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Robinson

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[54] **LIQUID SUSPENSION PURIFYING UNIT**

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Aug. 25, 1972 Sweden 11078/72

[52] **U.S. Cl.** ..... **210/512 M,** 55/349, 209/211
[51] **Int. Cl.** **B04c 3/04**
[58] **Field of Search** ..... 55/349; 209/211; 210/512 R, 512 M

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Primary Examiner—Granville Y. Custer, Jr.
Assistant Examiner—Paul A. Bell
Attorney, Agent, or Firm—Woodhams, Blanchard and Flynn

[57] **ABSTRACT**

One or more hydrocyclones are arranged in a common housing to form a liquid purifying unit. Each hydrocyclone has a casing having an inject inlet, for the suspension to be cleaned, an accept outlet and a reject outlet. The common housing is divided up so as to have an inject chamber, an accept chamber and a reject chamber. Each hydrocyclone is arranged so that each accept outlet is located at the bottom of the unit and each reject outlet is located at the top thereof, with reject outlet open above the surface of the liquid in said reject chamber. The reject chamber forms part of a closed circuit with the reject outlet connected to an outlet line in a manner to maintain a generally constant level of liquid in the reject chamber. This arrangement enables the outflow of reject in the reject chamber to be seen and also enables the unit to be incorporated in a closed system.

12 Claims, 13 Drawing Figures

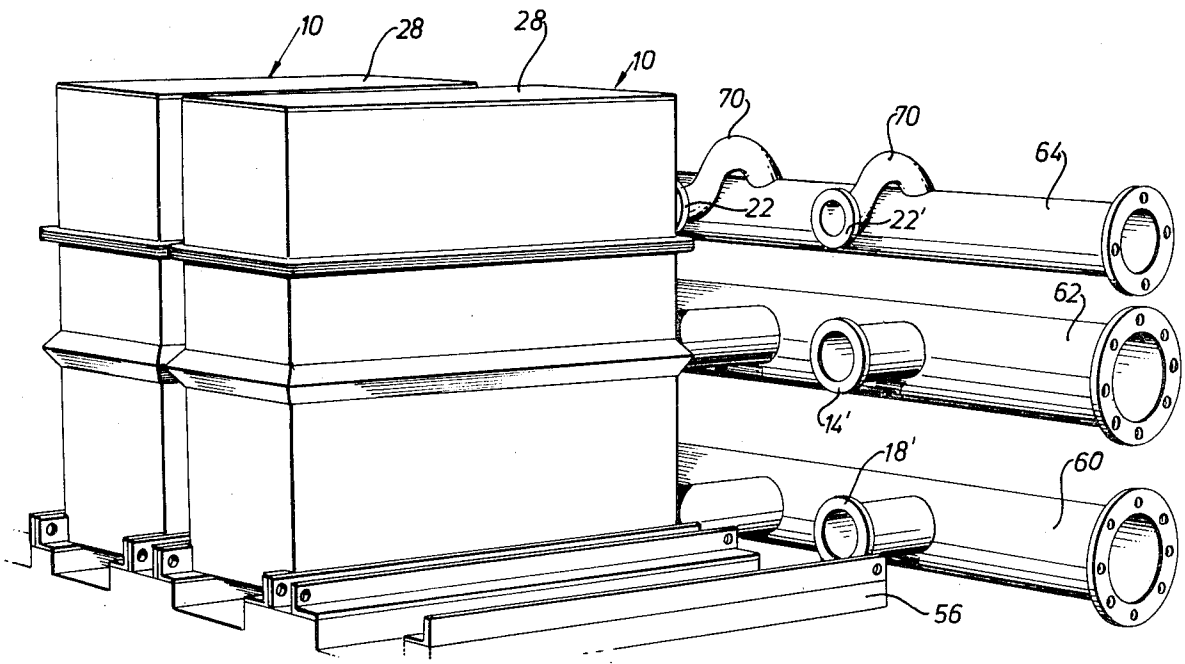
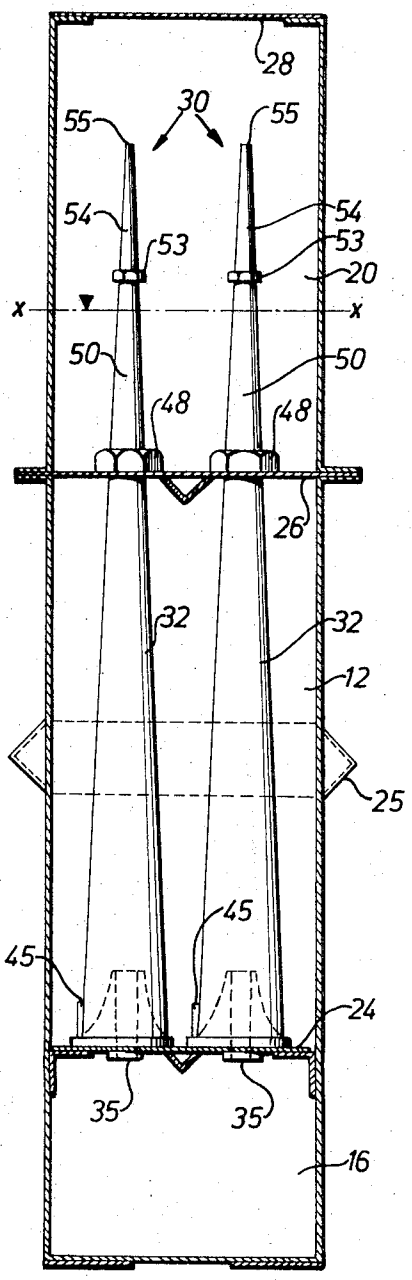


Fig.1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55
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54
54
53
53
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26
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12
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45
45
24
35
35
16

Fig.2

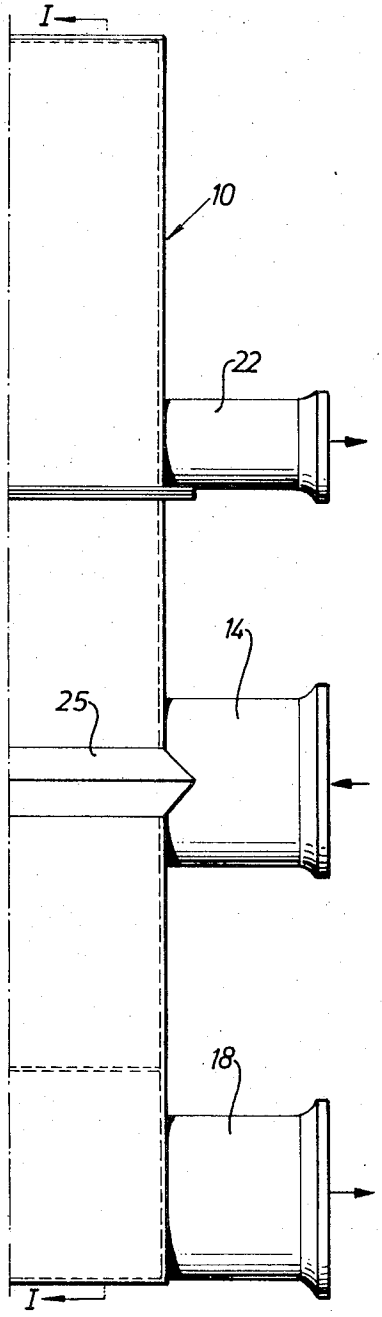

I
10
22
14
25
18
I

Fig. 3

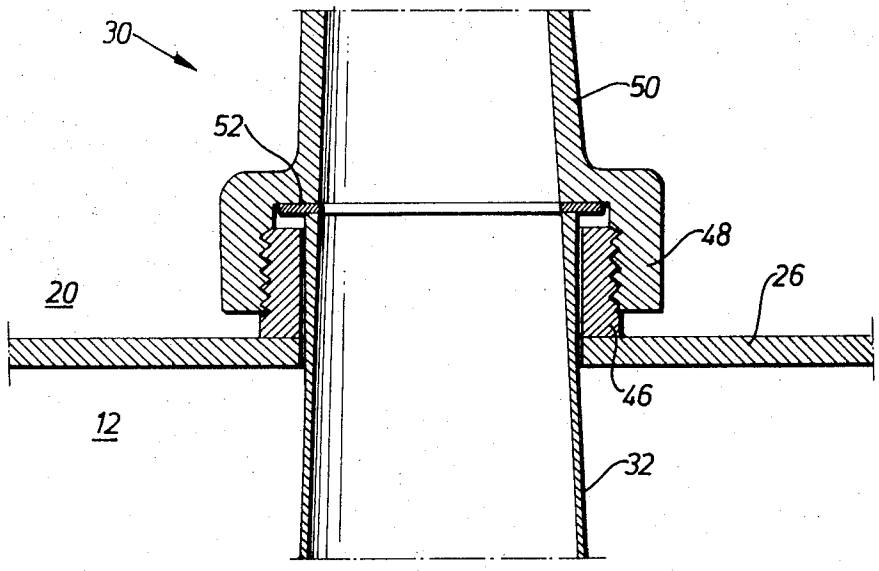
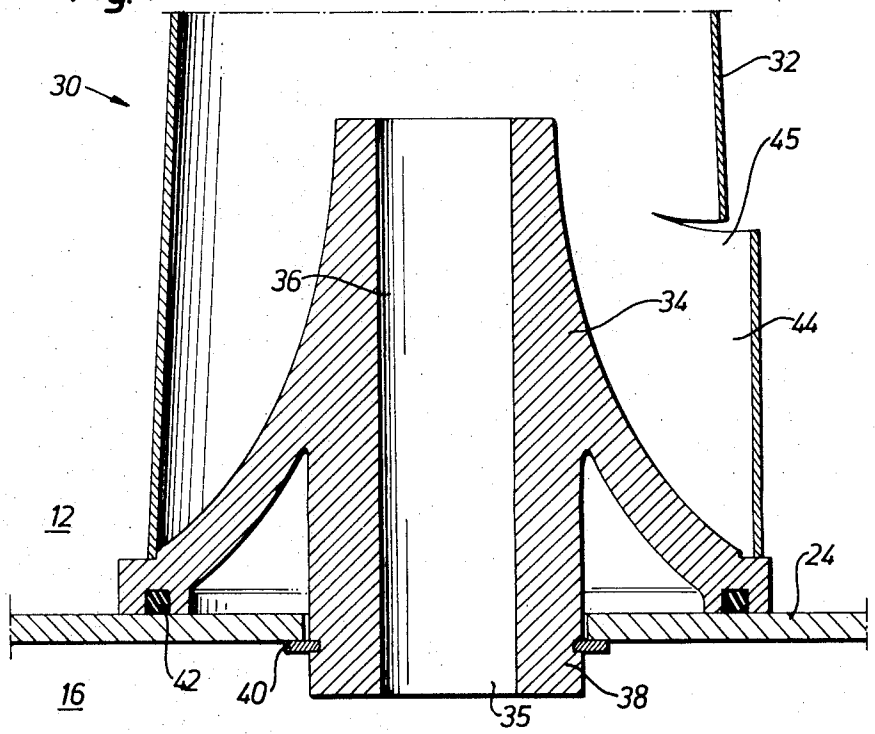


Fig. 4



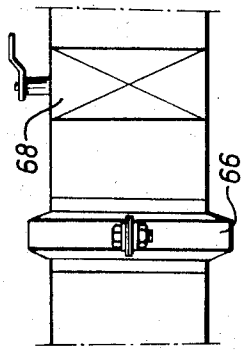


Fig.6

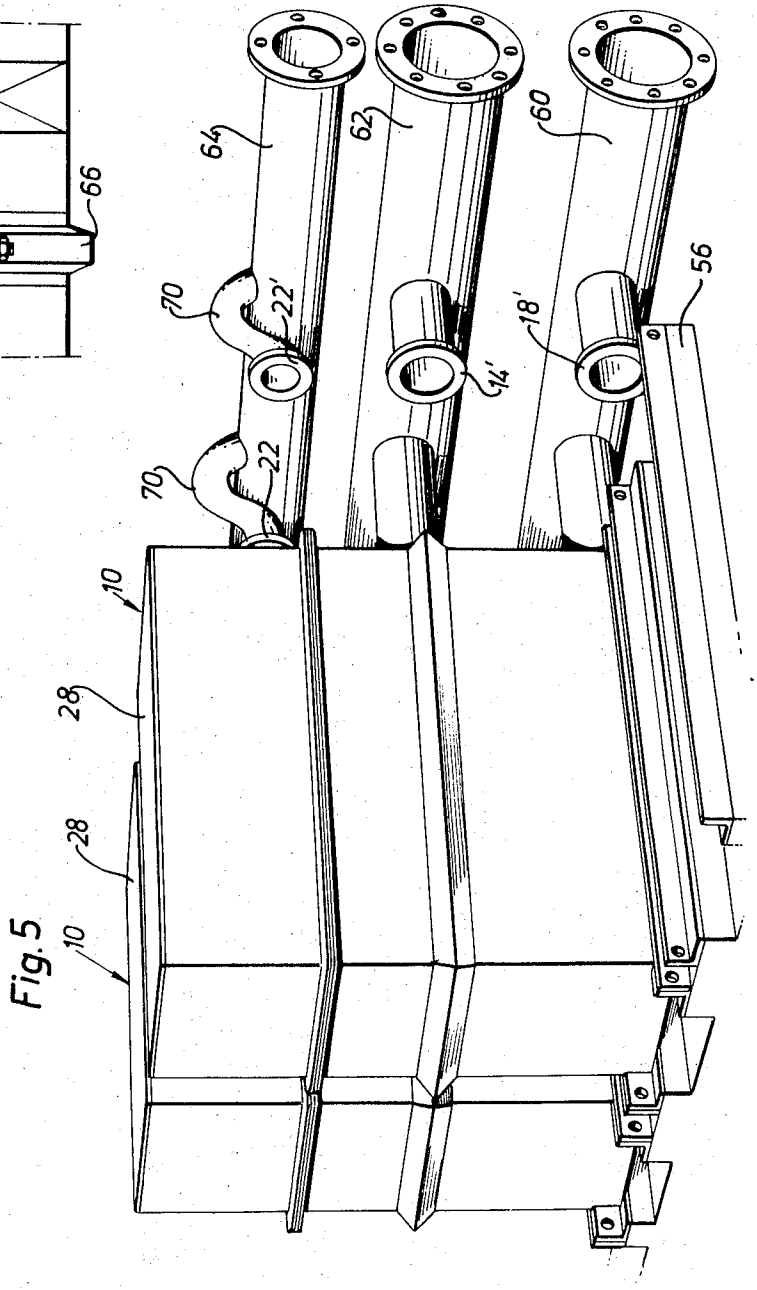


Fig.5

Fig.7

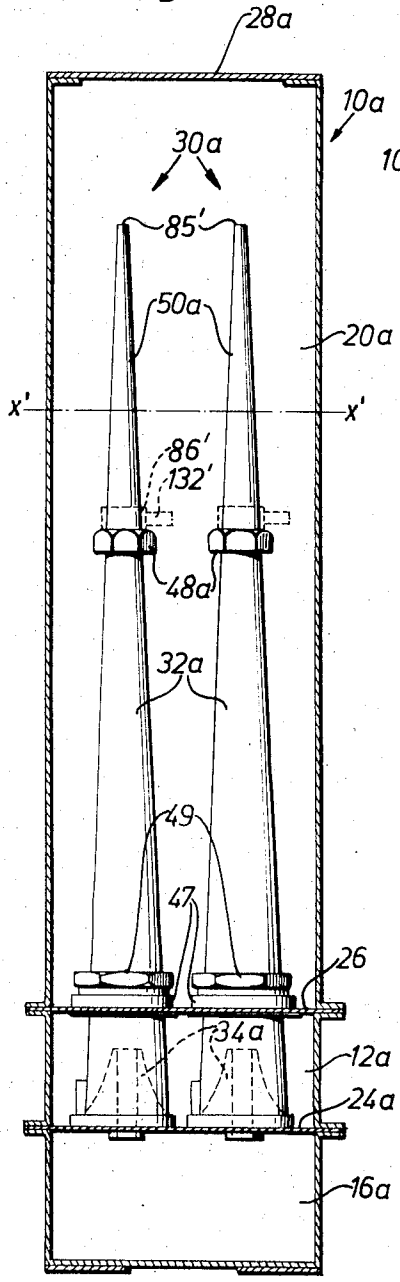


Fig.8

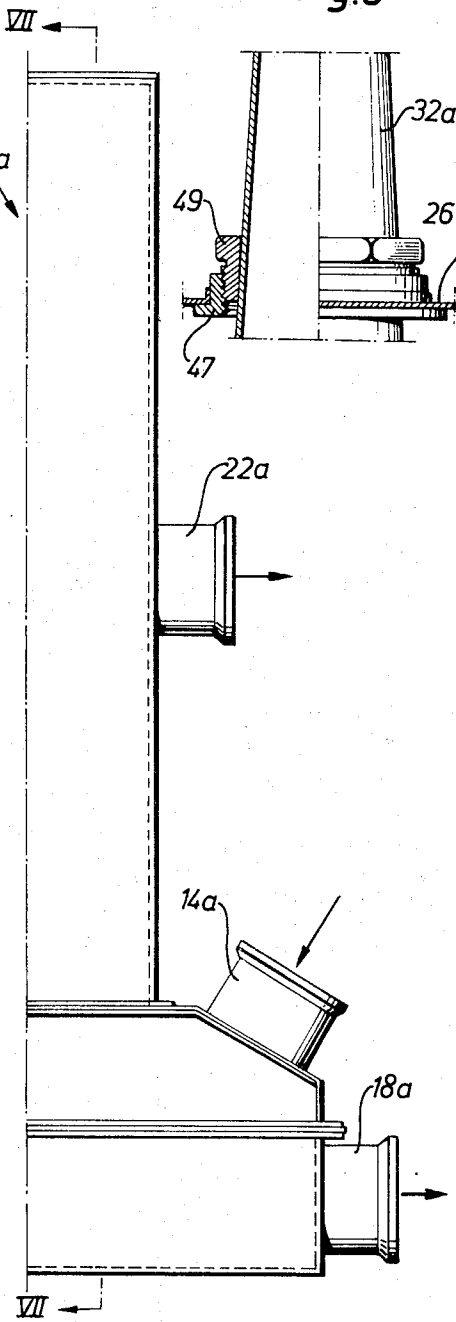


Fig.9

Fig.10

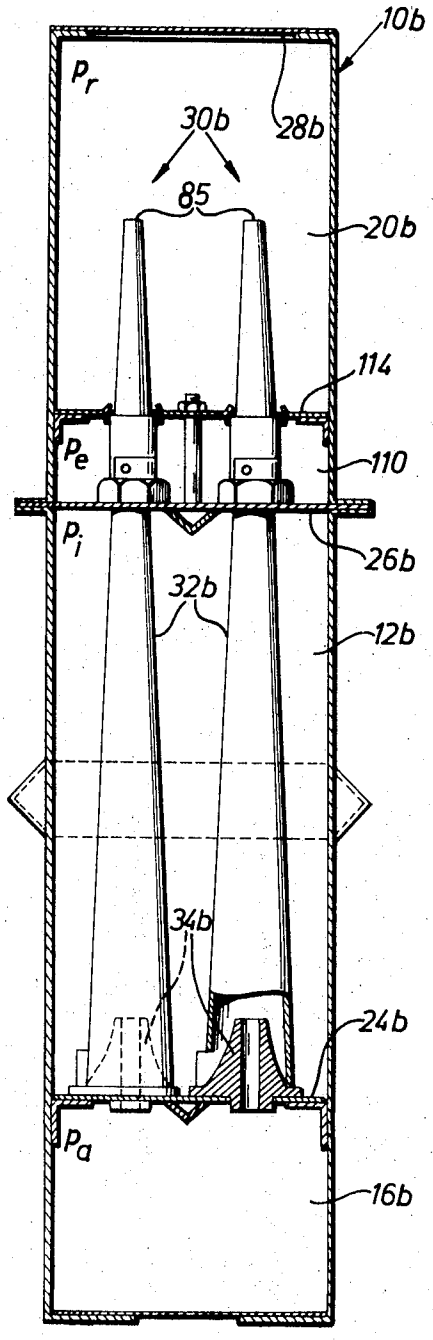

10b
P_r
30b
28b
85
20b
114
P_e
110
P_i
26b
32b
12b
34b
24b
P_a
16b

Fig.11

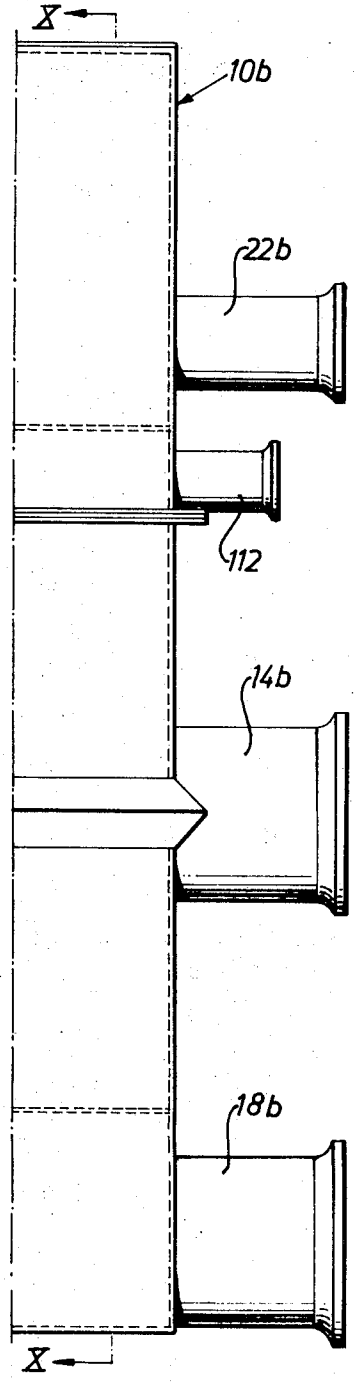

X
10b
22b
112
14b
18b
X

Fig.12

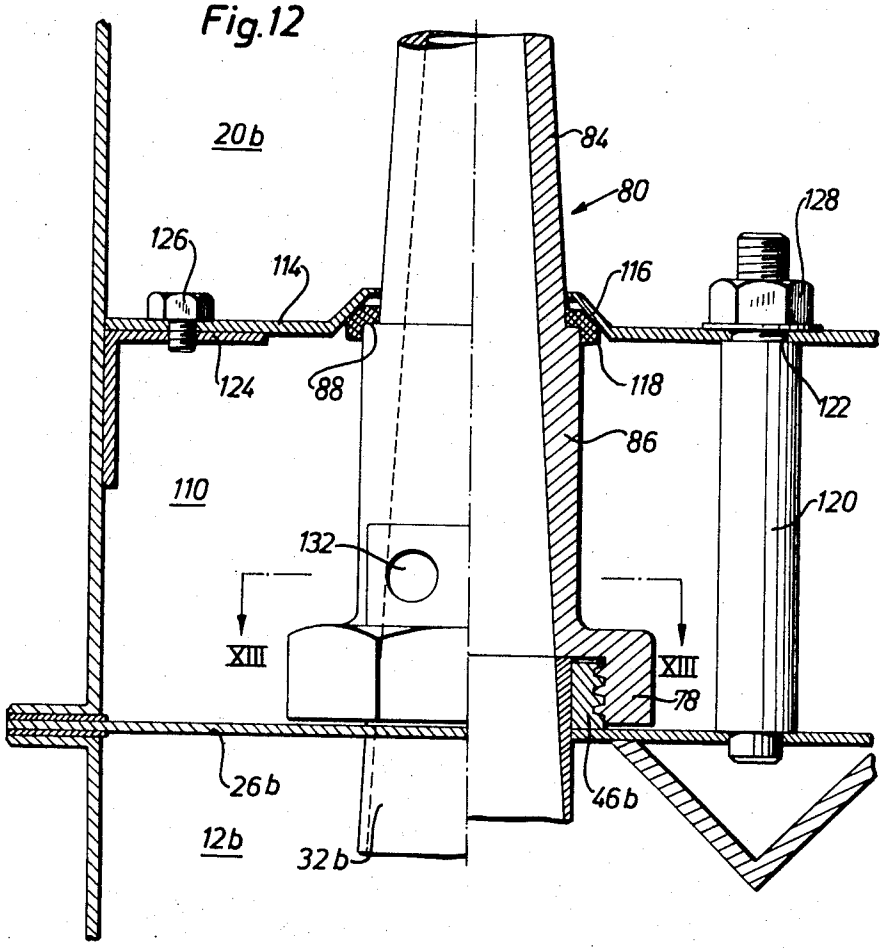
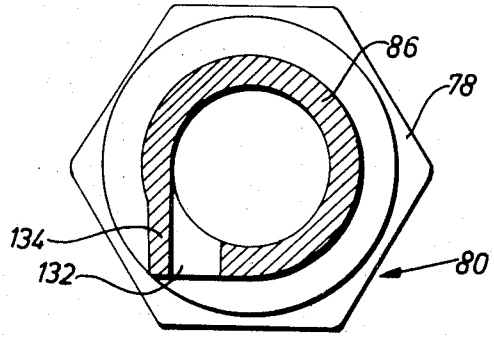

20b
84
80
128
126
114
116
124
88
118
122
86
110
120
132
XIII
XIII
78
26b
46b
12b
32b

Fig.13


86
78
134
132
80

LIQUID SUSPENSION PURIFYING UNIT

FIELD OF THE INVENTION

The present invention relates to arrangements for purifying liquid suspensions and more particularly to a battery or unit of so-called hydrocyclones for freeing liquids of impurities. The invention especially pertains to the provision of apparatus for purifying fibre suspensions and to the provision of such apparatus suitable for use in paper making factories, for example.

BACKGROUND OF THE INVENTION

In the paper and pulp industry, it is normal practice to use hydrocyclones to remove coarse and fine impurities and dirt particles from aqueous fibre pulp suspensions. Because of the very large through flow of fibre suspension in a conventional pulp or paper making factory, a very large number of hydrocyclones are required to obtain the desired degree of purification, the cyclones being coupled together in parallel to form large units or batteries. In one cyclone arrangement, a number of hydrocyclones are placed adjacent each to form a hydrocyclone battery, the cyclones extending vertically with their outlet nozzles or ports directed downwardly and with common inlet, outlet and waste chambers, e.g., a hydrocyclone battery such as that illustrated in Swedish Pat. No. 314,959, FIG. 8. With another arrangement, the cyclones are placed in horizontal layers, one on top of the other, the cyclones in each layer belt arranged radially with their nozzles pointing inwards.

There are two special requirements which have to be met when arranging cyclone batteries of this type. Hitherto, however, it has not been possible to fulfil both of these requirements satisfactory at the same time. One of these requirements is that the unit is incorporated in a closed system, i.e., the suspension to be cleaned, the cleaned suspension and the slurry containing the separated dirt particles — called in that order the inject, accept and reject respectively — are passed to and from the units through a closed conduit system. The other requirement is that it should be possible to see the cyclones, primarily their reject outflow nozzles, since disturbances in the operation of a particular cyclone, e.g., as a result of blockages, can be readily observed at the nozzles.

Both of these requirements primarily relate to the conditions at the aforementioned outflow nozzles, through which the slurry containing the separated dirt particles-reject-flows. With a closed system, the reject often flows directly into surrounding liquid, which means there is risk of the reject being drawn back into the cyclone. Experience has shown that this can greatly impair the purifying effect. If, instead, the reject is allowed to flow out into the surrounding air, thereby fulfilling the second requirement of being able to see the flow of reject leaving the cyclone, it can readily be checked whether individual cyclones are functioning correctly or not, since the pattern formed by the outflowing reject, the so-called outflow parasol, immediately reveals whether the cyclone is operating correctly or whether there is an obstruction or disturbance.

As before mentioned, none of the present day hydrocyclone purifying batteries can be said to fulfill these two requirements in a satisfactory manner. Known units comprising horizontal, radial cyclones extending towards a centre point can be connected in closed systems, but have the disadvantage that they suck back reject and cannot be visually checked. Cyclone batteries of the type described in the above mentioned patent can be operated so that the reject flows out into the surrounding air and to enable the cyclones to be visually superintended, but the task of connecting the cyclones to a closed system presents certain problems.

SUMMARY OF THE INVENTION

The object of the invention is to obviate the above two disadvantages and to solve the problem of providing for a visually checkable reject outflow and of enabling the cyclones to be connected to a closed system while fulfilling the obvious requirement of a compact space saving construction. The problem is solved in accordance with the invention by the surprising and radical step of arranging the separate hydrocyclones forming part of a purifying unit upside down in an upright position, i.e., with the nozzles upwards, while the reject chambers, which are thus uppermost in the unit, are arranged fully closed with their outlets connected to a closed conduit system.

Long term tests have shown that the purifying effect of the individual hydrocyclones is not noticeably affected by turning the cyclones upside down. The reason for this is thought to be that the effect of the gravitational forces is insignificant compared with the mass forces occurring during centrifugation.

According to another aspect of the invention the fact is considered that when purifying fibre suspensions by means of hydrocyclones there is always a tendency for the nozzles to block owing to a thickening of the suspension, i.e., an increase in its concentration — which creates the mentioned requirement of convenient, visual superintendence of the nozzle tips — and this tendency is particularly manifest when purifying, e.g., paper pulp consisting of long or coarse fibres, although other factors may also occur which tend to increase the extent to which blockages occur. It has been found that the risk of blockages can be reduced or totally eliminated by what is known to the art as "elutriation," which simply means that the suspension passing through the cyclone is diluted with clean water which is added at a point close to the reject outlet, so that the thickened reject at that point is diluted. At the same time the size of the reject outlets are increased, whereby the risk of blockages is decreased or eliminated. In practice this dilution can be said to form part of the dilution of the reject which normally takes place behind the cyclones to reduce the concentration of the reject, which is three to five times greater than the concentration of the inflowing suspension. Since part of this diluting process is effected already in the cyclone or cyclones, the purifying process is not affected to any great extent, but the reliability in operation of the unit is greatly increased, since the risk of blockages occuring is non-existent or negligible. One condition which must be satisfied for such an elutriation phase to be successful, however, is that the inflow of diluting liquid in the cyclone or cyclones must be effected in a carefully controlled manner, and hence simple, reliable and readily adjusted means for controlling the inflow of diluting liquid in the cyclones must be provided.

It has been found that in a purifying unit of the kind indicated above, having "inverted" cyclones, it is possible to provide by simple means devices for a controlled dilution of the reject in each of the cyclone compo-

nents of the unit before the reject exits from the cyclones and flows out into the reject chamber of the unit. According to the invention the cyclones of the units are provided with inflow openings for diluent liquid which is supplied from a source in a manner disclosed in greater detail in the following. Here the fact that the cyclones are inverted seems to contribute to a very efficient dilution elutriation with a minimum risk of the reject openings of the cyclones becoming blocked.

BRIEF DESCRIPTION OF THE DRAWINGS

A number of embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

FIG. **1** is a vertical section through a cyclone unit according to the invention, the section being taken through the line I—I in FIG. **2.**

FIG. **2** is a side view of one end of the unit provided with pipe connections.

FIG. **3** is a vertical section through the upper end of an individual cyclone shell with associated elements,

FIG. **4** is a corresponding section through the lower end of the shell and shows means co-acting with said end.

FIG. **5** is a diagrammatic view in perspective of a portion of a purifying plant comprising hydrocyclone units according to the invention and shows two units connected with the place for a third free before the connection.

FIG. **6** is a detail view of a connection portion between the units and the fixed conduit system.

FIG. **7** is a vertical section view through a portion of a cyclone unit similar to that shown in FIG. **1** but modified according to a further aspect of the invention, the section being taken through the line VII—VII in FIG. **8.**

FIG. **8** is a side view of one end of the modified unit with pipe connections.

FIG. **9** is a detail sectional view and illustrates a clamping device for the cyclones of the unit.

FIG. **10** is a vertical sectional view through a portion of a cyclone unit according to the invention and provided with an eleutriation chamber, the section being taken through line X—X in FIG. **11.**

FIG. **11** is a side view of one of the units with pipe connections.

FIG. **12** is a vertical detail sectional view through the upper portion of one of the cyclones forming part of the unit and illustrates the construction of the elements which attend to the dilution of the reject.

FIG. **13** is a cross-sectional view taken through the line XIII—XIII in FIG. **12.**

DETAILED DESCRIPTION

FIGS. **1** and **2** show the connecting portion of a purifying unit according to the invention comprising a number of hydrocyclones. The unit comprises a housing **10** made of stainless steel sheet and divided into three chambers, of which the middle chamber **12** is the inlet chamber having an inlet **14** for the liquid suspension to be purified, i.e. the inject. The purified suspension, i.e., the accept, is received in the bottom chamber **16** and flows through an outlet **18.** The slurry containing the separated material, i.e., the reject, is received in the top chamber **20** and departs through an outlet **22.** The three chambers are separated by partitions **24** and **26,** as shown in the Figure, and the inject chamber **12** may be reinforced on the outside thereof with a reinforcing rib **25.** Located between the walls is a number, e.g., 20 of upright hydrocyclones **30,** each of which is of a known design but which, in contradistinction to what is usual within the field, are turned with their outlet nozzles or tips facing upwards and discharging into the upper reject chamber **20.** The reject chamber is covered with a transparent cover **28,** e.g., made of plexiglass.

The manner in which the individual cyclones **30** can be mounted in a simple manner in the unit housing **10** will now be described with reference to FIGS. **3** and **4.** Each cyclone comprises in a known manner a slightly conical housing **32** of stainless steel. At its widest or inlet end the casing is provided with a cover element **34,** which, as illustrated, is provided with a substantially conically shaped portion which projects into the mouth of the casing. The cover element has a central, through passing channel **36** which forms the so called accept tube through which the purified suspension flows and which opens out into the accept chamber **16** at **35.** The cover element **34** has a boss **38** which extends down through an opening in the partition wall **24** between the inlet or inject chamber **12** and the accept chamber **16** (see FIG. **1**), the element suitably being secured in the opening by means of a circlip **40** mounted on the boss **38,** while the element is sealed against the wall **24** by means of an O-ring **42.** An inlet is arranged tangentially to the cyclone casing in a simple manner, by clipping a flap **44** in the casing metal from the edge of the casing and folding the flap out to form an inlet opening **45.**

The narrowest portion of the cyclone casing **32** extends through an opening in the upper wall **26** between the reject chamber **20** and the inject chamber **12.** An externally threaded sleeve **46** is welded to the upper side of the wall **26** around the opening and the dimensions of the elements are so adapted that the end of the cyclone casing projects slightly above the sleeve. A plastics outlet cone **50** is provided at its lower end with a hexagonal portion **48** or a similar portion which enables a spanner to be applied thereto and has an internal thread meshing with the external thread on the sleeve **46.** The outlet cone **50** is screwed onto the sleeve **46** and engages the upper end of the cyclone casing **32** over an inserted packing ring **52,** the remainder of the cone being of such internal configuration as to form a continuation of the casing **32.** As will be readily seen from FIGS. **3** and **4,** when the outlet cone **50** is tightened, by applying a spanner to the hexagonal or nut portion **48,** the nozzle casing **32** as a whole is forced downwards, which means that the cover element **34** is constantly urged against the lower partition wall **24.** As will be seen from FIG. **1,** the upper end of the outlet cone **50** is terminated with a so called reject nozzle **54** which extends from the outlet nozzle **55** and which by means of a suitable screw joint **53** is joined to the upper end of the outlet cone.

When the unit is in use the liquid suspension to be cleaned, e.g., a suspension of cellulose fibres, enters through the inlet **14** into the inject chamber **12,** from where it flows in through the inlet openings **45** of the cyclone casing and is caused to rotate rapidly to separate undesired matter therefrom in a desired manner. The purified suspension, the accept, is collected towards the centre of the cyclones and departs down through the accept tube **36** in the cover element **34** to

the accept chamber **16** and out through the outlet **18.** The separated particles are collected against the inner surfaces of the cyclone and accompany the reject flow out through the outlet nozzles **55** of the cyclones. With a normally operating unit, the exiting reject forms a parasol-like liquid curtain around the nozzle, it being possible to observe the discharge sequence through the transparent cover **28** of the unit. This latter possibility affords, as mentioned above, a useful advantage, since a fault in a cyclone, e.g., a blockage, is immediately reflected in the appearance of the "parasol" and can be seen. Removal of the plexiglass cover **28** affords easy access to the cones **50** and the nozzles **54** for exchange and cleaning purposes.

The reject is collected in the reject chamber **20** and departs through the reject outlet **22.** According to the invention it is possible to make the chamber **20** fully closed and to connect it to a closed conduit system but nevertheless be able to see the reject flowing out into the ambient air. In this way the risk of reject being drawn back into the cyclones is eliminated, this risk being prominent when the reject outlet nozzles lie under the surface of a liquid. The level of liquid in the reject chamber **20** can be readily held around the position shown by the line X—X by connecting the outlet **22** to a weir device or water trap, so that with normal operation the liquid in the reject chamber **20** takes a substantially constant level and a closed air space is defined at the top of the chamber in which the reject freely flows out to be collected in the lower portion of the chamber.

FIG. **5** illustrates diagrammatically how the cyclone unit according to the invention can be connected in practice, e.g., for purifying fibre stock in a paper making factory. Each battery **10** forms a unit which can be erected as a simple frame or base **56** for connection to central collecting lines, which extend in connection to the frame, namely an accept line **60,** an inject line **62** for stock to be purified and a reject line **64.** The connecting stubs **18, 14,** and **22** of the battery are connected to corresponding stubs **18'**, **14'** and **22'** on the pipe lines by means of a detachable pipe coupling **66,** see FIG. **6,** for example, of the type described in the British Pat. No. 1,288,680. Suitable shut-off valves **68** are preferably mounted on one or both sides of the pipe coupling **66,** to enable a battery to be rapidly shut off and disconnected without disturbing the remainder of the system. The batteries can be moved by means of a fork-lift truck or may be mounted on wheels. The reject chamber is suitably connected over a pipe bend **70,** whereby a water trap is produced in a simple manner for controlling the liquid level in the reject chamber **20,** FIG. **1.**

It is thought that FIG. **5** presents a clear picture of the practical advantages afforded by the purifying unit of the present invention. Each battery, which can thus comprise a large number of separate hydrocyclones, forms a readily moved and easily connected extremely compact unit, and in contradistinction to all previously known cyclone systems the operation of the unit can be conveniently superintended visually through the transparent cover **28** of the battery, since any disturbance in the functioning of an individual cyclone is immediately reflected in the appearance of the "reject parasol" appearing at the cyclone nozzles. As previously mentioned, each battery can be readily and rapidly disconnected from the system for securing purposes without interrupting the operation. Naturally, the proposed erection illustrated in FIG. **5** is given only by way of example and the orientation of the units when moved to and from their correct positions can be effected in many other simple ways.

In the purifying unit described above the height of the inlet or inject chamber **12** is somewhat greater than that of the reject chamber **20,** and the outlet or accept chamber **16** has a height of the order of half the height of the reject chamber, as seen in FIG. **1.** However, it is emphasized that it is in no way necessary to adjust the relative size of the chambers in this way. In the inlet chamber a pressure above atmospheric prevails which may amount in certain cases to about (40 psig), and then it may be advisable to reduce the dimensions of the inject chamber, primarily its height, which in turn reduces the requirement of stiffening and bracing of the casing of the unit. Such an adjustment of the relative size of the chamber may be readily carried out within the scope of the invention, and in FIGS. **7–9** an example is shown of such an embodiment of the cyclone unit according to the invention. The same or similar details reappearing from the unit described in the aforegoing have obtained the same reference characters with the addition of *a*.

As before, the unit comprises a housing **10***a* divided into an upper reject chamber **20***a* having a transparent cover **28***a* and an outlet **22***a*, an intermediate inject chamber **12***a* with an inlet **14***a* and, at the bottom, an outlet chamber or accept chamber **16***a* with an outlet **18***a*. The chambers are separated by partition walls **24***a* and **26***a* but, as may be seen, the wall **26***a* between the reject chamber **20***a* and the inject chamber **12***a* is disposed on a considerably lower level than before, so that the inlet chamber **12***a* will become very compact and exhibit a low height, for which reason the outer walls in particular of this chamber are exposed to less stress and strain with a lower risk of buckling under the action of the inject pressure. The individual cyclones **30***a* are provided as before with cover elements **34***a* at their inlet ends and are adapted to engage in openings in the partition wall **24***a* between the inject and accept chambers **12** *a* and **16***a*, respectively, as described before with reference to FIG. **4.** However, in this case the cyclones are applied against the wall **24***a* by means of a clamping device of a somewhat different design, which has been introduced into the partition wall **26***a* between the reject and inject chambers **20***a* and **12***a*, respectively, and which is shown in greater detail in FIG. **9.** The individual conical cyclone casings or shells **32***a* pass through clearance openings in the partition wall **26***a*, which openings are formed by internally threaded bushings or sleeves **47** which are welded to the wall **26***a*. Heavy nuts **49**, preferably of a suitable plastics material, such as nylon, are provided with external threads fitting the internal threads od the sleeves **47,** said nuts exhibiting an internal conical surface fitting the external conical peripheral surface of the through-passing cyclone on the very level where the cyclone passes through the partition wall **26***a*. Thus the nut **49** engages the conical peripheral surface of the cyclone and pulls with it, when screwed into the sleeve **47,** the cyclone downwards, and hereby the lower end of the cyclone is urged also in this case into engagement with the lower wall **24***a*. At the top each cyclone is provided as before with an outlet cone **50***a* having at its lower end an internally threaded hexagonal or spanner por-

tion **48***a* which, however, in this case is screwed directly onto the top end of the cyclone casing **32***a*. Hence, this screw joint is not utilized for mounting the cyclones in the housing of the unit.

Thus the cyclone units illustrated in FIGS. **7–9** exhibit a comparatively voluminous reject chamber which, however, in no way exercises any detrimental effect on the function and operation of the unit. On the contrary, an even greater freedom may be gained for adjusting the liquid level X'—X' in the reject chamber **20***a* by a suitable location of the reject outlet **22***a* and the connected weir outflow, water trap or the like. Furthermore, the lower portion of the reject chamber may be utilized to advantage as a so called "scrap trap," that is, heavier particles passing through the reject outlet are collected on the bottom of the chamber, and through a door in the chamber wall they may be removed and cleaned out periodically.

In FIGS. **10–13** a cyclone unit according to the invention is shown which is provided with the dilution of elutriation chamber mentioned in the introduction. The unit, whose reappearing details have the same numeral designation as before, but this time with the suffix *b* comprises also in this case a housing or casing **10***b* made of stainless steel and divided into three main chambers, namely an intermediate chamber **12***b* having an inlet **14***b* for the liquid suspension to be purified, i.e., the inject, a bottom chamber **16***b* having an outlet **18***b* and, at the top, a reject chamber **20***b* having an outlet **22***b*. In this instance, however, there is arranged between the inject chamber **12***b* and the reject chamber **20***b* a dilution or elutriation chamber **110** having an inlet **112** for the diluent, which in the case of pulp suspensions comprises fresh water. The inlet chamber **12***b* is separated from the accept chamber **16***b* by a partition wall **24***b* and from the elutriation chamber by a partition wall **26***b*. In turn, the elutriation chamber is separated from the reject chamber by a partition wall **114**.

Arranged in the unit housing **20***b* is a number, e.g., 20, of vertical cyclones **30***b*, which as before are placed with their outlet nozzles or tips facing upwards and thus discharging into the reject chamber **20***b* arranged in the upper portion of the unit and covere with a transparent cover **28***b*.

Each cyclone comprises in a known way a slightly conical casing **32***b* of stainless steel sheet, which at its downwardly facing widest end or inlet end is provided with a cover element **34***b* which in the manner disclosed is urged against the partition wall **24***b*. The narrowest portion of the cyclone casing **32***b* projects up through an opening in the upper partition wall **26***b* between the inject chamber **12***b* and the elutriation chamber **110**, see FIG. **12**. An externally threaded sleeve **46***b* is welded on the upperside of the partition wall **26***b* around the opening and a plastics outflow cone **80** is provided at its lower end with a hexagonal portion **78** or similar spanner engaging means, said portion having an internal thread meshing with the external thread of the sleeve **46***b*. The outflow cone **80** is screwed onto the sleeve **46***b* and engages the upper end of the cyclone casing **32***b*, the remainder of the case having such internal configuration as to form a continuation upwards on the interior of the cyclone casing **32***b*. When the hexagonal or nut portion **78** of the outflow cone **80** is tightened, the cone casing **32***b* is urged downwards in its entirety, see FIGS. **1** and **3**, whereby the cover element **34***b* is caused to bear against the partition wall **24***b* in the same way as in the previous embodiments.

As will be seen from FIG. **12**, the outflow cone **80** is divided into an upper portion **84** having an outlet opening or reject outlet **85** (see FIG. **10**) and a lower portion **86** which is generally cylindrical and which is terminated at the bottom with the aforementioned spanner engaging portion **78**. Between the upper and lower portions **84** and **86** of the cone **80** there is formed a shoulder **88**. The height position, see FIG. **12**, is so adjusted that when the outflow cone **80** is screwed into position the shoulder is located approximately level with the partition wall **114** between the elutriation chamber **110** and the reject chamber **20***b*. Disposed in this wall are openings **116** for the different outflow cones, wherewith the edges of the openings can be raised slightly, as shown in FIG. **12**, to allow a packing ring **118** to be fitted in between the shoulder **88** and the necked opening **116**. A number of spacing posts **120** are suitably arranged centrally in the long direction of the housing and welded to the partition wall **26***b*. The free ends of the posts are reduced in diameter and threaded to form a shoulder **122** whose height above the partition wall **26***b* corresponds to the position of attachment flanges **124** welded to the outer wall of the housing, the flanges **124** together with the shoulders **122** on the spacing posts supporting and aligning the partition wall **114** in its correct position, whereafter the wall **114** is fixed in a conventional manner by means of screws **126** passing into the flanges **124** and nuts **128** screwed onto the free ends of the spacing posts **120**. This construction is given only by way of example, however, and it is thought that one skilled in the art can suggest many other ways of embodying an elutriation chamber into the purifying unit.

Diluting liquid, in the present case clean water, passed to the elutriation chamber **110** defined between the walls **114** and **26***b* through the inlet **112** flows into the outflow cones **80** of the individual cyclones **30***b* through tangentially arranged inlets **132** placed in the lower portions **86** of the cones immediately above the spanner engaging portion **78**, see FIGS. **12** and **13**. The tangential inlet **132** suitably comprises a circular channel formed in a bead or bulge **134** on the outflow cone, as shown in the Figures. The diameter of the inlet **132** is adapted to the magnitude of the inflow envisaged, whereafter the exact size of the inflow is determined by adjusting the pressure conditions in the different chambers of the purifying unit, as explained hereinafter.

If the pressures (above atmospheric) prevailing in the reject chamber **20***b* the elutriation chamber **110**, the inject chamber **12***b* and the accept chamber **16***b* being designated p_r, p_e, p_i, and p_a respectively, are considered, it will readily be perceived that the through flow with subsequent purifying effect obtained in the unit as a result of the rotary movement of the liquid in the cyclones will be dependent on the pressures prevailing in the different chambers in relation to the dimensions of the different inlet openings. In general, certain chamber pressures are fixed and determined by the external conditions, for instance, the pressure above atmospheric p_r in the reject chamber **20***b* is, according to the principle of the unit, around 0, while the pressure p_a in the accept chamber is also around 0 or slightly above, up to 7.5 psig. Regarding the pressure in the inject, i.e., the pressure above atmospheric p_e in the inject chamber **12***b*, under optimal conditions this pressure is

around 35 psig. If the diluting liquid is now supplied to the elutriation chamber **110** under a suitably adjusted pressure above atmospheric, say around 15 psig, a certain amount of liquid is forced in through the tangential inlet **132** in the outflow cone **80** and mixes with reject flowing out through the cone outlet **85,** whereupon the aforementioned diluting action is obtained with reduced risk of blockages occurring in the outlet. From case to case a suitable continuity state with optimal conditions can be created in different respects by a readily effected control of the flow of the diluent liquid into the elutriation chamber **110** and therewith the pressure p_e above atmospheric prevailing in the chamber.

A series of purifying units according to this embodiment of the invention may be connected up, for example, for cleansing fibre suspensions in a paper making factory in the simple manner described in the aforegoing, only one extra connection to the fresh water supply being required for the elutriation chambers of the different units, and in other respects the installation may be carried out substantially as illustrated in FIG. **5.** In cases when the purifying unit is provided with a exceptionally low chamber and thus a very high reject chamber, in accordance with embodiment of FIGS. **7–9,** the elutriation may be suitably brought about by means of specific connections, for instance of the hose type, to each cyclone, as indicated by broken lines in FIG. **7.** The spanner portions **48***a* of the outlet cones are then extended on their top sides by raised portions **86'** provided with connections for inlet tubes or hoses **132'** for diluent liquid which is introduced tantentially into the lower parts of the outlet cones, approximately in the same way as disclosed with reference to FIGS. **12** and **13,** which liquid thus mixes with the reject before this exits through the reject opening **85'**. For instance, the hoses or pipes may be connected to the outlet cones by means of so called banjo coupling enclasping the cones or similar disconnectible coupling means known per se.

As a matter of course, the invention is not restricted to the described and illustrated embodiments, but can be modified in further respects within the scope of the inventive concept.

What is to be claimed is:

1. A liquid purifying unit, comprising at least one hydrocyclone having a casing enclosing a conically tapering cyclone chamber in whose widest portion or base the inject or the suspension to be purified is passed through an inlet, and two outlets arranged coaxially with the chamber, namely a reject outlet and an accept outlet at the point and base respectively of the cyclone chamber, the hydrocyclone being mounted in an outer housing which by means of upper and lower partition walls is divided into at least three chambers, namely an inject chamber in which the inlet of the hydrocyclone is located, an accept chamber into which the accept outlet of the hydrocyclone discharges, and a reject chamber into which the reject outlet of the hydrocyclone discharges, the hydrocyclone being arranged generally vertically with the accept outlet at the bottom and the reject outlet at the top and discharging into the reject chamber above the liquid level therein so that the reject may flow freely out into air, the widest portion of the casing being joined with a cover element defining therein the accept outlet while the inlet for the inject is arranged in the casing near the cover element, the upper and lower partition walls defining the inject chamber therebetween, the cover element being provided with a boss defining the accept outlet, said boss extending down through an opening the lower partition wall, the upper partition wall being provided with a corresponding opening arranged to allow the passing of the casing and surrounded by a threaded sleeve or pipe stub, the pipe stub cooperating with a threaded retaining member adapted to be screwed onto the pipe stub and to engage in doing so the casing and urge it with its cover element downwardly into engagement with the lower partition wall, and means for maintaining the liquid level in the reject chamber below the elevation of the reject outlet.

2. A unit according to claim **1** wherein the retaining member comprises a threaded portion provided at the connection end of the outflow element, said portion engaging the said pipe stub as well as the upper narrower end of the cyclone casing.

3. A unit according to claim **1,** wherein the retaining member comprises a nut element, preferably of plastics, engaging the said pipe stub as well as the conical external surface of the cyclone casing.

4. A liquid purifying unit, comprising at least one hydrocyclone having a casing defining a conically tapering cyclone chamber in whose widest portion or base the inject or the suspension to be purified is passed through an inlet and two outlets arranged coaxially with the chamber, namely a reject outlet and an accept outlet at the point and base respectively of the cyclone chamber, the hydrocyclone being arranged generally vertically with the accept outlet at the bottom and the reject outlet at the top, the hydrocyclone being mounted in an outer housing which by means of upper and lower partition walls is divided into at least three chambers, namely an inject chamber in which the inlet of the hydrocyclone is located, an accept chamber into which the accept outlet of the hydrocyclone discharges, and a reject chamber into which the reject outlet of the hydrocyclone discharges, the reject chamber as defined by the outer housing and the upper partition wall being substantially closed, the casing projecting upwardly into the reject chamber so that the reject outlet is spaced upwardly a substantial distance above the upper partition wall, and means for maintaining the liquid reject in the lower portion of the reject chamber at an elevation below the reject outlet and for maintaining a closed air space within the upper portion of the reject chamber in surrounding relationship to said reject outlet, whereby the reject freely flows out of the reject outlet into the air space.

5. A unit according to claim **4,** wherein said means for maintaining the liquid level in the reject chamber below the elevation of the reject outlet includes a weir, water trap, or like device for maintaining a substantially constant liquid level in the reject chamber.

6. A unit according to claim **4,** characterized in that the uppermost reject chamber in the housing is provided with a transparent openable cover.

7. A unit according to claim **4,** characterized in that the upper tapering portion of the hyhdrocyclone is provided with at least one inflow opening for diluent liquid which is introduced in a controlled manner from a source into the outflow portion of each cyclone to mix with and dilute the reject before this departs through the reject outlet of the cyclone.

8. A unit according to claim **7,** wherein the source of diluent liquid comprises a supply conduit connected to

the said inflow opening in the upper portion of the cyclone by means of a disconnectible connection means, e.g., a banjo coupling.

9. A unit according to claim **7,** wherein the source of diluent liquid comprises a dilution chamber, a so called elutriation chamber, which is positioned between the inlet chamber and the reject chamber so that the upper tapering portion of the hydrocyclone passes through the elutriation chamber where said portion is provided with said inflow opening, said liquid thus being arranged to enter the outflow portion of the cyclone through said opening.

10. A unit according to claim **9,** characterized in that said inflow opening disposed in the upper portion of the hydrocyclone is arranged tangentially relative to the axis of the cyclone.

11. A unit according to claim **9,** in which the elutriation chamber is defined between the inlet chamber and the reject chamber by means of partition walls placed in the housing, the upper tapering portion of the hydrocyclone consisting of an outflow element which at the bottom of the elutriation chamber is detachably joined to the remainder of the cyclone, the outflow element being provided with an external shoulder which when tightened co-acts with the edge of an opening accommodating the element and disposed in the ceiling of the elutriation chamber, said inflow opening being arranged in the outflow element between the shoulder and the attachment end of the element at the bottom of the elutriation chamber.

12. A unit according to claim **9,** wherein a partition wall forming the ceiling of the elutriation chamber has the form of a plate arranged to be fixed to attachment means on the housing, the plate being provided with an opening for receiving said outflow element, the edge of said opening being folded or bent up to form a seat for a packing ring or like sealing means arranged to sealingly engage a shoulder of the outflow element.

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