

Feb. 9, 1954

F. J. FONTEIN
MULTIPLE HYDROCYCLONE

2,668,620

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2 Sheets-Sheet 1

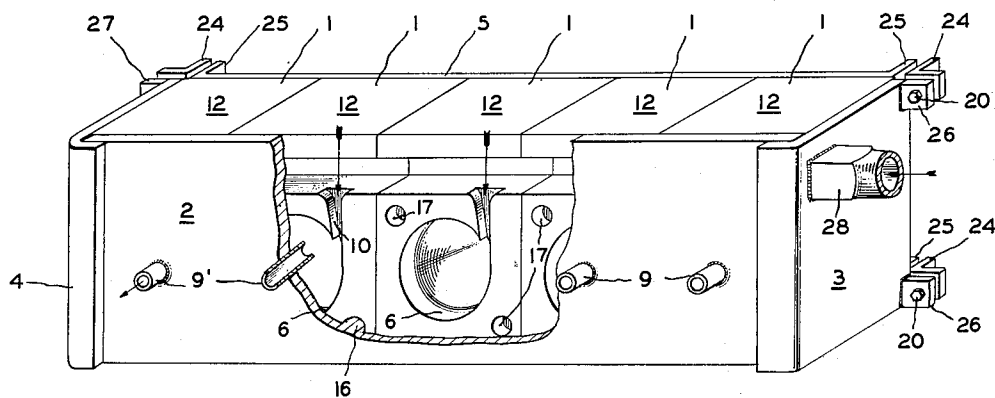


FIG. 1.

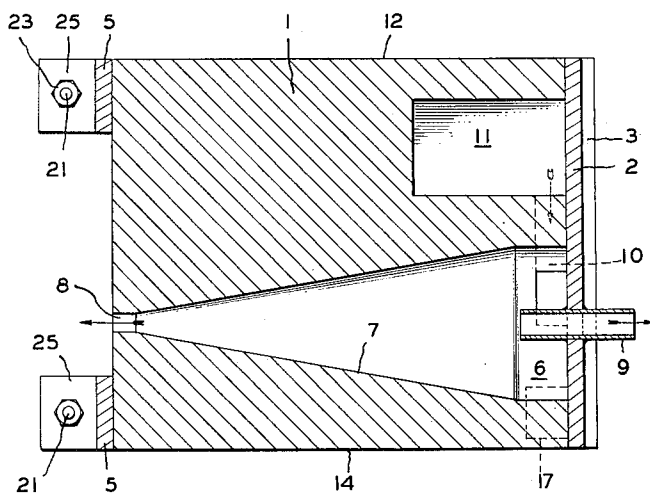


FIG. 2.

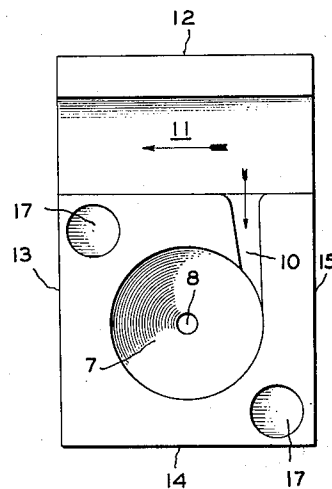


FIG. 3.

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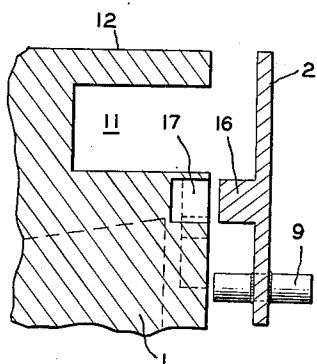


FIG. 4.

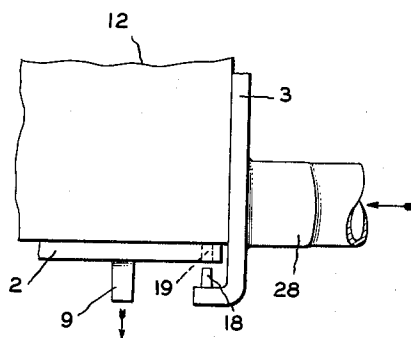


FIG. 5.

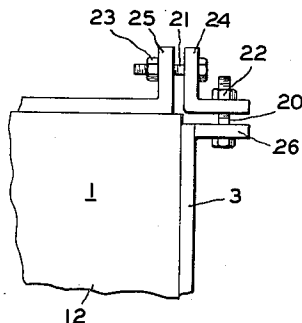


FIG. 6.

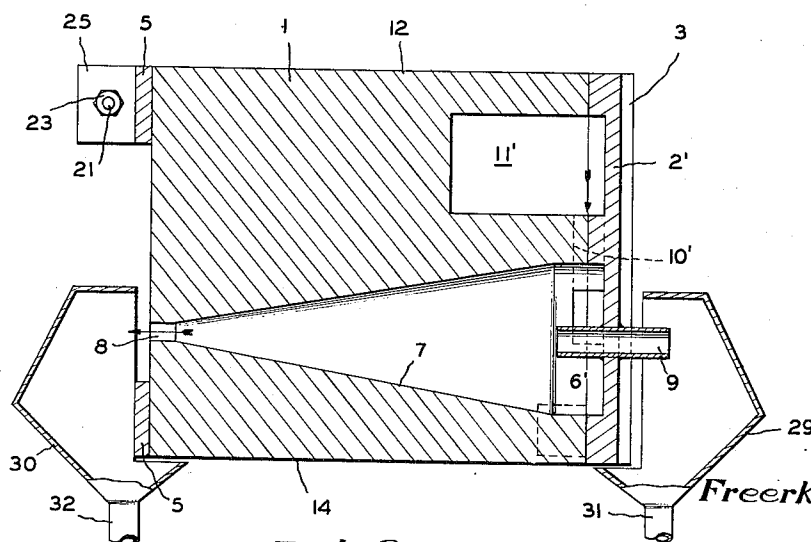


FIG. 7.

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MULTIPLE HYDROCYCLONE

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5 Claims. (Cl. 209-211)

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This invention relates to hydrocyclones such as are used to treat solids in liquid suspension for the purpose of thickening or of classifying the suspended solids into predetermined fractions. Such solids may be either organic or inorganic, such as starch, paper-pulp, ores, coal, phosphate rock, and the like. However, such diverse materials require different dimensions of hydrocyclones and different operating conditions, so a brief description of the general characteristics of such a hydrocyclone may be helpful.

A hydrocyclone is a generally cylindrical vessel comprising a truly cylindrical part or section which merges into a generally conical part or section. There is an opening at the apex of the cone of the conical section and there is another opening, coaxial with the apex opening, in the cover-plate on the cylindrical section.

In the opening in the cover-plate, is carried a tube that protrudes from that plate outward and extends inwardly into the cylindrical section of the hydrocyclone. This is called a vortex finder. There is a tangential feed inlet to the cylindrical section.

In operation, the liquid suspension is supplied to the hydrocyclone under pressure through the tangential feed inlet to the cylindrical section whereby the suspension is given a quick enough rotational impulse to keep it rotating during its passage through the hydrocyclone. One fraction of the suspended solids is discharged from the hydrocyclone through the apex opening while another fraction is discharged through the vortex finder and thus from the base of the generally conical hydrocyclone. The apex-discharge contains the larger suspended solids while the base-discharge contains the smaller suspended solids, if separation is being based upon size difference. If separation is based upon specific gravity difference, the solids having less specific gravity are discharged through the base, while the solids having greater specific gravity are discharged through the apex. As separation in a hydrocyclone is dependent upon intense rotational forces, no obstructions can be tolerated in the hydrocyclone which must have a perfectly smooth bore for otherwise harmful secondary eddies are set up. The feed entrance also must be smooth and unobstructed.

The functioning of a hydrocyclone is readily effected by slight environmental changes, such as changing the area of the infeed entrance; the infeed pressure; the diameter of the apex-discharge; the diameter of the length of the vortex finder; the diameter of the length of the cylin-

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dricl section; or the shape of the conical section. In general, the smaller the dimension of the suspended solids to be separated, the smaller must be the diameter of the cylindrical section of the hydrocyclone. For instance, a hydrocyclone for the separation of phosphate rock from limestone will have a cylindrical section of the order of 48 inches in diameter, whereas a hydrocyclone for the thickening of starch will have a cylindrical section of the order of one-half an inch in diameter. A 48-inch hydrocyclone will have an hourly capacity of about 10,000 times that of a half-inch hydrocyclone—the capacity of the latter being about 25 gallons per hour. Thus, in a starch factory where it is desired to thicken say 25,000 gallons of starch per hour, 1,000 half-inch hydrocyclones would be required. While this may seem to be a startling number, the efficiency of these smaller hydrocyclones for making satisfactory separations along the line of infinitesimal size differences, is such as to make their use desirable. However, mechanical problems of hooking up so many tiny hydrocyclones as to feed, and discharges, are serious. So it is a major object of this invention to take the tiny type of hydrocyclone out of the laboratory stage by devising ways and means whereby they are to be supplied and discharged economically without having a maze of feed and discharge pipes and fittings.

A further object of this invention is to devise means whereby such a hydrocyclone can be cast or moulded into a unit to present an exterior having abutable faces that permit such units to be secured together in multiple.

Another subject of the invention is to devise ways and means whereby a multiplicity of hydrocyclones, hereinafter referred to as a multiple-hydrocyclone, can be housed in a single casing or container.

A more specific object of the invention is to cast or mould the cylindrical and conical section of a hydrocyclone into a block-like body unit, while casting or moulding the cover-plate with its vortex finder as one separable unit for the body unit for enabling a group of body blocks of a multiple-hydrocyclone to have only one cover-plate for the multiple base-discharges. In other words, it is an object of this invention to secure together a multiple of hydrocyclone body blocks in a main body assembly to which can be applied a minimum of other separable sections that contain within themselves the essential feed and discharge openings required to make the multiple-hydrocyclone into an operable device with

no external accessories other than a unitary feed conduit, and a unitary conduit each for the base-discharges and for the apex-discharges.

To realize these objects, the invention comprises a construction consisting of a number of non-cylindrical blocks, a cover-plate and means to secure these parts together; this construction containing a feed channel and at least as many hydrocyclones as there are blocks in the construction. All the blocks are contoured in such a way that any two adjacent blocks in the multiple-hydrocyclone are secured together in face-abutting relationship. Every block together with the part of the cover-plate which covers it, contains at least one complete hydrocyclone plus a part of the infeed channel. When the blocks and the cover-plate are assembled and secured together, a single infeed channel has been formed through the multiple-hydrocyclone, which can be connected to one infeed tube. Part of every hydrocyclone is contained in a block, the other part being contained in the cover, the two parts joining in the cylindrical part of the hydrocyclone. The cover-plate contains at least the covers and the vortex finders whereas the blocks contain at least the conical parts and the tops of the hydrocyclones.

It is possible to manufacture the blocks and the cover-plate by casting or by moulding under pressure to obtain identical hydrocyclones without burrs. No infeed pipes are necessary within such a multiple-hydrocyclone; the number of hydrocyclones in one multiple hydrocyclone can be determined according to requirements.

Other features, objects and advantages of the invention will appear from the detailed description of illustrative forms of apparatus, which will now be given in conjunction with the accompanying drawings, in which Figure 1 is a perspective view of the multiple-hydrocyclone with its cover-plate partially broken away.

Figure 2 is a cross-section perpendicular to the channel 11 and through the axis of a hydrocyclone.

Figure 3 is a front elevation of a block.

Figure 4 is an exploded cross-sectional view perpendicular to the channel 11 through the centre line of the tenon and mortise joint (16 and 17) of the cover and a block.

Figure 5 is a plan view of a clamping device.

Figure 6 is an exploded plan view of the tenon and mortise joint (18 and 19) of the cover and plate 3.

Figure 7 is a cross-section like Figure 2, however, of another embodiment of the invention, perpendicular to the channel 11' and through the axis of a hydrocyclone.

In the assembled multiple-hydrocyclone, the body blocks 1 and the cover-plate or closure 2 are clamped together between plates 3 and 4 and strips 5. Each block 1 together with the part of the cover 2 which covers it, contains as a bore therein a complete hydrocyclone; the cylindrical part or section 6, conical part or section 7, apex opening 8 (Fig. 2), cover 2, tube or conduit 9 that function as a vortex finder and tangential infeed tapered entrance or inlet 10 along with a part of the infeed channel 11 through which the hydrocyclones can be fed.

The blocks 1 present flat faces 12, 13, 14 and 15 (Fig. 3) so that in the assembled multiple-hydrocyclone the face 13 of one block 1 is in face-abutting relationship with face 15 of another block 1. The cover is connected with the blocks by tenon 16 and mortise 17 joints (see Figs. 1

and 4) to secure the vortex finder 9 axially and centrally in the cylindrical bores 6.

Of course no suspension should leak out between the blocks 1. When rubber blocks are used they should be pressed against each other and against the cover. When the blocks are of a non-elastic material a packing is required between the blocks and between the cover and the blocks. The plates 3 and 4 are provided with curved edges overlapping the cover 2, which is connected with the plates 3 and 4 by tenon 18 and mortise 19 joints (Fig. 5). Figures 1 and 6 show how the blocks 1 and the cover 2 can be pressed together. The bolts 20 and 21 provided with the nuts 22 and 23 respectively, are received in perforations in the L-sectional members 24, the flanged edges 25 of the strips 5 and the square members 26 and 27 welded respectively to the plates 3 and 4. By tightening the nuts 22 and 23 the blocks and the cover are pressed together. Plate 3 is provided with infeed tube 28, plate 4 closes the infeed channel 11 at the other end.

In another embodiment of the invention (Fig. 7) part of the channel 11', infeed entrances 10' and cylindrical part 6' are provided in the cover-plate 2'. Of course, it is also possible to provide these parts in the cover only. Figure 7 shows further how the discharge of a multiple-hydrocyclone can be received in two receivers 29 and 30, each with a single discharge tube 31 and 32 respectively.

In operation, the suspension to be separated is pumped through tube 28 into the channel 11, and from there is forced into the infeed entrances 10. Rotating bodies of suspensions come into being in the cylindrical parts 6 and in the conical parts 7 of the hydrocyclones, with the separated fractions being discharged through the apex openings 8 and through the vortex finders or tubes 9 respectively by way of the receivers 30 and 29 into the discharge tubes 32 and 31.

Although for the sake of simplicity only five blocks have been indicated in Figure 1 it is obvious that much larger numbers of hydrocyclones can be united into corresponding multiple-hydrocyclones and it will be clear that the invention of this multiple-hydrocyclone makes the small hydrocyclone as useful an industrial separator as the large hydrocyclone already is:

I claim:

1. A unit block for a multiple-unit hydrocyclone, comprising a rectangular shape having exterior faces and a longitudinal bore of diminishing diameter, and associated therewith a feed inlet debouching tangentially into the larger end of the bore at a right angle thereto as well as a feed channel larger in cross-section than the feed inlet and as long as the shape is wide extending in a direction that is at a right angle to the axis of the bore with which bore the feed inlet connects the feed channel, each shape having a contour holdable by a cover for a multiple of such shapes when such shapes are in face-abutting relationship with the bores parallel and the feed channel of each space aligned thus forming a continuous feed channel.

2. Apparatus according to claim 1, wherein the feed channel is open cross-sectionally.

3. Apparatus according to claim 1, wherein the feed inlet is open cross-sectionally.

4. A multiple hydrocyclone assembly comprising a plurality of parallel circular spaces of diminishing diameter with each space being formed longitudinally in a block whose sides pre-

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sent faces holdable together in face-abutting relationship, a feed inlet debouching tangentially into the larger end of the space, a feed channel for each shape communicating with the entrance to the feed inlet extending in a direction that is at a right angle to the axis of the space with the feed channel for one block aligned with the feed channel of abutting blocks and with the cross-sectional area of the feed channel greater than that of the feed inlet, means for holding the abutting blocks together including an apertured plate for covering the abutting blocks at the larger end thereof that also encloses the feed channel between the cover plate and the blocks with one aperture for each block, and means for securing the cover plate on the abutting blocks with an aperture axially aligned with the space in each block.

5. A multiple hydrocyclone assembly comprising a plurality of shapes contoured for multiples thereof to be held together in face-abutting relationship with each shape having an axial bore of diminishing diameter and intersectingly thereto a tangential feed inlet debouching into the larger end of the bore, a feed channel for each shape communicating with the entrance to the feed inlet extending in a direction at a right angle to the bore and positioned in alignment with the feed channel of each abutting shape to make a continuous feed channel across the shapes and with the cross-sectional area of the channel greater than that of each feed inlet, means for holding the shapes together including

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apertured cover means for covering such abutting shapes at the feed inlet end of the bores thereof as well as to enclose the feed channel between the cover means and the shape with a coaxial tubular member extending outwardly from each aperture of the cover means, and means for securing the cover means on the shapes with one of the tubular members axially aligned with each bore.

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References Cited in the file of this patent UNITED STATES PATENTS

15	Number	Name	Date
	2,312,706	Freeman	Mar. 2, 1943
	2,372,514	Pootjes	Mar. 27, 1945
	2,530,181	Schilling	Nov. 14, 1950

FOREIGN PATENTS

20	Number	Country	Date
	693,823	France	Apr. 12, 1930
	880,715	France	Jan. 6, 1943

OTHER REFERENCES

- 25 Greer et al., "Preliminary American Tests of a Cyclone Coal Washer Developed in the Netherlands," American Institute of Mining and Metallurgical Engineers, Tech. Paper 2136 (1947), pages 2 and 3. (Copy in Sc. Lib.)
- 30 Taggart, "Handbook of Mineral Dressing," published 1945 by John Wiley and Sons Inc., New York, New York. (Copy in Div. 25.) Sec. 9, pages 9-07 through 9-13.