

Fig.1

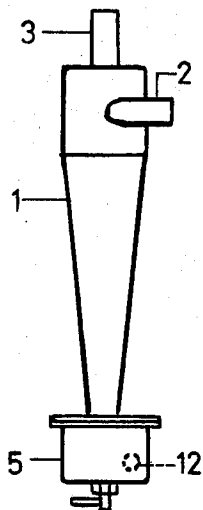


Fig.2

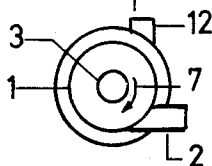


Fig.3

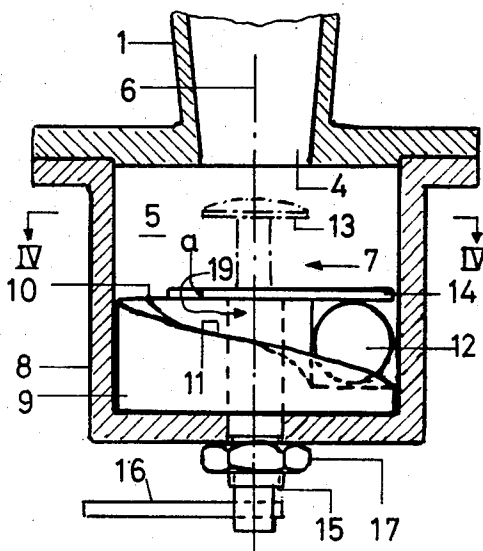
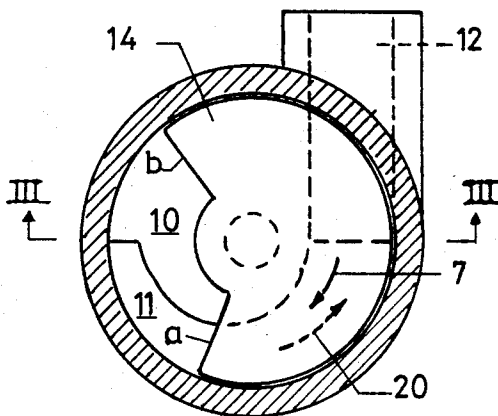


Fig.4



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[54] **HYDROCYCLONE**

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Feb. 23, 1969 Sweden1950/69

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[51] Int. Cl.B04c 5/16

[58] Field of Search209/211, 144; 210/512

[56] **References Cited**

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[57] **ABSTRACT**

A discharge chamber of circular cross-section extends axially from the vortex chamber and has at one end an inlet from the vortex chamber and at the other end a bottom provided with an outlet, the discharge chamber also having a central axis around which the heavy fraction separated in the vortex chamber is rotated in one direction while passing from said inlet to said bottom, the outlet being located below the plane of the bottom. The bottom has an open discharge groove communicating with the outlet and leading therefrom with a gradually diminishing cross-sectional area in said one direction along the circular side wall of the discharge chamber through an angle less than one revolution; and a covering disc is disposed in close parallel relation to the bottom plane and is movable around the central axis, this disc having a recess in its peripheral portion and otherwise covering said bottom substantially entirely.

2 Claims, 15 Drawing Figures

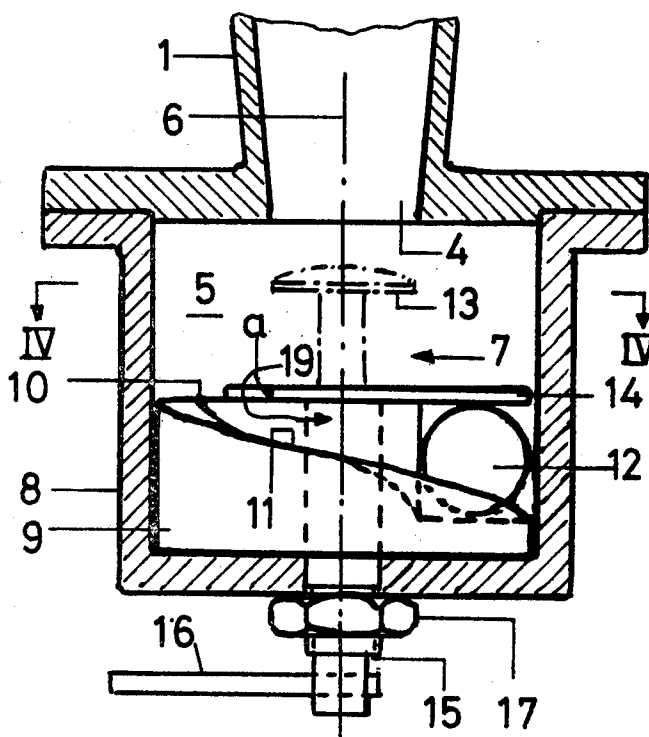


Fig. 5

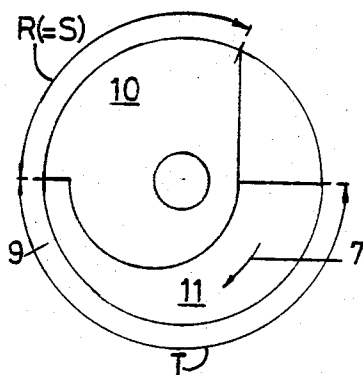


Fig. 6

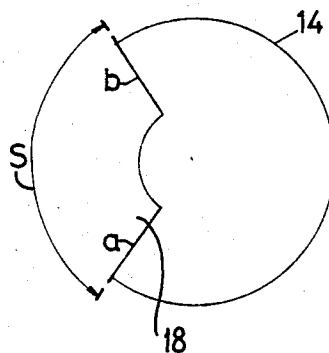


Fig. 7

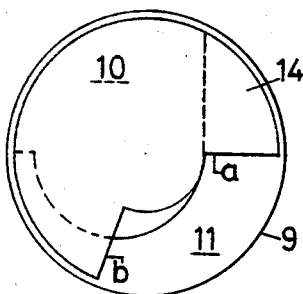


Fig. 8

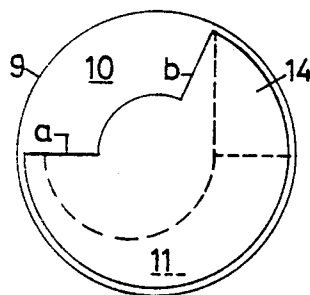
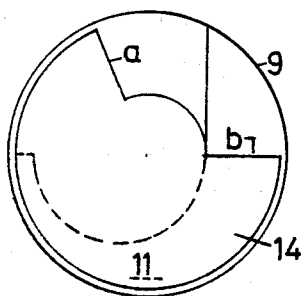


Fig. 9



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Fig.10

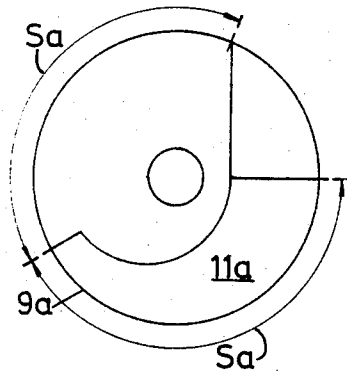


Fig.11

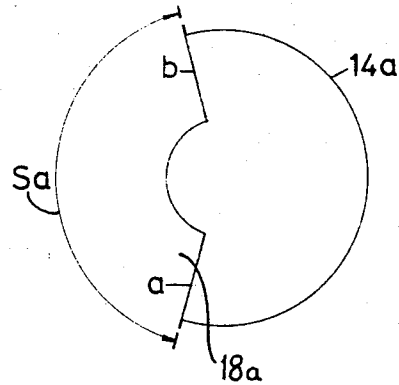


Fig.12

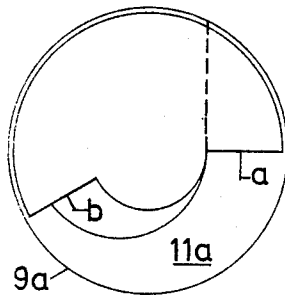


Fig.13

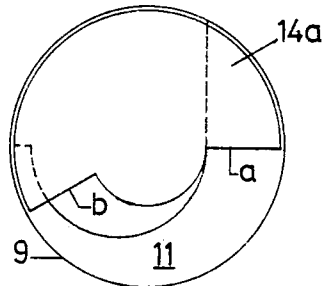


Fig.14

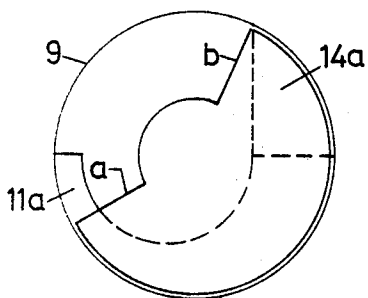
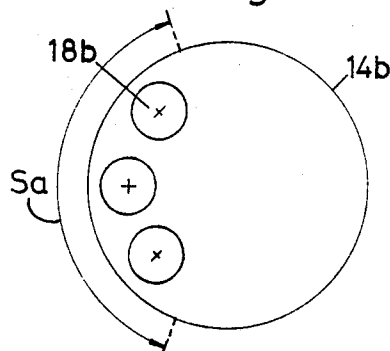


Fig.15



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HYDROCYCLONE

This invention relates to hydrocyclones for separating suspensions of solid particles, such as a pulp suspension, into light and heavy fractions. More particularly, the invention relates to such a cyclone wherein the separated heavy fraction is led away through an axially elongated discharge chamber of circular cross-section, the heavy fraction rotating around a central axis of the discharge chamber while moving from an inlet in one end of this chamber toward a bottom at the other end where the outlet for the heavy fraction is located.

In the operation of hydrocyclones as described above, it has been a problem to control the flow of heavy fraction through the outlet in such a manner as to avoid blockage of the control device by a collection of solid particles therein.

The principal object of the present invention is to provide a hydrocyclone which avoids this problem.

In a hydrocyclone made according to the invention, the bottom of the discharge chamber has an open discharge groove communicating with the heavy fraction outlet which is located below the plane of the bottom. This groove leads from the outlet with a gradually diminishing cross-sectional area in the direction in which the heavy fraction rotates about the central axis of the discharge chamber, the groove extending along the circular side wall of the discharge chamber through an angle less than 360°. A covering disc is disposed in close parallel relation to the bottom plane and is movable around the central axis, this disc having a recess in its peripheral portion and otherwise covering the bottom substantially entirely.

For a better understanding of the invention, reference may be had to the accompanying drawings in which:

FIG. 1 is a side elevational view of one form of the new hydrocyclone;

FIG. 2 is a plan view of the hydrocyclone shown in FIG. 1;

FIG. 3 is an enlarged vertical sectional view of the lower portion of the hydrocyclone, including the discharge chamber, this view being taken on line III—III in FIG. 4;

FIG. 4 is a sectional view on line IV—IV in FIG. 3;

FIGS. 5 and 6 are detailed plan views of the bottom of the discharge chamber and the covering disc, respectively, in FIG. 4;

FIGS. 7, 8 and 9 are similar views of the parts shown in FIGS. 5 and 6 in three different cooperating positions;

FIGS. 10 and 11 are views similar to FIGS. 5 and 6, respectively, but showing modifications;

FIG. 12 is a similar view showing the parts in FIGS. 10 and 11 in a cooperating position;

FIGS. 13 and 14 are similar views of details according to FIGS. 5 and 11, showing the parts in two different cooperating positions, and

FIG. 15 is a view similar to FIG. 11 but showing a modification.

As shown in FIGS. 1 and 2, the hydrocyclone comprises housing means including an upper part 1 forming a conventional vortex chamber. This chamber is provided at its upper end portion with a tangential inlet 2 for a suspension of solid particles, such as a pulp suspension, and with an outlet 3 for the separated light fraction. The lower end of the vortex chamber has an

outlet 4 (FIG. 3) constituting the inlet to a discharge chamber 5 formed by the housing means and extending coaxially from the vortex chamber. Due to the tangential direction of the inlet 2, the suspension is rotated around the central axis 6 common to the vortex chamber and the discharge chamber in the direction of the arrow 7 (clockwise as viewed in FIG. 4). The separated heavy fraction retains this direction of rotation in discharge chamber 5, although it is spread in all radial directions by a screen arranged in the discharge chamber in a conventional manner, the screen being indicated at 13 in FIG. 3 by dot-dash lines.

The discharge chamber 5 is circular in cross-section and is defined by a cylindrical casing 8 of the housing means. The lower part of this casing contains a bottom portion 9 (see particularly FIGS. 4 and 5) which consists of a cylindrical body, the upper plane of this body forming the bottom of the discharge chamber. The bottom portion 9 is provided with a counter-sink extending along a part of its periphery and which, in the direction of the arrow 7, gradually diminishes in breadth and depth below the bottom plane 10. This counter-sink forms an open discharge groove 11 which is limited radially outward by the circular side wall of casing 8. An outlet 12 for the heavy fraction is located in the side wall below the bottom plane 10, and the discharge groove 11 communicates with this outlet. The discharge groove thus leads from the outlet 12 with a gradually diminishing cross-sectional area along the circular side wall of the discharge chamber in the same direction as that of the rotation of the heavy fraction around the central axis 6, the groove extending through an angle of less than one revolution as shown at T in FIG. 5.

In close parallel relation to the bottom of the discharge chamber 5 is a covering disc 14 (see particularly FIGS. 4 and 6). This disc is mounted for rotation around the central axis 6 by means of a shaft 15 provided with a handle 16 (FIG. 3). Shaft 15 is centrally guided in the bottom portion 9 and can be locked in a selected rotational position by means of a lock nut 17. The disc 14 is of generally circular form, and its diameter is only so much smaller than the inner diameter of casing 8 that the disc can be turned freely. A recess 18 is provided along a peripheral portion of the disc and is confined between two edges *a* and *b*, so that the disc recess extends along the side wall of the casing through an angle or extension indicated at S in FIG. 6. The discharge groove 11 of varying cross-section extends along the same side wall through the angle or extension T, and the ungrooved part of the bottom 9 extends along this wall through an angle or extension R which is equal to S (FIG. 5).

In the operation of the hydrocyclone, when the heavy fraction circulates in the discharge chamber in the direction of the arrow 7 and the disc 14 is in the position shown in FIGS. 3 and 4, the heavy fraction will flow around the edge *a* of the disc, as shown by arrow 19 in FIG. 3, and will flow through the groove 11 in the direction of the arrow 20 (FIG. 4). The smallest cross-sectional area of the discharge groove 11 (the area which determines the discharge rate) is constituted by its cross-section at the edge *a*. The discharge rate can be controlled by turning the disc about axis 6 so that the edge *a* is situated over different cross-sections of the discharge groove 11.

In the rotational position of disc 14 shown in FIG. 7, the edge *a* is situated over the largest cross-section of groove 11, so that the discharge rate is maximal. In the disc position shown in FIG. 8, where the edge *a* directly overlies the juncture of groove 11 with the bottom plane 10, the parts cooperate in such a way that all communication (except unavoidable leakage) with outlet 12 is interrupted.

Referring to FIG. 9, the disc 14 is there shown with its edge *b* situated directly above the largest cross-section of groove 11, this position being particularly suitable when a rapid emptying of the discharge chamber 5 is desired. In this position, the discharge chamber will open directly in front of the outlet 12, and the discharge groove 11 will not be used at all.

The flow of the heavy fraction around the edge *a* of the covering disc 14, as previously explained, is an important feature of the invention. It achieves a high degree of dynamic loss of pressure and contraction in the cross-section of the discharge groove 11 below this edge. It is therefore possible to attain a large throttling effect also in a relatively large cross-section which increases considerably the ability to control the outlet flow within wide limits without any risk of blocking the outlet.

It should also be mentioned that when the covering disc 14 is turned to the position shown in FIG. 7 and adjacent rotational positions, the discharge groove 11 forms a pocket of considerable length under the covering disc 14 and behind the edge *b*. In experiments made heretofore, it has not been possible to determine with certainty to what extent this pocket may be of disadvantage to the functioning of the arrangement, for example, by catching and retaining an accumulation of solid particles. Any such accumulation can be loosened in the form of coherent flocks when the covering disc 14 is rotated to another position so that the pocket wholly or partially disappears. However, with the simple modifications shown in FIGS. 10 and 11, this eventuality can be avoided. In comparison with FIGS. 5 and 6, these modifications consist of a shortening of the extension *T* and a lengthening of the extensions *R* and *S* to the same extension *Sa*. FIG. 12 shows the disc 14a over the bottom portion 9a in the same rotational position as in FIG. 7 and shows that the previously mentioned pocket is not created. In the positions shown in FIGS. 8 and 9, the covering and opening conditions will be essentially unchanged.

If the shortening of discharge groove 11 should result in any disadvantage, a compromise can be achieved by combining the bottom portion 9 with the disc 14a. As shown in FIG. 13, this has the effect that the pocket is considerably diminished and disappears sooner when the disc is rotated so that more throttling positions are achieved. As shown in FIG. 14, this combination can also have the effect of preventing a complete shutting of the discharge groove 11a at the edge *a*, as the preceding edge *b* opens a direct passage to the outlet

12. However, this seems to be of little importance, since the shallowest parts of the groove 11a under the edge *a* generally give a through-flow area which is too small to be used practically for such control.

In the covering disc 14b shown in FIG. 15, the peripheral recess has been replaced by a row of holes 18b having the same effect. Although these holes are shown as being round, they can be of different shapes and in different numbers.

It will be understood that details of the invention as illustrated in the previously described examples can be modified in many ways within the scope of the invention. For example, the bottom portion 9 can be made to extend downward from the casing 8, or it can be completely replaced by a bottom constituting a part of the casing with the same form. Also, the discharge groove 11 can vary in profile. The covering disc 14 should be thin in order to retard the movement of the heavy fraction around the edge *a* as little as possible. For the same reason, this edge can be bevelled on its upper side. Furthermore, it is not necessary that the discharge chamber 5 be coaxially connected to the vortex chamber within the housing part 1. The discharge chamber can just as well be provided with a tangential inlet for the heavy fraction which will bring about the same conditions of flow and connect, for example, in the manner disclosed in Swedish Pat. No. 197,182a. In such an arrangement it is not necessary that the hydrocyclone be of a vortex chamber type, the main requirement being only that the hydrocyclone deliver a heavy fraction to the tangential inlet.

We claim:

1. In a hydrocyclone for separating a suspension of solid particles into heavy and light fractions, means forming an axially extended discharge chamber of circular cross-section having at one end an inlet for said heavy fraction and at the other end of a bottom provided with an outlet, the discharge chamber also having a central axis around which said heavy fraction is rotated in one direction while passing from said inlet to said bottom, said outlet being located below the plane of said bottom, said bottom having an open discharge groove communicating at one end with said outlet and leading therefrom with a gradually diminishing cross-sectional area in said one direction along the circular side wall of the discharge chamber through an angle less than one revolution, and a covering disc disposed in close parallel relation to said bottom plane and movable around said central axis, said disc having a recess in its peripheral portion and otherwise covering said bottom substantially entirely.

2. A hydrocyclone according to claim 1, in which said angle is no greater than the angle subtended along said side wall by an ungrooved portion of said bottom, said recess extending along the periphery of the disc through an angle the same as said angle through which said groove leads.

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