

Sept. 29, 1959

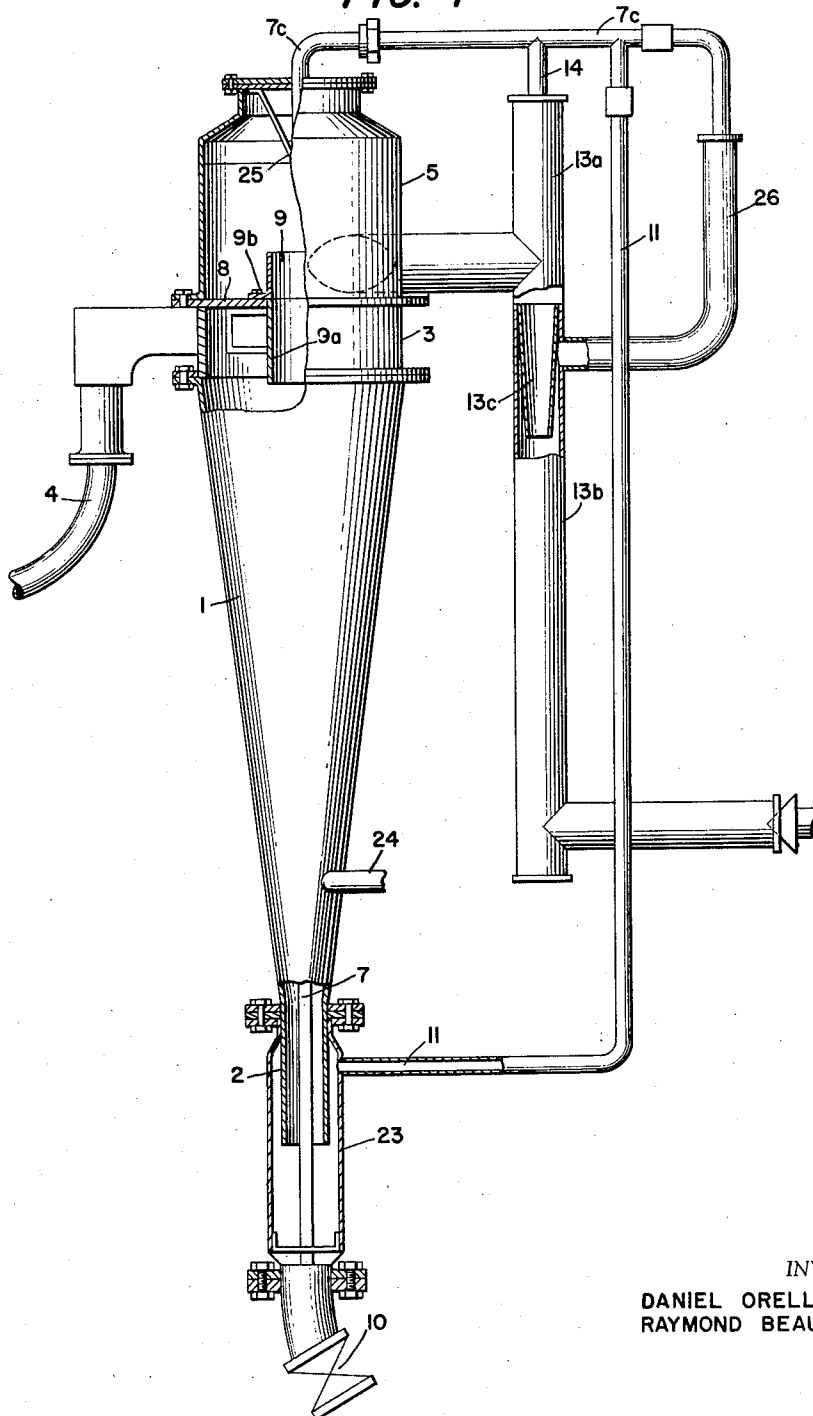
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CYCLONE SEPARATOR

2,906,404

Filed June 9, 1954

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FIG. 4



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CYCLONE SEPARATOR

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Application June 9, 1954, Serial No. 435,522

7 Claims. (Cl. 210-512)

It has long been known to use cyclones for separating from a fluid the solid particles which are suspended therein.

In such devices which are constituted by a frustoconical enclosure the two bases of which are in communication with the atmosphere, the products to be processed which are brought under pressure to or near the upper portion of this frustum of a cone, through a pipe arranged tangentially to the circular wall, are whirling about an air core, the solid particles being recovered at the lower orifice whereas the suspending fluid escapes through an upper central pipe.

In the known devices, the air or the gas forming the central core enters the conical portion either only through the upper portion, or through both portions simultaneously. Such air or gas is either at atmospheric pressure or at a higher pressure.

Applicants have found out that it was sometimes very difficult to control the separation process and particularly to keep the efficiency of the apparatus up to a constant figure because for unexplained reasons the air core sometimes completely changed in form or disappeared altogether during operation of the cyclone.

Finally, in some instances, the presence of such air or gas which constitutes the central core may interfere with the quality or the chemical composition of the products to be processed.

It is, therefore, a principal object of the invention to provide a cyclone avoiding said drawbacks.

Other objects and advantages will be apparent from a consideration of the specification and claims.

According to the invention, the conventional central air core is partially replaced by a solid cylindrical core element, around which the concentric vortex of the fluid to be treated rotates.

For optimum efficiency, the core should always have exactly the diameter of the central vortex. It is impossible to satisfy this condition with a solid core, and the invention consists in providing an adjustable core, which consists of said solid cylindrical core and an axially expandable gaseous sheath surrounding said solid core. By inflating said gaseous sheath, the core can be adjusted to the required diameter.

In a preferred embodiment of the invention, the gaseous sheath is enclosed in an inflatable envelope so as to prevent contact between the gas of the core and the liquid to be treated.

In addition, means may be provided to modify the operation of the cyclone conforming to the desired results and to the requirements of the specific materials treated.

A further embodiment of the invention consists in completing the cyclone by having the outlet line for the solid particles to open into a chamber the dimensions of which are larger than those of said line in order to bring about an expansion of the mixture containing said particles and to cause such particles to be separated from the gases which may have been entrained.

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Fig. 1 illustrates a cyclone with a rigid core surrounded with a gaseous sheath;

Fig. 2 shows a cyclone the core of which is constituted by an inflatable pocket;

Fig. 3 is a fragmentary cross-section of an expandable core with a solid core bar;

Fig. 4 shows a cyclone according to the invention, the expandable core being purposely not shown for the sake of clearness, illustrating certain additional features such as means regulating the gas core and means preventing air or gas to be entrained by the affluent.

It will be seen, from these figures, that the cyclone is constituted, as usual, by a first enclosure comprising a frusto-conical lower portion 1 having its longitudinal axis arranged vertically, and the smaller base, which is at the bottom, provided with a pipe 2 for the outlet of the effluent, a ring 3 rigid with the upper larger base of the cone frustum and receiving a tangential pipe 4 for leading-in the fluid to be treated, a second enclosure 5 cylindrical in shape and coaxially secured on top of the former, fitted with the pipe 6 for discharging the treated fluid. Both enclosures are separated by a partition 8 pierced with a single central communication orifice 9 called overflow.

In Fig. 1, the core is constituted by a cylindrical bar 7 arranged on the vertical axis of the cyclone. It may be held in place at its lower end by means of centering lugs 7p and at its upper end by a bushing through the upper dome.

Any other securing means may of course be contemplated, for instance the bar 7 may be centered by means of a frustum of a cone 25 which will be dealt with further on.

This rigid core 7, advantageously, could be substituted for the usual gaseous core should it be possible to calculate its cross-section to an accurate degree with regard to the operational requirements of the apparatus. Such a calculation is found hardly possible and this is why the diameter of the core 7 should be modified.

To this aim, it is possible to adopt either of the following embodiments or a combination of same:

In Fig. 1, it will be seen that at the upper portion of the cyclone, a line 7c for a gas under pressure is axially arranged. This line is coaxially disposed about the core 7 and provides about the rigid core a fluid sheath 7b, the diameter of which is a function of the separation to be achieved.

Since the dimension of the core 7 determines the minimum efficiency, it is possible to vary this efficiency by modifying the diameter of the sheath.

In Fig. 2, the circumference of the core is defined by a cylindrical pocket made from an expandable material, for instance a rubber or plastic tube attached at both ends thereof to two rigid tubes 7c and 7d secured to the frame and serving as a blowing nozzle for allowing said tube to be inflated so that it may be brought up to the diameter required.

In this modification the tubes 7c and 7d are connected by a rigid core element 7 inside the expandable envelope 7b, and the complete core comprises (Fig. 3) the central rigid core bar 7, the gaseous sheath 7b surrounding the core bar, and the outer expandable envelope 7a.

Satisfactory results could be obtained by restricting the expandable core (inflatable pocket for gaseous sheath about the solid core) merely to the portion extending between the effluent pipe 2 and the partition 8.

Fig. 4 illustrates a number of secondary improvements likely to improve the efficiency.

In the orifice 9 through the partition 8 is advantageously disposed a pipe 9a formed with a flange 9b about the orifice 9 and leaving between the two enclosures no

passage other than that which is formed by the interior of said pipe.

In this manner, the apparatus may be adjusted to the composition and rate of flow of the liquid to be treated by modifying the size of the passage from one enclosure into the other. This may be accomplished by replacing the pipe in use by another of a different diameter.

In the case when the core is formed by a rigid tube (not shown) and a gaseous sheath not enclosed within an inflatable pocket, the inlet pipe 7c for the air or gas, axially arranged at the upper portion of the dome 5 opens into a frustum of a cone 25 the smaller base of which is oriented downward and alone is open allowing the gaseous core to pass therethrough. Such a device constitutes a deflector which regulates the ingress of the fluid into the collecting chamber.

It has been noted that, when the concentration of the solid particles increases at the apex of the cone 1, it becomes sometimes difficult to discharge the effluent. Such a drawback is removed when one or more pipes 24 are branched at different levels along the generatrix of the cone for introducing a liquid which is a diluent for the concentrate or at least reduces the viscosity thereof.

Finally, in order to avoid air or gas being entrained by the effluent, the pipe 2 opens into an expansion pot 23 which allows an expansion to take place by virtue of its diameter being larger than that of the pipe 2. Such a pot receives the pipe 11 which makes it possible for both ends of the central gaseous core to be subjected to the same specific pressure. It will be seen, from Fig. 4, that the purified fraction of the treated fluid is discharged through the upper portion of the cyclone chamber, i.e. the so-called "collecting chamber" through a pipe 6 which opens tangentially into said chamber. This pipe 6 forms the horizontal portion of a lying T the arms 13a and 13b of which serve, respectively, for recovering any gas which may be contained in the treated fluid and for discharging said treated fluid. The branch 13a communicates with the upper portion of the "collecting chamber" through the pipes 14 and 7c. Inside the branch 13b, near the communication with the pipe 6, a frusto-conical pipe 13c is welded to said pipe 13b around its larger base, the apex of the cone being directed downwardly.

The annular space between the inner wall of the tube 13b and the outer wall of the tube 13c communicates through a pipe 26 with the upper portion of the collecting chamber of the cyclone. Preferably, this tube 26, of a fairly large cross-section, communicates with the pipe 7c which has a smaller diameter and which ensures a communication between the pipe 13a and said chamber.

This arrangement ensures that the gaseous cushion which forms in the pipe 13a is under the same pressure as the collecting chamber with which it communicates through the pipes 14 and 7c and hence under the same pressure as the upper portion of the central gaseous core. Similarly, such a pressure equilibrium is also maintained between said collecting chamber and the discharge circuit due to the communication of said chamber with the annular space between the interior of the pipe 13b and the tube 13c.

The described device, which maintains uniform gas pressure throughout the cyclone, allows to adjust the discharge rates of the concentrate effluent and the purified liquid without affecting the smooth operation of the apparatus.

As many changes could be made in the above construction, and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illus-

trative and not in a limiting sense. Particularly such cyclones may be used for the treatment of any solution.

What we claim is:

1. In a cyclone type separator adapted to separate by centrifugal action a liquid containing solid impurities suspended therein into a purified fraction and a fraction containing said impurities in concentrated form, said separator comprising, in combination, an upper cylindrical section; a lower frusto-conical section coaxially adjoining said cylindrical section and extending with its conical end downwardly, a partition dividing said upper section into two superposed compartments, the upper compartment forming a collecting chamber for the purified fraction of the liquid and the lower compartment forming an injection head for the liquid to be treated, a central aperture in said partition providing communication between said upper and lower section, a tangentially arranged inlet for injecting liquid into said injection head, a tangentially arranged outlet pipe for withdrawing purified liquid from said collecting chamber, a discharge pipe connected to the conical end of said lower section for withdrawing the concentrated impurities, the improvement which comprises a central core structure consisting of a solid inner cylindrical member, a gaseous axially expandable sheath surrounding said solid member, an inflatable envelope enclosing said gaseous sheath, and an inlet for the gas forming said gaseous sheath, said gas inlet being separate from the inlet for the liquid.

2. The cyclone separator of claim 1, wherein said core structure extends from said partition to the conical end of said lower section.

3. The cyclone separator of claim 1, wherein said gaseous sheath of the core extends throughout the height of the separator.

4. The cyclone separator of claim 1, including an inlet for supplying the gas for said gaseous sheath.

5. The cyclone separator of claim 1, including an expansion chamber below the conical end of said lower section, said discharge pipe opening into said expansion chamber and releasing therein gas entrained by the concentrate fraction of the treated liquid.

6. A cyclone separator as claimed in claim 1, wherein said outlet pipe has the form of a lying T comprising a horizontal leg and a vertical T bar, said leg and the upper end of said T bar communicating with said outlet, the upper part of said T bar serving as a gas recovering chamber in communication with said collecting chamber, the lower part of said T bar serving as a discharge tube for the purified liquid, a frusto-conical tube being welded around its larger base inside said lower part of said T bar below and near the junction of the leg and bar of the T pipe, the outer surface of said frusto-conical tube and the inner surface of said lower T bar portion defining an annular chamber receiving gas entrained by said purified liquid.

7. The combination of claim 1, including a pipe connecting said annular chamber and the upper part of said collecting chamber.

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