

A VAPOR SPRAYER AND PROCESS FOR  
PROVIDING A VOLATILE FLUID AS A VAPOR SPRAY

Technical Field

This invention relates to a novel apparatus and process for providing a volatile fluid as a vapor spray and specifically relates to the use of a less aggressive solvent for solvent cleaning applications.

Background Art

Heat generation of vapor spray is known. Illustrative of this type of prior art are U.S. Patent 2,128,263 to Ofeldt and U.S. Patent 2,790,063 to Bok, et al. The Ofeldt patent shows an apparatus for generating a spray in which the fluid to be sprayed is passed through a heating coil 4. Heat is provided to the heating coil using a fire pot. The vapor sprayer of Bok includes an easily transportable reservoir having electrical heating means provided within the reservoir. The electrical heating means is immersed directly into the fluid to be vaporized.

This prior art and the other prior art of which we are aware fails to provide an apparatus and process for generating a vapor spray from a volatile fluid that heats the volatile fluid within a heat exchanger in which the fluid is exterior to a heating element, that is capable of producing a continuous vapor spray, that modulates flow of the fluid prior to entry thereof into the heat exchanger whereby a selected pressure is maintained downstream from a pump drawing the fluid from a reservoir, and that controls the velo-

city of the stream of fluid as it enters the heat exchanger so as to ensure that the fluid is at a selected temperature when discharged from the heat exchanger.

Disclosure of the Invention

5                   It is accordingly one object of the present invention to provide a novel apparatus and process that heats the volatile fluid within a heat exchanger in which the volatile fluid is exterior to a heating element and that is capable of producing a continuous vapor spray.

10                   A further object of the present invention is to provide an apparatus and process of this type that modulates flow of the fluid prior to entry thereof into the heat exchanger whereby a selected pressure is maintained downstream from a pump drawing the fluid from a reservoir,  
15                   and that controls the velocity of the stream of fluid as it enters the heat exchanger so that it is ensured that the fluid is at a selected temperature when discharged from the heat exchanger.

                  According to one aspect of the invention there is  
20                   provided a vapor sprayer comprising a reservoir adapted to contain a volatile liquid; a pump for drawing the volatile liquid from said reservoir; a heat exchanger containing a heating element adapted to heat the volatile liquid to a selected temperature just below its boiling point, the  
25                   volatile liquid being in heat-transfer relationship with and surrounding said heating element as it passes through said heat exchanger, said pump being situated between and in liquid connection with said reservoir and said heat exchanger,

said heating element having heat output control means; a discharge valve for discharging the heated liquid from said heat exchanger, said discharge valve being in liquid connection with said heat exchanger and with at least one  
5 nozzle and being adapted to discharge the liquid supplied thereto as a vapor spray; and a temperature sensor positioned to sense the temperature of heated liquid, said heat output control means being operated by said temperature sensor to ensure that the liquid supplied to the nozzle in use of the  
10 sprayer is at said selected temperature so as to be sprayed as a vapor at atmospheric pressure.

In one embodiment, the heat exchanger is dimensioned so as to serve primarily as a conduit through which the volatile liquid passes as it is heated, and the  
15 discharge valve is an adjustable valve that provides the discharged liquid at a selected pressure to the nozzle.

In another embodiment the invention relates to such a vapor sprayer wherein the heat exchanger is dimensioned so as to serve as a storage chamber for the volatile liquid;  
20 wherein said heat exchanger contains a diffusion plate for spreading over a large area, the liquid stream as it enters said heat exchanger, said diffusion plate being located proximate the incoming stream, whereby the velocity of said incoming stream is substantially diminished so that mixing  
25 is reduced; wherein said temperature sensor is located in said heat exchanger storage chamber; wherein said heat exchanger is positioned so that said diffusion plate is situated in a lower region thereof; a valve is provided for modulating the flow of the liquid drawn by said pump  
30 through a bypass line connecting said pump and said reservoir, thereby maintaining a selected pressure downstream from said pump; and wherein said discharge valve is capable of being set either in an open position or a closed position.

35 In the latter embodiment, the vapor sprayer further

includes a pressure-responsive valve that modulates flow of liquid drawn by the pump through a by-pass line connecting the pump and the reservoir, thereby maintaining a selected pressure downstream from the pump. The discharge valve of 5 this embodiment is capable of being set either in an open position or a closed position.

Another aspect of the invention provides a process of generating a vapor spray from a volatile liquid, said process comprising drawing a volatile liquid from a 10 reservoir adapted to contain the liquid; passing at least a portion of the drawn liquid to a heat exchanger containing a heating element having heat output control means itself controlled by a temperature sensor positioned to sense the temperature of liquid heated in said heat exchanger; heating 15 the volatile liquid within said heat exchanger to a selected temperature just below its boiling point, the volatile liquid being in heat-transfer relationship with and surrounding said heating element; discharging the heated liquid at said selected temperature from said heat 20 exchanger and through a discharge valve; and delivering the liquid at said selected temperature to at least one nozzle from which it is discharged as a vapor spray.

Reference is hereby made to the accompanying drawing which forms a part of the specification of this 25 application.

Figure 1 depicts an embodiment of the present invention particularly suitable for continuous flow applications; and

Figure 2 depicts an embodiment of the present

invention useful for either intermittent or continuous flow applications.

Best Mode for Carrying Out the Invention

As explained above, in accordance with the  
5 invention, there is provided a novel vapor sprayer and  
process for providing a volatile liquid as a vapor spray.  
The vapor spray is used for solvent cleaning applications  
such as removal of solder flux residue from P/C board  
assemblies or of paste residue from hybrid circuits. A  
10 particular advantage of the invention is that it enables the  
vapor spray to be formed from a less aggressive solvent such  
as trichlorotrifluoroethane. The apparatus and process, as  
explained in detail below, provide the vapor spray by heating  
the volatile fluid under pressure to a temperature just below  
15 its boiling point prior to discharge from a heat exchanger.

The invention will now be described with reference  
to the embodiment shown in Figure 1 of the drawing. This  
embodiment is particularly suitable for continuous flow  
applications, and is especially designed to operate at steady  
20 state with a constant fluid flow rate and a constant heat  
output by the heating element thereof. In this embodiment, a  
vapor sprayer in accordance with the invention includes a  
reservoir, a pump, a heat exchanger, a discharge valve and at  
least one nozzle for delivering the discharged fluid as a  
25 vapor spray.

In vapor degreasing, a degreasing solvent is used  
to remove contaminants such as lubricants from work pieces.

The degreasing solvent is vaporized in a still, condensed and removed from the still during the process. A reservoir, in accordance with the invention, contains a volatile liquid and may be a degreaser sump or a distilled solvent reservoir. As  
5 indicated above, the present invention has broad solvent cleaning applications, and the reservoir could, for example, also be a separate tank.

The pump is conventional, and is situated between the reservoir and a heat exchanger. The pump draws the  
10 volatile liquid from the reservoir and feeds it to the heat exchanger. Conveniently, the pump is a centrifugal pump so that as downstream pressure increases, the pump output decreases. Alternatively, the pump could be a positive displacement pump. However, if a positive displacement pump  
15 were used, then the vapor sprayer should be modified to include a by-pass line and a pressure-responsive valve of the type described below with regard to Figure 2. Although the Figure 1 embodiment could be modified to include the bypass line and pressure-responsive valve when the centrifugal pump  
20 is used, no substantial advantage is gained.

The heat exchanger of this embodiment is dimensioned so as to serve primarily as a conduit through which the volatile liquid passes as it is heated. Suitably, a tube is used as the heat exchanger. The heat exchanger  
25 contains a heating element adapted to heat the volatile liquid to a selected temperature just below its boiling

point. The volatile liquid is in heat-transfer relationship with and exterior to the heating element as it passes through the heat exchanger. The heating element conveniently is a pipe through which a hot fluid such as steam or hot water is passed or is an electric coil. The heating element functions to raise the incoming liquid to a temperature just below its boiling point prior to discharge from the heat exchanger. The heat output of the heating element is suitably controlled by using a valve when the heating element is the pipe and by using a rheostat when the heating element is the electric coil.

The heated liquid is discharged from the heat exchanger through a discharge valve. In this embodiment, it is preferred that the valve is an adjustable valve. The valve is set to provide the discharged liquid at a selected pressure to the nozzle. The heated fluid is at the selected temperature when discharged from the heat exchanger. The nozzle delivers the discharged fluid as a vapor spray. As indicated above, one or more nozzles are used.

The adjustable valve and the nozzle combine to control the liquid flow rate. Once the valve has been adjusted to provide a desired pressure and the appropriate nozzle or nozzles have been selected or adjusted, the flow rate will be constant. Then, the heat output of the heating element is set so that the temperature of the solvent discharged from the heat exchanger is at a selected temperature just below its boiling point. As a result, the

vapor sprayer will operate in a steady state to provide a continuous stream of vapor spray. It is, of course, understood that the temperature of the liquid drawn from the reservoir must remain constant.

5           The vapor sprayer includes a temperature control device such as a thermostat. The temperature control device functions to ensure that the heated liquid is discharged at the selected temperature by operating the device controlling output of the heating element to take into  
10 account any fluctuations in flow rate.

          Preferably, the vapor sprayer includes a pressure gauge located downstream from the discharge valve. Conveniently, the pressure gauge is located at the nozzle, as a result of which the pressure measured is at the  
15 nozzle.

          As can be seen from the above description, the vapor sprayer heats the volatile liquid to a temperature just below its boiling point and delivers the heated liquid at a selected pressure to the nozzle. The fluid is then  
20 discharged through the nozzle as a vapor spray.

          A process for providing a volatile liquid as a vapor spray using the apparatus of Figure 1, will now be described. In the first step of the process a volatile liquid is drawn from the reservoir. In the next step, the  
25 drawn liquid is passed to the heat exchanger. In the third step, the liquid stream is heated within the heat exchanger to a selected temperature just below its

boiling point. During this heating step, the volatile liquid is in heat-transfer relationship with and exterior to the heating element contained within the heat exchanger.

In the next step, the heated liquid is discharged  
5 from the heat exchanger. The heated liquid is at the selected temperature when discharged. In the fifth step, the liquid is delivered through the nozzle to become a vapor spray to impinge on a work piece. During operation of the process the temperature of the heated liquid is measured and  
10 the heat output control device is regulated in response to the temperature sensed.

Modifications in the process result to the extent that the modifications described above are made in the vapor spray of Figure 1. Thus the pressure of the discharged  
15 liquid can be measured.

The invention will now be described with reference to the embodiment shown in Figure 2 of the drawing. In this embodiment, a vapor sprayer includes a reservoir, a pump, a pressure-responsive valve for modulating flow of the drawn  
20 liquid through a bypass line and thereby maintaining a selected pressure downstream from the pump, a heat exchanger containing a heating element, a discharge valve, and at least one nozzle for delivering the discharged liquid as a vapor spray. This embodiment of the invention is suitable to  
25 provide a ready reserve of hot solvent for use on demand or to provide a continuous flow of hot solvent.

The reservoir, the heating element, and the nozzle are the same as that described above with reference to Figure 1.

Conveniently, the pump is either a conventional positive displacement pump or conventional centrifugal pump. The pump is downstream from the reservoir, and is upstream from the pressure-responsive valve and the heat exchanger. The pump  
5 draws the volatile liquid from the reservoir and feeds it downstream.

The pressure-responsive valve modulates flow of the drawn liquid through a bypass line containing the pressure-responsive valve and connecting the pump and the  
10 reservoir. In operation, once the vapor sprayer has reached the steady state, in the event there is no demand for the vapor spray, the pressure-responsive valve returns all the drawn solvent to the reservoir. The pressure-responsive valve operates by opening or closing in response to the  
15 pressure downstream from the pump. It is particularly preferable to use a slightly oversized pump in combination with the pressure-responsive valve since it is possible to provide a constant pressure at the nozzle over a broad range of flow rates. A further advantage of the  
20 pressure-responsive valve is that it prevents heat build up when there is not any demand for the vapor spray.

The vapor sprayer of this embodiment could be modified to remove the pressure-responsive valve and the bypass line and to add a pressure-regulating valve between  
25 the pump and the heat exchanger. However, in this case, it would be necessary to use a centrifugal pump.

The heat exchanger is dimensioned so as to serve as a storage chamber for the volatile liquid. The heat exchanger contains a diffusion plate for spreading, over a large area, the liquid stream as it enters the heat

5 exchanger. The diffusion plate is located proximate the incoming stream. Use of the diffusion plate results in the velocity of the incoming stream being substantially diminished so that mixing of the incoming cold liquid and of heated liquid is reduced and it is ensured that the volatile  
10 liquid is at a selected temperature just below its boiling point when discharged from the heat exchanger. The heat exchanger is positioned so that the diffusion plate is located in a lower region thereof. As shown in the Figure, vertical positioning of the heat exchanger is preferable.

15 The diffusion plate has dimensions that enable it to fit snugly within the heat exchanger and has a substantially level surface that contains a plurality of apertures. The number and size of the apertures is selected to optimize spreading of the incoming stream. The optimum  
20 number and optimum diameter depends upon factors such as the flow rate, which in turn depends upon the number of output nozzles. A suitable aperture size is in the range of about 1/16 of an inch (1.5mm) or slightly less. The diffusion plate enables the heat exchanger to serve as a reservoir and  
25 yet to be relatively small. Without the diffusion plate, the heat exchanger would have to be of very large size in order

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for it to be ensured that the volatile liquid is at the selected temperature when discharged from the heat exchanger.

The heated liquid is discharged from the heat exchanger through the discharge valve. The discharge valve is capable of being set either in an open position or a closed position. The heated liquid is at the selected temperature when discharged from the heat exchanger. Thus, when spray is required, the discharge valve is opened and hot liquid is delivered to the nozzle.

10           The heat output control device is the same as that described for the previous embodiment. The heat output control device is modulated by a temperature controlling device such as a thermostat. The temperature controlling device is located within the heat exchanger, preferably  
15 near the mid-line of the heat exchanger. When there is not any demand for spray, the temperature controlling device reduces the heat output of the heating element so that the heated liquid is maintained at the selected temperature.

20           The pressure-responsive valve and the nozzle combine to control the liquid flow rate. As can be seen from the description of the embodiment in Figure 2, the vapor sprayer thereof heats the volatile liquid to a selected temperature just below its boiling point prior to discharge  
25 from the heat exchanger, and delivers the heated liquid at a selected pressure to the nozzle. The heated liquid then exits the nozzle as a vapor spray to contact a work piece.

5 A process for providing a volatile liquid as a vapor spray using the apparatus of Figure 2, will now be described. In the first step, a volatile liquid is drawn from the reservoir. In the second step, at least a portion of the drawn liquid is passed to the heat exchanger. In this embodiment, passing of the drawn liquid is accompanied by modulation of the flow of the drawn liquid through a bypass line connecting the pump and the reservoir, whereby a selected pressure is maintained downstream from the pump.

10 Flow modulation is achieved using the pressure-responsive valve. In the third step, the liquid stream is impinged onto the diffusion plate, as the stream enters the heat exchanger. As a result, the velocity of the incoming stream is substantially diminished so that mixing is reduced, and it is

15 ensured that the volatile liquid is at the selected temperature when discharged from the heat exchanger.

In the fourth step, the volatile liquid is heated within the heat exchanger to the selected temperature. During this heating step, the volatile liquid is in

20 heat-transfer relationship with and exterior to the heating element. In the next step, the heated liquid is discharged from the heat exchanger through the discharge valve, which is in the open position. The heated liquid is at the selected temperature when discharged. In the next step, the

25 discharged liquid is delivered as a vapor spray by the nozzle.

This process includes the step of measuring the temperature of the heated fluid within the heat exchanger and automatically modulating the heat output control device in response to the temperature sensed.

5            Modifications in the process result to the extent that the modifications described above are made in the vapor sprayer apparatus. Thus, for example passing of the drawn liquid to the heat exchanger could be modulated by a pressure-regulating valve, rather than by using the  
10 pressure-responsive valve and bypass line, provided that the pump were a centrifugal pump.

As noted above, a particular advantage of the present invention is that it enables the vapor spray to be formed from a less aggressive solvent. By the term "less  
15 aggressive solvent" is meant a solvent that is useless at room temperature and useful when heated to a temperature just below its boiling point, for various cleaning purposes such as dissolving solder flux residue or removing paste residue from hybrid circuits during a conventional time-  
20 restricted solvent spray and/or vapor cleaning sequence. Exemplary less aggressive solvents are trichlorotri-fluoroethane and mixtures thereof with lower alkyl alcohols or ketones. By "lower alkyl" is meant that from 1 to about 4 carbon atoms are present.

25            The use of a less aggressive solvent for cleaning purposes is desirable since this solvent is safer, more

compatible with plastic substrates and less energy intensive than the conventionally used chlorinated solvents. Hot, warm or boiling chlorinated solvents are very active and attack electronic substrates causing distortion of plastic material.

5 The use of chlorinated solvents has been made possible by providing vapor spray degreasers with built-in timing devices or by using rigid operation procedures so as to prevent overexposure of the substrates to the chlorinated solvents. In contrast, the use of a less aggressive solvent eliminates  
10 the need for time or cleaning mode restrictions.

Additionally, use of a less aggressive solvent results in greater solvent conservation because hot solvent sprays do not cause the collapse of a vapor blanket within a vapor degreaser and thus the chimney effect is reduced or  
15 eliminated.

Reference is now made to Figure 1 of the drawing. In this drawing, reservoir 10 contains a volatile liquid. The volatile liquid is drawn from reservoir 10 by pump 12 through line 14. The drawn fluid is passed by line 16 from  
20 pump 12 to heat exchanger 18, which contains a heating element 20. Heating element 20 has a valve 22 for controlling heat output. The heated liquid is discharged from heat exchanger 18 through discharge valve 24, which is an adjustable valve. The discharged liquid is fed by line 26  
25 to nozzle 28, through which it exits as a vapor spray. The spray contacts work piece 30. Shown in phantom are pressure gauge S and thermostat T. The thermostat operates valve 22

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to ensure that the heated liquid is discharged at a selected temperature just below its boiling point.

Reference is now made to Figure 2 of the drawing. In this drawing, reservoir 32 contains a volatile liquid. 5 Pump 34 draws the volatile liquid from reservoir 32 through line 36 and feeds the drawn liquid downstream through line 38. Pressure-responsive valve 40 modulates flow of the drawn liquid through bypass line 42 and thereby maintains a selected pressure downstream from pump 34. The appropriate 10 volume of the drawn liquid is passed by line 44 to heat exchanger 46. Shown in phantom is a pressure-regulating valve P, which could be used in place of valve 40 and line 42 so long as pump 34 is a centrifugal pump.

The incoming liquid stream impinges onto diffusion 15 plate 48, shown in cross section. The liquid is then heated to a temperature just below its boiling point by heating element 50, the heat output of which is controlled by valve 52. Shown in phantom is thermostat R, which is located about halfway up the sides of heat exchanger 46, which is 20 vertically positioned. Use of the thermostat R modulates valve 52 to ensure that the heated liquid is discharged at the selected temperature. The heated liquid is discharged from heat exchanger 46 through discharge valve 54, and is then passed by line 56 to nozzle 58. The hot fluid exits 25 nozzle 58 as a spray, and contacts work piece 60. Valve 54 is an on-off valve.

In order to determine the required heat input  $Q$  to a heat exchanger, several parameters must be known. These parameters are solvent flow (gallon/hour), (or  $m^3/s$ ) feed solvent temperature ( $^{\circ}F$ ), (or  $^{\circ}C$ ), spray solvent temperature ( $^{\circ}F$ ), (or  $^{\circ}C$ ) specific heat of solvent (Btu/lb. $^{\circ}F$ ) (or J/kg. $^{\circ}K$ ) and density (pound gallon) (or  $kg/m^3$ ). The following equation shows the relationship of heat output to these parameters:

$Q = V \times D \times SH \times (T_2 - T_1)$ , wherein  $V$  is the solvent flow,  $D$  is the density,  $SH$  is the specific heat of the solvent,  $T_2$  is the spray solvent temperature and  $T_1$  is the feed solvent temperature.

Using this equation, if for example it were desired to spray a work piece with trichlorotrifluoroethane at a temperature of  $115^{\circ}F$  ( $46.1^{\circ}C$ ) ( $T_2$ ) from a reservoir at  $72^{\circ}F$  ( $22.2^{\circ}$ ) ( $T_1$ ) at a rate of 60 gallons/hour ( $63 \times 10^{-6} m^3/s$ ) ( $V$ ), the required heat output is 7,097.6 BTU/hour (2079W). The specific heat of trichlorotrifluoroethane is 0.21 Btu/lb. $^{\circ}F$  (879 J/kg. $^{\circ}K$ ) and its density is 13.1 pound/gallon ( $kg/m^3$ ). Assuming electric heat, an input of 2.08 KW would be required.

The vapor sprayer of Figure 1 is exemplified by a heating element of about 1 kilowatt output attached to a metal tubing of about 3/4 inch (19mm) diameter and having a minimum of 5 feet (1.5m) length, for a solvent spray volume of about 2 gallons/minute ( $126 \times 10^{-6} m^3/s$ )

The apparatus and process of this invention are useful for solvent cleaning applications such as removal of solder flux residue from P/C board assemblies or of paste residue from hybrid circuits. The invention enables a useful  
5 vapor spray to be formed from a less aggressive solvent such as trichlorotrifluoroethane.



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CLAIMS

1. A vapor sprayer comprising a reservoir adapted to contain a volatile liquid; a pump for drawing the volatile liquid from said reservoir; a heat exchanger containing a heating element adapted to heat the volatile liquid to a selected temperature just below its boiling point, the volatile liquid being in heat-transfer relationship with and surrounding said heating element as it passes through said heat exchanger, said pump being situated between and in liquid connection with said reservoir and said heat exchanger, said heating element having heat output control means; a discharge valve for discharging the heated liquid from said heat exchanger, said discharge valve being in liquid connection with said heat exchanger and with at least one nozzle being adapted to discharge the liquid supplied thereto as a vapor spray; and a temperature sensor positioned to sense the temperature of heated liquid, said heat output control means being operated by said temperature sensor to ensure that the liquid supplied to the nozzle in use of the sprayer is at said selected temperature so as to be sprayed as a vapor at atmospheric pressure.

2. A vapor sprayer according to claim 1, wherein said heat exchanger is dimensioned so as to serve primarily as a conduit through which the volatile liquid passes as it is heated, and wherein said discharge valve is an adjustable valve that provides said discharged liquid at a selected pressure to said at least one nozzle.



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3. A vapor sprayer according to claim 2, further comprising pressure sensing means for measuring the pressure of said discharged liquid, said pressure-sensing means being located downstream from said discharge valve.

5           4. A vapor sprayer according to claim 2 or 3, wherein said temperature sensor is located downstream from said discharge valve.

5. A vapor sprayer of claim 1, wherein said heat exchanger is dimensioned so as to serve as a storage chamber  
10 for the volatile liquid; wherein said heat exchanger contains a diffusion plate for spreading over a large area, the liquid stream as it enters said heat exchanger, said diffusion plate being located proximate the incoming stream, whereby the velocity of said incoming stream is substantially diminished  
15 so that mixing is reduced; wherein said temperature sensor is located in said heat exchanger storage chamber; wherein said heat exchanger is positioned so that said diffusion plate is situated in a lower region thereof; a valve is provided for modulating the flow of the liquid drawn by  
20 said pump through a bypass line connecting said pump and said reservoir, thereby maintaining a selected pressure downstream from said pump; and wherein said discharge valve is capable of being set either in an open position or a closed position.

25           6. A process of generating a vapor spray from a volatile liquid, said process comprising drawing a volatile



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liquid from a reservoir adapted to contain the liquid;  
passing at least a portion of the drawn liquid to a heat  
exchanger containing a heating element having heat output  
control means itself controlled by a temperature sensor  
5 positioned to sense the temperature of liquid heated in said  
heat exchanger; heating the volatile liquid within said  
heat exchanger to a selected temperature just below its  
boiling point, the volatile liquid being in heat-transfer  
relationship with and surrounding said heating element;  
10 discharging the heated liquid at said selected temperature  
from said heat exchanger and through a discharge valve; and  
delivering the liquid at said selected temperature to at  
least one nozzle from which it is discharged as a vapor  
spray.

15 7. A process according to claim 6, wherein said  
heat exchanger is dimensioned so as primarily to serve as a  
conduit through which the volatile liquid passes as it is  
heated; wherein the heated liquid is discharged using an  
adjustable valve that provides the discharged liquid at a  
20 selected pressure to said at least one nozzle; wherein the  
pressure of said discharged liquid is measured downstream  
from said discharge valve; and wherein the temperature  
sensor is located downstream from said discharge valve  
with the measured temperature value being used automatically  
25 to modulate said heat output control means.

8. A process according to claim 6, wherein said  
heat exchanger is dimensioned so as to serve as a storage



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chamber for the volatile liquid and said heat exchanger is positioned so that a diffusion plate located within said heat exchanger is situated in a lower region thereof; and wherein the volatile liquid stream as it enters said heat exchanger is impinged onto said diffusion plate, which is located proximate the incoming stream, whereby the velocity of said incoming stream is substantially diminished so that mixing is reduced and it is ensured that the volatile liquid is at said selected temperature when discharged from said heat exchanger.

9. A process according to claim 8 wherein the liquid is drawn from the reservoir using a pump; wherein passing of said drawn liquid to said heat exchanger is accompanied by modulating flow of said drawn liquid through a bypass line connecting said pump and said reservoir, whereby a selected pressure is maintained downstream from said pump; said bypass line having a pressure-responsive valve; wherein said discharge valve is capable of being set either in an open position or a closed position; and wherein the temperature of said heated liquid is measured by the temperature sensor being located within said heat exchanger, said heat output control means being automatically modulated in response to the sensed temperature.

10. A process according to any one of claims 6 to 9 wherein said volatile liquid comprises trichlorotrifluoroethane.

11. A vapor sprayer constructed and arranged to operate substantially as hereinbefore described with



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reference to, and as illustrated in the accompanying drawings.

12. A process of generating a vapor spray from a volatile liquid, such process being substantially as hereinbefore described with reference to the accompanying  
5 drawings.

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