

[54] **GAS SCRUBBER**

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[51] Int. Cl. **B01d 47/02**

[58] Field of Search..... **55/220, 226-230, 55/239-241, 244, 248-250, 257, 261, 263, 266, 418-420; 261/110 R, 46; 210/137**

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[57] **ABSTRACT**

A scrubber for removing pollutants from a gaseous medium, having a chamber with a plurality of spaced straight and curved baffles positioned to direct incoming dirty air over a water reservoir at velocities sufficiently high to enable the dirty air to entrain multitudes of water droplets. The water droplets are thoroughly mixed with the dirty air, and the solid pollutants in the air are thoroughly wetted. The wet solid pollutants, being relatively heavy, are deflected downward through the action of the baffles and reduced air velocities into the water reservoir. A constant-volume air control means interposed between the chamber and the source of polluted air, such as dirty air from an incinerator or the like, contains a primary air inlet duct and a secondary air inlet duct where the air through each duct is controlled by a damper. The dampers of the two ducts are coupled to operate complementary to each other to provide a constant air flow to the chamber for various flows of polluted air directed to the scrubber through the primary air inlet duct.

9 Claims, 4 Drawing Figures

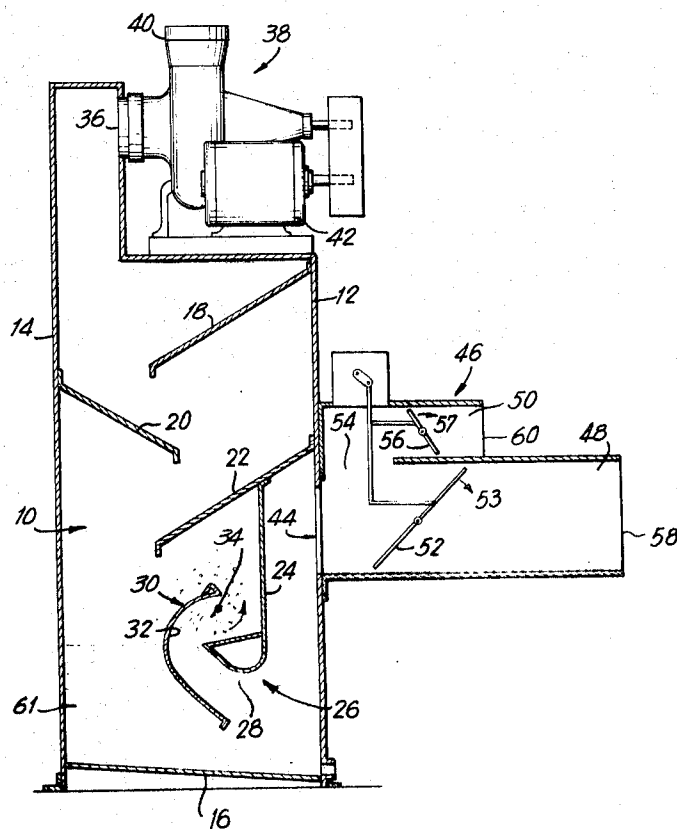
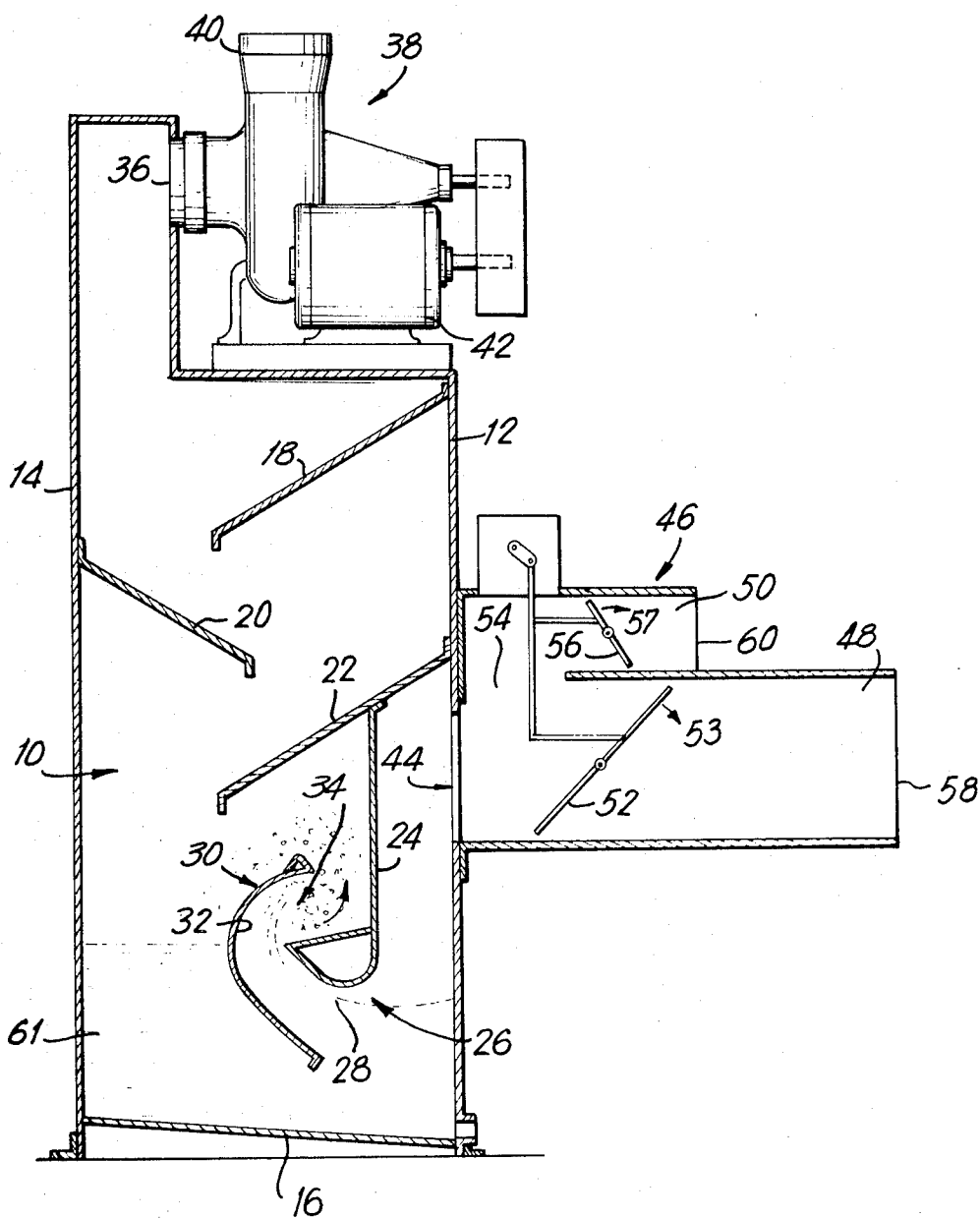


FIG. 1



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FIG. 2

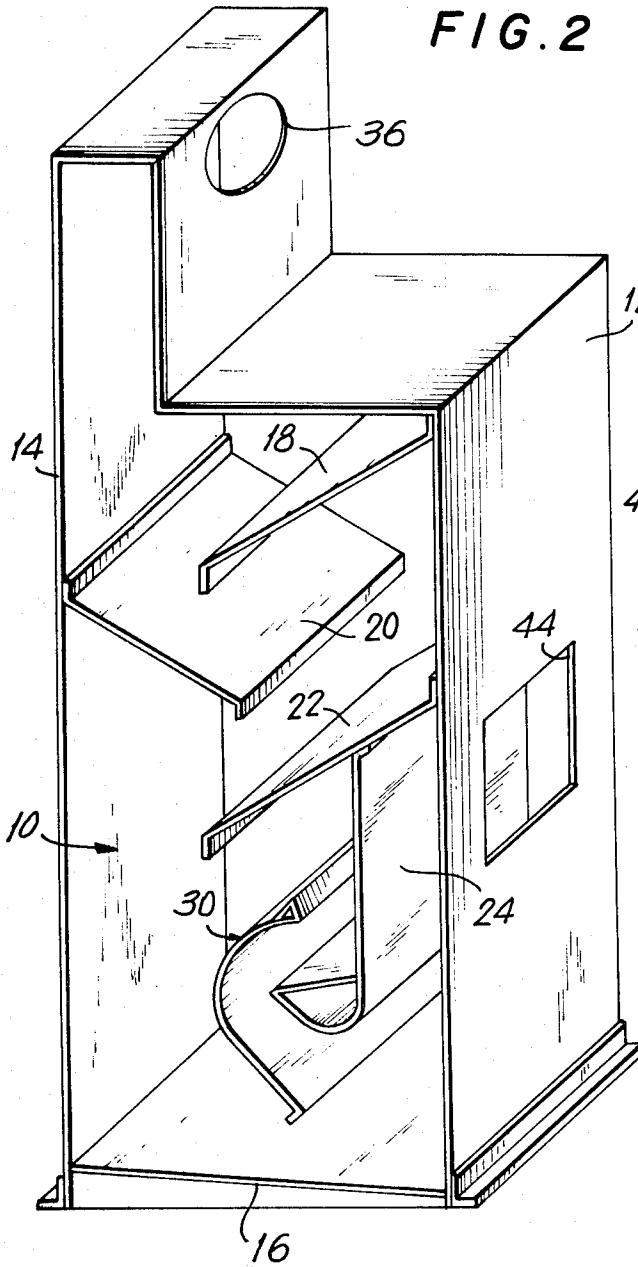


FIG. 3

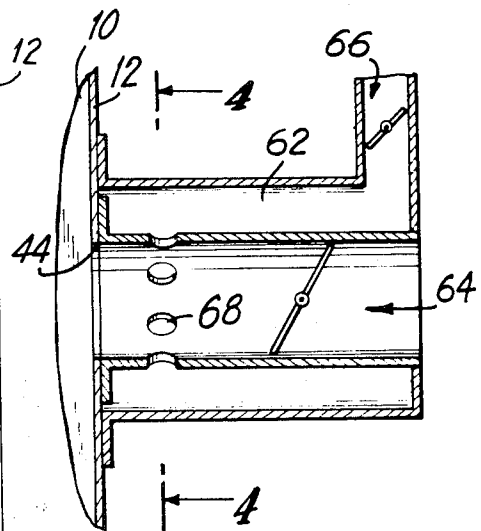
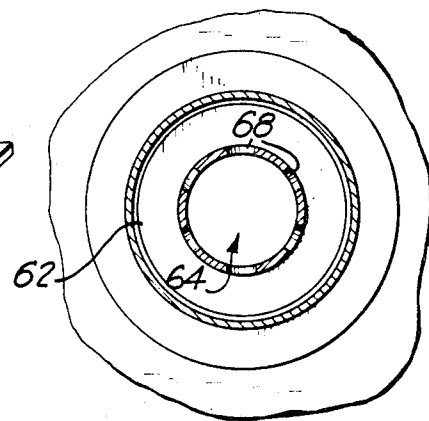


FIG. 4



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GAS SCRUBBER

This invention relates generally to a dust and fume collector, and more particularly to a scrubber-type structure that can remove pollutants from an air stream without imposing restrictions upon the rate of flow of the air stream.

A scrubber-type structure used to remove pollutants from a stream of air must process air flows that vary from a maximum rate to a minimum rate, the rates being different for various sizes and models of scrubbers.

Normally, a scrubber will operate at a maximum efficiency when it is processing air at its maximum rate. Frequently, however, the operating characteristics of a scrubber cannot be matched precisely to the operating characteristics of an air polluting device, such as an incinerator or the like.

It is an object of this invention to provide a scrubber which cleans dust from air by directing the dust-laden air over a reservoir of water.

It is another object of this invention to provide a scrubber which does not require water sprays, and which has an essentially self-adjusting inlet passageway which maintains a generally constant velocity of the gases despite variations in volume of incinerator gases drawn through it.

It is still another object of this invention to provide a scrubber which does not require a recirculating pump to prevent the excessive use of water.

It is still another object of this invention to provide a scrubber which can be used with gases of elevated temperatures and can cool the gases as well as clean them.

It is also an object of this invention to provide a scrubber that has no moving parts.

It is an additional object of this invention to provide a scrubber that can operate at maximum efficiency with full or reduced flows of dust and/or fume-laden air.

It is yet another object of this invention to provide a scrubber that is economical to build and reliable in operation.

These and further objects and advantages of the present invention are achieved, in general, through the use of a chamber having a plurality of spaced straight and curved baffles positioned to direct incoming dirty air over a water reservoir at velocities sufficiently high to enable the dirty air to entrain multitudes of water droplets. The water droplets are thoroughly mixed with the dirty air, and the solid pollutants in the air are thoroughly wetted. The wet, solid pollutants being relatively heavy, are deflected downward through the action of the baffles and reduced air velocity into the water reservoir. A constant volume air control means interposed between the chamber and the source of polluted air, such as dirty air from an incinerator or the like contains a primary air inlet duct and a secondary air inlet duct where the air through each duct is controlled by a damper. The dampers of the two ducts are coupled to operate complementary to each other to provide a constant air flow to the chamber for various flows of polluted air directed to the scrubber through the primary air inlet duct.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be

understood from the following description when read in connection with the accompanying drawing, wherein:

FIG. 1 is a side elevation view of a scrubber in accordance with the principles of this invention;

FIG. 2 is a view in perspective of the chamber of the scrubber having straight and curved baffles in accordance with the principles of this invention, the constant volume air control means having been removed;

FIG. 3 is a side sectional view of an embodiment of a constant volume air damper control means, in accordance with the principle of this invention; and

FIG. 4 is a cross-sectional view along line 4—4 of FIG. 3.

Referring specifically to FIG. 1, a chamber 10 defined by a front wall 12, a rear wall 14, two side walls and a bottom member 16 supports internally projecting partitions or baffles. Three straight baffles 18, 20, 22 are secured rigidly to the walls of the chamber, baffles 18 and 22 being secured to the inside surface of the front wall 12 and the baffle 20 being secured to the inside surface of rear wall 14. Each of the baffles project generally downward within the chamber and toward the opposite wall, the baffles 18, 22 forming substantially the same angle relative to wall 12 as baffle 20 forms with the wall 14. Each baffle 18, 20, 22 contains a slight downwardly extending vertical projection at its free end.

Secured rigidly to baffle 22 is a downward projecting baffle 24. The end 26 of the baffle 24 is bent back upon itself to form a curved baffle surface 28 having a closed top surface. A baffle 30 shaped to provide a curved or concave surface 32, is positioned in partial surrounding relationship with the curved baffle 28, and spaced from the curved baffle 28 to provide an arcuate passageway 34 of predetermined dimensions. Each of the baffles 18, 20, 22, 24, 28, and 30 extend for the full width of the chamber 10 as defined by the front wall 12 and the rear wall 14, and contacts and is secured to the two side walls of the chamber.

The top of chamber 10 contains a cutout 36 through which air in the chamber 10 is exhausted. A source of suction 38 such as a centrifugal type of fan 40 driven by a motor 42 through a belt and pulley arrangement, or the like, is coupled to draw air out of chamber 10 through cutout 36. Thus, cutout 36 can be considered to be the exhaust or outlet port of the scrubber. An inlet port 44 for receiving dust and/or fume-laden air is supported by front wall 12 and positioned below baffle 22.

Coupled securely to the outside surface of front wall 12 and aligned with inlet port 44 is a constant volume air control means 46 having a primary air inlet duct 48, a secondary air inlet duct 50, and a damper within each duct coupled to have motions which compliment each other.

Primarily air inlet duct 48 is coupled to direct air having solid or gaseous pollutants to the inlet port 44 and supports damper 52, which can be articulated to rotate in a clockwise direction, as indicated by arrow 53, to control the flow of air through the primary air inlet duct.

Secondary air inlet duct 50 is coupled to direct air from the atmosphere through an opening 54 to mix with the air in the primary air inlet duct 48 and to the

inlet port 44 of the scrubber. A damper 56, which can be articulated to rotate in a clockwise direction 57, is positioned within secondary air inlet duct 50 to control the flow of air through duct 50.

In operation, end 58 of primary air inlet duct 48 is coupled to receive air having solid and/or gaseous pollutants, such as that which is emitted from an incinerator; and end 60 of secondary air inlet duct 50 is open to the atmosphere. Chamber 10, which is substantially air- and water-tight except for the cutouts 36 and 44, is filled partially with water 61, the level of water being at some level above the bottom of curved baffle 28. Motor 42 is energized to drive fan 40 to create a partial vacuum in chamber 10; and air is drawn through primary air inlet duct 48 and secondary air inlet duct 50. The volume of air drawn through each duct is determined by the position of the corresponding damper associated with each duct.

The dirty air is drawn into chamber 10 via cutout 44 and is deflected downwardly by baffles 22 and 24. Curved baffles 28 and 30 form an orifice or passageway 34 through which dust-, dirt- and fume-laden air is drawn at a high velocity. The dirty air is drawn over the reservoir of water 61 at velocities sufficiently high to entrain multitudes of droplets of water which mix thoroughly with the dirty air through the turbulence caused by the baffles. The baffles effect velocity changes of the air and entrained water by directing the air and entrained water along a tortuous path.

Solid pollutants in the air are thoroughly wetted by being in intimate contact with the water and become relatively heavy. The wet and relatively heavy pollutants are deflected downward into the water reservoir by changes in air velocities and directions which are effected by the action of the baffles.

While the total volume of water in chamber 10 is relatively small, approximately 10 gallons, for some size chambers, it has been observed that the cleansing action of the swirling gases and water through passageway 34 in combination with the tortuous path captures the equivalent of 20 to 25 gallons of cleansing water for each 1,000 CFM of gas processed.

The passageway created between the first curved baffle 28 and the side of the chamber 10 is essentially self-adjusting in that it adjusts to the volume of gases being drawn through it, and in one embodiment maintained a velocity of gas being processed in the order of 55 MPH.

In this invention the action of the dusty air being drawn over the water at a high velocity in combination with the effect caused by the curved and straight baffles provides the cleansing of the air. Thus, sprays and spray equipment is not required. The water in chamber 10 can be drawn off together with the collected dirt and can be passed through a filter for removal of the dirt. Thereafter, the water can be automatically recycled back to the reservoir for reuse. A recirculation pump is not required to prevent excessive use of water.

Additionally, it is to be noted that the scrubber can be used to clean dirty gases at elevated temperatures such as gases that are obtained from an incinerator. The thorough and vigorous swirling and mixing of the gases with the water as the gas passes through chamber 10 provides intimate contact of the gases with the water for rapid evaporation of water and, therefore absorp-

tion of heat from and cooling of the gases as well as the washing of the gas.

Heavy solid particles trapped in the wash water are returned to the water reservoir where they settle out. The bottom of the scrubber can be sloped in two directions to a corner-located drain, where dirt and dirty water can be removed periodically through a drain valve and fed directly to a waste line or be processed prior to being discarded. Drain and overflow piping and a valve (not shown) are connected to the chamber and are a part of the device.

The washing fluid can be either water or another medium to which special chemicals, such as wetting agents, rust inhibitors, odor-elimination or masking chemicals can be added. The process of cleaning solid particles from the dirty gases can also be used to trap some gaseous pollutants. For example, special gaseous components can be absorbed from the gas being processed by using special chemicals in place of water as the washing medium.

It is here noted that explosive, inflammable or dangerous dusts which are removed from air being processed are stored within the water or other cleaning fluid used in chamber 10 until it is removed. This provides a safety factor.

If desired, viewing ports for viewing the scrubbing action across the unit can be provided for visibly checking the operation of the scrubber.

After the gas that is being processed is cleaned, baffles 22, 20, 18 turn the gas repeatedly and abruptly at high velocity to trap and collect additional water particles and return them to the reservoir of water for reuse. Thus, the cleansed gas is relatively free of water.

Fan 40 and motor 42 are mounted on the scrubber as a subassembly on a mounting plate, which is completely isolated from the scrubber by a plurality of rubber isolation pads mounted on each side. The inlet to the fan can be connected to the scrubber outlet through a flexible connection to further isolate the fan and motor from the scrubber.

Separate mounting of the fan and motor on its own removable platform permits easier handling, shipping, installation and service, and can help to reduce shipping costs. In addition, factory assembly of the fan, motor and drive reduces field erection and start-up costs since the entire drive subassembly can be pretested and aligned at the factory on a semi-mass-produced basis.

It is to be noted that chamber 10 and therefore the scrubber has no moving parts to wear.

A water level control device can be used to maintain the water level in chamber 10 automatically within the proper operating range. Additionally, the scrubber can be constructed to use nothing but makeup water or to operate on a constant overflow basis. The entire scrubber is sealed from inlet to outlet thus preventing the escape of damp, musty odors; and no external settling chambers are required, which can accumulate sludge or surface scum and emit odors or clog sensitive water level controls.

An automatic temperature control device can be incorporated near the exits of the scrubber to provide protection of all equipment against excessive heat.

The scrubber described above has a maximum and minimum operating range depending upon the size of

the unit. However, regardless of the size, the scrubber is most efficient when operating at its maximum rated capacity. The constant volume air control means having a primary air inlet duct and a secondary air inlet duct permits the scrubber to operate at maximum efficiency by drawing a volume of air from the device requiring cleaning and adding to the air being processed secondary air in sufficient quantities to bring the total amount of air fed to the chamber up to the maximum capacity of the scrubber. The use of a constant volume air control means also permits a continuous variation of the amount of air or gas drawn from an incinerator or other device where, as a result of the nature of the operation, the production or flow of gas that is to be cleaned is not constant.

The constant volume air control means also has the effect of extending the minimum capacity (minimum operating range) of the scrubber by permitting the scrubber to operate above its minimum range (handle more than the minimum ideal amount of air or gas) while drawing less than the rated scrubber minimum from the source of dirty air or gas.

Referring to FIG. 1, the secondary air inlet duct should exhaust downstream of the primary air inlet duct damper to obtain maximum efficiency of the secondary air inlet duct damper.

Secondary air inlet duct damper 56 operates in a manner that is opposite to the operation of primary air inlet duct damper 52. As the primary air inlet duct damper closes to reduce the draft at the incinerator or other device, and, therefore, the volume of air fed to chamber 10, the secondary air inlet duct damper opens to admit additional air, such that the total amount of air fed to chamber 10 remains essentially the same. A damper motor, which can be draft-controlled, is coupled to operate the dampers of the primary and secondary air inlet ducts.

Referring to FIG. 3, there is illustrated another embodiment of a constant-volume air control means. In this embodiment the secondary air inlet duct 62 is positioned to be concentric with primary air inlet duct 64, the inlet 66 to secondary air inlet duct 62 being positioned within the side wall of the secondary air inlet duct. As shown, the air from secondary duct 62 feeds into primary duct 64 through a series of circumferential openings 68 in the common wall.

Obviously many modifications and variations of the present invention are possible in the light of the above teaching. It is, therefore, to be understood that the invention may be practiced otherwise than as specifically described herein.

What I claim is:

1. In a scrubber for removing contaminants from a stream of air from a primary source, comprising a casing defining an interior chamber with lower and upper portions, a washing liquid contained within said lower portion and having a liquid surface, said casing having an inlet in one side wall above said liquid surface, and an outlet in the upper portion, a baffle wall extending obliquely downwardly from said one side wall above said inlet and toward the opposite side wall, a wall downwardly extending from said baffle spaced from and in front of said inlet with its lower end contiguous to said liquid, said lower end having a generally convex curved surface, a concave curved surface spaced from

and facing said convex surface to define a narrow generally sinuous flow passageway between said inlet and outlet to provide turbulent flow away from said liquid surface, means for causing a pressure drop across the scrubber said pressure drop being sufficient to lower the liquid on the inlet side of said sinuous passageway and raise it on the outlet side to provide a clear and turbulent passage through said sinuous passageway, so that an air stream is received in said chamber via said inlet and moves downwardly and impinges against the liquid surface and through the clear passage causing sufficient turbulence of the liquid in the sinuous passageway and then into the outlet, a secondary source of air coupled to said inlet, constant volume air control means coupled to said inlet and to said primary and secondary air sources, said control means varying the air supply to said inlet from said air sources to maintain constant the flow of air to said scrubber.

2 The structure of claim 1 wherein the outlet of said sinuous flow passageway faces said downwardly extending wall and towards said inlet, said water droplets directed initially away from said water surface.

3. The structure of claim 1 wherein the air stream passing through the sinuous passageway travels at essentially a constant velocity regardless of the volume of air entering via the inlet.

4. The structure of claim 1, wherein said constant-volume air control means comprises a first inlet duct coupled to said primary source of feed air to said scrubber, a second inlet duct coupled to said secondary source of air to feed air to said scrubber, and means to progressively restrict the flow of air through said second inlet duct and progressively increase the flow of air through said first inlet duct.

5. The structure of claim 4, including a first damper pivotally coupled within said second air inlet duct.

6. The structure of claim 5, including a second damper pivotally coupled within said first air inlet duct.

7. The structure of claim 6, including a damper motor coupled to control the position of said first and second dampers.

8. The structure of claim 7, wherein said second air inlet duct exhausts into said first air inlet duct downstream of the damper in said first air inlet duct.

9. In a scrubber for removing contaminants from a stream of air, comprising a casing defining an interior chamber with lower and upper portions, a washing liquid contained within said lower portion and having a liquid surface, said casing having an inlet in one side wall above said liquid surface, and an outlet in the upper portion, a constant-volume air control means coupled to the inlet in the side wall to maintain constant the flow of air to said scrubber, a baffle wall extending obliquely downwardly from said one side wall above said inlet and toward the opposite side wall, a wall downwardly extending from said baffle spaced from and in front of said inlet with its lower end contiguous to said liquid, said lower end having a generally convex curved surface, a concave curved surface spaced from and facing said convex surface to define a narrow generally sinuous flow passageway between said inlet and outlet and away from said liquid surface, so that an air stream is received in said chamber via said inlet and moves downwardly and impinges against

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the liquid surface and through the sinuous passageway and then into the outlet, said constant-volume air control means including a first inlet duct coupled to said inlet to feed air to said scrubber, a second inlet duct coupled to feed air to said scrubber, and means progressively restricting the flow of air through said second inlet duct and progressively increasing the flow of air through said first inlet duct, a first damper pivotally coupled within said second air inlet duct, a

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second damper pivotally coupled within said first air inlet duct, a motor coupled to control the position of said first and second dampers, said second air inlet duct exhausting into said first air inlet duct downstream of the damper in said first air inlet duct, said motor being draft controlled, and said first air inlet duct and a portion of said second air inlet duct being positioned in concentric relationship to each other.

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