Oct. 17, 1967 A. J. SCHIMPKE 3,347,535

GAS-LIQUID CONTACT APPARATUS

Original Filed Sept. 27, 1962 4 Sheets-Sheet 1

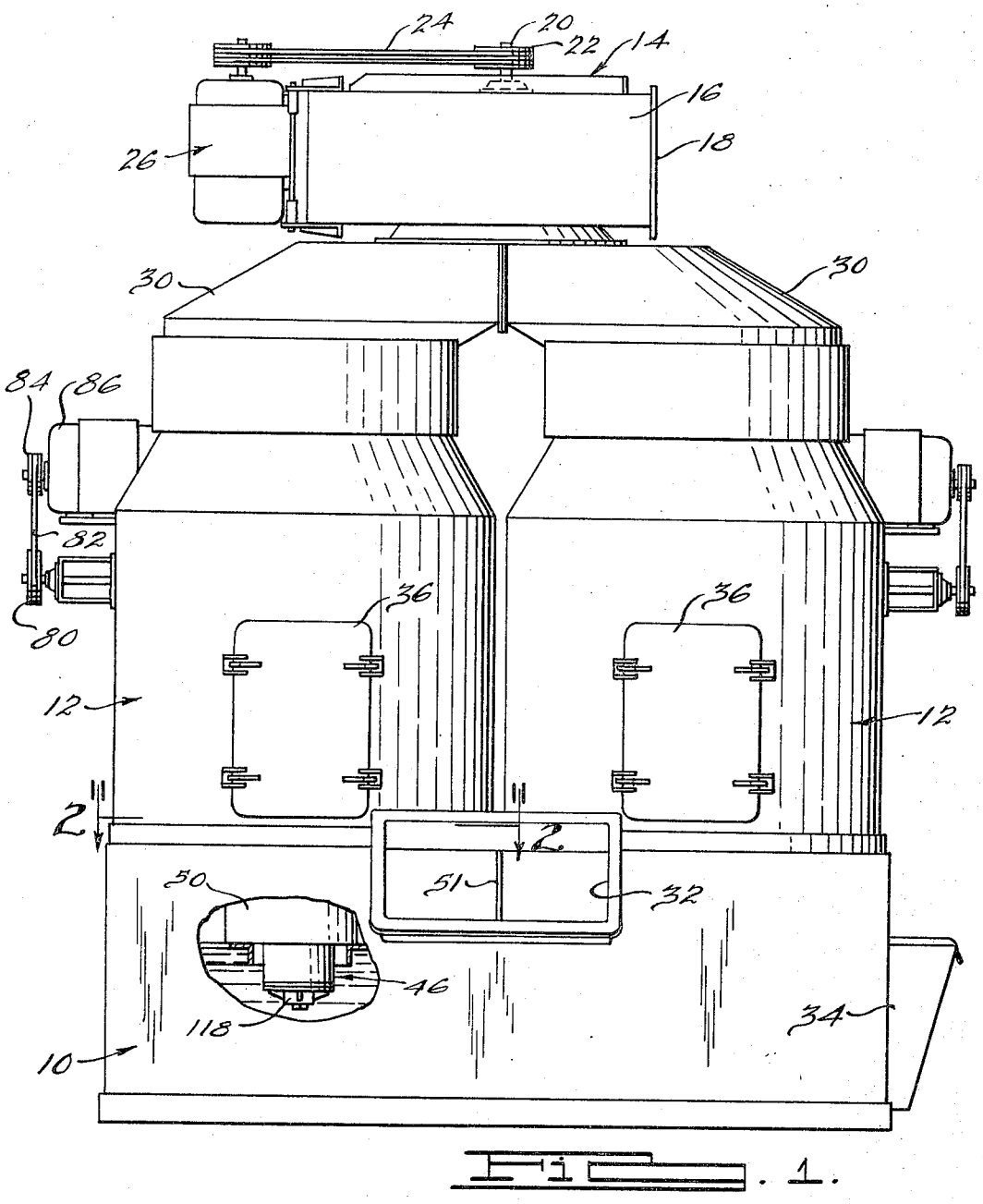

Fig. 1.

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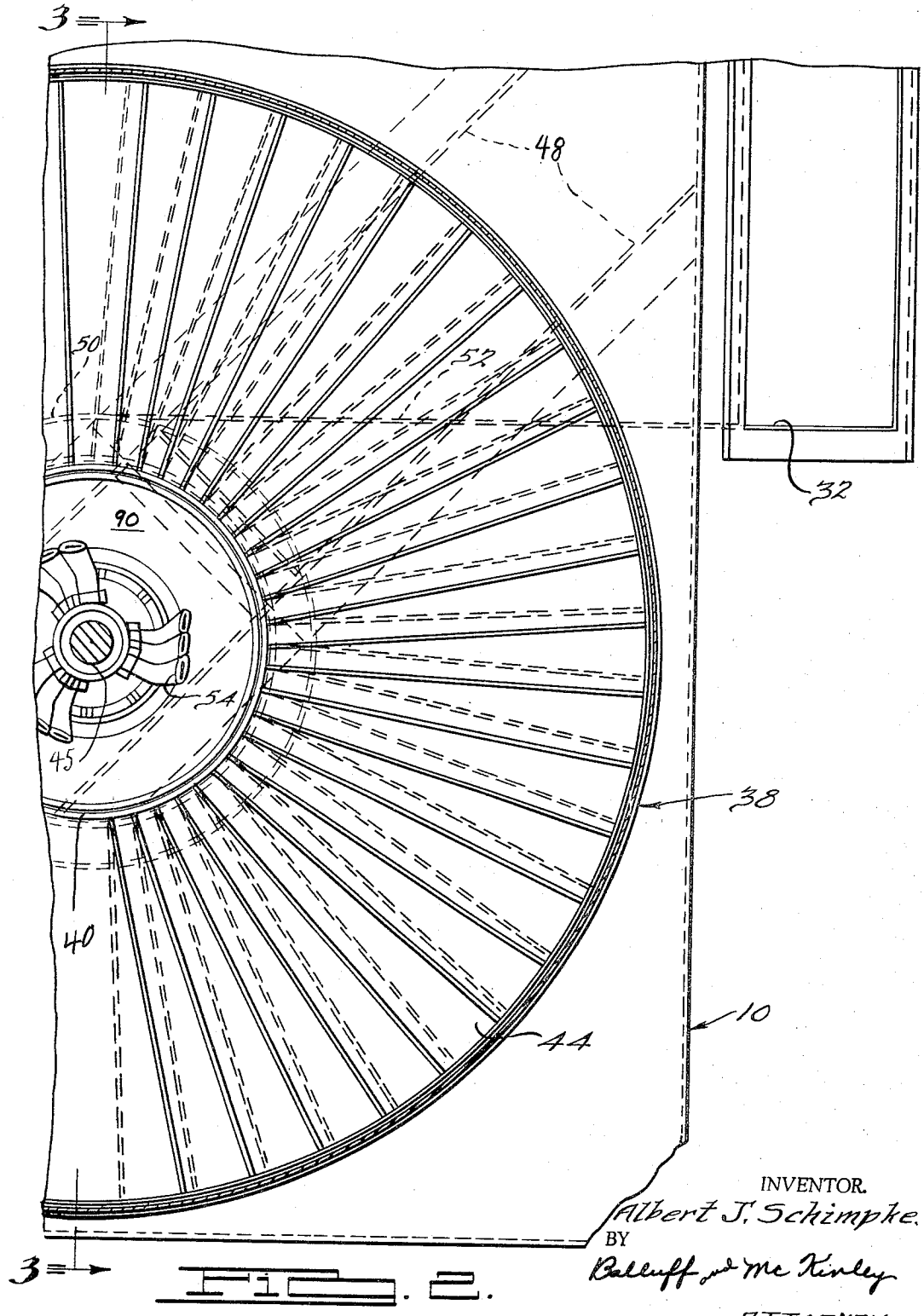

FIG. 2.

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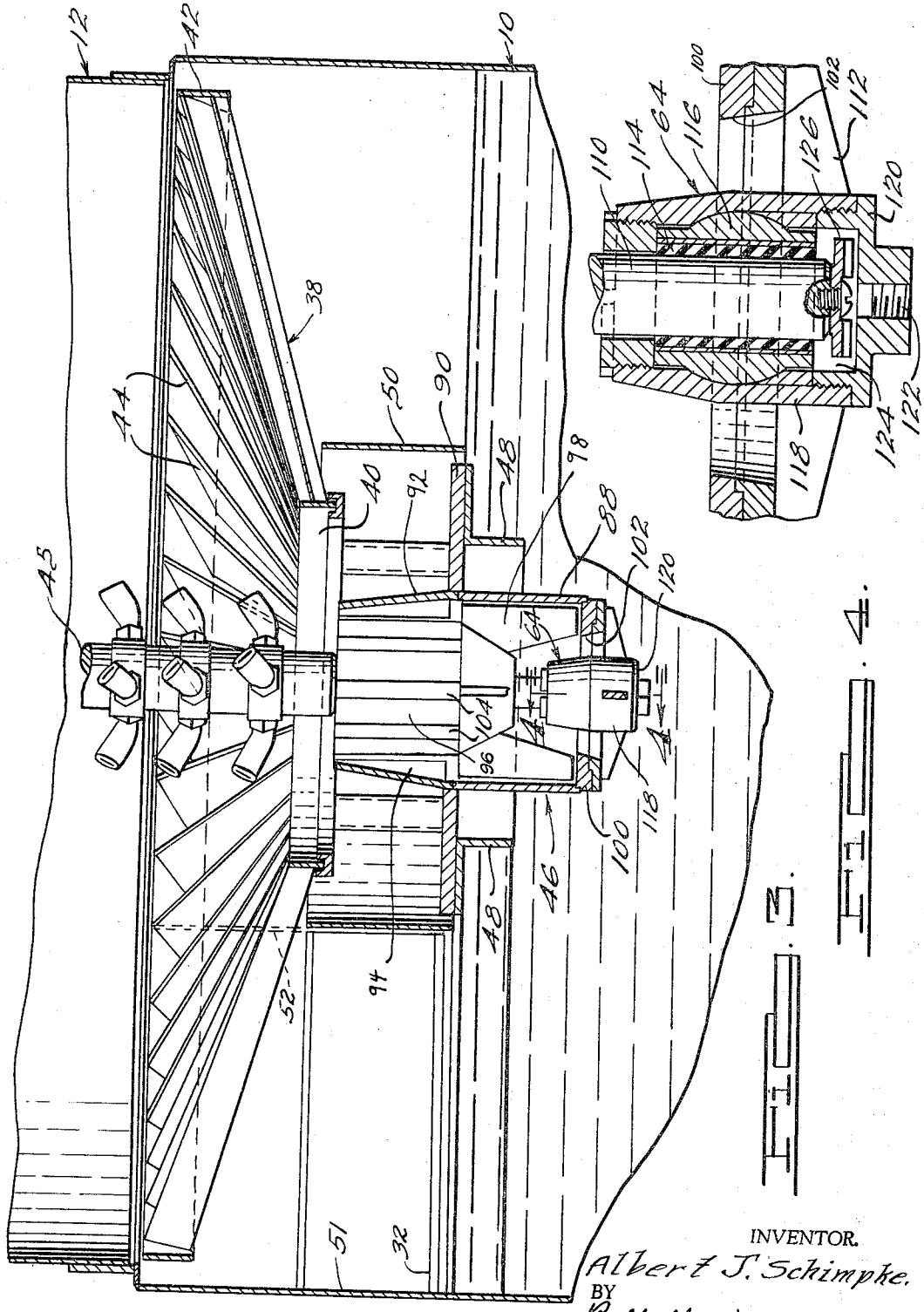
4 Sheets-Sheet 3



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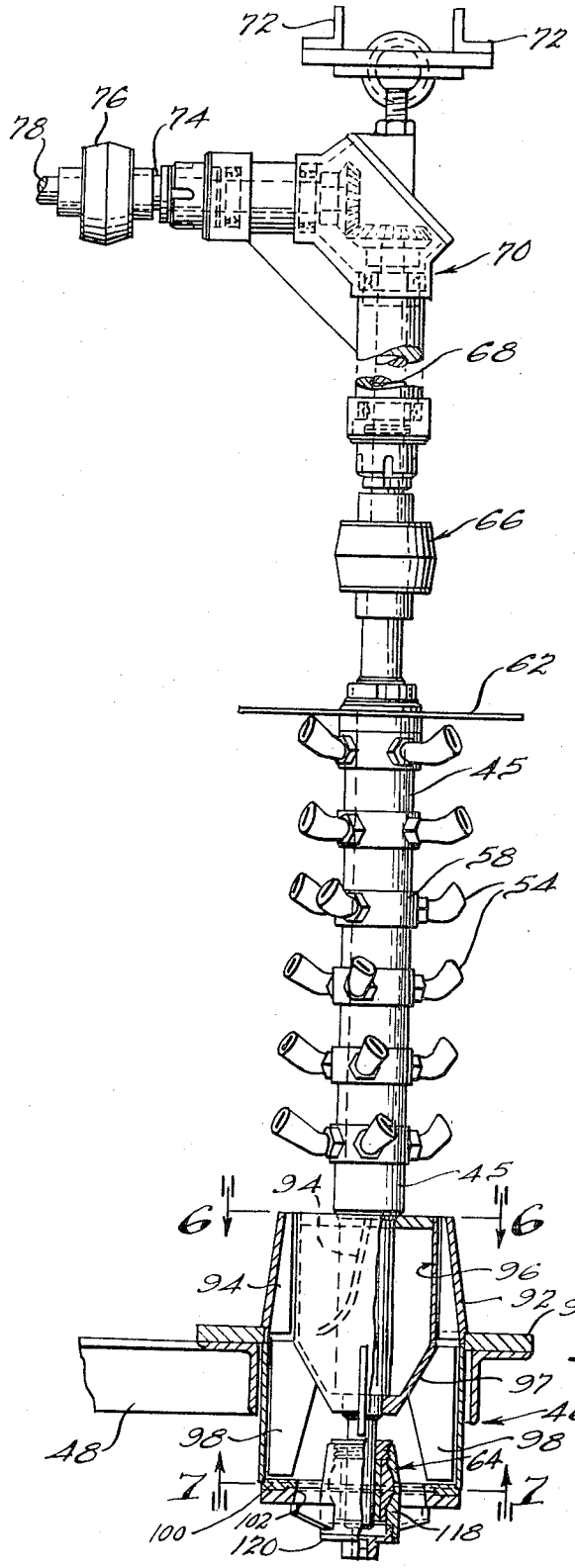

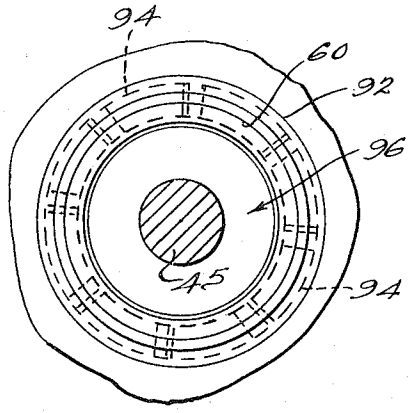

FIG. 6.

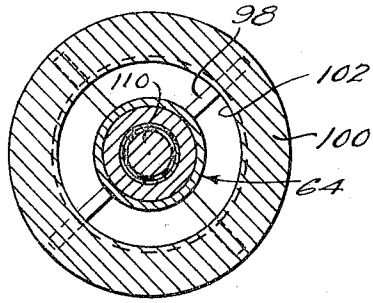

FIG. 7.

FIG. 5.

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3,347,535

GAS-LIQUID CONTACT APPARATUS

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Continuation of application Ser. No. 226,492, Sept. 27, 1962. This application June 3, 1966, Ser. No. 555,204
10 Claims. (Cl. 261—29)

ABSTRACT OF THE DISCLOSURE

An air washer in which dirt-laden air is brought into the lower end of a housing and caused to flow upwardly through an air-washing zone in the housing. A rotary spray generating means in the air-washing zone breaks up water supplied by a pump into fine particles which are thrown outwardly across the air-washing zone to intersect the air stream and remove dirt therefrom.

This invention relates to gas-liquid contact apparatus and in particular has reference to a machine for washing and cleaning dust-laden air. The apparatus herein disclosed is an improvement upon the air-washing apparatus disclosed in my prior Patent No. 2,599,202, issued June 3, 1952, for "Apparatus for Washing and Conditioning Air." This application is a continuation of my copending application Ser. No. 226,492, filed Sept. 27, 1962, now abandoned.

The present invention is directed to certain improvements in construction and in the spray generating means which serve to improve the efficiency, dependability and utility of the apparatus and to reduce the maintenance requirements thereof.

A principal object of the invention therefore is to provide in a gas-liquid contact apparatus an improved spray generating means.

Another object of the invention is to provide in an apparatus of the character described an improved pumping means.

Another object of the invention is to provide a new and improved air-washing machine.

Other and further objects of the invention will be apparent from the following description and claims and may be understood by reference to the accompanying drawings, of which there are four sheets, which by way of illustration show a preferred embodiment of the invention and what I now consider to be the best mode of applying the principles thereof. Other embodiments of the invention may be used without departing from the scope of the present invention as set forth in the appended claims.

In the drawings:

FIG. 1 is an elevational view of a machine embodying the invention;

FIG. 2 is an enlarged fragmentary section taken along the line 2—2 of FIG. 1;

FIG. 3 is a fragmentary section taken along the line 3—3 of FIG. 2;

FIG. 4 is an enlarged sectional view taken along the line 4—4 of FIG. 3;

FIG. 5 is an elevational view of the rotary impellers and the liquid pump, and the driving arrangement therefor;

FIG. 6 is an enlarged sectional view taken along the line 6—6 of FIG. 5; and

FIG. 7 is an enlarged sectional view taken along the line 7—7 of FIG. 5.

As illustrated in FIG. 1, the gas-liquid contact apparatus is an air washer which includes a tank 10, vertical housings 12 supported on the tank 10, and an exhaust

blower 14 having its inlet connected to the interior of the housings 12 for effecting the flow of air through each of the housings. The scroll 16 of the blower 14 is arranged to discharge the air pumped by the blower 14 into the atmosphere through the outlet 18 thereof. However, the outlet 18 of the blower may be connected with any suitable duct work if desired. The blower 14 includes a rotor (not shown) carried by a shaft 20 having a pulley 22 thereon which is driven by belt 24 from a pulley on the shaft of motor 26 which is mounted on the side of the blower 14.

The housings 12 are circular in cross section and are supported on the tank 10 in such a manner that the interior of each of the housings communicates at its lower end with the interior of the tank 10 at the upper end thereof. The tank is partly filled as indicated with liquid, preferably water. The interior of each of the housings provides a vertical air flow path through which air is circulated by the blower 14 which is arranged so that the inlet of the blower communicates with the upper end of each of the housings 12 through the manifold 30. The tank 10 is provided with an inlet 32 for dirt-laden air which opens into the upper part of the tank and thus provides a common inlet for the two housings 12. The tank is also provided with a lateral extension 34 which provides a cleanout whereby sediment, dirt, and the like which accumulate in the tank may be removed therefrom. Each of the housings 12 is provided with an inspection port normally closed by a closure 36. Liquid separating baffles (not shown) are provided in the upper end of the housings 12 so as to remove liquid from the airstream before it enters blower 14.

As shown in FIG. 3, the water level in the tank 10 is well below the lower open end of the housing 12 and an annular baffle structure 38 is disposed in the upper part of the tank below the lower end of the housing. The baffle structure 38 includes inner and outer rings 40 and 42 which support a series of inclined baffles 44, the baffles being spaced and overlapping and preferably sloping in such a direction that the air as it flows from the upper part of the tank 10 into the housing 12 must make a sharp turn so as to aid in separating dirt and water from such air. Baffles 44 impart a spiralling motion to the airstream as it flows upwardly through the housing 12 so as to aid in separating dirt from the airstream.

The inner ring 40 of the baffle structure provides a central opening for accommodating the drive shaft 45 of pump 46 which is supported on braces 48 which extend across the tank 10 at the water level. A shroud ring 50 encloses the pump 46 and extends from the water level in the tank 10 to just below the baffles 44 so as to prevent the flow of air from the tank upwardly through the inner ring 40 of the baffle. A vertical dividing wall 51 extends across the air space in the upper part of the tank 10 and cooperates with a spaced vertical wall 52 so as to conduct the air flowing into the air space in the tank on one side of wall 51 to approximately the center of the tank so as to better distribute the incoming air below the baffle structure 38. Wall 52 extends from inlet 32 to shroud ring 50 and is disposed tangent thereto. The cross section of the annular air flow path below baffle 38 is greater than that of inlet 32 which serves to substantially decrease the velocity of the dirt-laden air after it enters the upper part of the tank, and the cross section of the air flow path upwardly through housing 12 is greater yet. This, coupled with the abrupt change in direction of the air as it flows upwardly through the baffle structure and the spiralling action imparted to the air by the baffle structure, contributes to the separation of dirt particles from the air as it flows through the washer.

A spray generating means is disposed in the gas flow path provided by the housing 12 and is operable for cre-

ating and discharging a spray of liquid across the gas stream as it flows upwardly through the housing **12**. The spray generating means comprises the pump **46** which is arranged to discharge a hollow column of water upwardly into the gas stream parallel to the flow thereof, and a series of radially extending impellers or vanes **54** mounted on shaft **45**. A series of impellers **54** are adjustably mounted on a collar **58**. A series of collars **58**, each with a series of impellers **54** thereon, are fixed to the shaft **45** and spaced along the length thereof. The shaft **45** is disposed on the axis of the air path through the housing **12** and within the hollow column of water discharged upwardly into the air path from the annular discharge orifice **60** of the pump **46** so that the impellers **54** upon rotation of the shaft **45** are engageable with the upwardly flowing column of water discharged from the pump **46**.

A disc **62** mounted on the shaft above the impellers **54** serves to limit the upward flow of the column of water discharged by the pump **46** in the event that such column has not been completely dispersed by the impellers **54**. From FIG. 5 it is evident that the path of each of the impellers intersects the liquid column of water discharged by the pump **46**. The shaft **45** and the impellers **54** carried thereby are rotated at a speed sufficient to break up the upwardly flowing column of liquid and to impart an outward velocity to liquid particles thereof to form a dense liquid dispersion or spray which extends in an expanding spiral path across the gas stream and throughout a substantial portion of the length of the path provided by the interior of the housing **12** and so that the flow path of the liquid dispersion intersects the flowing gas stream in a zone substantially coextensive with the axial distance between the discharge orifice **60** of the pump **46** and the disc **62**.

The shaft **45** at its lower end is supported in a bearing **64** provided at the lower end of the pump **46** and at its upper end is driven through a flexible coupling **66** which connects the shaft **45** to a vertical shaft **68** which forms a part of the bevel gear drive **70**. The bevel gear drive **70** is suitably supported from cross brackets **72** disposed within the upper part of the housing **12**. The input shaft **74** of the bevel gear drive **70** is driven through a flexible coupling **76** from a shaft **78** which projects exteriorly of the housing **12** and is provided with a pulley **80** whereby it is driven through belt **82** from a pulley **84** fixed on the shaft of motor **86**. The motor **86** may be a variable speed motor whereby the drive shaft **45** and the impellers **54** carried thereby may be driven at any selected speed for the purpose of varying the spray created by the spray generating means and the output of pump **46**. In addition, the impellers **54** may be adjusted so as to change the angle of incidence of the impelling surface thereof with the liquid column for varying the nature of the spraying created. It is not necessary that all of the impellers **54** be of the same size or oriented in the same manner.

The rate of rotation of the impellers **54** should be sufficient to disperse all of the water discharged by the pump **46**. However, it is preferable to have the pump discharge sufficient water so that some will impinge against the under side of the disc **62** so as to insure that all of the impellers **54** will be supplied with water. It is also preferable that the impellers **54** act on the water so that the particles of the water will be deflected in an expanding spiral path across the gas stream and will forcibly impinge on the inner surface of the housing **12** so that the flow path of the liquid particles will intersect the flowing gas stream and serve to separate particles of dirt therefrom, the liquid particles carrying the dirt particles with them into contact with the inside wall of the housing **12** where such liquid with the dirt entrained therein will flow downwardly and drop into the liquid in the tank **10**. The rotary motion imparted to the upwardly flowing stream of air by the baffles **44** will additionally tend to centrifugally deposit dirt particles onto the inner surface of the housing **12** so as to be washed down into the liquid in the tank **10** by the downflowing liquid on the inside wall of the housing **12**.

The pump proper comprises a sleeve **88** which is carried by a ring **90** which in turn is supported by the braces **48**, the lower end of the sleeve **88** extending below the level of the liquid in the tank **10**. The upper part **92** of the sleeve **88** above the ring **90** is frusto-conical in shape and is interiorly provided with a series of fixed ribs or vanes **94** which span the clearance between the inside wall of the portion **92** and the hub **96** which encloses a lower portion of the shaft **45** and is carried thereby. There is, however, a running clearance between the outer surface of the hub **96** and the innermost edges of the ribs **94**. The hub **96** carries a series of radially and axially extending vanes or impellers **98** which rotate within the cylindrical pump chamber provided by the lower part of the sleeve **88**. The outer edges of the vanes **98** have a slight running clearance with respect to the inner annular surface of the lower part of the sleeve **88** and also with respect to the lower edges of the stationary vanes **94** and the lower end wall **100** of the pump chamber.

A central inlet **102** to the pump chamber is formed in the wall **100** whereby liquid from the tank will flow into the pump chamber where such liquid is subjected to the pumping action of the vanes **98**. Upon rotation of the shaft **45** at an appropriate speed the vanes **98** will force liquid upwardly through the annular passage between the frusto-conical portion **92** and the hub **96** and discharge such liquid through the discharge orifice **60** upwardly in the form of a hollow column around the shaft **45**. The stationary vanes **94** substantially eliminate the rotation of the liquid before it is discharged through the orifice **60**. The frusto-conical sleeve portion **92** provides an annular passage which tapers in cross section toward the orifice **60** and cooperates with vanes **94** to provide a high velocity upward discharge of liquid in the form of a hollow cylinder for engagement by impellers **54**.

To aid in cutting up any thread or lint or stringy material which may be carried along with the air which is brought into the air washer, the outer surface of the hub **96** may be provided with a series of vertically extending shallow corrugations **104** forming cutting edges or ribs for cooperation with the stationary vanes **94**. Optionally the upper part of the hub **96** which is coextensive with the stationary vanes **94** may be made separate from the rotating conical lower portion **97** of the hub and made stationary by having the vanes **94** secured not only to the inside of the portion **92**, but also to the outside of the upper portion of the hub which will in such event be stationary. The lower portion **97** with the vanes **98** will, of course, turn with the shaft **45**. The lower end of the shaft **45** is reduced as indicated at **110** and journaled in bearing **64**. The bearing **64** is carried by a spider **112** which is secured to the under side of the lower end wall **100** of the pump and is provided with an opening in line with the inlet **102** to the pump chamber.

The bearing **64** includes a sleeve **114** of resilient rubber-like material which is carried in a sleeve **116** of resilient rubber-like material that has a limited amount of universal movement in the bearing housing **118**. The lower end cap **120** of the bearing housing is provided with a threaded inlet opening **122** for receiving the end of a feed pipe whereby water may be supplied to the cavity **124** formed in the lower end of the bearing housing **118**. A rotary impeller **126** fixed on the lower end of the shaft **45** functions to draw water into the cavity **124** through the inlet **122** for lubricating the bearing, the water passing upwardly through the bearing and then being discharged around the reduced end of the shaft **110** into the tank **10**. Suitable means are provided for maintaining water at the desired level in the tank **10**.

While I have illustrated and described a preferred embodiment of my invention, it is understood that this is capable of modification, and I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

What I claim as my invention is:

1. In gas-liquid contact apparatus, a housing providing a vertical gas flow path with a gas inlet at its lower end, means for effecting the flow of a stream of gas spirally upwardly through said path, and liquid spray generating means operable for creating and discharging a spray of liquid across said path, said spray generating means comprising liquid pumping means arranged to discharge a column of liquid into said gas stream longitudinally thereof, a shaft rotatable about an axis extending longitudinally of said gas path and a series of impellers on said shaft and extending radially outwardly therefrom and being spaced along said axis substantially throughout the length of said column, each of said impellers intersecting and acting upon a portion only of said column to permit the remainder of the column to flow past such impeller to other of said impellers, and power means for effecting rotation of said shaft at a speed sufficient to break up the liquid impacted by said impellers into particles and to impart an outward velocity to the liquid particles to form a liquid dispersion which extends in a spiral path across said gas stream throughout a substantial portion of the length of said gas path.

2. Apparatus according to claim 1 wherein said liquid column is hollow and said axis is disposed within said column.

3. Apparatus according to claim 1 including baffle means at the lower end of said housing for distributing the gas throughout an annular flow path upwardly through said housing.

4. Apparatus according to claim 3 wherein said baffle means are arranged to cause an abrupt change in direction of gas flow as the gas passes through said baffle means into said housing.

5. Apparatus according to claim 4 wherein said baffle means are adapted to impart an upwardly spiraling motion to the gas.

6. Apparatus according to claim 5 including liquid collecting means below said baffle means.

7. In an air washing apparatus, a housing having an air inlet at its lower end and an upwardly extending encircling side wall, means for effecting the flow of air through said inlet and in a circumferential direction within said housing stationary baffle means adjacent the lower end of said housing in the path of the air flow but above said air inlet for distributing the incoming air substantially uniformly throughout an annular horizontal path below said baffle means and substantially co-extensive in radial extent with the encircling housing side wall, said baffle means directing the air upwardly from said annular path through said baffle means so as to be substantially uniformly distributed throughout an annular air washing zone above said baffle means and extending to the encircling housing side wall, said baffle means being arranged to cause an abrupt change in the direction of air flow as the air passes through said baffle means upwardly into said housing, liquid pumping means arranged to discharge a column of liquid upwardly into said housing along the axis of said air washing zone, and power driven rotary spray generating means disposed in the path of said liquid column above said baffle means and adapted to break up the liquid into particles which are thrown radially outwardly through said air washing zone to impinge on the encircling housing side wall.

8. An apparatus as in claim 7 wherein said baffle means are adapted to impart an upwardly spiraling motion to the air.

9. An apparatus as in claim 8 including liquid collecting means below said baffle means.

10. An apparatus as in claim 7 wherein said spray generating means includes a rotating plate lying perpendicular to said liquid column and limiting upward flow thereof.

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