June 3, 1952 A. J. SCHIMPKE 2,599,202

APPARATUS FOR WASHING AND CONDITIONING AIR

Filed April 17, 1947 3 Sheets-Sheet 1

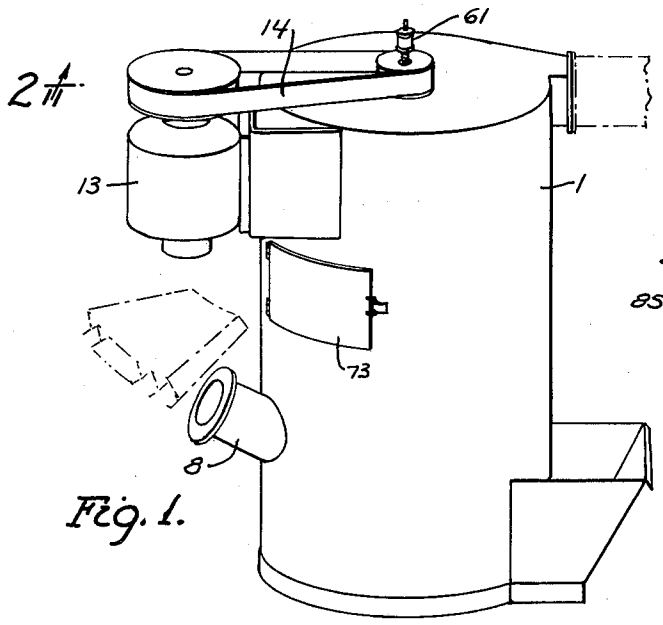

Fig. 1.

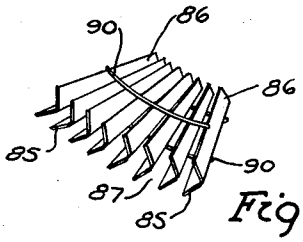

Fig. 6.

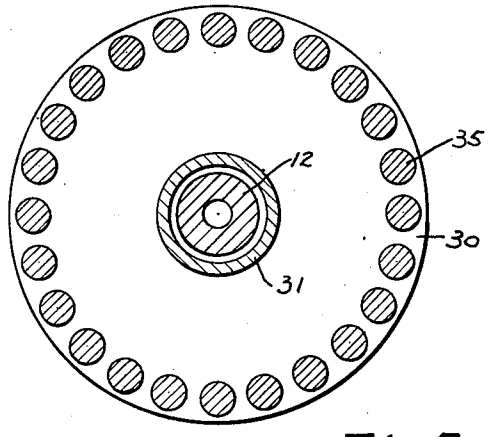

Fig. 5.

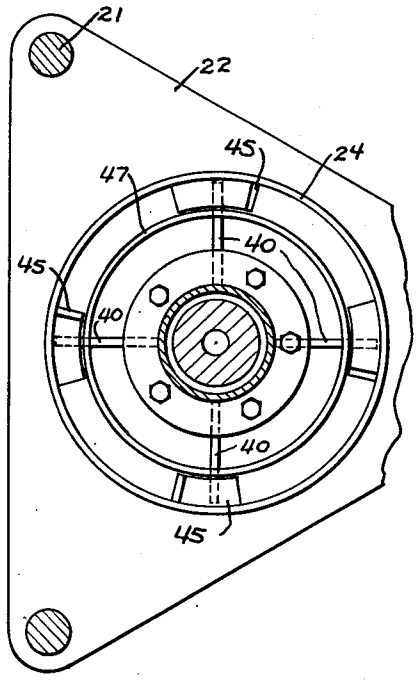

Fig. 4.

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APPARATUS FOR WASHING AND CONDITIONING AIR

Filed April 17, 1947 3 Sheets-Sheet 2

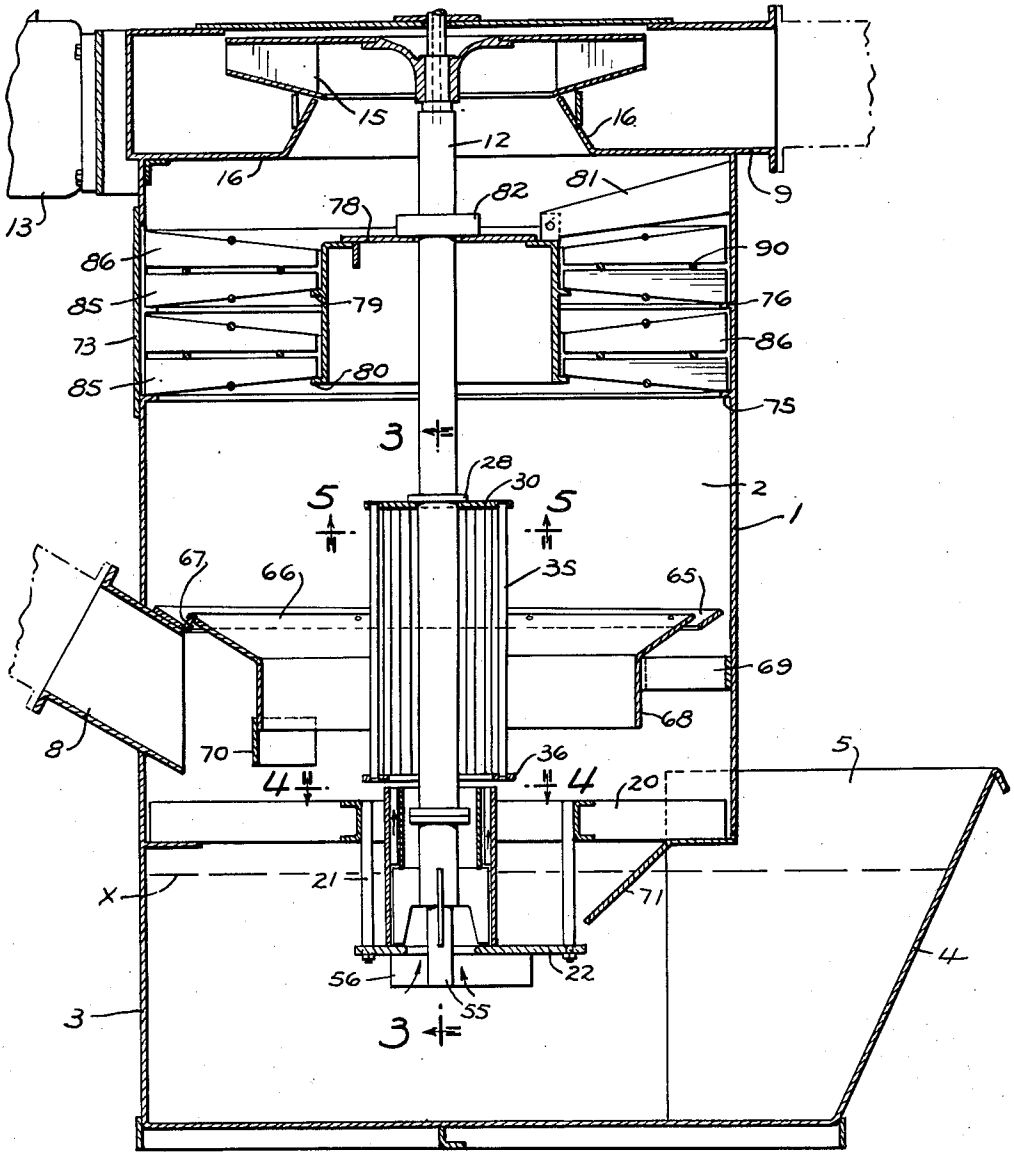

Fig. 2.

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APPARATUS FOR WASHING AND CONDITIONING AIR

Filed April 17, 1947 3 Sheets-Sheet 3

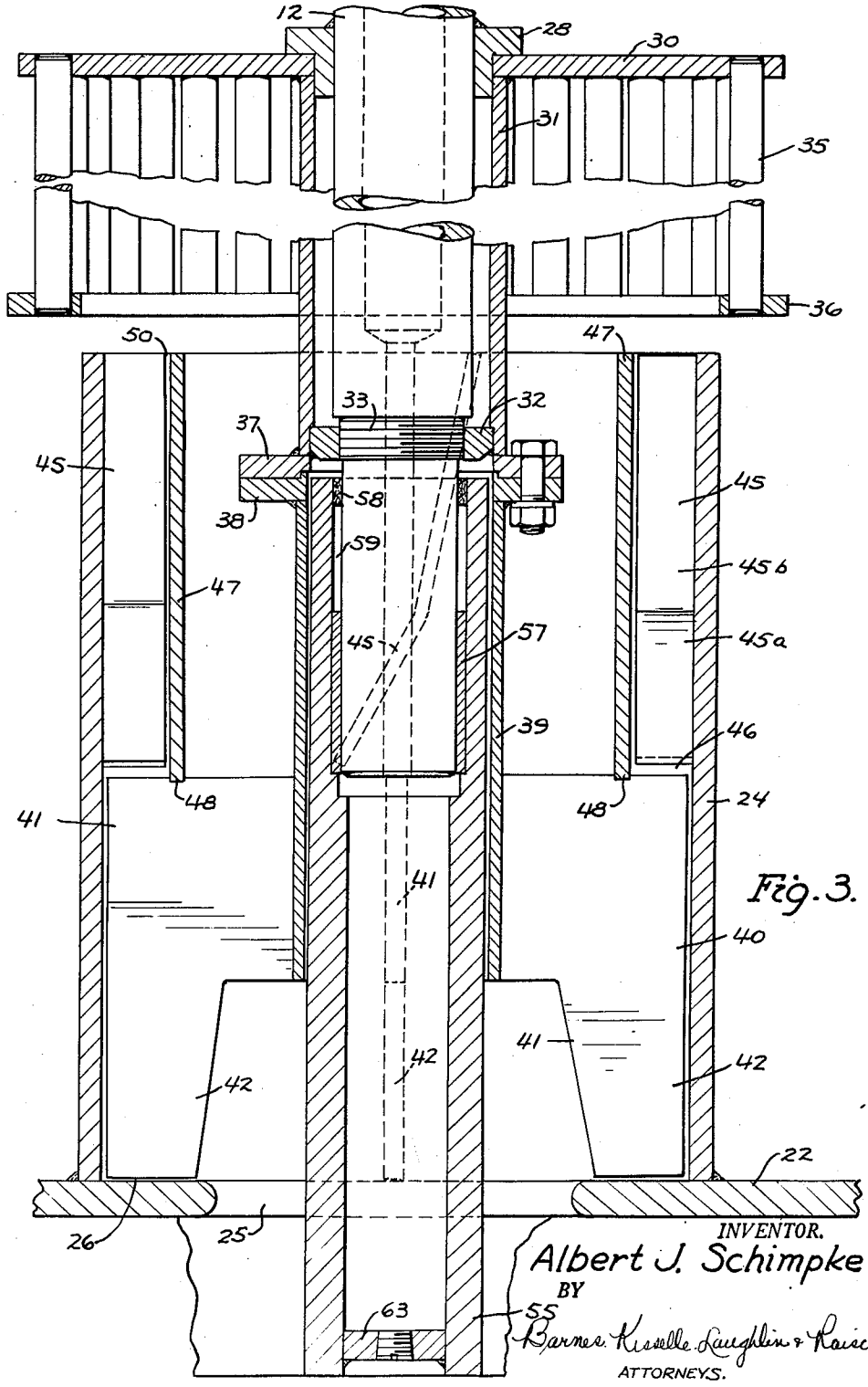

Fig. 3.

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APPARATUS FOR WASHING AND CONDITIONING AIR

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5 Claims. (Cl. 261—91)

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This invention relates to a machine for washing or cleaning dust laden air and it has to do particularly with a machine of this character which performs the cleaning functions by pumping and spraying in the form of a mist a cleaning or washing liquid, such as water.

The invention is directed particularly toward the provision of an improved air washing apparatus which efficiently cleans the air and which is essentially a wet type dust collector. In carrying out the invention, a chamber is provided through which the air is pumped and in the chamber is located liquid handling means which pumps the liquid or water from a sump or container and sprays the water in mist form. The entrained substances in the air are caught by the water and separated from the air.

Among the several objects of the invention are the provisions of an improved liquid pump and spray unit so organized and designed as to efficiently pump the liquid with a continuous non-surging action and so arranged and constructed that the spray may be varied. It will be understood that there are locations in factories where pieces of cloth, thread or string may enter the pump and the present invention embodies a pump which will not become clogged or otherwise interfered with by the presence of such substances. Other objects of the invention include a novel arrangement of a separator construction for separating the air from the moisture together with the entrapped substances and still other objects will become appreciated as the following detailed description is followed:

An apparatus for washing air is shown in the accompanying drawings and described herein. In these drawings:

Fig. 1 is a general view showing the exterior of a casing which embodies the invention.

Fig. 2 is an enlarged cross sectional view taken through the apparatus showing the pump mechanism, the spray device, and the separator structure.

Fig. 3 is an enlarged cross sectional view taken through the pump and operating shaft substantially on line 3—3 of Fig. 2.

Fig. 4 is an enlarged sectional view taken substantially on line 4—4 of Fig. 2 showing some of the pump structure and its support.

Fig. 5 is an enlarged sectional view taken substantially on line 5—5 of Fig. 2 showing the liquid spraying element.

Fig. 6 is a perspective view of a segment of a separator.

As illustrated in Figs. 1 and 2, the apparatus

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comprises an exterior shell 1 which provides a chamber 2 therein. The lower portion of the shell at 3 provides a sump for the liquid which may be plain water where air is to be cleaned and the sump portion has an extending part 4 with an opening 5 through which the accumulated material may be removed in any suitable manner.

The inlet for air is shown at 8, the same entering the side of the shell 1 and preferably discharging the air slightly above the level of the liquid which is indicated at x. The outlet for the air is at the top of the shell, as shown at 9. Mounted centrally in the shell is a shaft 12 which may be driven by a suitable motor 13 operating through driving means, such as a plurality of V-belts 14, as shown in Fig. 1, and on the upper portion of this shaft is a fan 15 provided with suitable shrouding 16. When the fan is operated the air is drawn in through the inlet 8 and discharged through the outlet 9 with the air moving generally upwardly in the shell 1.

The pump structure is primarily supported by an interior supporting brace structure 20, suspended from which by rods 21 is a supporting plate 22. Attached to the plate 22 is an upwardly extending bowl 24. The plate has an opening 25 which provides an opening in the bottom of the bowl. The opening 25 has a cross dimension less than that of the bowl and thus provides a circumferential ledge 26. The shaft 12 is hollow, as indicated, and as shown in Figs. 2 and 3, it has a collar 28 fixedly secured thereto. Mounted on the shaft is the spray element of the unit and this comprises an upper plate or bracket 30 with a tubular center part 31 through which the shaft 12 extends. Secured to the lower end of the tubular member 31, as by means of welding or the like, is a nut 32 arranged to engage the threads 33 on a reduced portion of the shaft. When the sleeve 31 is passed over the shaft and rotated relative thereto, the nut screws onto the thread 33 and draws the collar 28 tightly against the upper plate 30 and, therefore, the spray element is fixedly united in driving relationship with the shaft. Needless to say, the hand of the thread is such that the direction of rotation tends to keep the threaded engagement tight.

Mounted on the upper plate 30 are a plurality of rods 35. These rods extend downwardly from the upper plate and their lower ends are attached to a lower ring or plate 36. Thus, when the shaft revolves, the spray element, which may be considered as being a cage-like element, is rotated with the shaft.

The lower end of the tubular element 31 is provided with a flange 37 which is bolted to a flange 38, in turn united as by means of welding or the like, to a rotary tubular element 39. Mounted as by means of welding on the tube 39, are a plurality of impeller blades 40. As shown in Fig. 4, there may be four of such impeller blades. These blades extend outwardly and have a running clearance with respect to the interior of the bowl 24. The lower portions of the blades are preferably cut away as at 41 to provide relatively narrow portions 42, the lower edges of which are located immediately above the ledge 26. These blades are preferably vertically positioned.

Positioned above the blades are guide vanes 45. These are preferably welded to the interior of the bowl and have an adequate running clearance as at 46, with respect to the impeller blades. A tubular element 47 is welded to the upper portions of the blades 40, as indicated at 48. This tubular element encases the element 39 and has a running clearance 50 with respect to the guide vanes 45. There may be, and preferably are, four of such guide vanes 45, although this number may be varied, and they are angularly disposed, as illustrated by the dotted lines in Fig. 3. These guides preferably have a bend formation to provide a lower portion 45*a* at a different angle from an upper portion 45*b*. The annular space between tubular element 47 and the upwardly extending bowl 24 thus provides a circumferential passage through which the water is pumped upwardly and which is deflected by the guide vanes. No substantial amount of water is pumped through the space inside the tubular element 47.

It will be seen, therefore, that when the shaft 12 is rotated, that the spray element comprising the rods 35 is rotated, the lower end of the spray element being slightly above the bowl, and also the impeller blades 40 are rotated. The level of the liquid, as indicated in Fig. 2, is such that the blades 40 are normally submerged.

In order to provide an adequate bearing for the lower end of the shaft, there is a bearing support of tubular form as at 55, which is supported by brackets 56 welded to the underside of the plate 22 and which extends upwardly in the tube 39. As shown in Fig. 3, this is a relatively strong bearing supporting element and it is provided with a bearing 57 for the lower end of the shaft. At the upper end of the bearing support and positioned between the bearing support and the shaft is a sealing element 58, the same being spaced from the bearing 57 to provide a space 59. As mentioned above, the shaft is hollow and its upper end may be provided with an oil cup 61 and the entire hollow portion of the shaft is filled with oil. It follows that if the hollow bearing support 55 is filled with oil, the lower end being closed by a suitable plug 63, this oil moves upwardly, particularly in the operation of the device, to thus lubricate the bearing 57 and the oil also fills the space 59. As the device operates the space 59 is full of oil, but its escape is checked at least in part by the seal 58. Therefore, if the apparatus stands at rest for any considerable period of time, there is adequate oil present to lubricate the bearing. Moreover, if, due to inadvertence, the oil cup is not kept filled, there is a large supply of oil which will serve to lubricate the bearing for a long period of time.

Surrounding the spray element is a sort of baffle structure, which includes an inclined baffle ring 65 secured in spaced relation to the inside of the shell 1, and another element having a frusto-conical portion 66 which overlies the ring 65 in spaced relationship to provide a passageway 67. The member 66 has a circumferential wall portion 68 which may be supported by a plurality of brackets 69. Adjacent the inlet 8, the wall 68 carries a depending baffle 70. This structure, including the elements 65, 66 and 68 is offset or eccentrically disposed as shown in Fig. 2, so that the air entering through inlet 8 is caused to flow upwardly around the element 35 in substantially uniform manner. A baffle 71 projects into the liquid and thus prevents the air from flowing through the outlet trough 5.

Mounted in the upper portion of the casing is a separator structure, access to the space accommodating the same being made through a door 73. There are two circumferential supporting ledges 75 and 76 and an interior supporting structure 78 having circumferential supporting flanges 79 and 80. The interior structure 78 may be supported by a plurality of brackets 81. The structure 78 may also support a bearing 82 for the shaft 12.

The separator structure embodies baffles carried by the ledges 75, 76, 79 and 80 and these baffles are arranged in segments. One segment is shown in Fig. 6 and it comprises a plurality of plates 85 and 86 which are arranged in pairs. The pairs of plates are more or less nested together in spaced relationship to provide tortuous passageways 87 therethrough and the plates of each segment may be mounted in the segment subassembly by rods or strips 90 welded to the plates. As shown in Fig. 2, there are preferably two layers of separator plates resting respectively on the ledges 75 and 80 and 76 and 79. In order to place the separator structure in the shell, a segment is passed through the opening 73 and brought to rest on its supporting ledges. This segment is pushed circumferentially along the ledges to make room for a second segment. This operation may be continued until there is a full circumferential ring of segments.

In the operation of the apparatus, the dust-ladened air passes into the shell through the inlet 8 and then passes upwardly through the shell passing inside the circumferential wall 68 and through the separator plates. The baffle 70 is arranged to deflect the air circumferentially so that the air which passes upwardly inside the wall 68 is quite uniformly distributed throughout the area inside the wall 68. The center of the separator structure is closed by the support 78. The air then passes out through the outlet 9. When the pump and spray unit are in operation, the blades 40, which are submerged in the water or other cleansing liquid, displaces the water upwardly. This is due to several factors including the head of liquid at the level *x*, the presence of the ledge 26, and the angularity of the blade. However, the water would be displaced upwardly even if the blades were not angularly disposed. The water passes upwardly through the circumferential passage outside the rotating tubular element or ring 47 and inside the fixed bowl 24 and is guided by the inclined vanes 45 so that the water is forcibly pumped upwardly in the form of a cylinder and into the revolving spray cage. The rotation of the spray cage throws the water outwardly by centrifugal force and thus creates a fine mist inside the casing. As mentioned above, the angularity of the vanes 45 may be varied to attain the desired mist characteristics. If the vanes 45

are fairly steep in angularity, the water will wet the rods **35** all the way to the top plate **30**. If the vanes **45** are at a lesser angle, the water will travel up and wet the rods **35** only part of the distance. So, it will be seen that the angularity of the vanes may be selected as desired. Other factors in selecting the angularity are such things as the speed of rotation in the operation of the machine and the height of the spray cage. The action appears to be one where the pumped water strikes and accumulates in a film on the rods **35** and travels upwardly on the same, which water is thrown off centrifugally providing the fine mist or spray.

The air passing through the casing travels through the mist and then through the baffles of the separator. The water carrying the dust and dirt particles collect on the baffle plates of the separator and form drops of water larger than those of the spray and, therefore, these drops fall by gravity especially along the interior walls of the casing **1**. The drops of water carrying the extraneous material thus fall back into the sump. Some of the water strikes the angular ring **65** and flows downwardly through this space **67** thence into the sump and some flows through the space between the wall of the shell and the ring **65**.

It has been found in practice that the apparatus is so efficient in cleaning air, in a factory for example, that the air which is discharged through the outlet **9** may be discharged directly back into the factory building. This represents a large saving in fuel for heating the plant inasmuch as the warm air is not necessarily discharged to the outside of the building. The pump construction, as aforesaid, is one which will not be clogged nor will the function thereof be impaired by threads or strings or the like which may pass into the same with the air. There is an adequate running clearance between the blades **40** and the walls of the bowl, between the blades **40** and the vanes **45**, and between the ring **47** and the blades **45**. Fibrous or stringy particles will not, therefore, catch and collect in masses in these locations of clearance.

I claim:

1. In an air cleaning device of the type comprising a shell forming an interior chamber having an air inlet adjacent its lower end and an air outlet adjacent its upper end, a sump at the lower end of the shell for containing liquid and a vertically disposed operating shaft having a pump at the lower end thereof and a fan at the upper end thereof for moving air upwardly through said chamber, the improvement which comprises a cage-like spray device secured to said shaft above the liquid level in said sump and below said fan, said spray device comprising a bracket mounted on said shaft, a plurality of circumferentially spaced rods attached to the bracket and extending downwardly therefrom, and a supporting ring for stabilizing the lower ends of said rods, concentric cylindrical elements forming a hollow circumferential outlet for pumped liquid which is axially disposed and which opens upwardly into said chamber, said supporting ring having an aperture spaced inwardly of said rods and which overlies the open end of said outlet passage so that liquid discharged therefrom contacts and flows upwardly along the surface of said rods whereby the rods are wet by the liquid and the liquid is thrown out from said cage-like device in a fine mist by centrifugal action and baffle means for guiding air upwardly in the interior chamber and around the outside of the spray device.

2. In an air cleaning device of the type comprising a shell forming an interior chamber having an air inlet adjacent its lower end and an air outlet adjacent its upper end, a sump at the lower end of the shell for containing liquid and a vertically disposed operating shaft having a pump at the lower end thereof and a fan at the upper end thereof for moving air upwardly through said chamber, the improvement which comprises a cage-like spray device secured to said shaft above the liquid level in said sump and below said fan, said spray device comprising a bracket mounted on said shaft, a plurality of circumferentially spaced rods attached to the bracket and extending downwardly therefrom, and a supporting ring for stabilizing the lower ends of said rods, concentric cylindrical elements forming a hollow circumferential outlet for pumped liquid which is axially disposed and which opens upwardly into said chamber, said supporting ring having an aperture spaced inwardly of said rods and which overlies the open end of said outlet passage so that liquid discharged therefrom contacts and flows upwardly along the surface of said rods whereby the rods are wet by the liquid and the liquid is thrown out from said cage-like device in a fine mist by centrifugal action, said bracket being substantially imperforate and forming a barrier at the upper end of said cage-like device for preventing the passage of air and liquid upwardly through the upper end of said spray device and baffle means for guiding air upwardly in the interior chamber and around the outside of the spray device.

3. In an air cleaning device of the type comprising a shell forming an interior chamber having an air inlet adjacent its lower end and an air outlet adjacent its upper end, a sump at the lower end of the shell for containing liquid and a vertically disposed operating shaft having a pump at the lower end thereof and a fan at the upper end thereof for moving air upwardly through said chamber, the improvement which comprises a cage-like spray device secured to said shaft above the liquid level in said sump and below said fan, said spray device comprising a bracket mounted on said shaft, a plurality of circumferentially spaced rods attached to the bracket and extending downwardly therefrom, and a supporting ring for stabilizing the lower ends of said rods, concentric cylindrical elements forming a hollow circumferential outlet for pumped liquid which is axially disposed and which opens upwardly into said chamber, said rods being generally circular in cross section, said supporting ring having an aperture spaced inwardly of said rods and which overlies the open end of said outlet passage so that liquid discharged therefrom contacts and flows upwardly along the surface of said rods whereby the rods are wet by the liquid and the liquid is thrown out from said cage-like device in a fine mist by centrifugal action and baffle means for guiding air upwardly in the interior chamber and around the outside of the spray device.

4. In an air cleaning device of the type comprising a shell forming an interior chamber, a sump at the lower end of the shell containing liquid and a vertically disposed shaft having a pump at its lower end for pumping liquid upwardly into said chamber, the combination of a cage-like spray device secured to said shaft above

the liquid level in said sump, said spray device comprising a circular plate mounted on said shaft, a plurality of circumferentially spaced rods attached to said plate and extending downwardly therefrom, a supporting ring for stabilizing the lower ends of said rods, and means defining a hollow circumferential pump outlet passage extending axially upwardly from said pump around the shaft and opening into the chamber adjacent to the lower end of said cage-like device, said supporting ring extending outwardly of the open end of the said outlet passage and having an opening therein registering with the open end of said outlet passage so that only liquid is discharged upwardly through said opening in said ring and into the cage-like spray device for contact and flow upwardly along the surface of said rods whereby said rods are wet by said liquid and said liquid is thrown outwardly of said cage as a fine mist by centrifugal action and baffle means for guiding air upwardly in the interior chamber and around the outside of the spray device.

5. In an air cleaning device of the type comprising a shell forming an interior chamber, a sump at the lower end of the shell containing liquid and a vertically disposed shaft having a pump at its lower end for pumping liquid upwardly into said chamber, the combination of a cage-like spray device secured to said shaft above the liquid level in said sump, said spray device comprising a circular plate mounted on said shaft, a plurality of circumferentially spaced rods attached to said plate and extending downwardly therefrom, a supporting ring for stabilizing the lower ends of said rods, and means defining a hollow circumferential pump outlet passage extending axially upwardly from said pump around the shaft to a point adjacent said supporting ring,

said circumferential outlet passage being open at its upper end, said supporting ring having an opening therein spaced inwardly of said circumferentially spaced rods and arranged over the upper open end of the circumferential outlet passage, said ring being disposed outwardly of the upper open end of the circumferential outlet passage so that only the liquid is discharged upwardly through said opening in the ring and into the cage-like spray device for contact and flow upwardly along the surface of said rods whereby said rods are wet by said liquid and said liquid is thrown outwardly of said cage as a fine mist by centrifugal action and baffle means for guiding air upwardly in the interior chamber and around the outside of the spray device.

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