# United States Patent [19]

**Chapman**

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[54] **APPARATUS AND METHOD FOR CLEANING GASEOUS FLUIDS**


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[52] **U.S. Cl.** .....**55/89,** 55/236, 55/258, 55/459, 261/79 A

[51] **Int. Cl.** .....**B01d 50/00**

[58] **Field of Search**..... 55/235–238, 89, 258, 459; 261/79.1, 116, 126, 79 A



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[57] **ABSTRACT**

The invention resides in dust collecting apparatus combining the principles of so-called "dry-cyclone" and "wet-cyclone" dust collectors, subjecting dust-laden air or gas successively to centrifugal action first in a "dry-phase" vortex during which relatively large entrained particles, particularly together with some of the smaller ones are ejected from the air or gas stream which then enters a "wet-phase" vortex coaxial with the "dry-phase" one into which a liquid is introduced and broken into a spray or mist to dampen and coagulate the smaller dust particles and effect their centrifugal separation in a sludge or slurry whereby substantially all solid particles are extracted from the air or gas before its discharge from the apparatus.


**6 Claims, 5 Drawing Figures**

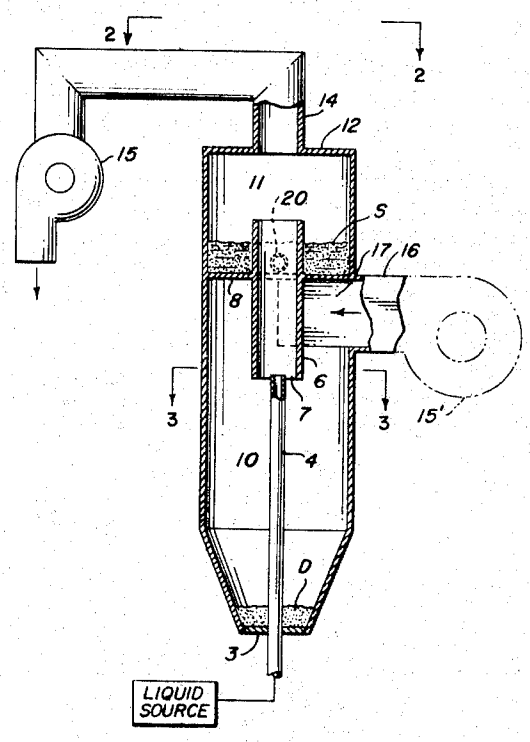


FIG. 1.

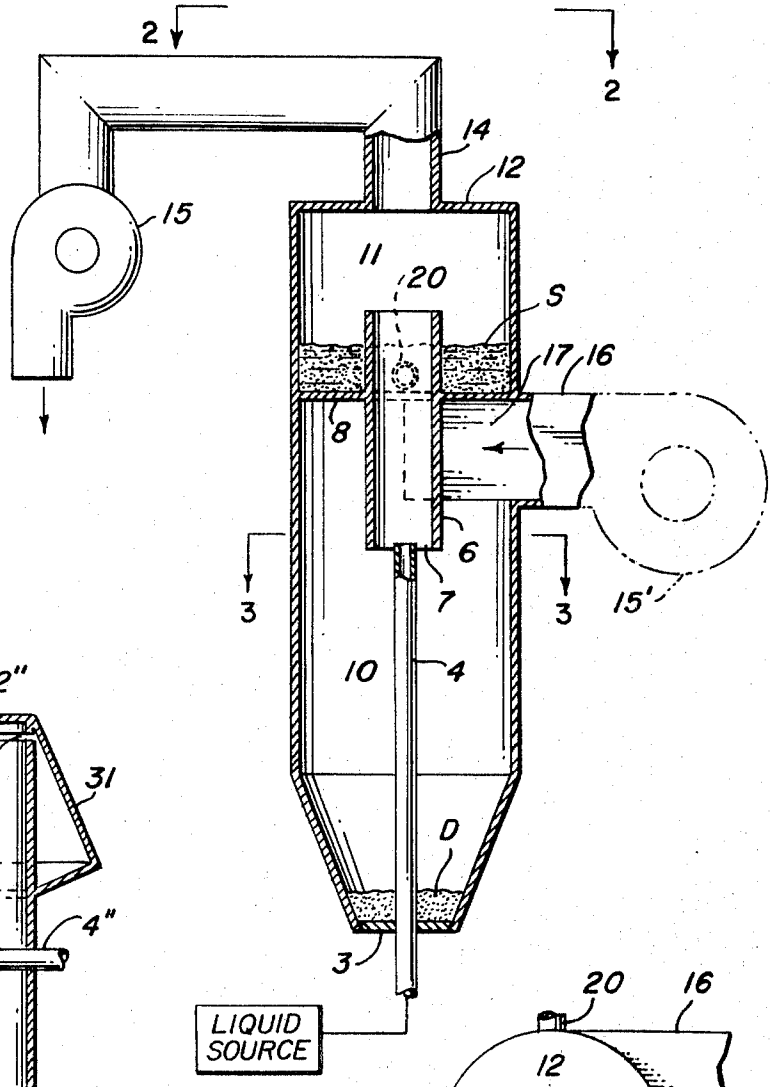
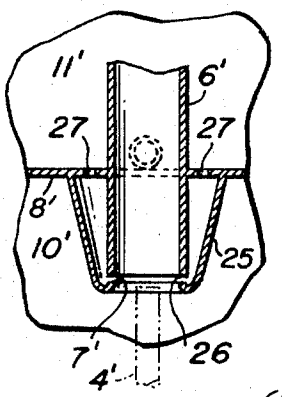



FIG. 4.



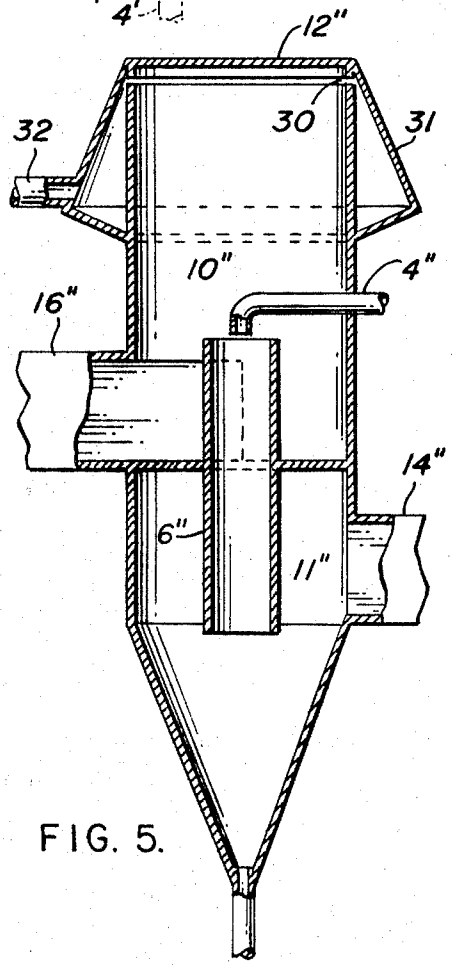




FIG. 5.

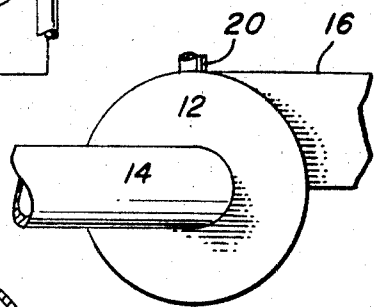



FIG. 2.

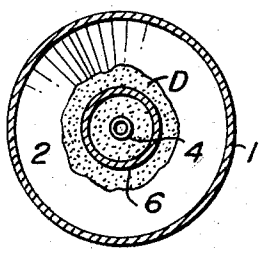



FIG. 3.

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# APPARATUS AND METHOD FOR CLEANING GASEOUS FLUIDS

## BACKGROUND OF INVENTION

The present inventor is patentee in prior U.S. Pat. No. 2,896,744 granted to him July 28, 1959 in which there is disclosed and claimed an improved "dry cyclone" dust collector and others have heretofore utilized somewhat similar principles of continuous centrifrigal separation of dust particles from a stream of air or gas by introducing a liquid of suitable character as a spray into the stream or as a film coating for confining surfaces and each of these general classes of dust collectors comprehends embodiments reasonably effective for their intended purposes but so far as is presently known there has not heretofore been available a collector possessing the advantages of both classes.

## SUMMARY OF THE INVENTION

In the present apparatus a dust-laden stream of air or gas is introduced vortically into a generally cylindrical housing or casing defining a chamber having a hopper including a closure permitting removal of accumulated dust, an axial tubular discharge conduit at the mouth of which a liquid carrying inlet port provides for introduction to the stream of a suitable liquid as the air or gas passes through the conduit from said chamber into a second chamber coaxial with but separated from the first and an exhaust conduit in which may be interposed an appropriate pump or other impelling device for drawing the cleaned air or gas from the collector.

## BRIEF DESCRIPTION OF THE DRAWINGS

More particularly the preferred embodiment of the invention will now be described with reference to the accompanying drawing in which

FIG. 1 is a diagrammatic vertical section partly in side elevation of the said preferred embodiment;

FIG. 2 is a fragmentary diagrammatic top plan view thereof;

FIG. 3 is a horizontal section on line 3—3 in FIG. 1;

FIG. 4 is a fragmentary axial section of a modified embodiment of the invention showing means defining an annular port for radial discharge of liquid into the vortically moving stream, which permits reuse of much of the liquid employed in the "wet phase" separation aspect of my apparatus; and

FIG. 5 is a view generally corresponding to FIG. 1 of a further embodiment demonstrating that the location of the "dry phase" and "wet phase" chambers with respect to the vertical may be reversed if desired without impairing the effectiveness of apparatus utilizing the principles of the invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now more particularly to the drawing the apparatus illustrated in FIGS. 1–3 comprises in general a hollow cylindrical shell or housing 1 which may be fabricated of sheet metal or the like, having its lower end closed by a sleeve 2 conveniently one congruent with an inverted conic frustum defining a bin or hopper for collection primarily of coarse dust particles, and hence provided with a removable closure 3 normally



obstructing the discharge port defined by the lower end of the sleeve. In this embodiment there extends upwardly coaxially with the sleeve 2 and housing 1 and through the closure 3 a liquid inlet pipe 4 terminating in substantial alignment horizontally with the lower end of a primary exhaust conduit 6 whereby the pipe 4 and conduit 6 cooperate to define an annular discharge port 7 to which further reference will hereinafter be made, any other arrangement of the pipe which enables it to define annular port 7 adjacent the conduit end being acceptable.

Above the lower end of the exhaust conduit 6 and externally of it a horizontal partition 8 divides the interior of the housing into a lower "dry phase" compartment 10 into which conduit 6 projects, and an upper "wet phase" compartment 11, while a cover 12 over the top of housing 1 encloses the upper compartment except for the axial discharge conduit 14 through which the cleaned air is discharged, usually being impelled by a fan or blower 15 connected with conduit 14, although if preferred and the desired pressure difference between the interior of tangential inlet duct 16 and that of discharge conduit 14 may be generated by a comparable fan or blower 15' indicated in broken lines in FIG. 1 while other suitable pressure or vacuum producing means may be utilized as well.

In the operation of the apparatus just described a stream of dust laden gas or air, hereinafter generically designated air enters the housing 1 through tangential inlet duct 16 and on encountering the cylindrical inner wall of the housing 1 it has imparted to it a swirling or vortical motion about the axis of the housing, a tangential arrangement of the inlet being preferred, although not required, if the inlet otherwise disposed be provided with means (not shown) for imparting vortical movement to the stream. Relatively coarse dust particles usually carrying some fine ones with them projected by centrifugal force against the housing wall fall by gravity into the subjacent bin or hopper in sleeve 2 accumulating there as a mass of dust D which may be removed from time to time by opening closure 3, and the remaining air now deprived of its coarser solid contaminants but still carrying a major portion of the fine particles originally suspended in it continues in its spiral vortex downwardly until its direction is reversed by the presence of the hopper 2 whereupon while still pursuing a generally vortical path it reverses its direction to spiral upwardly adjacent the axis of the housing toward the exhaust conduit 6 where it enters the annular port 7 defined by said conduit and the water tube 4.

The substantially reduced cross sectional area of the annular port 7 as compared with that of the inlet port 17 at the inner end of duct 16 causes the linear velocity of the stream to increase at the said port and as it passes the end of the liquid tube 4 its enhanced velocity induces a relatively negative pressure which draws from the end of liquid tube 4 a finely dispersed spray or mist generated from a continuous supply of liquid maintained in the tube by appropriate means (not shown). This mist or spray wets fine dust particles still carried by the air stream and the vortical motion of the latter forces them to the wall of the conduit where the liquid particles carrying fine solid ones in suspension coalesce to form a film of sludge or slurry on the inner wall of

the conduit which friction of the air continuously forces longitudinally in the conduit to overflow into the "wet phase" compartment **11** from which it may be withdrawn through a suitable discharge port **20** in the wall of housing **1**. The purged air leaves chamber **11** through the exit duct **14** and the sludge or slurry S of fine dust and liquid deposited on the partition **8** may be withdrawn continuously or from time to time for disposition as waste or recovery of its valuable components, if any.

In a modification of the invention fragmentarily illustrated in FIG. **4**, the remainder of the collecting apparatus being the same as in the preceding figures, the conduit **6'** connecting and coaxial with chambers **10'** and **11'** is surrounded in that portion thereof projecting into chamber **10'** by a conical shroud **25** having at its lower end an annular lip **26** forming with the adjacent end of conduit **6'** an annular port **7'** through which liquid flowing through apertures **27** in partition **8'** can be drawn by the vortically moving stream into the latter, thus recirculating the liquid, fresh supplies of which may be introduced through an axial liquid pipe **4'**, (shown in broken lines) which may be omitted and an inlet pipe (not shown) feeding liquid into chamber **11'** provided in its stead, only a portion of the dust bearing liquid deposited in chamber **11'** from the moving stream is then bled off from the latter chamber, the remainder with its burden of finer particles being recirculated through apertures **27** and port **7'**.

The apparatus illustrated in FIG. **5** utilizes like principles but the flow of the vortical stream of gas downwardly rather than upwardly therein demonstrates the adaptability of apparatus embodying the invention. Thus a vortical flow of the air stream in an upper "dry phase" chamber **10''** is induced by introduction of the dust laden air through a tangential or other suitable inlet duct **16''** from whence it flows in an ascending vortex until it encounters a cover **12''** which reverses it into a descending vortex for passage through axial connecting conduit **6''**, liquid from inlet pipe **4''** moistening the fine particles to form a sludge which falls to the bottom of "liquid phase" chamber **11''** as the purified air is discharged through duct **14''**. The larger particles carried by the stream are ejected from chamber **10''** through a peripheral port **30** about which a shroud **31** defines a bin for their collection and discharge through a port **32**.

The practice of my invention thus comprehends a treatment for dust-laden gaseous fluid in a continuous stream comprising successive steps which include inducing vortical movement in and separating from the stream by centrifugal force primarily the larger solid particles carried thereby, then increasing the velocity of the stream while introducing into it substantially at the axis of its vortex a liquid particle-collecting agent which action of the stream disperses into minute particles; these latter, becoming associated with the finer solid particles still remaining in the stream, coalesce into a film which is thereafter collected into a liquid mass and separated from the gaseous fluid by sudden diminution of the velocity of the latter whereby the fluid may be recovered or disposed of substantially devoid of all solid particles carried by it prior to treatment and the sludge or slurry created by the wet finer particles disposed of separately from the coarser particles, which remain dry throughout the treatment. Hence changes and modifications in the design, structure, arrangement and relationship of the several components of the apparatus will readily occur to those skilled in the art and may be utilized if desired without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

**1**. Apparatus for continuously separating solid particles from a gaseous fluid in which said particles are suspended which comprises a substantially cylindrical housing, a duct communicating with said housing for introducing thereinto a particle laden stream of gaseous fluid vortically with respect to the cylindrical wall thereof, means at one end of said housing for collecting and removing a portion of the solid particles in a dry state from said housing, a substantially cylindrical conduit of substantially uniform diameter coaxial with the housing for removing said vortical stream of gaseous fluid from said housing, means for continuously supplying a liquid into the upstream end of said conduit, and means associated with the downstream end of said conduit for separating the particle-containing liquid from the gaseous fluid stream.

**2**. Apparatus as defined in claim **1** in which the liquid supplying means cooperate with said conduit to define an annular port for passage of gaseous fluid, said means terminating adjacent said port to provide a passage in said conduit of larger transverse area than said port.

**3**. Apparatus as defined in claim **1** including means providing a passage for conducting particle containing liquid from the downstream end of said conduit to the upstream end thereof for repassage through said conduit.

**4**. Apparatus as defined in claim **1** in which said liquid supplying means include means defining with said conduit an annular port for discharge of liquid radially inwardly into said conduit.

**5**. The method of separating from a stream of gaseous fluid solid particles carried thereby which comprises introducing the gaseous fluid stream vortically into a substantially cylindrical chamber to thereby project against the substantially cylindrical wall of said chamber relatively coarse solid particles carried thereby, collecting said relatively coarse solid particles in dry condition at one end of said chamber, then introducing the gaseous fluid stream vortically into a substantially cylindrical conduit coaxial with said chamber while discharging a liquid by induction into the vortical gaseous fluid stream while in said conduit whereby solid particles and liquid are deposited on the inner wall of said conduit and carried axially along said wall by the vortical flow of said gaseous fluid stream, and separating said liquid and the solid particles carried thereby from said gaseous fluid stream.

**6**. The method defined in claim **5** wherein a portion of said liquid carrying in suspension therein solid particles is reintroduced from the down stream end to the upstream end of said conduit.

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