May 31, 1949. N. C. CHRISTENSEN 2,471,724

GAS WASHER

Filed Dec. 30, 1944 2 Sheets-Sheet 1

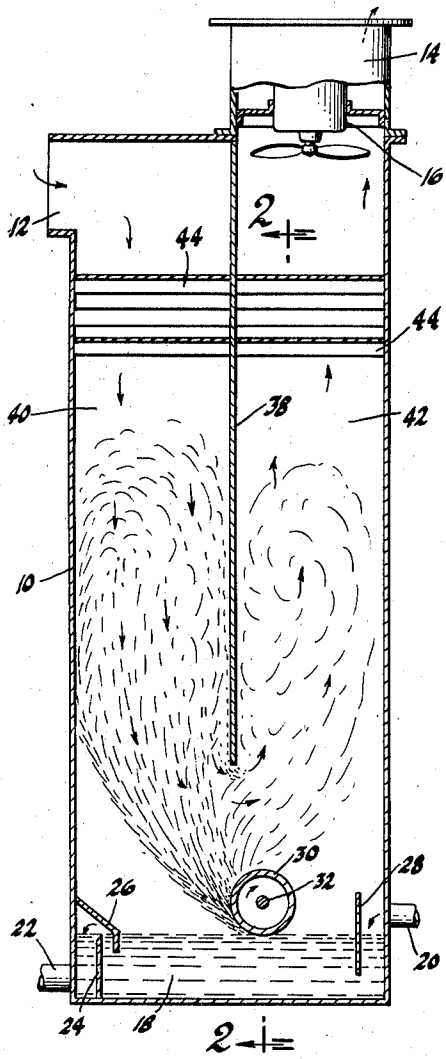


Fig. 1

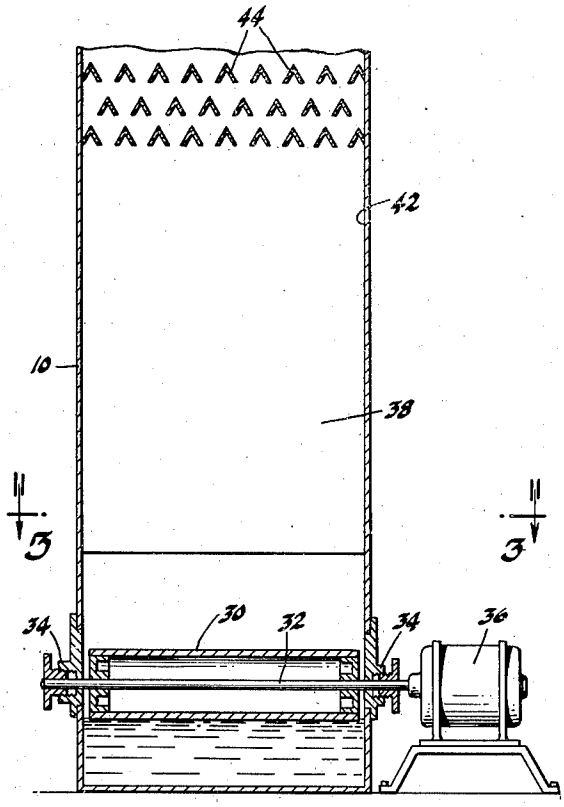


Fig. 2

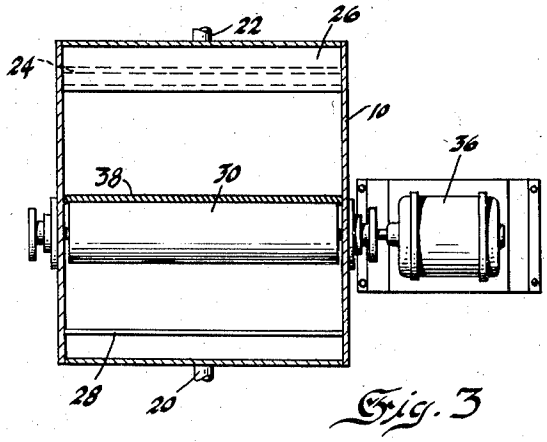


Fig. 3

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GAS WASHER

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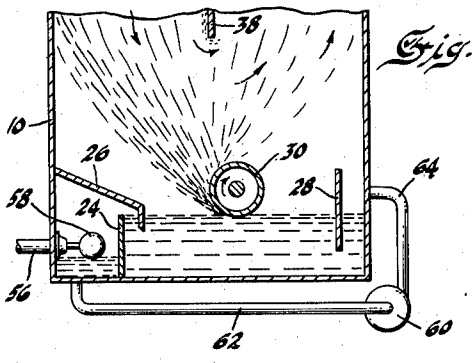


Fig. 8

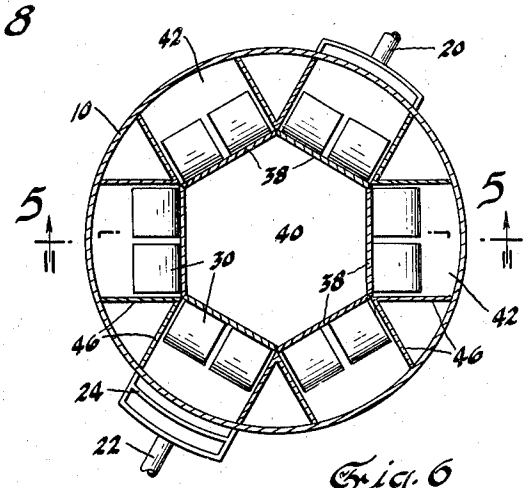


Fig. 6

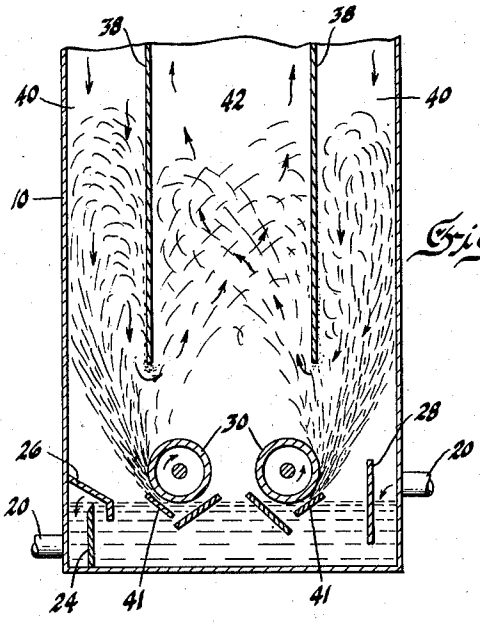


Fig. 4

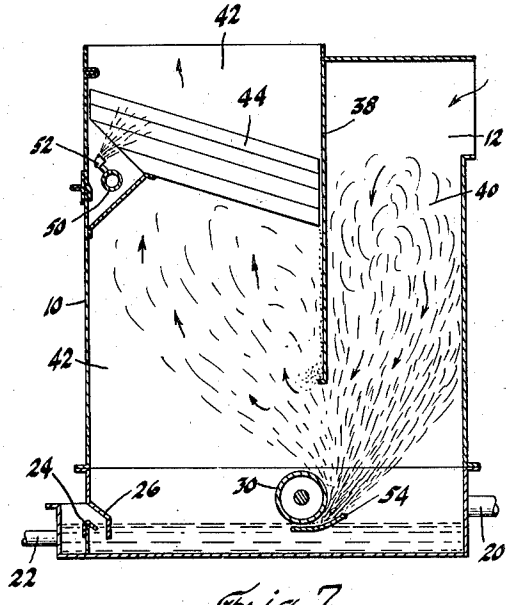


Fig. 7

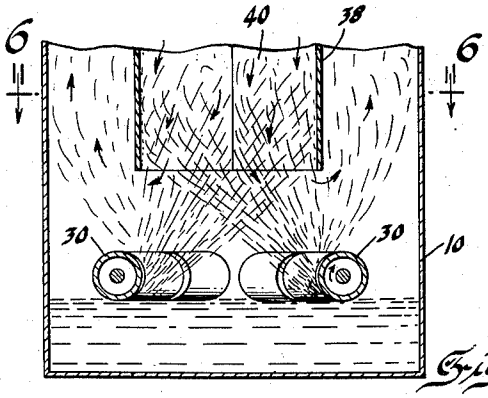


Fig. 5

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UNITED STATES PATENT OFFICE

2,471,724

GAS WASHER

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9 Claims. (Cl. 183—22)

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This invention relates to improvements in air washers.

Washers employing spray rotors to develop liquid sprays through which gas to be cleaned is passed, such as disclosed in Christensen Patent No. 1,462,363 or Dalton Patent No. 2,243,839, are well known, and this invention pertains to improvements in washers of this rotor spray type.

An object of this invention is to provide a rotor spray washer of extreme simplicity and cheap construction which will economically handle a large volume of gas and which possesses a high degree of efficiency.

It has been the conventional practice in rotor spray washers to direct all of the spray thrown by the rotor into a washing chamber and to pass the gas to be cleaned through this entire mixture of spray. The air to be cleaned was passed through the spray counter the direction of travel of the spray or concurrently therewith or axially of the spray rotor as was desired.

An object of this invention is to provide a rotor spray gas washer wherein the entire spray thrown off by the rotor is segregated into separate portions of spray of different characteristics and the gas to be cleaned is so passed therethrough as to produce the most effective cleaning of the gas.

While the characteristics of the spray thrown off by a spray rotor vary with the dip of the rotor into the liquid and the speed of rotation of the rotor as well as with the character of the rotor itself, as set forth in the patent to Christensen supra, I have found that under normal operating conditions a liquid spray rotor throws from 75% to 80% of the liquid spray on the rising side of the rotor and only 20% to 25% on the descending side of the rotor. I have also found that the portion of the spray which is thrown off on the rising side of the rotor is a coarse, heavy spray including large drops and globules of liquid and the spray thrown off by the rotor on its descending side is a relatively fine spray and mist.

An object of this invention is to segregate the large volume of coarse heavy spray from the smaller volume of fine spray and to make the most advantageous use of each in the washing of the gas passed through the spray.

A further object of this invention is the provision of a rotor spray washer wherein the gas to be cleaned is first caused to pass through the heavy coarse spray concentrated within one portion of a washing chamber and is thereafter caused to pass through the fine spray thrown off by the rotor which fine spray is concentrated in a second portion of the washing chamber. Preferably the gas is passed through the large volume of heavy spray counter the direction of travel of the spray.

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Another object is to provide an upright air washer casing superimposing a spray rotor which casing is divided interiorly by a partition which superimposes the rotor in spaced relationship into a downdraft air passageway and an updraft air passageway. The partition is disposed tangentially to the median line of the rising side of the rotor so as to cause the large volume of coarse heavy spray which is thrown off by the rotor on its rising side to enter the downdraft passageway of the casing and to cause the fine spray which is thrown off by the rotor on its descending side to enter the updraft passageway.

In a preferred construction the rotor and partition are so disposed within the casing that the updraft passageway is of substantially greater cross sectional area than the downdraft passageway and the large volume of coarse heavy spray is concentrated in the restricted capacity downdraft passageway and the air travels at a substantially higher velocity through the downdraft than it does outwardly through the greater capacity updraft.

A further meritorious embodiment of the invention consists in the provision, within an upright air washer casing having a liquid sump in its bottom, of a plurality of spray rotors spaced apart in the same horizontal plane to dip into the liquid in the sump. The casing is divided interiorly into a plurality of washing chambers by a plurality of spaced apart upright partitions spaced above the rotors tangentially with respect to the rising sides of the rotors. The partitions are so arranged that a selected portion of the spray thrown off by each rotor is thrown into crossing commingling relationship within one portion of the casing with a similar portion of the spray thrown off by another rotor.

Other objects, advantages and meritorious features will more fully appear from the following description, appended claims and accompanying drawings, wherein:

Figure 1 is a vertical sectional view through an air washer embodying my invention.

Figure 2 is a vertical sectional view taken on the line 2—2 of Figure 1.

Figure 3 is a horizontal sectional view taken on the line 3—3 of Figure 2.

Figure 4 is a vertical sectional view of a washer similar to that of Figure 1 but employing two spray rotors and two air inlet passages and one common air outlet passage.

Figure 5 is a fragmentary vertical sectional view

taken on the line 5—5 of Figure 6 and showing a modified form of plural rotor construction.

Figure 6 is a horizontal sectional view taken on the line 6—6 of Figure 5.

Figure 7 is a vertical sectional view illustrating another modification of the invention.

Figure 8 is a fragmentary vertical sectional view illustrating a further adaptation of my invention.

In the drawings, an upright air washer casing is indicated as 10. The casing is shown in Figure 1 as provided with an air inlet 12 and an air outlet 14. A fan 16 is shown mounted in the outlet in Figure 1 and is adapted to draw air or other gas to be cleaned through the casing. It is understood that in those figures of the drawings wherein the air inlet and outlet and fan are not shown that such would be provided in suitable form. The lower part of the casing serves as a liquid containing sump or reservoir 18 having a liquid inlet 20 and a liquid outlet 22 as shown in Figure 1. A weir 24 is provided separating that portion of the sump surrounding the outlet from the main portion of the sump and by its height determines the height of the water within the sump. A baffle 26 extends across the sump spaced inwardly from the weir and a baffle 28 extends inwardly across the sump spaced inwardly of the inlet 20 as shown in Figure 1. These two baffles serve to prevent surging of the liquid and maintain a quiet pool within the casing between the baffles.

A spray rotor 30 is suitably supported to extend across the interior of the casing and dip into the liquid in the sump. In Figures 1 through 3 this rotor is shown as a hollow cylindrical rotor mounted upon a shaft 32 which shaft is suitably supported within end bearings and provided with packing glands as shown at 34 in Figure 2. The shaft is coupled with the shaft of an electric motor 36 whereby the spray rotor may be driven rotatably as desired.

Spray rotors of many different kinds have heretofore been provided. The smooth surfaced hollow cylindrical rotor shown in the Christensen patent supra has been used as has also a hollow cylindrical rotor provided with a roughened surface. Rotors formed of a plurality of discs mounted upon a horizontal shaft in axially spaced apart relationship as shown in the Dalton patent supra have also been used. As stated above, and as shown in the drawings, the spray rotors 30 extend across the interior of the shaft or casing from end to end so that the entire cross-section of passages within the casing is filled with spray thrown by the rotors 30 so that no part of the gas passed through the apparatus can escape intimate mixture and contact with the sprayed liquid.

The interior of the casing superimposing the rotor shown in Figures 1 and 2, is divided by a partition 38 to provide a downdraft passageway 40 which communicates with the air intake into the casing and an updraft passageway 42 which communicates with the air outlet from the casing. These two passageways communicate with each other below the partition and above the rotor. This partition depends from the ceiling of the casing and terminates spaced above the rotor as shown in Figure 1. It is disposed as shown in Figures 1 and 3 within an upright plane which is tangent to the median line of the rising side of the rotor. As will be clear from the drawings since the partition 38 is in a plane tangent to the rising side of the rotor 30 the spray projected upward in this plane is parallel to the partition and there is therefore no "dead space," i. e. space not filled with spray, on either side of the partition 38 through which gases might pass without coming into contact with the sprayed liquid.

Conventional water eliminators 44 are provided in the upper end of the casing. They are here shown in Figures 1 and 2 as provided in the upper portion of both the updraft and downdraft passageways, though they might be provided only in the upper portion of the updraft passageway as shown in Figure 7.

It has been found that a rotating spray rotor when dipping into a liquid as here shown throws the larger portion of its spray upon the rising side of the rotor and that such larger portion of the spray is a coarse heavy spray including large drops and globules of water. It has also been found that the portion of the spray which is thrown off on the descending side of the rotor is a fine spray and is of much smaller quantity than that which is thrown off on the rising side of the rotor.

With a rotor made up of discs mounted upon a horizontal shaft on one and one-half inch centers and dipping approximately three inches into the liquid in the sump and with the rotor rotating at four to five hundred revolutions per minute it was found that approximately 75% of the spray thrown off by the rotor was thrown off on the rising side and approximately 25% of the spray thrown was thrown off on the descending side. The spray thrown off on the rising side was much coarser and heavier than the spray thrown off by the rotor on the descending side. With a cylindrical rotor as shown in the drawings the preferred dip is less than one-half inch and speed of rotation is higher but the result of throwing the larger portion of the spray upon the rising side is similar and the spray thrown off on the rising side was much heavier and coarser than that thrown off on the descending side.

The partition is here so disposed that it separates that portion of the spray thrown off on the rising side from that portion thrown off on the descending side. The larger portion of the spray which is thrown off on the rising side is caused to enter the downdraft passageway 40 while the spray thrown off on the descending side is thrown into the updraft passageway 42.

In Figure 4 a twin rotor arrangement is shown. In other words, the casing 10 is provided with the liquid containing sump having a water inlet 20 and a water outlet 22 which sump is provided with baffles 26 and 28 and has mounted therein a pair of rotors 30. These rotors are disposed in the same horizontal plane and extend substantially in spaced apart parallelism. Two partitions 38 are provided, one for each rotor. This divides the casing into two downdraft passageways 40 and one updraft passageway 42 which updraft passageway superimposes the space between the rotors.

Instead of providing merely two rotors as shown in Figure 4, a larger number may be provided as shown in Figures 5 and 6. In these figures the casing is shown as being circular in cross section and contains six rotors 30. These rotors may be of the self-contained variety disclosed in my copending application Serial No. 563,257 (now Patent 2,448,297, dated Aug. 31, 1948) or they may be driven by power means located at a point external to the rotor. In this figure of the drawing the interior of the casing is divided by upright wall portions 46 relatively angularly disposed between successive rotors as shown in Figure 6 which wall portions define a common downdraft passageway 40 common to each rotor and an

updraft passageway **42** for each rotor. The downdraft **40** communicates with each of the updraft passageways. The sump has a water inlet **20** and an outlet **22** and a weir **24** is arranged within the outlet beyond the boundary of the casing **10**. Baffles **41** are shown in Figure 4 to minimize surging of the water above the rotors. Baffles **41** beneath the spray rotors, such as shown in Figure 4, should preferably be used in all forms of the apparatus to prevent lateral swinging movement of the liquid in the basin or sump so as to prevent surges in the spray above the rotor and secure a uniform spraying action.

In Figure 7 a modified form of the construction shown in Figures 1 and 2 is illustrated wherein the rotor **30** and the partition **38** are so disposed within the casing that the downdraft passageway **40** has a cross sectional area which is only about half that of the updraft passageway **42**. The water eliminators **44** are disposed only within the updraft passageway and a spray is directed thereupon from a header pipe **50** which is provided with a linear arrangement of spray nozzles **52** and which may be fed from the same pump that supplies water to the sump. A baffle deflector **54** is shown as disposed beneath the rotor **30**.

In Figure 8 an arrangement is illustrated which is designed for a small air-conditioning unit wherein it is desired to employ a minimum amount of water. In this construction the arrangement is similar to that shown in Figure 1 except that the weir **24** defines an auxiliary tank portion wherein the water level is maintained by a float valve controlled inlet **56**. The float valve is indicated as **58**. A pump **60** communicates with the auxiliary sump portion by an intake **62** and recirculates the water therefrom back into the sump through a pump outlet **64**.

In the several constructions shown the upright partition is so disposed as hereinabove set forth to separate the coarse heavy spray thrown off from the rising side of the rotor from the fine spray thrown off upon the descending side of the rotor. Preferably the incoming air enters counter the heavy spray and flows downwardly toward the liquid in the sump and a substantial portion of the foul material is wetted and passes directly out of the air stream into the sump. The air born particles which are not wetted pass with the air into the updraft passageway and are there wetted by the fine spray as it rises and falls and fall back therewith into the liquid in the sump.

In the construction shown in Figure 4, the spray thrown off upon the descending side of the two rotors commingles within the common updraft passageway to produce a more thorough wetting of the foreign particles in the air.

In the construction shown in Figures 5 and 6 the rotors are so driven that the coarse heavy spray from each rotor enters the central downdraft passageway **40** and mingles therein with the corresponding spray from each of the other rotors and produces a particularly dense concentrated spray through which the air must pass downwardly for exit through the updraft passageways **42**.

In Figure 7 the larger capacity of the updraft passageway as compared with the downdraft passageway permit the air to be taken into the downdraft passageway at a speed of approximately one thousand feet per minute and exhausted from the updraft passageway at a speed of not to exceed five hundred feet per minute. This arrangement increases the capacity of the machine and furthermore the slow movement of the air through the updraft passageway insures effective cleaning and moisture elimination. The water which is discharged on to the water eliminator plates flows down over the baffle **38** on to the rotor to be again thrown off by the rotor.

What I claim is:

1. In an air washer, an upright casing having a liquid containing sump in its bottom portion, a rotatably driven spray rotor horizontally supported within the casing and extending from one side of the casing to the other and disposed to dip into the liquid in the sump, an upright partition superimposing in spaced relationship the spray rotor and extending upward tangentially to the rising side of the rotor and extending from one side of the casing to the other dividing the space within the casing above the rotor into an upright downdraft portion and an upright updraft portion communicating below said partition.

2. In an air washer, an upright casing having a liquid containing sump in its bottom portion, a rotatably driven spray rotor horizontally supported within the casing and extending from one side of the casing to the other and disposed to dip into the liquid in the sump, an upright partition superimposing in spaced relationship the spray rotor and extending tangentially to the rising side of the rotor and extending from one side of the casing to the other dividing the space within the casing above the rotor into a vertical downdraft portion superimposing the rising side of the rotor and having an air inlet at the top and a vertical updraft portion superimposing the descending side of the rotor and having an air outlet at the top, said portions communicating through the space between the lower edge of the partition and the rotor, and means for introducing air into the casing through the upper end of the downdraft portion and exhausting air therefrom through the upper end of the updraft portion.

3. In an air washer, an upright casing having a liquid containing sump in its bottom portion, a pair of rotatably driven spray rotors supported in horizontally spaced apart relationship within the casing dipping into the liquid in the sump, a pair of upright spaced apart substantially parallel partitions dividing that portion of the casing spaced above the spray rotors into a plurality of upright passageways communicating directly above the spray rotors, one partition occupying a plane tangent to the rising side of one rotor, the other partition occupying a plane tangent to the rising side of the other rotor whereby a portion of the spray thrown by one rotor commingles with a portion of the spray thrown by the other rotor within the upright passageway which superimposes the space between the rotors and the remaining portion of the spray thrown by each rotor is directed into a different passageway, and means for introducing air into the upper end of one of said upright passageways to pass downwardly therethrough and upwardly through another of said upright passageways for exhaust from the casing.

4. In an air washer, an upright casing having a liquid containing sump in its bottom portion, a pair of rotatably driven spray rotors supported in horizontally spaced apart relationship within the casing dipping into the liquid in the sump, a pair of upright spaced apart substantially parallel partitions dividing that portion of the casing spaced above the spray rotors into a plurality of upright passageways communicating directly above the spray rotors, one partition occupying

a plane tangent to the rising side of one rotor, the other partition occupying a plane tangent to the rising side of the other rotor whereby a portion of the spray thrown by one rotor commingles with a portion of the spray thrown by the other rotor within the upright passageway which superimposes the space between the rotors and the remaining portion of the spray thrown by each rotor is directed into a different passageway, and means for introducing air into the upper ends of the two upright passageways which superimpose the spaces over the rising sides of said rotors to flow downwardly through the passageway which superimposes the space between the rotors.

5. In an air washer, an upright casing having a liquid containing sump in its bottom portion, a rotatably driven spray rotor horizontally supported within the casing to dip into the liquid in the sump, an upright partition superimposing in spaced relationship the spray rotor and extending tangentially to the rising side of the rotor and dividing the space within the casing above the rotor into a downdraft portion superimposing the rising side of the rotor and having an air inlet at the top and an updraft portion superimposing the descending side of the rotor and having an air outlet at the top, said portions communicating through the space between the lower edge of the partition and the rotor, and means for introducing air into the casing through the upper end of the downdraft portion and exhausting air therefrom through the upper end of the updraft portion, said updraft passageway having a cross sectional area substantially greater than the cross sectional area of the downdraft passageway whereby the air flows through the updraft passageway at a substantially slower rate than it flows through the downdraft passageway.

6. The invention described in claim 5 characterized in that the updraft passageway is provided within its upper end with water eliminator plates and means is provided for directing a water spray on to said eliminator plates to flow thereover and on to the partition to flow down over the partition and on to the rotor.

7. The air washer described in claim 5 wherein the partition is tangent to the rising side of the rotor.

8. An air washer comprising, in combination, an upright casing having a liquid containing sump in its lower portion, a weir dividing the sump into an auxiliary portion and a main portion, means for delivering water into the auxiliary portion to maintain a determined water level therein below the height of the weir, a rotor extending across the main portion and dipping into the water therein, and a pump having an inlet communicating with the auxiliary portion of the sump to draw water therefrom and deliver water into the main portion of the sump to flow therethrough and over the weir.

9. Apparatus for washing air comprising, in combination, an upright casing surmounting a liquid containing sump, a spray rotor supported within the casing for rotation about a horizontal axis and dipping into the liquid of the sump, means for rotating said rotor at such a speed as to cause a diverging fan of spray to be thrown upwardly from the rising side of the rotor characterized by being relatively coarse and heavy in the area generally over the rising side of the rotor and being relatively fine in the area generally over the descending side of the rotor, a substantially vertical partition within the casing extending downwardly tangentially to one side of the rotor and into said fan of spray and having the lower edge thereof terminating at a height above the top level of the rotor, the lower portion of the partition entering the fan of spray and acting to separate the coarser heavier section thereof from the finer section thereof and to subdivide the space within the casing above the rotor into two vertical air passageways communicating with one another through the opening provided between the lower edge of the partition and the rotor, and means for causing air to be drawn down one of said passageways into one of said sections of said spray and thence through the communicating opening and up the other passageway through the other section of the spray.

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