# United States Patent

**Waldrum**

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## [54] VIBRATING SPRAY APPARATUS AND METHOD OF SPRAYING


[72] Inventor: **John E. Waldrum**, Ambler, Pa.

[73] Assignee: **Amchem Products, Inc.**, Ambler, Pa.



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[52] **U.S. Cl.** .....**239/229**, 239/DIG. 1

[51] **Int. Cl.**.....**B05b 3/00**

[58] **Field of Search**.....239/102, 229, 263, 380, 225, 239/210, DIG. 1



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*Primary Examiner*—Lloyd L. King

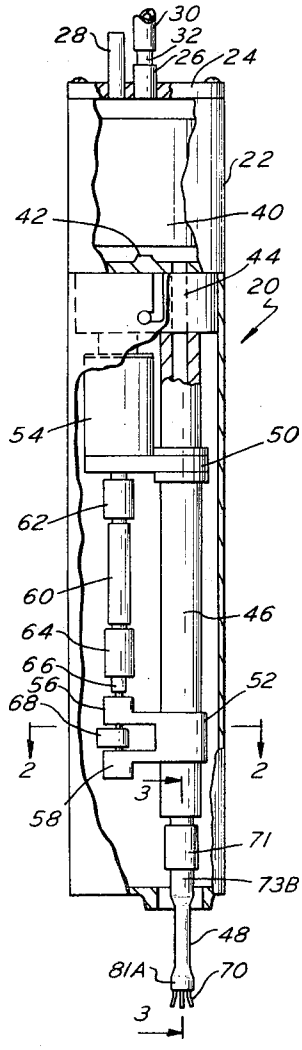
*Attorney*—Caesar, Rivise, Bernstein & Cohen



[57] **ABSTRACT**

A vibrating spray apparatus and method of spraying which produces a spray pattern of substantial uniform density, the spray apparatus including a spray tube that is free at one of its ends, means to supply liquid to the spray tube from the other end thereof, a motion transmitting device associated with the spray tube to impart vibrations of sufficient magnitude to the spray tube to cause the free end of the tube to move in an orbital path. The method of the present invention involves the movement of a stream of liquid in an orbital path wherein the liquid is discharged while moving in the orbital path to produce a pattern of uniform density.


**9 Claims, 5 Drawing Figures**



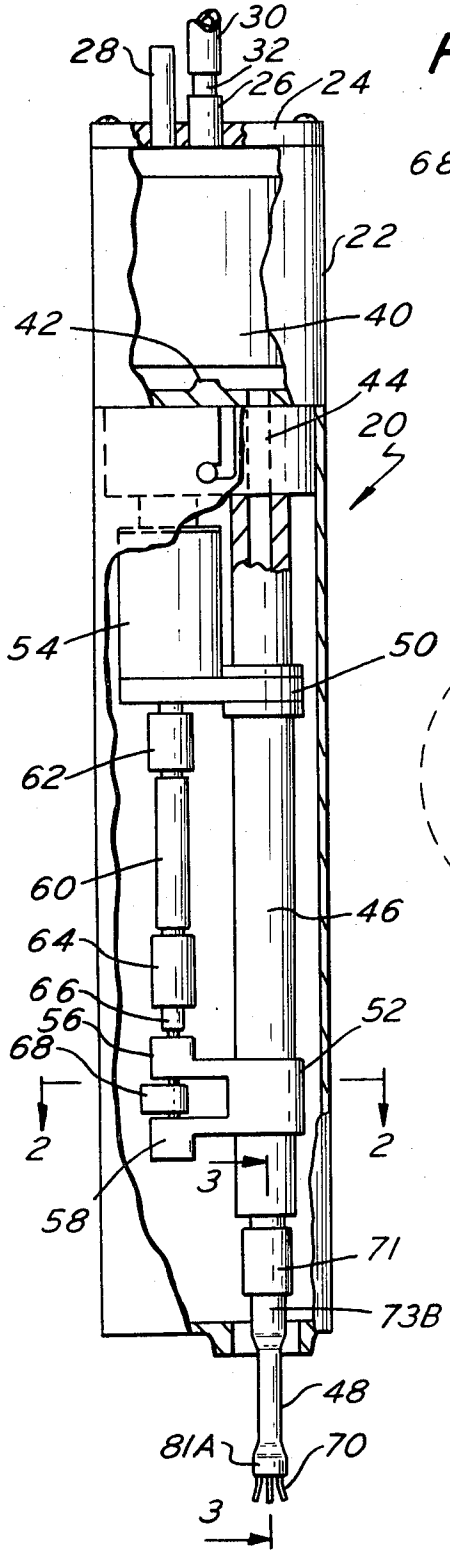



FIG. 1

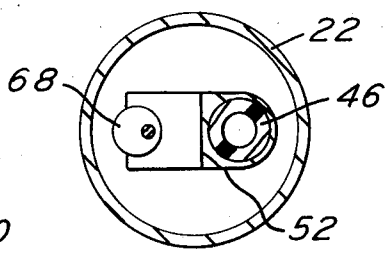



FIG. 2

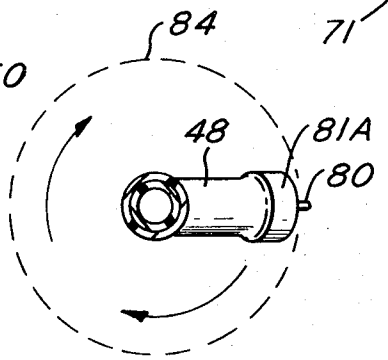



FIG. 5

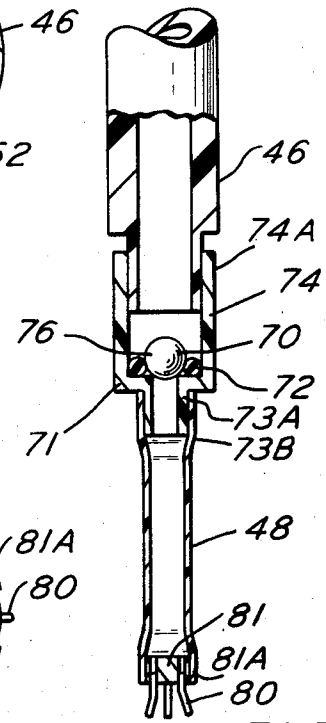



FIG. 3

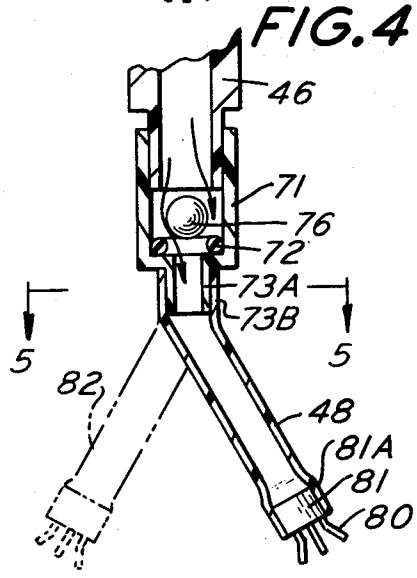



FIG. 4

INVENTOR
JOHN E. WALDRUM
BY
Caesar, Rivise, Bernstein & Cohen
ATTORNEYS.

# VIBRATING SPRAY APPARATUS AND METHOD OF SPRAYING

This invention relates to a vibrating spray apparatus and method of spraying and has as its objective the provision of a new and improved device of this general class as well as a significant method to achieve amazingly uniform spraying in agricultural and other fields.

There are many spray operations wherein the achievement of a uniform spray is most desirable. Many liquids are sprayed in very dilute form, since in this way minor variations in spray rate are quite insignificant in view of large volumes being handled. However, spraying in large volumes necessitates a supply of large volumes of a diluent like water, and the handling thereof could require a considerable capital investment. Furthermore, there are many substances which are either partially or wholly insoluble in water, but instead are soluble only in organic solvents which are more expensive than water, and clearly uneconomical to use in large volumes.

Accordingly, it has been suggested that spraying of concentrated liquids be attempted. However, here relatively minor variations in the spray pattern can be quite significant. A seemingly slight increase in spray rate of a concentrated liquid could result in an overdosage and waste, and a slight decrease in spray rate could result in an ineffective amount of active ingredient being applied to the target area.

Another advantage inherent in spraying concentrated liquids is that a very small volume will almost necessarily produce a lower total amount of fine droplets (less than 400 microns in diameter), and this will minimize drift of spray droplets that is caused by drafts and wind whereas in high volume spraying a large number of fine droplets is usually produced. Also, where a droplet is produced having a size greater than 2,000 microns in diameter, it normally will subdivide into a primary droplet and a satellite droplet, with the latter usually being a fine droplet.

The problem is spraying of concentrated liquids to assure uniformity has been solved by an apparatus disclosed and claimed in co-pending application Ser. No. 8,581. However, it was believed desirable that a spray apparatus be provided with even a small number of moving parts.

Accordingly, it is an object of the present invention to provide a liquid spray device which is relatively simple and inexpensive to manufacture in view of its small number of moving parts. Still another object of this invention is to provide a spray device that produces stable droplets (between 400 and 2,000 microns in diameter).

Another object of the present invention is to provide a liquid spray device including an elongated spray tube fixedly mounted at one end and free at the other wherein a restricted outlet is provided, said tube being associated with motion transmitting means capable of imposing vibrations on the free end of the tube of a magnitude and in a direction sufficient to cause the free end of the tube to move in an orbital path whereby liquid supplied to and passing through said tube is broken into discrete particles as it is emitted therefrom through the restricted outlet and is thrown outwardly thereof in a generally uniform, curvilinear pattern by the movement of said tube.

In carrying out the above object, it is a further object to use a plurality of orifices at the free end of said tube as means for forming said restricted outlet, wherein the number, size and direction thereof is used to control the shape and size of the spray pattern, all other factors remaining constant.

Another object of the invention is to provide means for orbitting the tube that is positioned remote therefrom whereby the tube is subjected to little or no wear.

Another object is to dispose the spray tube in a generally vertical position with respect to its major axis whereby the spray emitted therefrom is directed downwardly in an expanding pattern of great uniformity and under close control whereby spraying operations may be generally improved.

A still further object of the invention is to provide a method for producing a curvilinear spray pattern wherein an elongated spray tube is provided which is fixedly mounted at one



end and free at the other end; the tube being caused to gyrate by means acting adjacent the fixed end thereof whereby the free end describes an orbital path. Liquid supplied to the tube and passing outwardly from the free end thereof is broken into substantially uniform particles that are thrown outwardly in an expanding curvilinear pattern, the shape, size and direction of which is controlled, within limits, by the rate of vibrations imparted to said tube and the design of the free end of said tube.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of a spray apparatus embodying the present invention, with certain portions cut away and certain other portions shown in section in order to reveal internal portions of the device;

FIG. 2 is a sectional view taken along the lines 2—2 of FIG. 1;

FIG. 3 is an enlarged sectional view taken along the lines 3—3 of FIG. 1;

FIG. 4 is a greatly enlarged sectional view of the free end of the spray tube shown in FIG. 1 in actual rotation in an orbital path, and showing a second position of the end of the spray tube; and

FIG. 5 is a view taken along the lines 5—5 of FIG. 4.

Referring to the drawings and particularly FIG. 1, an improved spray device 20 is shown. This device may be formed from any suitable material that is resistant to the liquid to be sprayed and which has sufficient strength to be useful over extended periods of time, this material is a matter of choice and forms no part of this invention. In one embodiment, the entire device, except for some moving parts, is molded from a polycarbonate plastic.

The device 20 includes a liquid reservoir 22 at the upper end thereof which is cylindrical in cross section and which is closed at its upper end by cover 24. The cover 24 carries an inlet 26 and an overflow and air vent 28 therein. The inlet 26 is connected to any suitable source of liquid by means of conduit 30.

The inlet 26 is preferably formed from a tubular metal insert 32 pressed into the cover 24.

Within the reservoir 22 is contained a float 40 which is a hollow cylindrical member that is dimensioned so as to control the amount of liquid admitted to said reservoir 22. When the liquid level rises to a desired point, the float moves upwardly to cause a valve (not shown) to close and prevent further liquid to enter. As the float moves downwardly, the valve opens. A protuberance 42 is provided at the bottom of the reservoir 22 to prevent the float 40 closing off an outlet passage 44 from the reservoir. This outlet 44 connects with an elongated standpipe 46 that carries a flexible, liquid spray device 48 at its lower extremity. This device 48 includes several important details and controls that will be described in detail hereinafter.

A pair of supports, 50 and 52 may be molded on or attached to the standpipe 46 and these carry the remainder of the mechanism of the device 20. Support 50 extends outwardly and normal to the standpipe 46 and supports a small motor 54. This motor 54 is a commercially available device (see U.S. Pat. No. 2,842,692) and forms no part of my invention. The motor 54 is fixedly positioned on the support bracket 50 which is bifurcated so that the motor may be easily inserted and removed.

The lower bracket 52 is also bifurcated but in the opposite direction whereby two arms 56 and 58 are formed, their functions will be described later. The motor 54 is connected to a shaft 60 through a shock absorbing connection 62. This consists merely of a rubber-like sleeve that embraces the motor shaft at one end and the drive shaft 60 at the other.

The lower end of shaft 60 connects through a second shock absorbing member 64 with a shaft 66. This shaft 66 passes through the arm 56 and is journalled thereby and is also jour-

nalled in the arm **58**. Between the arms **56** and **58** and fixedly positioned on the shaft **66** is a weight **68**. This weight **68** is mounted off-center with respect to the shaft **66** whereby during rotation of the shaft **66**, the weight **68** causes vibration of the device. This vibration is controlled with respect to the motor **54** and its bearings (not shown) by means of the two shock absorbing connections **62** and **64** and suffers little transmission of the vibration caused by the off-center weight **68**, certainly not enough to cause any harm.

The off-center weight **68** is the means for imparting vibrations to the standpipe **46** which carries the spray device **48** at its lower extremity. It will be noted that the upper end of the device **48** is fixedly mounted to the standpipe **46** but that the lower end thereof is free and unsupported. When the motor **54** causes the off-center weight **68** to rotate, vibrations are set up in the standpipe **46**, particularly in the lower end thereof. These vibrations, because of the way they are induced, create an orbital movement that is imperceptible within the standpipe **46** but which is amplified as it reaches the free end of the spray tube **48** causing it to gyrate in an orbit of curvilinear extent. When liquid passes downwardly through the standpipe **46** and outwardly from the free end **70** of the spray tube **48**, the liquid is dispersed into uniform particles to form a spray that has an expanding curvilinear pattern. By controlling the shape, size and direction of the open end **70** of the tube **48** and by controlling the speed of the motor and the extent of vibration caused by the weight (which may be varied as desired) it is possible to obtain a wide variety of patterns of varying extent as well as affecting control of size of the spray particles.

Specifically, with the motor **44** operating free at from 10,000 to 12,000 RPM and using a polyethylene spray tube **48** having a free and unsupported length of 1½ inches, an outer diameter of three-sixteenths of an inch and a bore of one-eighth of an inch, that the motor speed was reduced to 1,200 to 1,500 RPM when a aqueous vehicle was being sprayed through a terminal nozzle on the tube **48** having four orifices each of 0.017 inches in diameter. In this instance, the vibrations were caused by a brass weight one-half inch long, three-eighths of an inch in diameter and positioned with its axis one-eighth inch off center. The reduction of motor speed was caused by the load imposed by the resonant frequency induced by the spray tube gyrations. Obviously, these figures will change widely with different terminal orifices, lengths of tube **48**, different off-center weights **68**, different placements thereof and varying motor speed, etc., and the above figures are only given as exemplary of one workable embodiment of the device.

Again referring to the drawings, FIGS. **3** and **4** are offered to show various details of the spray tube **48**. In FIG. **3** an enlarged sectional view is depicted wherein a check valve **70** is used which prevent leakage when the device is inactive. The valve **70** includes an elastomeric seat **72** consisting of an O ring seated in the base of a tubular extension **74** which is closed by gravity by a ball bearing **76** when the device is inactive. As shown in FIG. **3** tubular extension **74** ends in a nipple **73A** that is slipped within upstream end **73B** of tube **48**. The downstream end **81A** of tube **48** receives plug **81**.

Upon energization of the motor **54** and the resulting induced vibrations, the ball **76** rises and opens the valve **70** whereby liquid may flow downwardly to the end of the tube **48**. In the specific embodiment disclosed, the tube **48** includes a plug **81** with several identical restricted orifices or passages **80** at the free end thereof. It will be noted that these are each bent outwardly a small amount and this acts to increase the extent of the spray pattern. It is apparent that many such deviations in design may be used to alter the type, extent and shape of pattern. It will be discovered that desired results may best be accomplished through trial with limited experimentation for any specific application of the device.

FIG. **4** shows in dotted lines the positions assumed by the tube **48** when the device is in operation. Another limit is depicted in dotted lines at **82**. FIG. **5** is offered to show that the orbit **84** of the tube **48** is of generally circular extent although it is apparent that it may also be elliptical, if desired. It is also possible to oscillate the tube **48** through suitable modification. However, more energy is absorbed in this instance due to the cyclic changes in direction of the tube **48**. Such an energy loss does not occur when using orbital movement since the direction of movement is always the same.

If desired, an outer cover (not shown) may be used. The cover may be provided with bayonet slots which cooperate with protuberances on the lower portion of the reservoir **22**. In the instant case, these protuberances are formed by collars that project and protect the power lines for the motor **54**. The cover in this form is easily attached or detached as desired.

It is apparent that in place of plastic, the device of this invention may be formed by die-casting, machining or built up from a plurality of parts made from metal, plastic or a combination thereof. The invention is in no way limited to specific materials or constructions but is broadly directed to a novel and inexpensive way to obtain an orbital movement of a spray tube which in turn affects a controlled atomization and distribution of liquid particles.

When the device is used for agricultural pursuits, it may be useful to provide a dust boot or cover (not shown) which may be slipped over the collar **71**. Such a shield, if resilient, will in no way affect the gyrations of the tube **48** but will prevent dust from affecting the moving parts of the exciting mechanism. In this same connection, it is obvious that a flexible spray tube **48** (as shown) has many advantages in agricultural applications. When the spray device is positioned rather close to the ground, the flexible tube may flex when clearance is insufficient to pass vegetation, for example. Such flexing does not affect operation nor does it harm the tube or nozzles. Further, the use of replaceable nozzles or orifices **80** is highly useful since the quantity and type of spray pattern may be modified by simply changing said nozzles.

One additional matter that bears amplification concerns the spray tube **48**. In this disclosure, the tube **48** has been disclosed as being formed from a flexible plastic material. On the other hand, it may be fabricated from a relatively non-flexible plastic or from metal, if desired. In this instance, the orbital movement of the free end of the tube will not be as great when exposed to the same exciting force. However, lengthening of the tube and or increasing the exciting force (by greater vibration or increased frequency or both) will improve the extent of the orbital path and it is believed that the exercise of these changes is clearly within the purview of persons skilled in the art.

While the device as disclosed is limited to a generally vertical application due to gravity flow of the liquid to be sprayed, it is apparent that the same may be positioned in any desired manner, due to disposition or desire, and if the gravity feed is not practical, that a pressure feed may be used while still enjoying the many advantages of the device.

It can be seen from the foregoing that with the apparatus of the present invention the spray tube is caused to rotate about an axis by a vibrating source of energy, rather than a turning force. In view of the excellent spray patterns achieved with the apparatus of the present invention, small quantities of concentrated liquid, such as 1 pint per acre, can be precisely and evenly applied to a target area. It is to be noted that the apparatus of the present invention can handle liquids other than solutions, such as suspensions, and can handle liquids having a wide range of viscosities.

Yet in view of all the foregoing, the present invention is relatively compact and inexpensive. Furthermore, with the present invention the pattern can be made to be dense in the center or dense on the outside or uniform throughout.

Without further elaboration, the foregoing will so fully illustrate my invention, that others may, by applying current or future knowledge, readily adapt the same for use under various conditions of service.

What is claimed as the invention is:

**1**. A liquid spray device adapted to produce a spray of substantially uniform density having a generally curvilinear pat-

tern, comprising in combination: an elongated flexible spray tube fixedly mounted at one end and free at the other end and having a restricted outlet at said free end thereof; liquid supply means connected to said tube adjacent said fixed end and adapted to supply liquid thereto to be sprayed from said outlet; and a motion transmitting device associated with said tube and adapted to impart vibrations thereto at a resonant frequency in a direction and of sufficient magnitude to cause the outlet end of said tube to describe an orbital path about a fixed stationary axis through the fixed end of said spray tube whereby liquid being emitted from said outlet is thrown outwardly in the form of discrete particles to produce a predetermined curvilinear spray pattern.

2. The device claimed in claim 1 wherein the restricted outlet consists of at least two orifices.

3. The device claimed in claim 2 wherein at least a portion of said spray tube adjacent said free end is flexible.

4. A liquid spray device adapted to produce a spray having a substantially uniform density and of a generally circular pattern, comprising in combination: a generally perpendicularly disposed, elongated, flexible spray tube fixedly mounted at the inlet end thereof and free at the outlet end; liquid supply means connected to said tube adjacent the fixed end thereof and adapted to supply liquid thereto to be sprayed from said outlet; and a motion producing device associated with said tube and adapted to impart vibrations thereto at a resonant frequency in a direction and with sufficient magnitude to cause the outlet end of said tube to move in a generally circular orbital path about a fixed stationary axis through the fixed end of the spray tube whereby liquid being emitted from said outlet is thrown therefrom in the form of discrete particles to produce a predetermined circular spray pattern.

5. The device claimed in claim 4 wherein said restricted outlet consists of at least two separate small diameter orifices.

6. The device claimed in claim 5 wherein said restricted outlet consists of four separate small diameter tubes each bent slightly adjacent the ends thereof so as to be non-parallel with the major axis of the device.

7. The device claimed in claim 4 wherein said motion producing device is mounted outside the vertical axis of said spray tube and consists of a rotating off-center weight.

8. The device claimed in claim 4 including a motor and off-center weight which are positioned in misalignment with the axis of said tube.

9. A liquid spray device adapted to produce a spray having a substantially uniform density and of a generally circular pattern, comprising in combination: a generally perpendicularly disposed, elongated flexible spray tube fixedly mounted at the inlet end thereof and free at the outlet end; liquid supply means connected to said tube adjacent the fixed end thereof and adapted to supply liquid thereto to be sprayed from said outlet; and a motion producing device associated with said tube and adapted to impart vibrations thereto at a resonant frequency in a direction and with sufficient magnitude to cause the outlet end of said tube to move in a generally circular orbital path about a fixed stationary axis through the fixed end of the spray tube whereby liquid being emitted from said outlet is thrown therefrom in the form of discrete particles to produce a predetermined circular spray pattern, valve means being provided adjacent the device wherein valve means are provided adjacent the fixedly mounted end of the spray tube, said valve means being sensitive to said vibrations to remain open for permitting liquid flow therethrough and closing only when said vibrations cease to prevent such flow.

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