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PROCESS AND APPARATUS FOR PRODUCING A FOG

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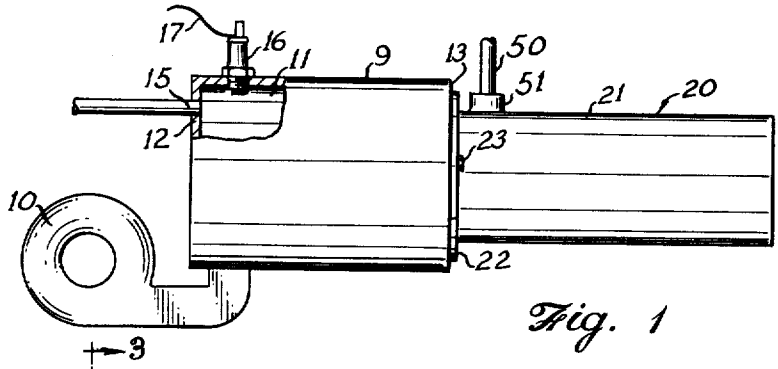


Fig. 1

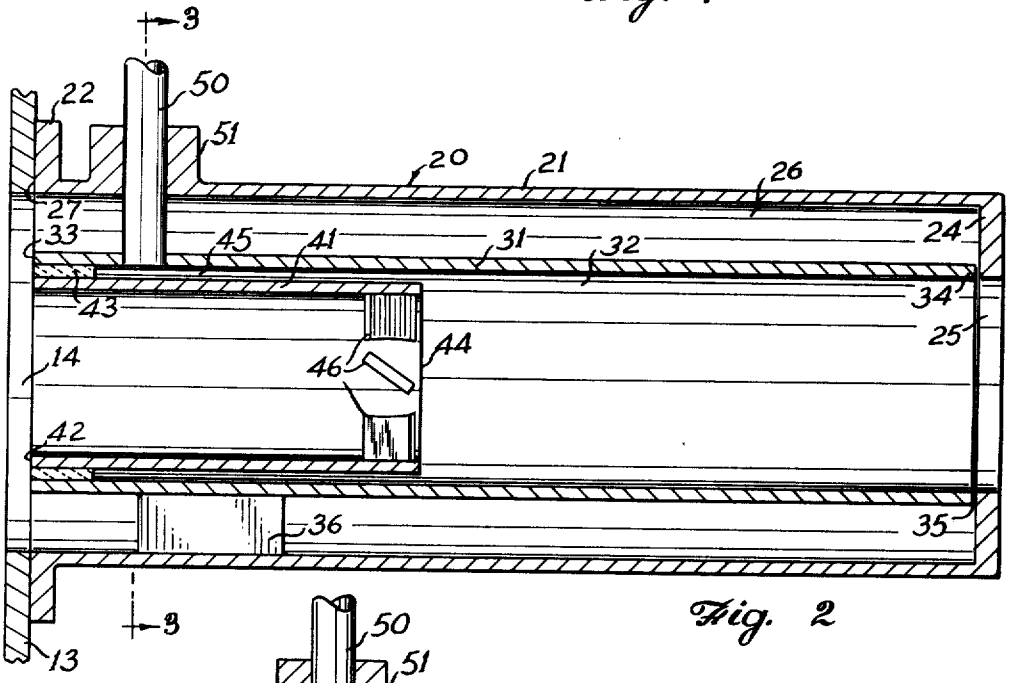


Fig. 2

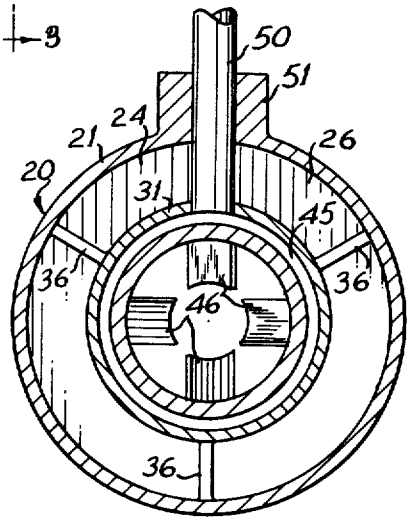


Fig. 3

INVENTOR.
David W. Waldron, Jr.
BY
ATTORNEY

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PROCESS AND APPARATUS FOR PRODUCING A FOG

David W. Waldron, Jr., Valdosta, Ga., assignor to Lowndes Engineering Company, Inc., Valdosta, Ga., a corporation of Georgia

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This invention relates to a fogging nozzle assembly, and is more particularly concerned with an apparatus for dispensing a relatively large volume of a liquid material in an atomized condition.

In the past, fogging nozzles have been employed for dispensing a liquid insecticidal mixture by the atomization of the liquid with hot air, steam and other gases which are relatively inert with respect to the insecticidal liquid. Usually such insecticidal liquids have included an insecticide dispersed or dissolved in an oil, such as a light diesel oil. The atomized liquid is sprayed onto foliage in order to kill such pests as mosquitos, beetles, boll weevils, blight, fungus growths, and the like. A requirement, of course, is that the insecticidal liquid not kill the foliage on which the material is sprayed.

If the liquid is not finely dispersed when discharged from the nozzle, relatively large drops of the liquid will collect on and wet the foliage to such an extent that the foliage will be damaged and perhaps killed. Thus, it is extremely important that the nozzle be capable of dispersing the liquid into such finely divided droplets that it does not injure or damage the foliage.

The efficiency of a fogging device is usually determined by the amount of liquid that it is capable of dispensing in a given time, Generally speaking, most prior art devices are limited to about 40 gallons per hour of liquid dispensed, and therefore the spraying operation is relatively slow and time consuming. If a quantity in excess of 40 gallons per hour were dispensed with these prior art devices, say 80 gallons per hour, the fog created would be termed as "wet" and essentially unsuitable for its intended purpose.

Certain prior art devices also tend to mix the liquid with the heated air in the open atmosphere and hence entrain large particles together with small particles in a heterogeneous mixture, with respect to size. Certain prior art devices, in many instances, are so constructed as to impede the ready discharge of the heated air at full velocity into the atmosphere and thereby reduce the efficiency of the mechanism.

Briefly, the present invention, which overcomes the disadvantages described above, includes a plurality of coaxial cylinders joined together, the inner cylinder being provided with vanes which deflect heated air which is fed therethrough. The liquid is fed into the intermediate cylinder, between the inner and intermediate cylinder, so as to flow around and be heated by the inner cylinder, the liquid flowing toward the outer end of the inner cylinder where it is entrained in the swirling air emerging from the inner cylinder. Then, the air and liquid travel toward the outer end of the intermediate cylinder, being thoroughly mixed as they travel.

Around the intermediate cylinder is a still larger outer cylinder which feeds air to an annular opening normal to the axis of the nozzle, the air discharging into the path of the air and liquid so as to pick up and feed toward the center portion thereof any droplets which have not been dispersed to extremely fine form.

It is therefore an object of the present invention to provide a fogging nozzle which will disperse a very large quantity of liquid in a relatively short period of time.

Another object of the present invention is to provide

a high volume fogging nozzle which will evenly disperse a relatively large volume of liquid.

Another object of the present invention is to provide a fog nozzle assembly wherein relatively low pressures are required to create a large volume of fog.

Another object of the present invention is to provide a fogging nozzle assembly which is inexpensive to manufacture, durable in structure and efficient in operation, the nozzle assembly having essentially no moving parts to get out of adjustment.

Other and further objects, features and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings wherein like characters of reference designate corresponding parts throughout the several views, and wherein:

FIG. 1 is a fragmentary, side elevational view of the fogging nozzle assembly constructed in accordance with the present invention.

FIG. 2 is an enlarged vertical sectional view of the fogging nozzle of the assembly disclosed in FIG. 1.

FIG. 3 is a cross sectional view taken along line 3—3 in FIG. 2.

Referring now in detail to the embodiment chosen for the purpose of illustrating the present invention, it being understood that in its broader aspects the present invention is not limited to the exact details herein depicted, numeral **10** denotes generally a blower by means of which atmospheric air is introduced into the bottom of and is fed in an upwardly direction into a combustion chamber **11**.

The combustion chamber **11** includes a horizontally disposed, hollow, cylindrical body **9** having a flat back wall **12** and a flat front wall **13** disposed essentially perpendicular to the axis of the body **9**. The front wall **13** is provided with a circular opening **14**, seen in FIG. 2. Protruding through an opening in the upper portion of back wall **12** is a fuel feed nozzle **15** which feeds a fuel, such as a liquified petroleum product, gasoline, or diesel fuel, under pressure from a source of fuel (not shown), into the combustion chamber **11**, beneath the end of a spark plug **16** mounted on the top of combustion chamber **11**. The spark plug **16** is intermittently fired by means of an electrical circuit, including wire **17**. The incoming air and fuel combine together to form a combustion mixture which, when ignited by the spark of spark plug **16**, explodes intermittently and therefore expands and is discharged through opening **14** at a temperature of about 1000° F. and at a relatively high velocity.

Secured to the combustion chamber **11** over the opening **14** is a fogging nozzle denoted generally by numeral **20**. The fogging nozzle includes a straight, hollow cylindrical housing **21** open at both ends. The housing **21** is substantially the same diameter, inside, as the diameter of opening **14**, and, at its inner end, is provided with an annular, outwardly protruding, butt flange **22**. The flange **22** is provided with radially spaced holes through which bolts, such as bolt **23**, protrude and secure the flange **22** flat against the front wall **13** of chamber **11**. Thus, housing **21** and chamber **11** are coaxially arranged, end-to-end, in abutting relationship.

The housing **20** is a relatively long member which protrudes outwardly from the chamber **11**, the outer end of housing **20** being provided with an inwardly protruding annular end flange **24** provided with a central discharge opening **25** aligned with opening **14** and through which the heated air is discharged.

Disposed within the housing **21** in concentric relationship thereto is an intermediate cylinder **31** which defines, with the outer cylinder or housing **21**, an annular passageway **26** for the heated air. The interior of the intermediate cylinder **31** defines a main cylindrical passageway **32**

for the fogging mixture to be produced. Passageway **32** is aligned with and is approximately the same diameter as opening **25**.

It will be observed in FIG. 2 that the inner end **33** of intermediate cylinder **31** terminates in the plane of the inner end **27** of the housing **21**, while the outer end **34** of intermediate cylinder **31** terminates in spaced relationship to the inner surface of flange **24** whereby an annular slot **35** is provided perpendicular to the axis of the passageway **32**.

As best seen in FIG. 3, the intermediate cylinder **31** is supported by radially spaced struts **36** which project inwardly from the inner periphery of the outer cylinder or housing **21** and are joined to the outer surface of intermediate cylinder **31**. The struts are flat, axially disposed members which do not impede the flow of hot air through the annular passageway **26**.

Within the inner portion of passageway **32** is the inner cylinder **41** which is concentric with the intermediate and outer cylinders **21** and **31**, the inner cylinder having an inner end **42** terminating in the plane of ends **27** and **33**. The inner end portions of the intermediate cylinder **31** and the inner cylinder **41** are fixed together by an annular weld **43** extending around the inner cylinder so as to constitute a common wall therebetween which closes the inner end of the intermediate cylinder **31**.

The inner cylinder **41** protrudes outwardly beyond weld or wall **43**, within the passageway **32** and terminates in an outer end **44**, intermediate the ends **33** and **34** of intermediate cylinder **31**, in about its midportion. Thus, a narrow annular passageway **45** is defined between the inner surface of cylinder **31** and the outer surface of cylinder **41**.

Within the outer end portion of the inner cylinder are means for imparting a swirling motion to the air passing therethrough. For this purpose, I prefer to employ radial vanes arranged at angles to the path of travel of the heated air. In more detail, I have provided four radially spaced, inwardly protruding vanes **46** which are secured along the inner periphery of the inner cylinder **41**. The vanes **46** are each flat, straight edged members arranged at angles of about 30° to the axis. The outer end of each vane **46** is concaved and spaced from its opposed vane to provide a central unimpeded area therebetween.

The insecticidal liquid is introduced in essentially a horizontal path through a liquid feed pipe **50** which passes through the outer cylinder **21** and intermediate cylinder **31**, terminating in alignment with the inner periphery of the intermediate tube **31**. If desired, a boss **51** may be provided on the cylinder **21**, surrounding the pipe **50** to eliminate the passage of air around the pipe **50**.

Pipe **50** is preferably arranged radially with respect to the axis so that the discharge end of the pipe **50** is adjacent the weld or wall **43**. Therefore, the liquid under relatively low pressure is discharged against the outer periphery of cylinder **41** and flows around the annular passageway **45**, being heated by the heat passing from the heated air to the cylinder **41**.

The heating of the liquid by cylinder **41** tends to volatilize the liquid as it travels outwardly through passageway **45**. Further, the aspirating effect of the hot air in passing from the end of cylinder **41** into the central portion of cylinder **31** tends to create a vacuum which may further volatilize the liquid as it mereges from passageway **45**.

When the liquid emerges from passageway **45**, it is entrained in the swirling air and heated still further, due to the fact that the intermediate cylinder **31** is being heated by air passing through the annular passageway **26** and the air in the main passageway **32**. Therefore, when the liquid reaches the end **34** of cylinder **31**, a very substantial part of the liquid has been reduced to vapors or small droplets which are discharged into the atmosphere through opening **25**. Any liquid which is of relatively large size is thrown by centrifugal force against the surface of cylinder **31** and hence may reach the end **34**. At this point, however, it is subjected to an inward blast of essentially unsaturated fresh hot secondary air passing through the annular slot **35** and hence is driven inwardly toward the relatively lean air in the center of the stream of air and liquid emerging through opening **25**. This action should be sufficient to cause the yet unentrained liquid to be broken into small droplets or vaporized either in the lean central stream of air and liquid or in the richer and more turbulent swirling peripheral air and liquid.

The net result of the agitation and heating of the liquid is to mix the air and liquid into what would be termed a relatively "dry" fog emerging in great quantity from opening **25** of nozzle **20**.

By the provision of the annular passageway **45** which introduces the liquid to the heated air, a large surface area of liquid is available for the action of the heated air. The pre-heating of the liquid from two sides and over the wide area provided by its passage along passageway **45** renders the emerging liquid relatively volatile and materially aids the ultimate entrainment of the liquid by the air in fog forming proportions. The subsequent heating and mixing of the air and liquid in cylinder **31** and the final driving of the centrifuged particles of liquid inwardly into the body of the air liquid mass by the secondary air tends to complete the fog formation. Hence a dense yet dry fog is produced which appears to have excellent particle dispersion, distribution and size, the particles being in such finely divided state that the liquid, when applied to foliage, does not materially affect the virility of the plant life.

While I have described the operation of the present device in terms of a mixing of air and liquid, it will be understood that any fluid may be substituted for the liquid referred to herein and that the term "air" includes air, steam or other gas, inert to the liquid being employed. It will also be understood that the present device is not limited to producing insecticidal fogs, but can be employed for the intimate admixture of two fluids.

It will be obvious to those skilled in the art that many variations may be made in the embodiment chosen for the purpose of illustrating the present invention without departing from the scope thereof as defined by the appended claims.

I claim:

1. In a process of mixing gas and liquid, the steps of heating said gas, passing said gas along a predetermined path of travel, swirling said gas, expanding said gas immediately after it has been swirled, passing liquid into said gas as it is being expanded, and introducing additional heated gas to the mixture in said path for driving particles of the liquid toward the central portion of the mixture.

2. In a process of producing a fog, the steps of passing a main stream of heated air along a straight cylindrical path to the atmosphere, passing additional heated air in an annular path around said main stream, then directing said additional heated air inwardly in a radial direction into said main stream of heated air, and introducing in an axial direction an annular flow of liquid to said main stream of heated air before said additional air is introduced thereto.

3. In a fogging nozzle, three concentric straight hollow cylinders arranged one within the other, the inner cylinder being substantially shorter than said intermediate cylinder, said intermediate cylinder defining in front of said inner cylinder a main passageway, said outer cylinder and said intermediate cylinder being spaced apart so as to define an annular air passageway therebetween, said inner cylinder and said intermediate cylinder being spaced apart to define an annular liquid passageway communicating with said main passageway, means for introducing liquid to be fogged into said liquid passageway, a source of air under pressure connected to the end of said outer

cylinder and communicating with said annular passageway, said inner cylinder defining a main air passageway and being so constructed and arranged that said main air passageway communicates with said source of air under pressure and with said main passageway for directing air from said source of air to said main passageway for entraining in fog forming proportions the liquid emerging from said liquid passageway, and means for directing air from said annular air passageway inwardly into the air and fluid in said main passageway.

4. In a fogging nozzle, three concentric hollow cylinders arranged one within the other, the inner cylinder being substantially shorter than said intermediate cylinder, said intermediate cylinder defining in front of said inner cylinder a main passageway, said outer cylinder and said intermediate cylinder being spaced apart so as to define an annular air passageway therebetween, said inner cylinder and said intermediate cylinder being spaced apart to define an annular liquid passageway communicating with said main passageway, means for introducing liquid to be fogged into said liquid passageway, a source of air under pressure connected to the end of said outer cylinder and communicating with said annular passageway, said inner cylinder defining a main air passageway and being so constructed and arranged that said main air passageway communicates with said source of air under pressure and with said main passageway for directing air from said source of air to said main passageway, and means for directing air from said annular air passageway inwardly into the air and liquid in said passageway, and means for imparting a swirling motion to said air as it emerges from said main air passageway for entraining in fog forming proportions the liquid emerging from said liquid passageway.

5. A fogging nozzle comprising three concentric hollow cylinders arranged one within the other, said inner cylinder being substantially shorter than said intermediate cylinder, said intermediate cylinder being shorter than said outer cylinder, an annular inwardly extending flange at the outer end of said outer cylinder, the opening of said inwardly extending flange being aligned with the inside diameter of said intermediate cylinder, a source of air under pressure, said intermediate cylinder defining in front of said inner cylinder a main passageway, said outer cylinder and said intermediate cylinder being spaced apart so as to define an annular air passageway therebetween, means for connecting one end of said annular air passageway to said source of air, the outer end of said intermediate cylinder being spaced from said inwardly extending flange to define an annular slot therebetween perpendicular to the axis of said nozzle and communicating with said air passageway, said inner cylinder and said intermediate cylinder being spaced apart to define an annular liquid passageway communicating with said main passageway, means for introducing liquid into said liquid passageway, said inner cylinder defining a main air passageway means connecting one end of said main air passageway with said source of air, the other end of said main air passageway connecting with said main passageway for directing air from said source of air to said main passageway, and means connected to said inner cylinder and projecting into said main air passageway for imparting a swirling motion to air passing therethrough.

6. A fogging nozzle comprising three concentric hollow cylinders arranged one within the other, means extending between the outer cylinder and the intermediate cylinder for supporting said intermediate cylinder by said outer cylinder, said outer cylinder communicating with a source of air under pressure, a wall joining the inner ends of said intermediate cylinder and the inner cylinder, said inner cylinder being substantially shorter than said intermediate cylinder, said intermerdiate cylinder being shorter than said outer cylinder, an annular inwardly extending flange at the outer end of said outer cylinder, the opening of said inwardly extending flange being aligned with and substantially the same diameter as the inside diameter of said intermediate cylinder, said intermediate cylinder defining in front of said inner cylinder a main passageway, said outer cylinder and said intermediate cylinder being spaced apart so as to define an annular air passageway therebetween, the outer end of said intermediate cylinder being spaced from said inwardly extending flange to define an annular slot therebetween perpendicular to the axis of said nozzle and communicating with said air passageway, said inner cylinder and said intermediate cylinder being spaced apart to define with said wall an annular fluid passageway communicating with said main passageway, means interconnecting the inner ends of said inner cylinder and said intermediate cylinder and closing one end of said annular fluid passageway, means for introducing fluid into said fluid passageway, said inner cylinder defining a main air passageway and being so constructed and arranged that said main air passageway communicates with said source of air and with said main passageway for directing air from said source of air to said main passageway, and means connected to said inner cylinder and projecting into said main air passageway for imparting a swirling motion to air passing therethrough.

7. A fogging nozzle comprising three concentric hollow cylinders arranged one within the other, means extending between the outer cylinder and the intermediate cylinder for supporting said intermediate cylinder by said outer cylinder, a wall joining the inner ends of said intermediate cylinder and the inner cylinder, said inner cylinder being substantially shorter than said intermediate cylinder, said intermediate cylinder being shorter than said outer cylinder, an annular inwardly extending flange at the outer end of said outer cylinder, the opening of said inwardly extending flange being aligned with and substantially the same diameter as the inside diameter of said intermediate cylinder, an outwardly extending flange on the inner end of said outer flange by means of which the nozzle is secured to a source of air under pressure, said intermediate cylinder defining in front of said inner cylinder a main passageway, said outer cylinder and said intermediate cylinder being spaced apart so as to define an annular air passageway therebetween, the outer end of said intermediate cylinder being spaced from said inwardly extending flange to define an annular slot therebetween perpendicular to the axis of said nozzle and communicating with said air passageway said inner cylinder and said intermediate cylinder being spaced apart to define with said wall an annular fluid passageway closed at one end and communicating with said main passageway at its other end, means for introducing fluid into said fluid passageway, said inner cylinder defining a main air passageway and being so constructed and arranged that said main air passageway communicates with said source of air and with said main passageway for directing air from said source of air to said main passageway, and means connected to said inner cylinder and projecting into said main air passageway for imparting a swirling motion to air passing therethrough.

8. In a fogging nozzle, a member defining a straight cylindrical passageway, a substantially unobstructed essentially straight hollow cylinder protruding within said passageway, said cylinder and said member being spaced apart to define therebetween an annular liquid passageway having an inner end communicating with said main passageway, said liquid passageway having substantially the same major diameter as the diameter of said main passageway, a wall joining the ends of said member and said cylinder and closing the outer end of said liquid passageway, a pipe projecting through said member at a position adjacent said wall for introducing a liquid into said liquid passageway, said cylinder defining an air passageway and being so constructed and arranged that said air passageway communicates with a source of heated air under pressure at its outer end and with said main passageway at its inner end for directing air from said source of air to said main passageway, and vanes within

said air passageway for imparting a swirling motion to said air as it emerges from the inner end of said air passageway for entraining in fog forming proportions said liquid as said liquid emerges from said liquid passageway into the main passageway.

9. In a fogging nozzle, a member defining a straight cylindrical passageway, a substantially unobstructed essentially straight hollow cylinder protruding within said passageway, said cylinder and said member being spaced apart to define therebetween an annular liquid passageway having an inner end communicating with said main passageway, said liquid passageway having substantially the same major diameter as the diameter of said main passageway, a wall joining the ends of said member and said cylinder and closing the outer end of said liquid passageway, a pipe projecting through said member at a position adjacent said wall for introducing a liquid into said liquid passageway, said cylinder defining an air passageway and being so constructed and arranged that said air passageway communicates with a source of heated air under pressure at its outer end and with said main passageway at its inner end for directing air from said source of air to said main passageway, and vanes within said air

passageway for imparting a swirling motion to said air as it emerges from the inner end of said air passageway for entraining in fog forming proportions said liquid as said liquid emerges from said liquid passageway into the main passageway, said vanes being radially spaced and secured by their ends to the inner periphery of said cylinder adjacent the inner end of said cylinder, said vanes projecting inwardly into said air passageway, the inner ends of said vanes terminating in the central portion of said air passageway, said vanes being disposed at angles to the axis of said nozzle.

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