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Bennett

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[54] **APPARATUS FOR VAPOR GENERATION**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 208,296, Dec. 15, 1971, abandoned.

[52] **U.S. Cl.** .... **219/300,** 219/272, 219/308, 219/373, 222/146 HE, 239/136

[51] **Int. Cl.** **H05b 1/00,** F22b 1/28, B05b 1/24

[58] **Field of Search** .... 219/271–276, 219/300, 301, 362, 373, 296–299; 239/133, 135, 136, 137, 138; 222/146 HE

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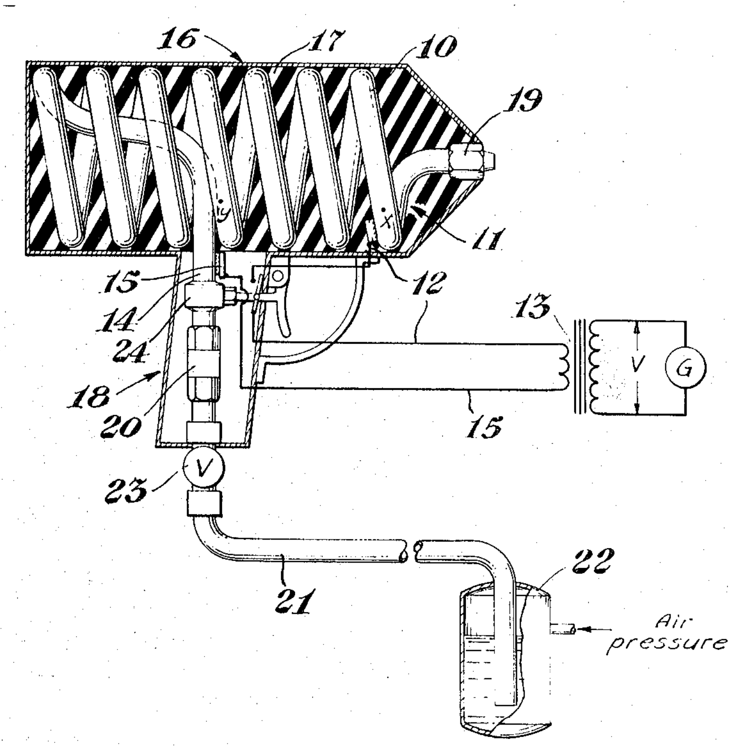
[57] **ABSTRACT**

An apparatus for providing, in a continuous or intermittent manner, a superheated vapor of an organic liquid, such as methylene chloride, for reflowing plastic surfaces or causing a plastic material to flow onto a surface to create a film or coating thereon. The apparatus includes a tubular metal member defining a flow passage for both the liquid and gaseous phases of the liquid being vaporized. A vapor flow control member having a vapor flow orifice is provided at one end of the tubular member while the other end of the tubular member communicates with a source of organic liquid under pressure through an on-off valve. A source of electrical energy is connected in circuit with the tubular member through a switch operated concurrently with the valve whereby electrical current is caused to flow through the tubular member to heat the member to a temperature adequate to vaporize the liquid flowing therethrough. The tubular member is electrically and thermally insulated by a shield and a handle associated with the shield contains the valve and switch.

2 Claims, 2 Drawing Figures



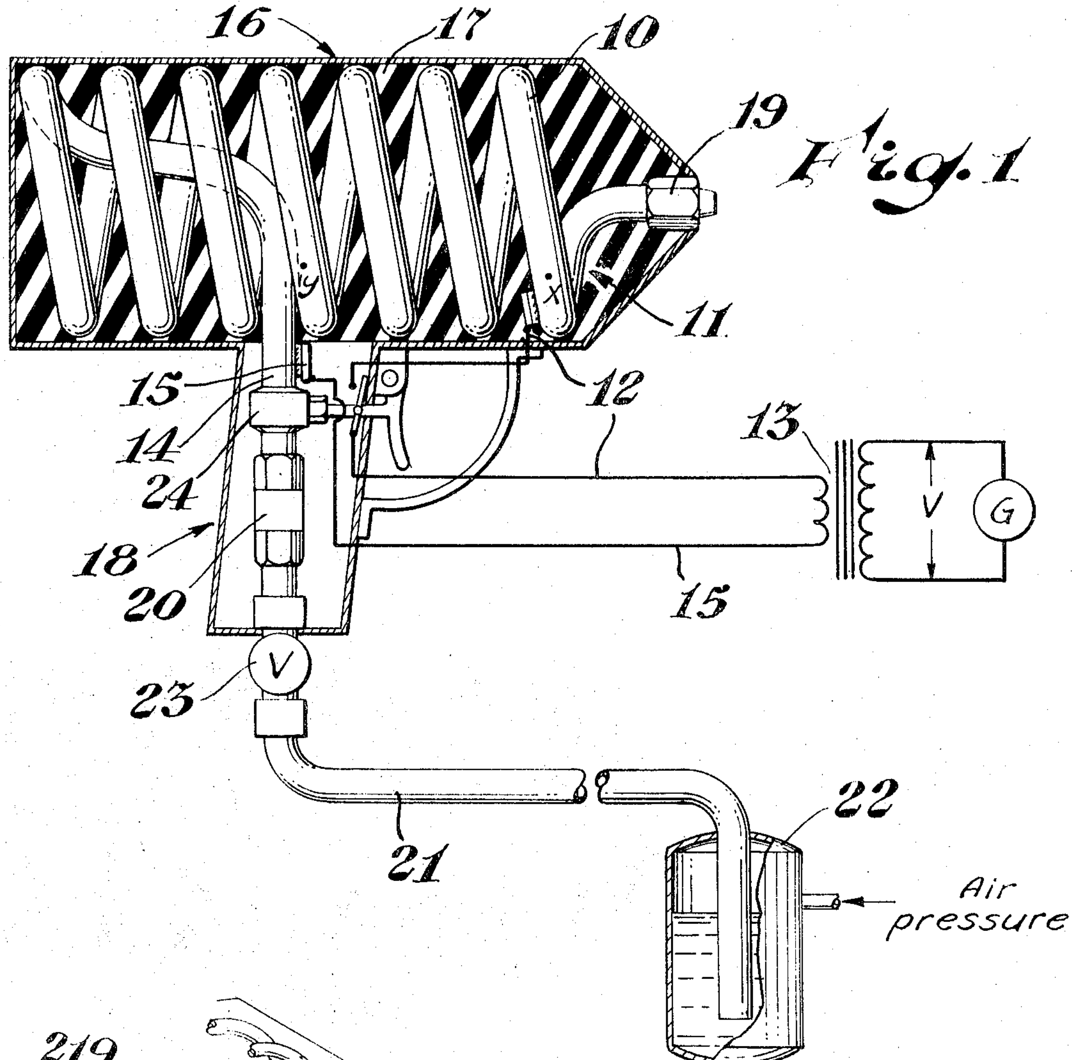

16
17
10
19
11
12
15
14
24
18
20
13
V
G
12
15
23
V
21
22
Air pressure

Fig. 1

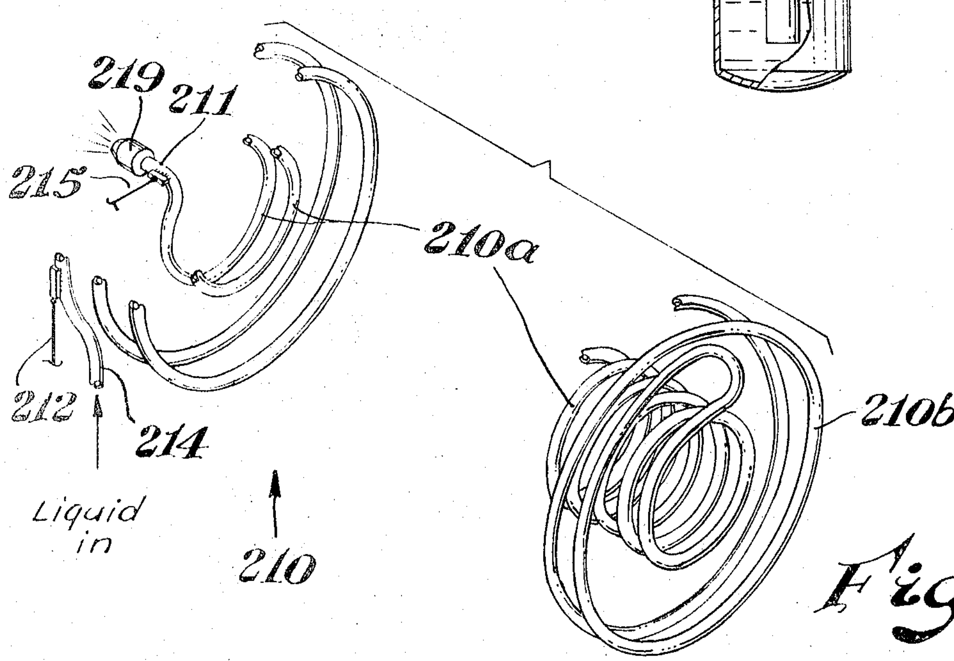

219
211
215
210a
212
214
Liquid in
210
210b

Fig. 2

APPARATUS FOR VAPOR GENERATION

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of my copending application filed Dec. 15, 1971, Ser. No. 208,296 now abandoned.

BRIEF DESCRIPTION OF THE INVENTION

The present invention relates to a novel apparatus and a process employing the apparatus for vaporizing fluids, such as volatile organic solvents or mixtures of solvents, to produce superheated vapors of said fluid(s). More particularly, the present invention concerns a pressurized apparatus from which superheated vapors of volatile organic solvents, generated within the apparatus, can be discharged in a controlled manner to impinge against a plastic surface, e.g., coating or surface of a body of plastic, to effectuate the modification of the surface, viz., remove surface imperfections and defects, according to the vapor reflow principle or to flow a plastic powder on a surface to create a film or coating thereon.

Several embodiments of apparatus within the scope of the present invention are illustrated in the Drawings:

FIG. 1 illustrates in cross-sectional elevation the configuration of a light weight apparatus within the scope of the present invention suitable for continuous or intermittent usage to produce superheated vapors of a fluid, for example, a vaporizable organic solvent or a mixture of vaporizable organic solvents and propel them with sufficient force to effectively produce a pattern of superheated vapors (vapors of the solvent or mixture of solvents 100° to 300°C. above their atmospheric boiling point) up to 1 to 2 feet from the discharge orifice of the apparatus;

FIG. 2 illustrates another embodiment of a vaporizer element of the present invention in cross-sectional view, which eliminates the effect of inductance when alternating current is employed.

DETAILED DESCRIPTION OF THE INVENTION

In accordance with the present invention, having particular reference to FIG. 1 of the Drawings, there is provided a tubular member **10** which is made of a metal or an alloy of a metal having a resistance sufficient to convert electrical energy, supplied at low voltage and high amperage, into heat energy at a rate to supply, within a length of several feet, the sensible heat necessary to raise the temperature of the liquid to the boiling point, the heat of vaporization of the liquid and the heat of superheat of the vapor of the liquid to a predetermined temperature. Connected to one end **11** of the tubular member **10** is an electric cable **12** which provides one lead from the power source **13.** Connected to the other end **14** of the member **10** is another electric cable **15** which provides the second lead from the power source **13,** thus completing an electric circuit from the power source **13** to the tubular member **10** (the electrical resistance) and back to the power source **13.** In the embodiment shown in FIG. **1,** the tubular member **10** is provided with a shielding member **16** which surrounds the member **10** and retains insulation **17** in position to isolate member **10** from the shield, thus insulating the member **10** from loss of heat to ambient atmosphere, as well as electrically insulating the member **10** from the ambient atmosphere and the operator. Extending from the shielding member **16** is a handle member **18** to accommodate the manual manipulation of the apparatus. The tubular member **10** is provided at one end **11** with a nozzle or orifice **19** or other vapor pattern directing means. The other end **14** of tubing **10** is provided with a tubular electrical and heat insulating connector **20.** Connector **20** is further connected by piping or flexible tubing **21** to a pressurized container **22** which contains the liquid to be vaporized. Pressure controls and a source of pressure, neither of which are shown, are associated with the container **22.** The power source **13** is also provided with controls, transformers, and/or rectifiers, etc., as necessary to produce the desired voltage and current to provide the wattage to produce the desired temperature in the member **10.**

The tubular member **10** is preferably provided, as shown, with a fluid flow control valve **23** to permit adjustment of the rate of flow and a simultaneously operable trigger mechanism or valve **24** to permit off-on flow of fluid through tube **10** as well as an electrical switch which simultaneously permits flow of electricity to the member **10** when fluid is flowing and shuts off the flow of electricity to the member **10** when fluid flow is interrupted.

In operation of the apparatus illustrated in FIG. **1,** a volatilizable liquid, for example, a halogenated hydrocarbon such as methylene chloride, is provided in container **22** and the container pressurized with from about 30 to about 200 pounds per square inch air pressure. The power source is activated, and, for example, if methylene chloride is to be delivered under 30–35 psig. as a superheated vapor at 400°F. just outside the nozzle **19,** is adjusted to deliver about 30 volts at 75 amperes of alternating current, converted from 220 volt source through an isolated secondary of a transformer. Thermocouples, as at points x and y or by trial and error, simplify the adjustment of the power source to provide a superheated vapor of methylene chloride of a temperature of about 400°F.; it being clearly understood the temperature of the vapor inside the apparatus will necessarily be higher than that outside the nozzle due to expansion and cooling phenomena of gases. The apparatus illustrated in FIG. **1** is capable of delivering several gallons an hour of such vapor continuously or intermittently. The preferred embodiment of the apparatus illustrated in FIG. **1** includes the control of the temperature of the member **10** by using the signal generated by the thermocouples x and y to either shut off the current or turn it on intermittently.

It is one advantage of the apparatus of the present invention that once the current is turned off and simultaneously the flow of fluid is stopped, the member **10** cools rapidly since it is of inconsequential volume, that is, its volume as a heat sink is less than the volume of the liquid in the tube. The apparatus can be even more rapidly cooled by merely allowing a small quantity of liquid from the container **22** to pass through the member **10** after the current has been shut off at the transformer controls, for example. Similarly, the member **10** heats up rapidly. Both of these features are important when the liquid being heated is degradable by prolonged contact with high temperature.

The embodiment of the present invention illustrated in FIG. **2** illustrates one method for winding the tubular heating member to eliminate substantially the effect of inductance associated with a current flowing through a coil. The tubular member **210** is wound back over itself so that the current flowing at any instant in the inner coil **210A** is directly opposite that flowing in the **210B**. The outlet end **211** is provided with a nozzel **219** and opposite ends of the coil **210**, i.e., **211** and **214**, are provided with electrical connection **212** and **215** which are connected to a power source, not shown. Similarly, the coil **210** is connected at end **214** to a source of liquid not shown. The apparatus may be, in all other aspects, identical with that illustrated in FIG. **1**, that is, the coil may be arranged within a shell provided with a handle to form a manually operated apparatus.

It is to be understood that either configuration of the coil **10** or **210** of FIGS. **1** and **2**, respectively, may be employed to heat or vaporize liquid materials for purposes other than those contemplated by the gun-like design. Thus, one could employ the coil to heat water or to generate saturated or superheated steam. Similarly, the coil may be employed to heat liquids or generate vapors for chemical reactions.

Having described my invention in general, the following examples are set forth to illustrate specific embodiments of the invention.

EXAMPLE 1

A type 316 stainless steel tube having an outside diameter of ¼ inch and a wall thickness of 0.028 inch was close wound on a 2 inch mandrel to provide thirteen turns then a space equal to about two turns followed by fourteen turns. The coil was started by bringing a point about five inches from one end into a groove in the mandrel near its center, and bringing the tubing to the rear of the mandrel along a groove to the point of beginning of the coil forming section. The coil so wound was insulated between each turn with a disc of insulating material, compressed asbestos, capable of withstanding 1,200°F. temperatures. The coil was also insulated along and about its peripheral dimensions with an alumina-silica ceramic fiber insulation (e.g., Fiberfrax or Kaowool) of about ¼ inch. A 3¼ inch OD tube of Type 304 stainless steel was placed about the assembly, closed at the rearward end and provided with an end cap to receive the discharge end of the tube and aid in holding the tube within the shield assembly. The shield was provided with a handle of metal to surround the inlet end of the tube. The space between the tube and the handle was insulated. The inlet end of the tube was provided with a fitting to receive a Teflon nipple, to which was fitted a liquid control valve. The leads from a 10 KVA alternating current isolated secondary 220 volt transformer were brazed, one to the tube and one to the handle. A container provided with an air pressure system was connected to the control valve. Upon pressurization of the container which contained methylene chloride, and activation of the transformer to deliver 30 volts and 75 amperes, the methylene chloride flowing into the tube was converted into a vapor which had a temperature upon leaving the nozzle of about 400°F.

The following table illustrates the versatility of the apparatus of FIG. **1** to vaporize various requirements of a methylene chloride composition employed to flow an acrylic paint surface.

Flow Rate Gallons/Hour	Watts at Indicated Ave. Voltage
1	600/16.5
2	1200/22
3	1800/27.5
4	2400/33
5	3000/38.5
6	3600/44
7	4200/49.5

The pressure on the apparatus provided a pattern of vapor of about 1 square foot one foot from the nozzle which upon impinging on the surface of a panel coated with an acrylic lacquer of the type used to paint automobiles and which painted panel had been lightly sanded, removed surface imperfections.

The apparatus illustrated in FIG. **1** can also be operated from a 110V source using a five KVA transformer — 32 volts isolated secondary to supply up to 2 gallons per hour of the methylene chloride composition at 400°F.

I claim:

1. An apparatus for converting a volatilizable organic liquid or mixture of liquids into superheated vapors which consists essentially of:

a tubular metal member which is electrically conductive but has a resistance to the flow of an electrical current and which member defines a flow path for the liquid to be vaporized and for the vaporized liquid,

a vapor flow control member at one end of said tubular metal member, said vapor control member having a vapor outlet orifice, a manually actuated open-close liquid flow control member at the opposite end of said tubular metal member for selectively controlling liquid flow into said tubular metal member,

a source of electrical energy connected at a pair of spaced points to said tubular metal member by means arranged to be controlled concurrently with and in on-off corresponding relationship with said liquid flow control member whereby electrical energy is caused to flow through a predetermined segment of said tubular metal member to heat the tubular metal member to a temperature to vaporize the liquid flowing therethrough,

a source of volatilizable organic liquid connected in flow communication with the tubular metal member through said liquid flow control member, said source of liquid being under superatmospheric pressure whereby the liquid therein is caused to flow into the tubular metal member when the liquid flow control member is opened,

the tubular metal member being heated to such a temperature and the length of the heated portion of the tubular metal member, the bore of the tubular metal member and the orifice of said vapor flow control member being of such a size relative to each other such that the liquid supplied under pressure into the tubular metal member will vaporize and said vapor will be heated to above its boiling point at a rate to maintain a pressure of vapor at the vapor flow control member sufficient to propel the vapors from the apparatus at least about one foot, said means connecting said electrical energy source to said tubular metal member including connectors in current flowing contact with the respective ends of said tubular metal member,

said electrical energy source being connected in circuit with said connectors and said connecting means further including a switch associated with said liquid flow control member in concurrent similarly functioning open-close relation to said liquid control member for controlling application of energy to said connectors from said source whereby electrical current is caused to flow through the tubular member to heat the member to a temperature adequate to vaporize the liquid flowing therethrough,

a connector connecting said tubular metal member through said liquid flow control member to said source of vaporizable organic liquid,

said tubular metal member, vapor flow member, and said liquid flow control member being capable of withstanding superatmospheric pressures and a temperature of 1,200°F. and said electrical energy connectors and switch being capable of withstanding five to ten KVA alternating current power,

said tubular metal member electrically and thermally insulated by a shield and a handle associated with said shield and containing the liquid flow control member and the switch, said vapor control member projecting from one end of the shield.

2. An apparatus for converting a volatilizable organic liquid or mixture of liquids into superheated vapors which consists essentially of:

a tubular metal member which is electrically conductive but has a resistance to flow of an electrical current and which member defines a flow passage for carrying both liquid and gaseous forms of said liquid to be vaporized,

a vapor flow control member at one end of said tubular metal member having a vapor outlet orifice,

a manually operated open-close liquid flow control member at the other end of said tubular metal member for controlling liquid flow into the tubular metal member,

said tubular metal member being disconnectable and removable from said flow control member,

electrical energy connectors in current flowing contact with the respective ends of said tubular metal member,

an electrical current source in circuit with said electrical energy connectors and a switch associated with said liquid flow control member in concurrent similarly functioning open-close relation to said liquid control member for controlling application of energy to said connectors from said source whereby electrical current is caused to flow through the tubular member to heat the member to a temperature adequate to vaporize the liquid flowing therethrough,

a connector associating said tubular metal member through said liquid flow control member to a source of vaporizable organic liquid and means associated with the source for causing the liquid to flow into the tubular metal member when the fluid control member is opened,

said tubular metal member, vapor flow member, and said liquid flow control member being capable of withstanding superatmospheric pressures and a temperature of 1,200°F. and said electrical energy connectors and switch being capable of withstanding five to ten KVA alternating current power,

said tubular metal member electrically and thermally insulated by a shield and a handle associated with said shield and containing the liquid flow control member and the switch, said vapor control member projecting from one end of the shield.

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