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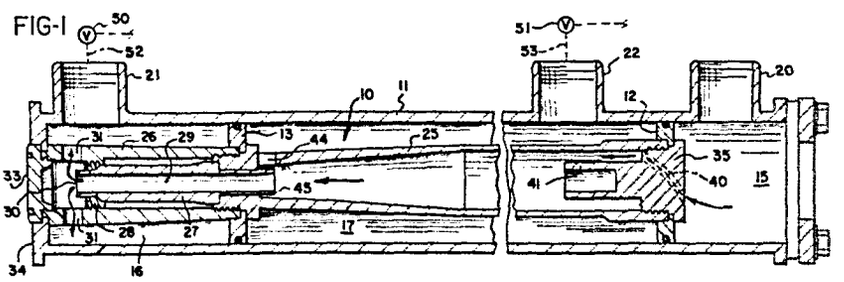
(54) **Reverse centrifugal cleaning of paper making stock.**

(57) A system and process for separating paper fibers from contaminants of similar lower specific gravities employ a reverse centrifugal cleaner (25) wherein the discharge port (30) for lights (rejects) is located at the apex of the conical cleaner body, and the discharge port (44) for heavies (accepts) is located upstream from the apex.

FIG-1



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REVERSE CENTRIFUGAL CLEANING OF PAPER MAKING STOCK

Centrifugal cleaners have been employed for many years in the paper industry for removing small particles of higher specific gravity than paper fibers from slurries of paper making fiber, especially waste paper stocks.

In centrifugal cleaners used for that purpose, in what is hereinafter referred to as "conventional centrifugal cleaning technique," the discharge outlet at the apex (tip) of the cylindrical-conical vessel is relatively small in comparison with the inlet and accepts outlets, e.g. 1/8 inch in diameter as compared with 5/8 inch diameters for the other two ports in a conventional cleaner 3 inches in diameter. In such conventional cleaning operations, therefore, the reject discharge through the apex outlet is correspondingly small in comparison with the accepts flow, e.g. 3% and 97% respectively.

In comparatively recent years, there has been an increasing use of centrifugal cleaners to separate good paper fibers from contaminants of closely similar or lower specific gravity such that they cannot be readily separated by conventional centrifugal cleaning technique.

In general, cleaners for such "reverse" centrifugal cleaning have been made by modifying the construction and/or operation of a conventional cleaner to provide operating conditions which cause the good fiber to be discharged through the apex outlet as the accepts flow while the lights are discharged as reject through the base (top) outlet which is the accepts outlet in conventional

centrifugal cleaning. For an extended discussion of prior and up dated reverse centrifugal cleaning developments, reference is made to Seifert et al. U.S. Patent No. 4,155,839 wherein the present inventor was a joint patentee.

A primary object of this invention is to provide a centrifugal cleaner particularly adapted for reverse centrifugal cleaning wherein both of the discharge ports, for the two fractions into which the cleaner separates the feed flow, are located adjacent the apex end of the cleaner, so that there is no reversal of flow within the cleaner as in past practice for both conventional and reverse cleaning.

More specifically, in a reverse centrifugal cleaner in accordance with the invention, the apex outlet, which heretofore has been used as the outlet for the "heavy" fraction, whether it be reject in conventional cleaning or accepts in reverse cleaning, becomes the outlet for the light fraction which constitutes rejects in reverse centrifugal cleaning. The cleaner of the invention is provided with a second discharge outlet in its side wall, and preferably at the downstream end of the conical portion of the interior of the cleaner, which is then the discharge outlet for the heavy fraction constituting the accepts flow in reverse centrifugal cleaning.

Thus in the practice of the invention, there is a through flow of the feed stock from the base end to the apex end of the cleaner, with no reverse flow through the central part of the cleaner as in both conventional and

reverse cleaning as heretofore practiced. This feature is of particular value in the application of the invention to cyclone assemblies or "canister" cleaners wherein multiple individual centrifugal cleaners are assembled in parallel relation within a common canister whose interior is divided into feed, accepts and reject chambers which connect respectively with the inlet and discharge ports of all of the individual cleaners.

Further on this feature of the invention, when conventional cleaners are assembled in a canister, for example as shown in Rastatter U.S. Patent No. 3,940,331, the reverse flow within each of the individual cleaners creates substantial opposed forces (tensile loading) and stresses on the individual cleaners by reason of the opposed flows within each cleaner. With the cleaners of the invention, however, wherein the flow within each cleaner is all in one direction, there are no such opposing forces, and the stresses and strains on the cleaners are correspondingly reduced.

In order that the invention may be more readily understood, reference will now be made to the accompanying drawings, in which:

Fig. 1 is a view in axial section of a reverse cleaning unit in accordance with the invention;

Fig. 2 is a fragmentary view similar to Fig. 1 and showing a modified inlet port arrangement; and

Fig. 3 is a fragmentary view illustrating the application of the invention to a canister-type cyclone assembly.

A typical reverse centrifugal cleaner indicated generally at 10 is shown in Fig. 1 as housed in a casing 11 which has its interior divided by partitions 12 and 13 into a supply or feed chamber 15 at one end of the casing 11, a reject chamber 16 at the other end of the casing, and an accepts chamber 17 located intermediate the chambers 15 and 16, each of these chambers being provided with its own port 20, 21 and 22, respectively.

The cleaner 10 comprises a main tubular vessel 25 the interior of which is cylindrical over a portion of its length and frusto-conical throughout its remaining portion. A housing 26 is threaded on the smaller end of the vessel 25, and a tubular tip piece 27 is secured within the housing 26 by a retainer nut 28 as shown. The cylindrical bore 29 within the tip piece 27 forms a continuation of the interior of housing 25 which leads to the discharge port 30.

The housing 26 has one or more radially or tangentially arranged ports 31 therethrough which provide a total flow area larger than that of the port 30 leading into the interior of the reject chamber 16. The lower end of the housing 26 is closed by a threaded cap 33 which extends through an opening in the end wall 34 of the casing 11 and clamps the casing wall against the end of housing 26 to the casing wall. The base end of the vessel 25 is provided with a closure plug 35 which is threaded into the end of the vessel 25 and also clamps the partition 13 between itself and the vessel 25.

A helical groove 40 on the outer surface of the plug 35 forms the inlet port to the interior of the

cleaner vessel 25, the spiral configuration of this groove assuring that stock to be cleaned will be delivered from the interior of the feed chamber 15 to the interior of the vessel 25 with a substantial circumferential flow component. The plug 35 is otherwise solid, but it includes a cylindrical extension 41 on its inner end which acts in part as a vortex finder but more particularly as a stabilizer for the air core which forms during operation of the cleaner. The groove 40 may be duplicated around the periphery of plug 35 to increase the effective inlet port size as needed.

In addition to the outlet port 30 at its apex, the cleaner 10 is provided with one or more outlet ports 44 at the lower end of the frusto-conical portion of vessel 25. The outlet ports 44 are preferably arranged tangentially of the vessel 25, in the same direction as the circulatory movement of stock within the vessel, and these ports lead into the chamber 15 within the casing 11. Preferably, the tip piece 27 includes a cylindrical extension 45 which projects upstream therefrom into the interior of the vessel 25 sufficiently far so that it at least radially overlies the outlet port or ports 44 and thus serves as a baffle preventing direct flow therefrom to the interior of tip piece 27 and the outlet port 30, and the upstream end of the extension 45 thus effectively is the apex outlet port of the vessel 25.

The inlet construction shown in Fig. 1 has special advantages in that it assures the all stock entering the cleaner will continue to flow with a substantial component lengthwise of the cleaner, rather

than having some heavy particles tend to orbit the inlet end of the cleaner and thereby wear away its inner wall surface. The invention can be practiced, however, with the alternative inlet construction shown in Fig. 2, which is essentially the same as in the above noted patent No. 4,155,839. It includes a plug 35' which differs from plug 35 only in having no groove 40 in its outer surface. Instead, an inlet port 40' of rectangular shape leads tangentially through the wall of vessel 25 as shown in patent No. 4,155,839. The position of the partition 12 with relation to the vessel 25' therefore has to be shifted so that the port 40' will be open to the feed chamber 15, and the partition 13 is therefore clamped between a shoulder 46 on the vessel 25' and a nut 47 threaded on the vessel 25' in opposed relation with the shoulder 46.

In the use of a cleaner of the construction described in connection with Figs. 1 and 2, the slurry to be cleaned is delivered to the supply chamber 15 at the appropriate pressure to cause it to enter the inlet port 40 or 40' at the desired flow rate and velocity as described in patent No. 4,155,839, to develop within the vessel 25 centrifugal force conditions causing vortical separation of the slurry into an outer fraction containing the large majority of the paper fibers, an inner fraction containing the large majority of light contaminant particles, and commonly also an innermost air core.

The outer fraction will travel down the frusto-conical portion of the interior of vessel 25 until it reaches the discharge port or ports 44, and it will

exit through those ports to the accepts discharge chamber 17 and its outlet port 22. The inner fraction will enter the upstream end of the extension 45 and travel therethrough and through the interior of the tip piece 27 and the outlet port 30 to the reject discharge chamber 16 and its port 21.

Separation of the heavy and light fractions which form within the cleaner as they discharge therefrom is readily controlled by regulating the respective discharge flows from the chambers 16 and 17, by means such as valves 50 and 51 on the lines 52 and 53 leading from the ports 21 and 22. Determination of the proper flow splits from the two discharge chambers will usually involve some experimentation, depending upon the nature of the feed stock, the feed flow rate and the feed pressure, and satisfactory results have been obtained under test conditions with this split varied from approximately equal flows from both discharge chambers to approximately 80% from the accepts chamber 17 and 20% from the reject chamber 16.

As a more specific example of the practice of the invention, test runs were made with a cleaner constructed as shown in Fig. 2 wherein the inlet port 44' had a flow area of 0.625 sq. in., the minimum flow area of the apex outlet port was 0.785 sq. in., and there were two outlet ports 40 each of a flow area of approximately 0.25 sq. in. In a test run wherein the feed flow rate was 50 gallons/minute at 30 p.s.i.g., satisfactory results were obtained with flows from the discharge chambers 16 and 17 of approximately 26 and 24 gallons/minute. Better results

were obtained with a feed flow rate of 68 g.p.m. at a feed pressure of 40 p.s.i.g., and with the flows from the discharge chamber 16 and 17 at the rate of 54.5 and 13.5 g.p.m. respectively.

The invention has also been tested with a cleaner constructed as shown in Fig. 1 wherein the inlet port flow area was 0.625 sq. in., the minimum flow area of the apex port was 0.306 sq. in., and the accepts port 40 was rectangular, similarly to the inlet port 40' in Fig. 2, with dimensions of 1.5 inches x 3/8 in. and a flow area of 0.47 sq. in. Highly satisfactory results were obtained with a feed flow at 80 gallons/minute and a pressure of 45 p.s.i.g. with the flow from the chambers 16 and 17 at the rates of 8.5 and 71.9 gallons/minute.

As pointed out hereinabove, the invention is especially applicable to cleaner assemblies of the canister type, as illustrated in Fig. 3, wherein the canister 60 has internal walls 61 and 62 dividing its interior into a central chamber 63 and opposite end chambers 64 and 65. Multiple cleaners 10 of the construction described in connection with Fig. 1 are shown as mounted within the canister 60, with the interior walls 61 and 62 and end wall 66 providing the same mounting and partitioning functions as the partitions 12 and 13 and end wall 34 in Fig. 1.

The operation of a canister cleaner assembly of the invention as shown in Fig. 3 is the same as already described in connection with Fig. 1. The chamber 64 serves as the feed chamber and is provided with an appropriately located port for receiving the inlet flow of

feed stock, and the chambers 63 and 65 become the reject and accept chambers as described in connection with the chambers 16 and 17 in Fig. 1. Since there is no reverse flow within any of the cleaners 10, the individual cleaner bodies are not subjected to tension strains but need only support the compression loads imposed by the pressures within the chambers 33-65, and since the maximum pressure is in the feed chamber 64, no practical problem is involved. It should also be noted that the canister cleaner of Fig. 3 can in effect can be made double-ended by doubling the length of the canister, installing a second set of partition walls and cleaners opposite the set shown in Fig. 3, and then using chamber 64 as the feed chamber for both sets of cleaners.

CLAIMS

1. A system for separating paper making fibers from light contaminants of similar and lower specific gravities, characterised by:

(a) means for forming a pumpable aqueous slurry wherein the solid constituents consist essentially of paper fibers and one or more light contaminants such as wax and plastic fragments similar in size to and not sufficiently greater in specific gravity than paper fibers for separation by conventional centrifugal cleaning technique,

(b) a conical vessel (25) having an inlet port (40, 40') adjacent the base thereof,

(c) a first outlet port (44) in the side wall of said vessel adjacent or spaced upstream from the apex end thereof,

(d) a second outlet port (30) located axially at the apex end of said vessel,

(e) means for supplying said slurry to said vessel through said inlet port (40, 40') at a sufficiently high flow rate circumferentially of said vessel and under sufficient pressure to develop in said vessel centrifugal force conditions causing vortical separation of said slurry within said vessel into an outer fraction containing the large majority of the paper fibers and an inner fraction containing the large majority of said light contaminant materials, and

(f) means (50, 51) for controlling the discharge flows from both of said outlet ports to cause said outer fraction to discharge through said first outlet port (44) and said second fraction to discharge through said second outlet port (30).

2. The system defined in claim 1 wherein said inlet port (40, 41) is defined by means in the base of said vessel for delivering an inlet flow of slurry to said vessel circumferentially of said vessel.

3. The system defined in claim 1 wherein said vessel comprises means (41) at the base end thereof for stabilizing the adjacent end of the air core which forms within said vessel during operation of said system.

4. The system defined in claim 3 wherein said stabilizing means (41) comprises a cylindrical member projecting axially inwardly of said vessel from the base end thereof and open only at the innermost end thereof.

5. The system defined in claim 1 further comprising closure means (35) at the base end of said vessel, means defining said inlet port (40) as a spiral passage in said closure means (35) to impart a circumferential component to liquid flow through said passage, and a cylindrical extension (41) on the inner side of said closure means for stabilizing the adjacent end of the air core which forms within said vessel during operation of said system.

6. The system defined in claim 1 further comprising baffle means (45) blocking direct flow of liquid from the apex end of the side wall of said vessel to said second outlet port (30).

7. The system defined in claim 6 wherein said baffle means comprises a cylindrical member (45) extending upstream from the apex end of said vessel into radially overlying relation with said first outlet port (44).

8. A multiple centrifugal cleaner assembly for separating paper making fibers from light contaminants, characterised by:

(a) an enclosed container (60),

(b) walls (61, 62) within said container dividing the interior thereof into a central chamber (63) and opposite end chambers (64, 65),

(c) a plurality of centrifugal cleaners (10) located within said container,

(d) each of said cleaners including a cylindrical-conical vessel (25) having an inlet port (40, 40') adjacent the base thereof, a first outlet port (44) in the side wall thereof adjacent the apex end thereof, and a second outlet port (30) located axially thereof at the apex end thereof,

(e) means (61, 62) supporting each of said cleaners (10) within said walls with said inlet ports ()40, 40') thereof in one (64) of said end chambers, said first outlet ports (44) thereof in said central chamber (63), and said second outlet ports (30) thereof communicating directly with the second (65) of said end chambers,

(f) said one end chamber (64) having an inlet port (20) for receiving an aqueous slurry of paper fibers and light contaminants for delivery to said inlet ports (40, 40') of said cleaners, and

(g) discharge ports (21, 21') from each of the other two of said chambers.

9. The process of separating paper making fibers from light contaminants characterised by the steps of:

(a) forming a pumpable aqueous slurry wherein the solid constituents consist essentially of paper fibers and at least one light contaminant such as wax or plastic fragments similar in size to and not sufficiently greater in specific gravity than wet paper fibers for separation by conventional centrifugal cleaning technique,

(b) supplying said slurry to the larger end of a conical vessel at a sufficiently high flow rate circumferentially of said vessel and under sufficient pressure to develop in said vessel centrifugal force conditions causing vortical separation of said slurry within said vessel into an annular outer fraction containing the large majority of the paper fibers and an annular inner fraction containing the large majority of said light contaminant material,

(c) causing said outer fraction to be discharged laterally from said vessel at a station adjacent or spaced upstream from the smaller end thereof, and

(d) causing said inner fraction to be discharged axially from said small end of said vessel.

10. The method defined in claim 9 wherein said discharge causing steps are effected by regulating the relative volumetric flows of liquid discharged laterally and axially from said vessel.

11. The method defined in claim 9 further comprising the step of stabilizing any air core which forms within said vessel and causing such air to be discharged from said vessel with said inner fraction of said slurry.

12. A centrifugal cleaner particularly adapted for fibers from light contaminants of similar and lower specific gravities, comprising:

(a) a conical vessel (25) having an inlet port (40, 40') adjacent the base thereof,

(b) a first outlet port (44) in the side wall of said vessel adjacent or spaced upstream from the apex end thereof,

(c) a second outlet port (30) located axially at the apex end of said vessel, and

(d) baffle means (45) blocking direct flow of liquid from the apex end of said side wall of said vessel to said second outlet port.

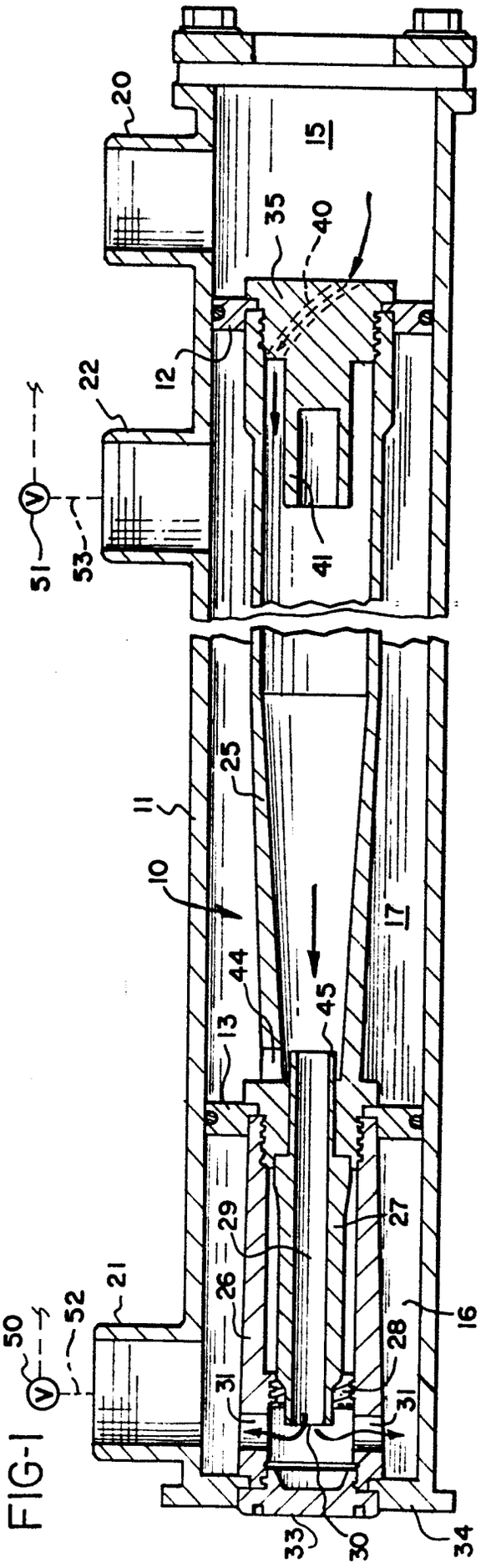

FIG-1

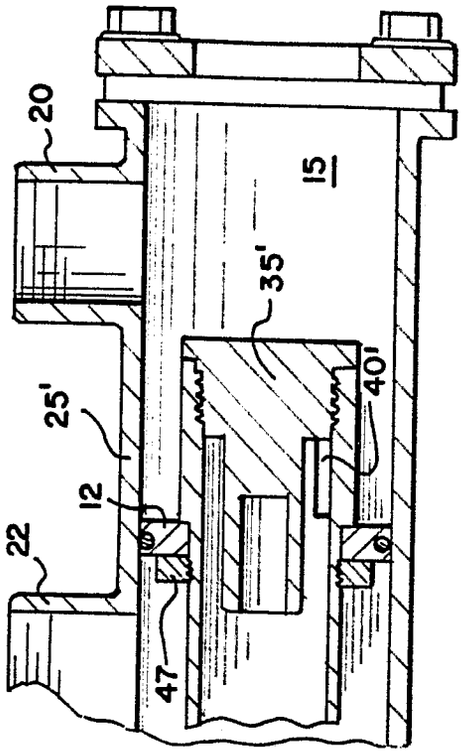

FIG-2

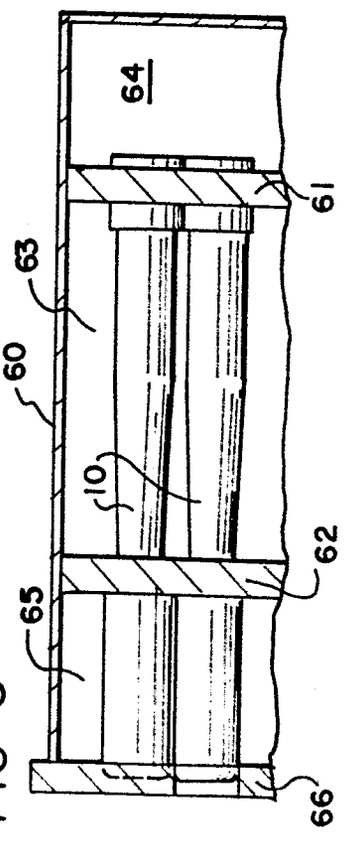

FIG-3