEYS

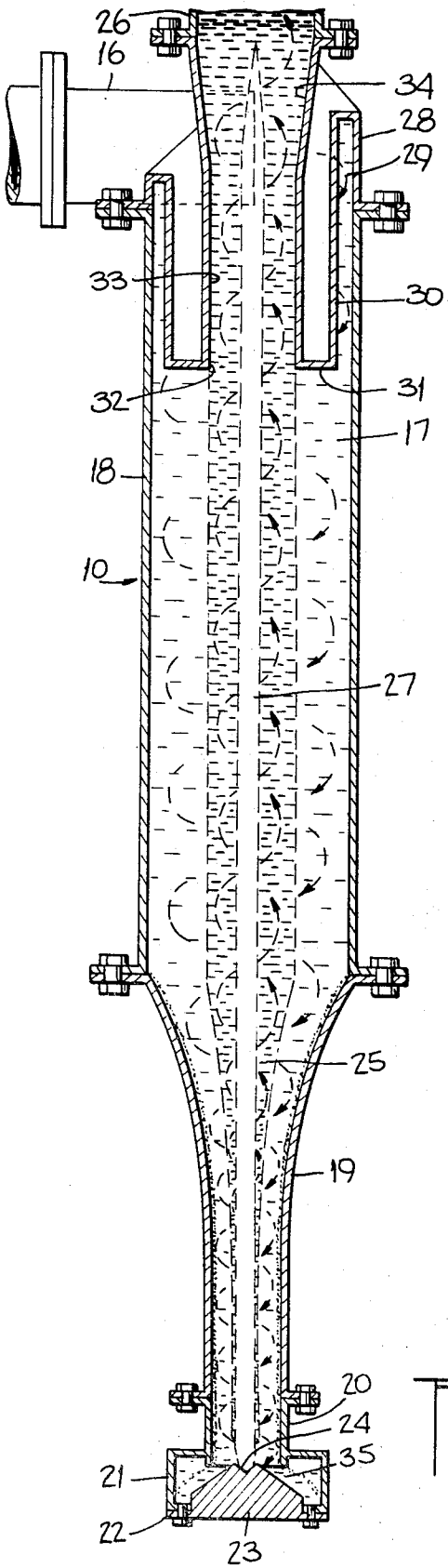


Fig. 2.

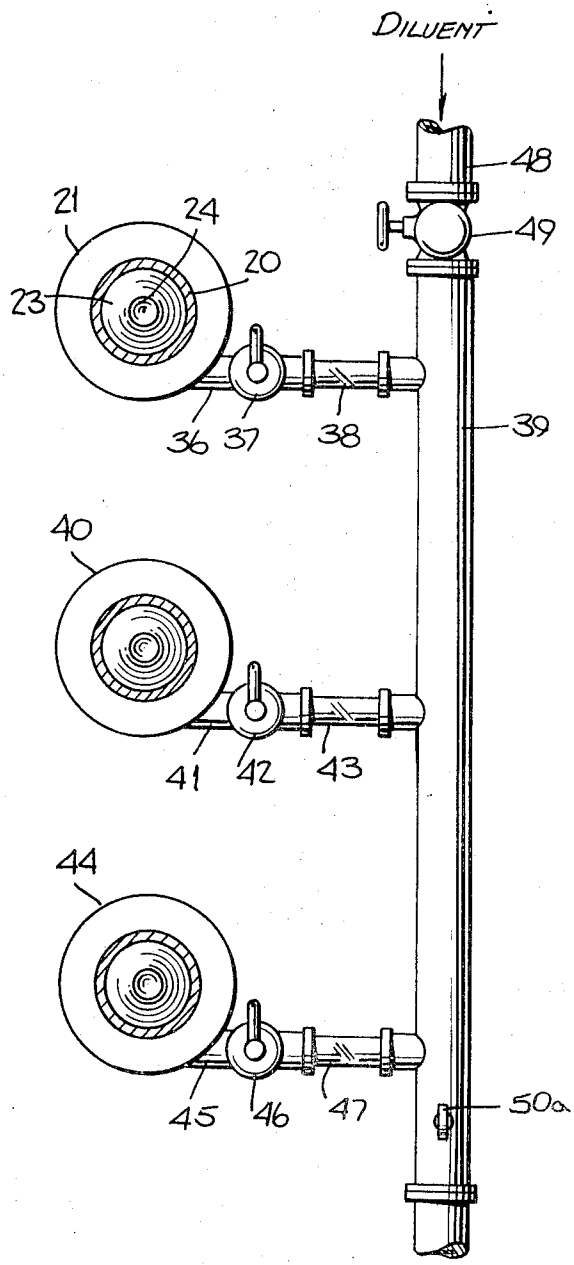


Fig. 3.

INVENTOR.
EDWARD L. RASTATTER
BY
Ward, Haselton, McElhannon, Brooks & Fitzpatrick
ATTORNEYS

VORTEX CHAMBER REJECT CONTROL

DISCLOSURE

The present invention relates to apparatus for separating undesired particles from liquids and liquid suspensions. The apparatus of the invention is particularly adapted, among other uses, for the separation of undesired particles from paper pulp stock.

Vortex chambers for separating solid particles from a liquid suspension are now well known, One separator of this type is described in U.S. Pat. No. 2,927,693, issued Mar. 8, 1960, to Nichols Engineering and Research Corporation as assignee of Horace Freeman and John D. Boadway. As described therein, the apparatus involves an elongated chamber of circular cross section, either cylindrical or somewhat tapered, as desired. Into one end of the chamber the suspension to be treated will be introduced under pressure through a restricted tangential inlet such that a substantial part of the pressure energy is con converted to velocity energy. This will cause a high velocity vortex to be developed and to extend from the inlet end of the chamber to the opposite end and then, due to an accepted stock outlet. The vortices are usually of such velocity as to maintain an axial gas core therein. The end of the chamber opposite from the inlet is made conical with the elements of the cone preferably inwardly curved and its apex entering an enclosure so shaped that the positions of the vortices which will extend through such apex, as well as the gas core therein, will be retained in a stabilized centered position, while the separated particles containing a small amount of liquid stock will pass through an annular slot and then be withdrawn tangentially and so as not to disturb such stabilized conditions.

The above-mentioned vortex separator is designed with an inverted conical structure within the aforesaid enclosure which cooperates with the mouth of the conical section of the chamber to provide a restricted aperture or orifice, thereby maintaining the discharge from the chamber within practical limits.

In a typical system for cleaning or treating paper pulp suspensions the untreated stock may be supplied in parallel to a plurality of vortex chambers which constitute a primary cleaning stage. The accepted stock from such chambers may be fed directly to the paper making machines or to storage containers or the like, as desired. The reject stock from the primary cleaning chambers may be supplied to the inlet of a secondary cleaning chamber or chambers from which accepted stock is returned to and mixed with the untreated stock fed to the primary stage. Reject stock from the secondary chamber may be directed to a waste outlet, or a tertiary stage may be employed.

Heretofore, various attempts have been made to control the reject rate from the individual chambers of the primary stage within necessary limits for efficient operation without giving rise to various clogging problems. These attempts have included the use of vortex separators wherein each of the enclosures receiving the discharge from the apices of the conical ends of the chambers (otherwise referred to as the reject section) has its outlet joined to a restrictive orifice in an outlet pipe connection in order to develop a back pressure in the reject region. However, it has been found from experience that the orifices, when selected of a size suitable to frequent plugging or clogging. If the orifice of a unit is plugged with fibrous matter, it can often be back flushed. If the offending particle is solid and does not disintegrate, the vortex unit must be isolated from the system and partially dismantled to remove the particle. This problem of plugging is time consuming and costly in commercial operation.

It is an object of the present invention to overcome the plugging problem mentioned above while retaining overall flexibility in being able to control the reject rate from the individual vortex chambers.

In accordance with the present invention, the apparatus for separating undesired particles from liquid and liquid suspensions comprises a plurality of vortex type cleaning devices;

each device having a columnar chamber of circular cross section, means for introducing untreated stock at one end of said chamber for producing a high velocity helical outer vortex traveling toward the opposite end of said chamber, means including an annular housing and a centrally located cone at said opposite end of said chamber for extracting a radially outer fraction of said outer vortex and for stabilizing and causing the remaining stock to return to said one end of the chamber as a helical inner vortex surrounded by said outer vortex, said annular housing having a tangential outlet for removal of said fraction extracted from said outer vortex, means at said one end of chamber for removing accepted stock form said inner vortex; a common manifold for receiving said fraction extracted from said outer vortex; individual coupling means for coupling said outlet of each of said devices to said manifold; and removal means for removing said fraction from said manifold at a restricted rate and for simultaneously maintaining a back pressure at said outlet of said devices to limit the rejection rate of each of said devices, said removal means including means for introducing diluent fluid upstream of the junctions between said individual coupling means and said manifold, and a common restrictive orifice downstream of said junctions adapted to maintain said individual coupling means and said common manifold filled with diluent fluid and extracted fractions under normal operating conditioning whereby the outlet of each of said devices is maintained at a back pressure sufficient to limit the rejection rate.

The invention will be better understood after reading the following detailed description of the presently preferred embodiments thereof with reference to the appended drawings wherein:

FIG. 1 is a diagrammatic illustration of a typical cleaning system employing a primary and secondary stage;

FIG. 2 is a vertical cross-sectional view of one of the chambers of the primary stage of FIG. 1 taken along the line 2–2 in FIG. 1; and

FIG. 3 is a sectional view taken along the line 3–3 in FIG. 1, although rotated in the plane of the paper for convenience of illustration.

Reference should now be had to the drawings wherein the same reference numerals are used throughout the several FIGS. to designate the same or similar parts.

It should be noted that while hereinabove, as well as in the remaining parts of the Specification and Claims, certain portions of the apparatus are referred to by the terms "upper" and "lower," these terms are used for convenience and in their relative sense inasmuch as the equipment may be installed and used in various oriented positions and even upside down, if desired, as compared with the position thereof in the appended drawings.

Referring to FIG. 1, there is shown a typical installation embodying a plurality of vortex type cleaning devices for removing dirt and other undesired particles, particularly heavier particles, from paper pulp suspension. Three such devices are shown generally at **10**, **11** and **12**, by way of example, connected via a common inlet pipe **13** to a pump **14** supplied with untreated stock through a supply pipe **15**. Although not shown, a pressure gauge may be provided connected to pipe **13** for indicating the inlet pressure to these cleaning devices.

The construction and operation of each of the devices **10**, **11** and **12** can best be described with reference to FIG. 2 to which attention is now directed. While FIG. 2 is represented as a sectional view of the vortex device **10**, it is to be understood that devices **11** and **12** are identical in construction. As indicated, the suspension is fed through a tangentially positioned inlet **16** at the top, thereby causing a downwardly directed helical outer vortex **17** to be established in the cylindrical chamber portion **18** of the device. The vortex **17** extends down into another and lower portion **19**, which preferably is of generally conical shape with elements of the walls being curved somewhat inwardly, as shown, so that the downward vortex **17** becomes more and more restricted down to the lower end portion thereof which may be contained

within a short cylindrical extension piece 20 opening into a more or less annular chamber portion 21 which is closed by a bottom plate 22. Such bottom plate preferably is formed with an upstanding conical midportion 23, the apex of which has an inverted, preferably conical or otherwise generally depressed, central portion 24.

As the downwardly flowing vortex 17 becomes more and more restricted, inner portions thereof become reversed and gradually form an upwardly flowing helical inner vortex 25 surrounded by the downward vortex 17. This inner vortex extends up through and fills the accepted stock outlet 26. Outlet 26, as shown in FIG. 1, may be joined with similar outlets from devices 11 and 12 and connected to the paper making machine, storage tank, or the like (not shown).

Meanwhile, throughout the length of the vortices 17 and 25, an inner axial, substantially liquid-free core 27 is maintained. The core 27 is terminated and positively closed at its lower end by the depressed portion 24. The gas core 27 will ordinarily extend upwardly at least into the expanding outlet portion where, due to the increasing diameter of the outlet, the core will soon become extinguished.

As shown in FIG. 2, the inlet 16 is trumpet-shaped to so restrict the fluid entering under pressure as to convert a considerable part of the pressure energy into velocity energy. This creates the downward vortex 17. Further, inlet 16 enters a headpiece 28 which includes a passage as at 29 that may be of rectangular cross section and in which the liquid spirals around and downwardly at the start of the formation of the vortex 17. Inwardly of this passage 29 is a cylindrical partition portion 30 terminating at its lower end at an annular plate portion 31 containing a central outlet aperture 32 for the discharge of the cleaned "accepted" stock. An inner cylindrical portion 33 extends up from outlet aperture 32 and has a portion 34 of expanding diameter which is adapted to be connected to the treated stock outlet conduit 26.

During the travel of the liquid of the vortex 17 downwardly, the larger and heavier particles therein which are of a nature which would settle faster than the remainder of the mixture, are thrown outwardly by centrifugal force to the wall of the chamber and then travel downwardly to the conical section 19. At the conical section, the more central portions of the vortex, that is, the cleaner portions thereof, are reversed in direction and turned upwardly to form the inner vortex 25. By the time it reaches the top of the chamber, the vortex 25 is sufficient in diameter to approximately fill the outlet opening 32.

The heavier or larger particles which are thrown onto the wall of the chamber and which slide down over the internal surface of the conical section 19 enter the enclosure or reject control chamber 21. In entering such chamber they pass through an annular aperture 35 formed between the upper surface of cone 23 and the lower edge of the cylindrical portion 20 of the chamber. From the chamber 21 the rejected stock which has passed through the annular aperture 35 is allowed to flow out through a tangentially located outlet connection 36, which is best seen in FIG. 3.

The cleaning device per se, as above described with reference to FIG. 2, is similar to that shown and described in the aforesaid U.S. Pat. No. 2,927,693. More specifically, it corresponds to the embodiment described therein with reference to FIG. 7 as a modification of FIG. 1 of the patent. However, as will appear hereinafter, the present invention is applicable to vortex cleaners of the general type here involved and is not limited to the specific constructions described herein.

In the present case, in order to produce the necessary back pressure for efficient operation of the cleaning device 10, the reject discharge 36 is connected through a valve 37 and a sight glass 38 to a manifold pipe 39. A significant feature of the present invention is that a plurality of vortex type cleaning devices, in this case the devices 10, 11 and 12, are connected in common to the manifold pipe 39, as best seen in FIG. 3. Thus, the reject chamber 40 of cleaning device 11 is connected to manifold 39 by way of outlet connection 41, valve 42 and sight glass 43. In similar manner, device 12 has its reject chamber 44 connected through outlet pipe 45, valve 46 and sight glass 47 to the manifold 39. The back pressure is adjusted in a manner to be described hereinafter for optimum operation of the devices.

Diluent, which may be in the form of white water, is supplied to the upstream end of manifold 39 through an inlet pipe 48 and an adjustable flow control valve 49. At the opposite end of the manifold pipe, downstream of the junctions with sight glasses 38, 43 and 47, there is disposed a restrictive orifice 50 and a pressure gauge 50*a*. By suitably adjusting the rate of flow of the white water through valve 49 relative to the flow capacity of orifice 50, it is possible to maintain the manifold and the various outlet pipe connections between the reject chambers and the manifold filled with liquid at all times. At the same time, it will be possible through observance of gauge 50*a* to regulate the back pressure developed in the individual reject chambers. Correct operation can be ascertained by observation in known manner through sight glasses 38, 43 and 47.

By paralleling a plurality of vortex devices (three in the present example) and connecting all of their reject outlets to a common manifold, the orifice 50 that is required to maintain the necessary back pressure can be much larger than would be required of an orifice operating on the reject fluid from a single vortex cleaner. As the size of the orifice is increased, the potential for plugging with solid material is diminished. It has been found that a sufficiently large orifice can be used with a plurality of vortex cleaning chambers that the danger of plugging is virtually eliminated.

In selecting the manifold 39, its diameter should be chosen so that the pressure drop or "head loss" along its length is as small as possible. That is, it is desirable for efficient operation to develop substantially the same back pressure on all of the reject chambers independent of the point of connection to the manifold.

As described above, the proper pressure in the manifold 39 is obtained by admitting an amount of diluent which, with the rejection from the vortex separators 10, 11 and 12, is sufficient to create the desired back pressure behind the fixed orifice 50. However, it may be preferably to replace fixed orifice 50 with an adjustable orifice in the form of a gate valve or the like and regulate the back pressure by control of the orifice while maintaining a fixed supply of diluent.

As further shown in FIG. 1, the reject fluid from primary cleaning devices 10, 11 and 12, after passing through the orifice 50, may be led through the pipe 51, combined with additional diluent, e.g., white water, introduced via supply pipe 52, and supplied to pump 53 from which it is conducted via pipe line 54 containing a control valve 55 to the inlet of a secondary cleaning stage 56. Stage 56 may be of the same construction as described with reference to FIG. 1 of the aforesaid U.S. Pat. No. 2,927,693. It differs from the primary stages previously described by the provisions of an elutriation chamber 57 to which elutriation water (e.g., white water) is supplied by pipe connection 58. The reject outlet 59 from the cleaning stage 56 may lead to a sewage or waste line or outlet. Alternatively, it may be supplied to a tertiary stage. Accepted stock from secondary cleaner 56 may be conducted through a return pipe 60 under the control of a valve 61 to the inlet pipe 15 which feeds pump 14. In this way the accepted stock from cleaner 56 is returned to the supply line for the primary cleaners 10, 11 and 12.

Whether one chamber is connected to the manifold or a plurality, the combination of manifold, diluent supply, and outlet or downstream orifice permits the use of larger reject apertures in the chambers, or the like, with the attendant alleviation of the clogging problem. Furthermore, the present arrangement provides means for convenient regulation of the back pressure on the individual chambers and accompanying reject rate without time consuming replacement of structural parts.

While the present invention has been described with reference to cleaning devices in which the gas core is self-extinguishing, it will be understood that the invention may also be applied to vortex type cleaners attached to a deaerating device of known construction.

The presently preferred embodiments of the invention have been described for purposes of explanation. It should be understood that modifications may be made therein as will appear evident to those skilled in the art to which the invention pertains. It is, therefore, intended to encompass all such changes as fall within the true spirit of the invention defined in the appended claims.

I claim:

1. Apparatus for separating undesired particles from liquids and liquid suspensions comprising a plurality of vortex type cleaning devices; each device having a columnar chamber of circular cross section, means for introducing untreated stock at one end of said chamber for producing a high velocity helical outer vortex traveling toward the opposite end of said chamber, means including an annular housing and a centrally located cone at said opposite end of said chamber for extracting a radially outer fraction of said outer vortex and for stabilizing and causing the remaining stock to return to said one end of the chamber as a helical inner vortex surrounded by said outer vortex, said annular housing having a tangential outlet for removal of said fraction extracted from said outer vortex, means at said one end of the chamber for removing accepted stock from said inner vortex; a common manifold for receiving said fraction extracted from said outer vortex; individual coupling means for coupling said outlet of each of said devices to said manifold; and removal means for removing said fraction from said manifold at a restricted rate and for simultaneously maintaining a back pressure at said outlet of said devices to limit the rejection rate of each of said devices, said removal means including means for introducing diluent fluid upstream of the junctions between said individual coupling means and said manifold, and a common restrictive orifice downstream of said junctions adapted to maintain said individual coupling means and said common manifold filled with diluent fluid and extracted fractions under normal operating conditions whereby the outlet of each of said devices is maintained at a back pressure sufficient to limit the rejection rate.

2. Apparatus according to claim 1, wherein means are provided for introducing said diluent fluid at an adjustable rate into said common manifold so as to regulate the rejection rate of said devices.

3. Apparatus according to claim 1 wherein said common restrictive orifice is adjustable so as to regulate the rejection rate of said devices.

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,543,932 Dated December 1, 1970

Inventor(s) EDWARD L. RASTATTER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 18, at end of line delete --con--

" 1, line 21, after "to" second occurrence add --
a constricted section, back as an inner vortex

Column 4, line 42, "preferably" should be --preferable--

Signed and sealed this 13th day of April 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents