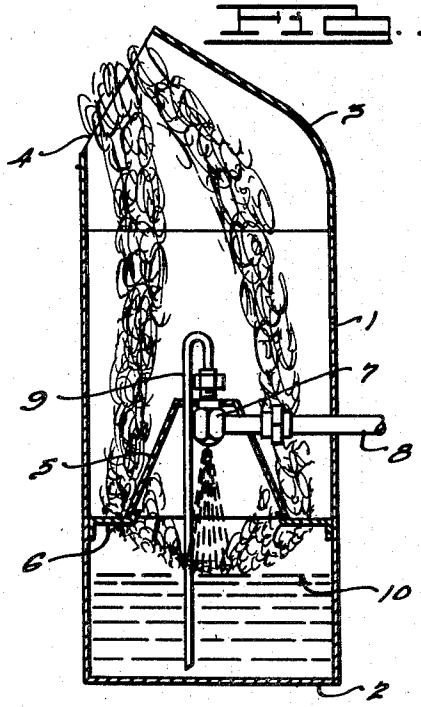
March 30, 1948. V. A. TRIER 2,438,868

METHOD AND APPARATUS FOR ATOMIZING LIQUIDS

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Fig. 1.



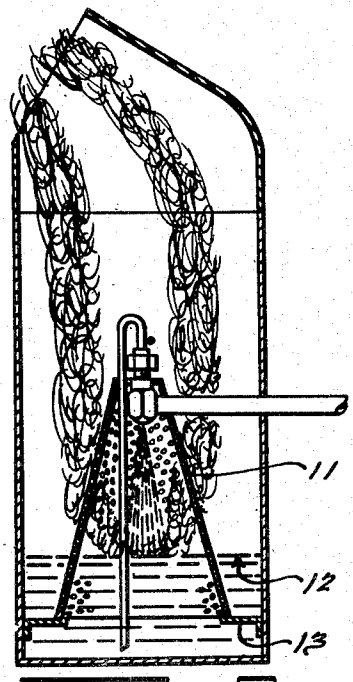


Fig. 2.

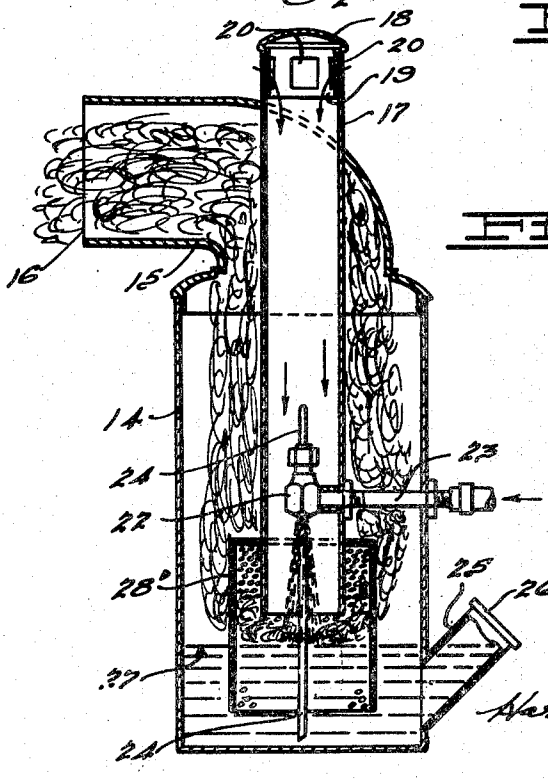


Fig. 3.

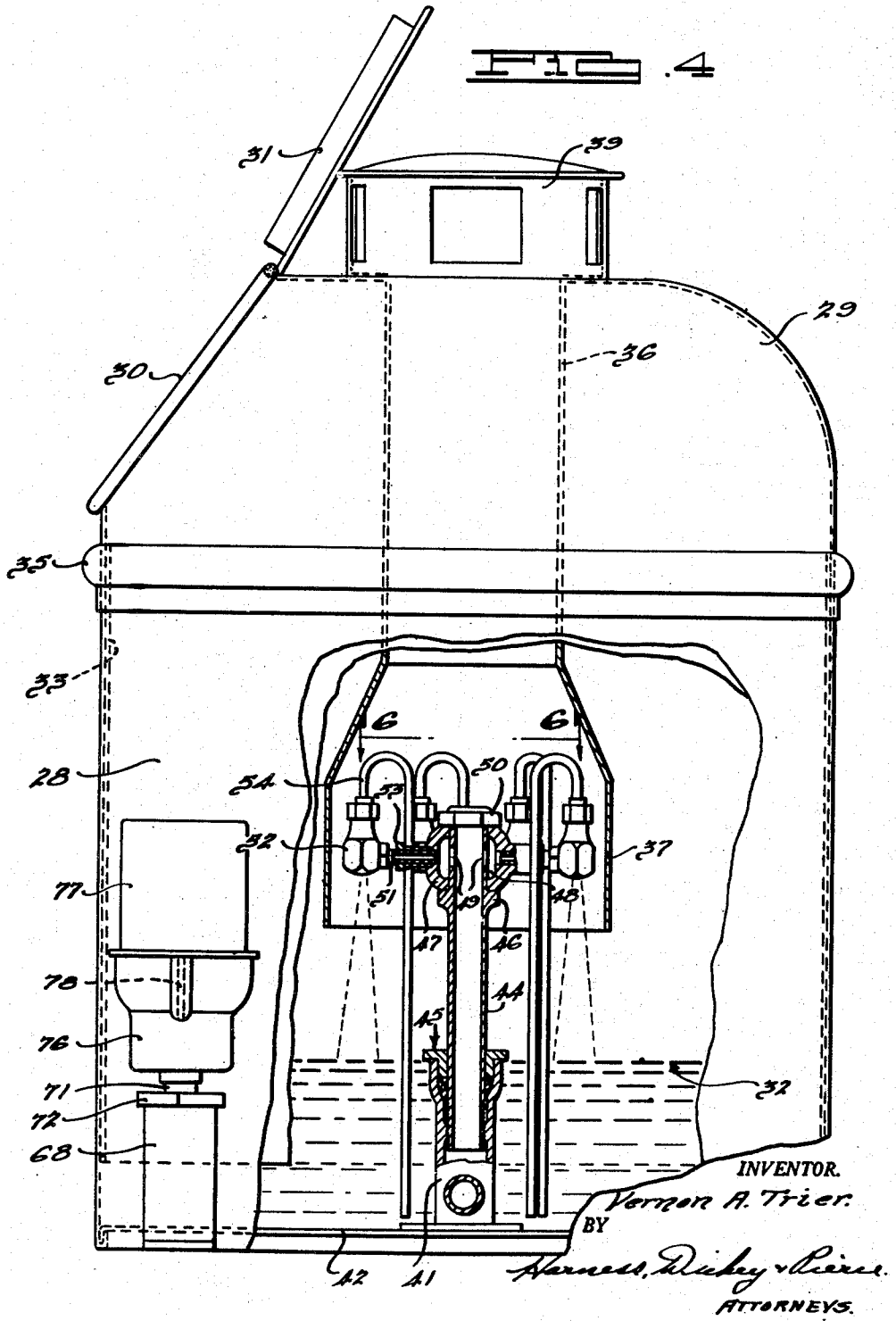
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METHOD AND APPARATUS FOR ATOMIZING LIQUIDS

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FIG. 4



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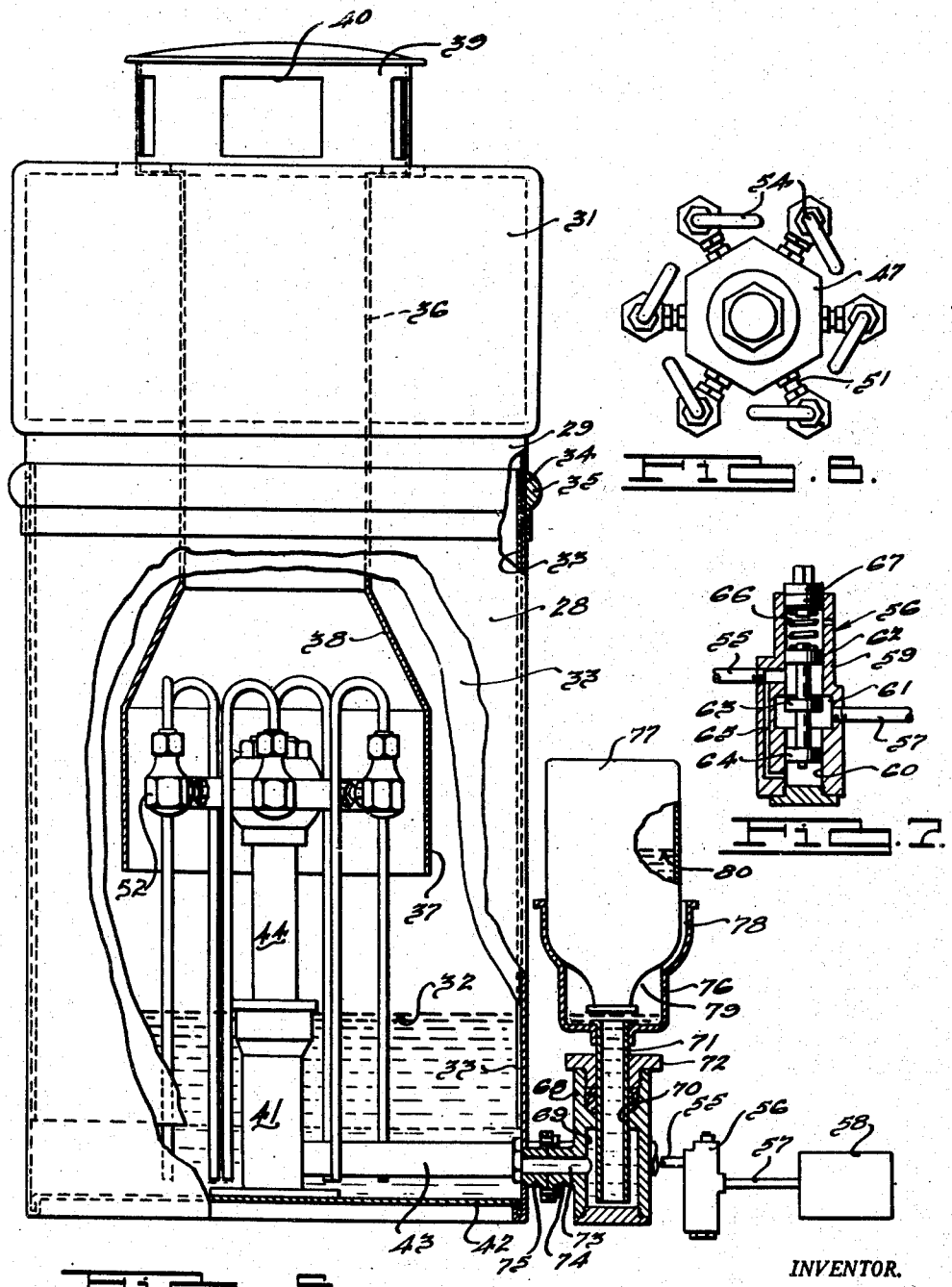


Fig. 5.

Fig. 6.

Fig. 7.

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METHOD AND APPARATUS FOR ATOMIZING LIQUIDS

Vernon Anthony Trier, London, England

Application August 22, 1944, Serial No. 550,595
In Great Britain September 9, 1943

3 Claims. (Cl. 261—116)

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The present invention relates to the atomization of liquids, and in particular to a method and apparatus for producing a mist composed of liquid particles capable of remaining in suspension in the atmosphere or other gaseous medium. Fine mists of the type to which the present invention relates, when suspended in the atmosphere, have been found useful as germicides and as insecticides. In such cases the liquid employed comprises or contains a germicide or insecticide. The apparatus and method of the present invention may, however, be employed to produce a mist of a liquid capable of suspension in any gaseous medium for any desired purpose.

Hitherto in the production of similar mists liquid has been discharged from an atomizing chamber in the form of a mist by means of an atomizer nozzle supplied with compressed air or gas, and baffles within the chamber have been employed to prevent the discharge from the chamber of the undesirable larger liquid particles.

It is the general object of this invention to provide an improved and simplified method and apparatus for producing a mist of the type mentioned.

Another object of the invention is to provide a method and apparatus by means of which the fineness and rate of discharge or concentration of the mist may be controlled.

Other objects and advantages of the invention will become apparent from the following specification, the accompanying drawings, and the appended claims.

In the drawings:

Figure 1 is a sectional view illustrating a simplified form of the apparatus which may be employed to carry out the improved method.

Figure 2 illustrates a slightly modified apparatus of the type illustrated in Figure 1.

Figure 3 is a sectional view of a further form of the apparatus employing means to control the concentration of the mist as well as its rate of discharge.

Figure 4 is a front elevation of the preferred form of apparatus, with parts of the outer casing broken away to show the interior construction.

Figure 5 is a side elevation of the apparatus illustrated in Figure 4.

Figure 6 is a fragmentary plan view of the nozzle assembly and manifold employed in the apparatus in Figures 4 and 5.

Figure 7 is a more or less diagrammatic section of an air pressure control valve employed in connection with the preferred form of apparatus.

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Referring to Figure 1, there is illustrated a casing 1 which may be of any desired form, such as a vertical cylinder, with a closed bottom 2 and a removable top 3 having a discharge opening 4. A frusto-conical shield 5 is mounted centrally within the casing 1 in any suitable manner, as by four spaced brackets 6, in spaced relation to the bottom and side walls of the casing. The shield carries an atomizing spray nozzle 7 to which is connected an air inlet pipe 8 and a liquid feed pipe 9, the latter pipe being extended to a point close to the bottom of the casing. The casing is filled to the level indicated by the numeral 10 with the liquid to be atomized, thus leaving a space between the lower edge of the shield 6 and the top surface of the liquid.

When air or any other gaseous medium is supplied under pressure through pipe 8, the nozzle 7 will project a fine mist or spray vertically downward upon the surface of the liquid itself. As a result of this arrangement, the larger particles discharged by the nozzle will break down the surface tension of the liquid and be absorbed in the main body of the liquid at the bottom of the container, while the fine particles necessary to produce a mist, which will remain in suspension, will not overcome the surface tension of the liquid, and hence will pass upwardly around the outer sides of the shield 5 and out through the opening 4 along with the air or gas discharged by the nozzle 7. Thus, the surface of the liquid serves a double purpose in acting as a shock surface and as a means to absorb the larger particles discharged by the nozzle without permitting them to pass out through the opening 4 into the surrounding atmosphere. The shield 5 acts as a splash arrestor and consequently terminates a short distance above the surface of the liquid.

The spray nozzle 7 is of the well-known atomizer type in which a supply of air or gas under pressure is employed to atomize the liquid discharged with the air or gas by the nozzle. In the type of apparatus illustrated, the nozzle must be of the type capable of creating enough vacuum at the liquid discharge opening to draw the liquid through the pipe 9. The nozzle is preferably one capable of producing as fine an atomization as possible and is preferably equipped with an adjusting needle valve for the liquid discharge portion of the nozzle in accordance with standard practice. It may also employ an adjustment to control the size of the air discharge passage. Since atomizer nozzles having these features are well known, and the nozzle per se forms no part

of the present invention, it is not illustrated in detail.

The fineness of the mist produced by the apparatus may be varied by varying the distance between the nozzle 7 and the liquid level 10 in accordance with the principles hereinafter outlined. The fineness of the mist may also be controlled by the pressure of the air gas supplied through pipe 8 and the quantity of gas and liquid discharged by the nozzle.

The apparatus illustrated in Figure 2 is similar to that illustrated and described in connection with Figure 1, except that in place of the imperforate shield or splash arrestor 5, there is provided a frusto-conical foraminous shield 11, the lower end of which projects beneath the level 12 of the liquid. The shield is suspended in any desired manner as by four spaced brackets 13. The shield 11 in this form of the invention may be formed either of screen material or of any type of perforated sheet material. In either event, the shield serves as a splash arrestor without preventing the discharge of the fine mixed particles. With this exception, the apparatus illustrated in Figure 2 functions in the same manner as that illustrated in Figure 1.

It will be noted that in forms of invention illustrated in Figures 1 and 2 the mist is carried out of the casing solely by the flow of gas discharged from the nozzle. The quantity of gas so discharged is preferably chosen to produce the most satisfactory atomization of the liquid at the nozzle and consequently in some cases it may result in an unnecessary or undesirable concentration of the mist or an insufficient rate of discharge of the mist from the casing.

Accordingly, there is illustrated in Figure 3 a further modification of the invention incorporating means to circulate air or gas through the apparatus in addition to the air or gas supplied to the nozzle. As there shown, the apparatus comprises a cylindrical casing 14 having a removable top 15 provided with a discharge opening 16. A vertically extending centrally located tube 17 is fixed to the top 15 and projects downwardly into the casing 14. The upper end of the tube 17 is provided with a rotatable cap 18 having a depending flange 19 which is telescoped within the upper end of the tube. The tube 17 and flange 19 of the cap 18 are provided with a plurality of circumferentially spaced openings 20 which may be moved into and out of registry to any desired degree by rotating the cap 18 relative to the tube. There is thus provided an adjustable inlet opening for the upper end of the tube 17.

An atomizing nozzle 22 is carried by the tube 17 near its lower end and is supplied with gas or air under pressure by means of a pipe 23. A liquid inlet pipe 24 for the nozzle 22 projects upwardly from the nozzle and is then bent downwardly and extends to a point immediately above the bottom of the casing 14. Near the lower end of the casing there is provided an inlet neck 25 having a removable cap 26 through which liquid may be inserted into the container. The liquid level is maintained at the line indicated by the numeral 27 by means of periodic fillings. This level is spaced slightly below the lower end of the tube 17. A foraminous cylindrical shield or splash arrestor 28' is carried by the tube 17 and projects downwardly below the liquid level.

It will be apparent that when the nozzle 27 is operating, it will act as an air ejector and draw air or gas through the registered openings 20 at the upper end of the tube 17. This air passes downwardly through the tube, outwardly through the openings in the splash arrestor 28' and thence upwardly through the casing to the discharge opening 16, thus establishing a circulation of air through the apparatus which may be adjusted by rotation of the cap 18 to produce any desired increase in the rate of discharge or decrease in the concentration of the mist.

It will be appreciated that in either of the three forms of the invention illustrated in Figures 1 to 3, any desired number of spray nozzles may be employed, and that means may be provided for (1) adjusting the distance between the nozzles and the liquid surface, (2) the pressure of the air supplied to the nozzle, and (3) the quantity of liquid supplied through the nozzle feed pipe. These adjustments are desirable to adapt the unit for use with different liquids and also for the purpose of controlling the fineness of the mist produced.

In Figures 4 to 7 is shown the preferred form of apparatus used in carrying out the process, in which form means are provided for making all necessary adjustments. Referring particularly to Figures 4 and 5, it will be seen that the unit comprises a generally rectangular casing 28 having a removable cover 29 provided with a discharge opening 30, which may be closed by hinged cover 31. The lower portion of the casing is filled to the level, indicated by the numeral 32, with a liquid, and the cover 29 is provided with a depending flange 33 which telescopes within the casing 28 and extends beneath the liquid level in order to seal the casing. The depending flange 33 is welded or otherwise secured to the interior of the lower portion of the cover at 34, and that portion of the cover is provided with an exterior bead 35 to reinforce the cover and provide a means by which it may be grasped for removal. Fixed to the cover is a depending air inlet tube 36 which carries a generally cylindrical splash arrestor 37 connected to the tube by means of an outwardly flared portion 38. The upper end of the tube 36 above the top of the cover 29 is enlarged and telescopically fitted within a rotatable cap element 39. The enlarged upper end of the tube 36 and the cap element are provided with circumferentially spaced openings 40 adapted to register to any desired degree on rotation of the cap. As a result of this arrangement, the size of the air inlet openings at the upper end of the tube may be adjusted at will by rotating the cap.

A vertically extending, generally cylindrical casting 41 is fixed in any suitable manner to the bottom wall 42 of the casing, and is connected to an air inlet pipe 43 which communicates with a hollow central bore in the casting. The central bore in casting 41 is threaded to receive the threaded end of a vertical pipe 44, and a packing gland is provided to seal the joint between the pipe and the casting. The upper end of the pipe 44 is provided with a flange 46 against which is seated a circular manifold 47, defining with the pipe an annular chamber 48 which communicates with the interior of the pipe through openings 49 formed in the pipe wall. The upper end of the pipe 44 is threaded to receive a nut 50 which secures the manifold against the flange 46, and any suitable gaskets or other packing means may be provided to prevent leakage past the nut and the flange.

The particular unit illustrated is provided with six nozzles which are secured in fluid communi-

cation with the manifold chamber 48 by means of nipples 51, one such nipple being fixed to each nozzle 52. The nipples project into suitable radially disposed openings in the manifold 47, and each nipple is provided with a packing gland 53, shown best in Figure 4. The nozzles are atomizing nozzles of the type previously described and may be of any desired design or construction. They are provided with liquid inlet pipes 54 which extend to a point beneath the surface 32 of the liquid.

Any suitable gas, such as air, is supplied to the inlet pipe 43 by means of a communicating pipe 55 which is connected through an adjustable regulating valve 56 and pipe 57 to a source of gas or air under pressure. It will be appreciated that the gas pressure source may either be a self-contained pressure cylinder or a pump. The regulator valve may be of any desired or conventional construction effective to maintain the pressure in the inlet pipe 43 at any desired level independent of the pressure existing at the source. However, in Figure 7 is illustrated more or less diagrammatically one possible form of regulating valve. As there shown, the valve comprises a casing 59 having a central bore 60 and an annular recess 61 in communication with the supply pipe 57. Slidably mounted within the bore of the valve is a valve spool having three lands 62, 63, and 64. The outlet pipe 50 communicates with the bore at a point above the annular recess 61 and between the lands 62 and 63 of the valve spool. A small passageway 65 connects the outlet pipe 55 with the lower end of the valve bore and thus subjects the lower face of the land 64 to the pressure existing in the discharge pipe 55. This pressure is balanced by means of a spring 66 fitted within the upper end of the valve bore and bearing against the spool. The force exerted by the spring may be readily adjusted by adjusting the rotatable screw-threaded plugs 67. Air is supplied through passage 57 and flows upwardly past the land 63 to the outlet pipe 55. The spool is balanced against the influence of pressure supplied from pipe 57, and the spools 62 and 63 balance the pressure existing within the space between them. Consequently, the position of the valve spool is determined solely by the tension of the spring 66 and the pressure in the discharge outlet 55, and any desired level of discharge pressure may be maintained by adjusting the tension of the spring.

Means are likewise provided to adjust the distance between the lower edge of the splash shield 37 and the liquid surface, and at the same time to maintain a constant level of the liquid within the chamber. This means comprises the filler unit shown best in Figure 5. This unit comprises a casting 68 having an enlarged bore 69 closed at its lower end and provided with a reduced opening 70 at its upper end into which is slidably fitted a tube 71. A packing gland 72 is provided to seal the joint between the casting 68 and the tube 71 against leakage and to fix the tube 71 frictionally against vertical movement relative to the casting. The central bore 69 in the casting is connected to the interior of the casing 28 by means of passageway 73 formed by a pair of nipples 74 and 75 carried by the casting 68 and casing 28 respectively and detachably secured together by mating flanges.

The upper end of the tube 71 is provided with a funnel-shaped sheet metal member 76 into which may be inserted a bottle or other suitable container 77 for the liquid tube used in producing

the mist. The funnel is provided with one or more vertical grooves 78 to permit the entry of atmospheric air to the space 79 surrounding the neck of the bottle 77.

As is well known, the filling device so far described will operate to maintain the level in the casing 28 in the lower extremity of the open mouth of the bottle 77, regardless of the location of the liquid level 80 in the bottle itself. As a result of this arrangement, the level of the liquid within the container may be readily adjusted at any time by slightly loosening the packing gland 72 and raising or lowering the tube 71 with respect to the casting 68. Consequently, the distance between the lower end of the splash shield 37 and the level of the liquid in the container may be readily adjusted at will.

It will be noted that adjustments in the distance between the end of the splash shield 37 and the liquid level will also adjust the distance between the nozzles 52 and the liquid level. For most purposes, this is the only adjustment which need be made to produce optimum results. However, in some cases it may be desirable to adjust the vertical location of the splash arrestor 37 relative to the nozzles 52, and it is for this reason that the adjustable pipe 44 is provided to support the nozzles. When the cover 27 is removed, it is possible to change the vertical location of the nozzles with respect to the splash shield 37 by loosening the packing gland 45 and threading the pipe 44 into and out of the casting 41 to any desired extent. This adjustment, however, will not normally be necessary, particularly if a foraminous splash shield of the type illustrated in Figures 2 or 3 is employed, and it is contemplated that such a shield may be utilized in place of the shield 37, if desired.

It will be apparent that when the cover 29 is removed the vertical tube 36 and the splash arrestor 37 will be removed with the cover, thus exposing the nozzles for convenient adjustment, as desired. It is contemplated that in place of the manifold mounting for the multiple nozzles illustrated in Figures 4, 5, and 6, each of the nozzles may be provided with a separate gas inlet pipe, each pipe containing a shut-off valve in order to control the number of nozzles in operation.

It is apparent that there is provided in Figures 4 through 7 an exceedingly simple mist-producing apparatus in which convenient means are provided for making all necessary adjustments in order to produce the most satisfactory form of mist of any given material. The principle of operation of the apparatus is the same as that described in connection with the more simplified constructions illustrated in Figures 1 to 3.

In each of the several forms of apparatus illustrated, the liquid is drawn into the atomizer nozzle by the suction produced by the jet action of the gas supplied to the nozzle. It will be understood, however, that the liquid may be fed to the nozzles under pressure in any desired manner, as from a pressure tank or by means of a pump, without departing from the spirit or advantages of the invention. While it is preferred to direct the nozzles against the surface of a body of the same liquid utilized in the mist in order to avoid waste, the liquid surface may be of a different liquid so long as the two liquids are miscible.

It will be appreciated that the essential feature of the present method and each of the forms of apparatus disclosed resides in the idea of separating the undesirably large mist particles pro-

duced by the atomizer nozzle from the desirable exceedingly fine particles by projecting the mist from the nozzle against the liquid surface. This separation is critical since it is desired to produce a mist of particles which are so small that they resist vaporization and remain in suspension in the gas. Such particles have a Brownian movement and are probably ionized.

The separation which results from the practice of the present invention is believed to result from a combination of a number of factors. In the first place, the larger particles (assuming the same shape for all particles) present less frontal area for a unit of weight than the smaller particles, and hence can more readily penetrate the slower moving gas region above the liquid and the surface of the liquid itself. In this connection the surface tension of the liquid is an important factor. Secondly, the desirable small particles are sufficiently small to be deflected on collision with molecules of the gas. Third, the small particles being ionized are repelled by their electric charges from each other and the surface of the liquid. Finally, the liquid surface due to its surface tension may act to some extent as a solid baffle or shock surface which deflects and further breaks up the particles.

The factors which control the fineness of the mist produced are, first, the fineness of the spray or mist produced by the spray nozzle and, second, the distance between the nozzle and the liquid surface. In so far as the design and operation of the nozzle itself is concerned, well-known principles prevail, and it only need be noted that in general the higher the gas pressure and the smaller the quantity of liquid supplied for a given amount of gas, the finer will be the mist produced. The amount of gas and liquid and the pressure of the gas may be regulated to produce as fine a mist as possible without reducing the amount of liquid discharged to an impractical quantity. A nozzle which discharges a substantial quantity of liquid may be employed with success, since it is not necessary that all of the liquid discharged by the nozzle be in the form of a mist of the requisite fineness. For a given gas pressure and nozzle, the distance between the nozzle and the liquid to produce the best results depends primarily upon the surface tension of the liquid. In general for a given gas the optimum distance decreases with an increase in surface tension and increases slightly with the density of the liquid. It also decreases slightly with an increase in density or viscosity of the gas. In addition, for any given combination of gas and liquid, the fineness of the resultant mist increases as the nozzle approaches the liquid surface until a point is reached where the stream of liquid-laden gas causes excessive turbulence and splashing of the liquid. Thus, there is a more or less definite limit to the degree of approach which can be achieved to advantage. The splash guard of the present invention serves to counteract splashing and thus makes possible a closer approach of the nozzle and liquid surface with resultant reduction in the size of the mist particles produced.

The air inlet tube for auxiliary air provides means for controlling the dilution of and increasing the rate of ejection of the mist-laden gas discharged by the nozzles. If the mist particles are too concentrated in the gas they tend to coalesce, and, since the air flow through the nozzles is adjusted to that which most effectively produces a mist, it is desirable to provide an independent means to adjust its ultimate concentration. The air flow through the tube is induced by the jet effect of the nozzles themselves.

The present invention may be applied to the suspension of almost any liquid in almost any gas, and consequently it is not possible to set forth detailed specifications of the apparatus required for each possible case. However, as an illustrative example, in producing a mist of 5% lethane and 95% kerosene by volume suspended in air for the purpose of destroying insects, excellent results have been achieved with the type of apparatus herein disclosed in which one nozzle was used and spaced two inches from the liquid surface the output of aerosol being 0.1 oz. per minute and the volume of free air 1 cubic foot of air per minute. The air was supplied to the nozzle under pressure at a pressure of five pounds per square inch. The splash guard was in the form of a cylinder made of perforated sheet metal, the lower edge of which was immersed in the liquid.

These specifications may be varied to a substantial degree in accordance with the principles herein outlined, and various modifications and changes in the design and arrangement of the parts may be made without departing from the spirit or advantages of the invention. While the best results are obtained by a correlation of the various portions of the apparatus in accordance with the principles outlined, it is not necessary to determine the optimum relationship of the different portions by elaborate experiment in order to realize the substantial advantages of the invention.

What is claimed is:

1. A method of producing a mist of fine liquid particles suspended in a gas, which includes dividing the liquid into a fine mist-like spray by discharging it into a rapidly moving stream of gas, directing the rapidly moving stream of gas into an enlarged space and directly against the surface of a liquid to separate the larger drops of liquid from the stream of gas, and controlling the size of the suspended mist particles by adjusting the distance through which the liquid-laden gas travels through the enlarged space before it strikes the liquid surface.

2. An apparatus for producing a mist of fine liquid particles suspended in a gas, which includes a container for a body of liquid and an atomizer nozzle arranged to direct a stream of gas containing an atomized liquid substantially vertically downward against the surface of the body of liquid, and a foraminous splash arrestor shield surrounding the stream of gas and atomized liquid above the liquid surface and extending below the liquid surface.

3. An apparatus for producing a mist of fine liquid particles suspended in a gas which includes a container for a body of liquid and an atomizer nozzle arranged to direct a stream of gas containing an atomized liquid substantially vertically downward against the surface of the body of liquid, a splash arrestor shield surrounding the stream of gas and atomized liquid and terminating above the liquid surface, means to adjust the distance between the lower end of the splash arrestor shield and the liquid surface, and independent means to adjust the distance between the nozzle and the liquid surface.

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