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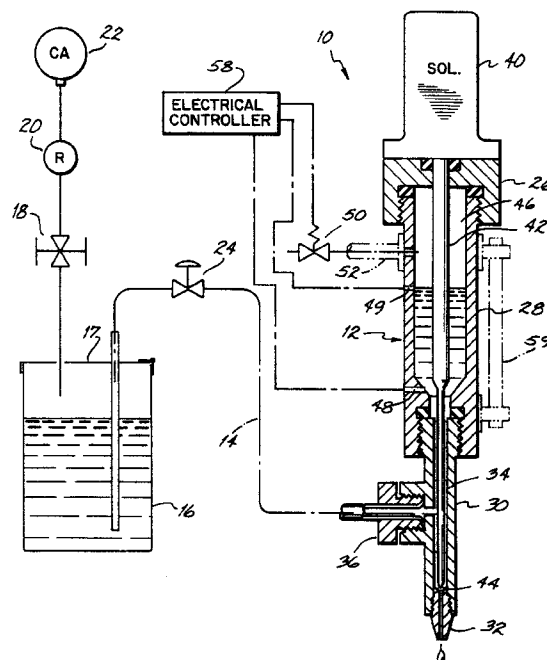
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(54) **Liquid dispensers.**

(57) A liquid dispenser (10) with bubble removal capability includes a dispensing gun (12) supplied with pressurized liquid from a sealed vessel (16). The dispensing gun includes connected body sections (26, 28, 30 and 32) which form a central passageway (34) that terminates at a nozzle (32). An axially movable plunger valve (42) extends through the passageway, along the gun, and seats adjacent the nozzle. A solenoid (40) mounted at an opposite end of the passageway connects to and controls the plunger valve to open and close the passageway near the nozzle, thereby to initiate and terminate, respectively, liquid dispensing from the gun. Adjacent the solenoid, the central passageway includes an increased diameter portion (46), i.e. a gas collection chamber, and the plunger valve also has an increased diameter. These increased diameter elements provide additional surface area which promotes removal of gas and/or bubbles from the liquid prior to dispensing. An exhaust valve (50) is provided to vent the gas collection chamber, and preferably this is done automatically when liquid in the passageway reaches a predetermined lower level, prior to refilling the passageway with liquid until a predetermined upper level is reached.



This invention relates to a liquid dispenser for intermittently dispensing minute amounts of liquid.

Many commercial liquid coating operations require dispensing of precise and minute amounts of liquid. These amounts may be as low as 1.0 mg, with an approved error range of ± 0.05 mg. For instance, application of insulation material to an integrated circuit substrate requires precision of this magnitude. Some adhesive applications also require this order of precision.

Typically, the liquids used for such applications have a relatively high viscosity, and therefore a dispenser for delivering a precise amount of this type of liquid is operated intermittently.

While a liquid dispenser of this type can provide a high degree of accuracy and control over intermittent dispensing of minute amounts of liquid, such dispensers are susceptible to the formation of gas bubbles in the liquid as it is supplied under pressure to the delivery apparatus, i.e. the gun.

Since these bubbles have no way of escaping from the gun, they are eventually dispensed with the liquid, thereby adversely affecting the accuracy and control of the coating operation, particularly where very minute amounts of material are dispensed.

A liquid dispenser in accordance with the invention comprises a gun body having a central passageway which extends therethrough and terminates at a nozzle opening at a first end of the body, means for supplying pressurized liquid to the central passageway, a plunger valve extending through the central passageway from a second end of the body, the plunger valve adapted to move axially along the passageway to open and close the passageway adjacent the nozzle opening, thereby to permit and to prevent, respectively, dispensing of liquid from the nozzle opening and means for moving the plunger located at the second end of the body wherein means are provided, located between the first and second ends of the body, for promoting removal of bubbles from the pressurized liquid while in the central passageway.

Such an arrangement substantially eliminates accuracy and control problems caused by the formation of air bubbles in an intermittently operated, liquid dispensing apparatus. This may be achieved via use of a gas collection chamber located in the gun which promotes removal of air bubbles from the pressurized liquid while in the gun, in combination with periodic operation of a venting valve to vent the gas collection chamber to remove the collected gas from the gun.

The central liquid passageway of a plunger valve dispensing gun may have an enlarged diameter portion, i.e. a gas collection chamber, opposite a nozzle end of the gun. The plunger valve may also have an increased diameter within this portion. The increased surface area of the sides of the collection chamber and the valve promote passive removal of bubbles from the pressurized liquid while in the passageway.

The gun may also have an outlet in fluid communication with the gas collection chamber. A venting valve may control fluid flow through the outlet. By opening the valve when the liquid in the passageway reaches a predetermined low level, collected gas can be removed from the chamber inside the gun. The valve is then closed, and the passageway is refilled until the liquid level reaches a predetermined upper level.

With two liquid level sensors mounted to the gun and an electrical controller connected to the sensors, the venting valve and the components which supply liquid to the gun, these venting and refilling procedures can be automated.

If this procedure is not automated, it is preferable to have a transparent gun body, or in the alternative, a transparent liquid gauge mounted to a non-transparent gun body and in fluid communication with the collection chamber, thereby to allow visual detection of the liquid level.

Dispensers in accordance with the invention passively promote removal of air bubbles from pressurized liquid in an intermittently operated dispenser, and also actively remove the collected gas from the gun, thereby eliminating accuracy and control problems that may result from the dispensing of liquid with gas bubbles entrapped therein. The gas bubbles may be removed without interrupting normal dispensing operations.

The invention will now be described by way of example and with reference to the accompanying drawing, which is a cross sectional schematic which illustrates a liquid dispenser, with bubble removal capability, in accordance with the invention.

The Figure shows a liquid dispenser 10 with bubble free capability, in accordance with the invention. The dispenser 10 includes a dispensing gun 12 supplied with liquid under pressure via a tube 14 which terminates in a pressure vessel 16, sealed by a lid 17. A valve 18 and a regulator 20 control pressurized air which is supplied to the vessel 16 by a pressure source 22. The pressurized air forces the liquid out of vessel 16 through conduit 14 to gun 12, preferably through an in-line valve 24.

The dispensing gun 12 includes threadably connected body sections 26, 28, 30 and 32, and the sections 28 and 30 include a central passageway 34 through which the liquid under pressure moves toward section 32, which acts as an outlet nozzle for intermittent liquid dispensing. The conduit 14 connects with central passageway 34 via an externally threaded connector section 36 which threads within body section 30.

The top of the dispensing gun 12 includes a solenoid 40, and the solenoid 40 connects to a plunger valve 42 which extends through the gun 12 along the passageway 34. The plunger valve 42 controls liquid dispensing from the nozzle 32. When plunger valve

42 is in a down position, as viewed in the Figure, a bottom end 44 thereof seats against a valve seat in the top of nozzle 32, thereby closing off the end of the passageway 34 and preventing discharge of liquid. When solenoid 40 raises plunger valve 42, the bottom end 44 unseats from nozzle 32, thereby causing liquid under pressure to discharge through nozzle 32.

The structure of this dispensing gun 12 promotes removal of bubbles from the liquid within the central passageway 34. This results from a combination of features, including an increased diameter upper portion 46 of central passageway 34, also referred to as a gas collection chamber. This increased diameter portion 46 provides increased surface area in the body 12, which facilitates the escape of entrapped gas or air bubbles from the liquid. Additionally, within chamber 46, the plunger valve 42 also has an increased diameter. This additional surface area also promotes bubble or gas removal from the dispensing liquid.

In addition to this internal structure which passively promotes the removal of gas from the liquid, the invention also contemplates active removal of gas from the gun 12 during dispensing. Preferably, the dispensing gun 12 includes a lower liquid level sensor 48 and an upper liquid level sensor 49 mounted to gun 12 in fluid communication with central passageway 34. When the liquid level in passageway 34 reaches a lower threshold level, i.e. the level of sensor 48, a normally closed exhaust valve 50 is opened by an electrical controller 58 to vent upper portion 46 via a fluid outlet 52. Simultaneously therewith, central passageway 34 refills with liquid due to the pressure in vessel 16 until a desirable level is reached, i.e. the level of sensor 49. Controller 58, electrically connected to both sensors 48 and 49, in response closes venting valve 50 and further flow into chamber 46 stops as the pressure in chamber 46 reaches approximately the pressure in vessel 16.

If refilling and venting are not performed automatically, by a controller 58, it is preferable that body section 28 be transparent, so that the liquid level may be visually detected. Alternatively, a liquid level gauge 59 may be mounted alongside body section 28, with body section 28 having upper and lower ports (not shown) to place the inside of the gauge 59 in fluid communication with the central passageway 34. In this case, when air is to be manually removed from chamber 46, valve 50 is opened manually when the level of liquid in chamber 46 is low, and once the liquid level in chamber 46 rises to the desired level in chamber 46, due to the pressure vessel 16, valve 50 is then manually closed.

Thus, the invention provides an open volume between solenoid 40 and nozzle outlet 32 to allow collection and eventual venting of gas from the gun 12, thereby eliminating the dispensing of bubbles from the nozzle section 32 and assuring that only liquid is

dispensed. Also because of the manner of intermittent liquid dispensing via operation of the plunger valve 42, the dispensing gun 12 can be vented without stopping normal liquid dispensing operations.

Claims

1. A liquid dispenser for dispensing small amounts of liquid comprising a gun body having a central passageway which extends therethrough and terminates at a nozzle opening at a first end of the body, means for supplying pressurized liquid to the central passageway, a plunger valve extending through the central passageway from a second end of the body, the plunger valve adapted to move axially along the passageway to open and close the passageway adjacent the nozzle opening, thereby to permit and to prevent, respectively, dispensing of liquid from the nozzle opening and means for moving the plunger located at the second end of the body wherein means are provided, located between the first and second ends of the body, for promoting removal of bubbles from the pressurized liquid while in the central passageway.
2. A dispenser according to claim 1 wherein the promoting means comprises an enlarged diameter portion of the central passageway, the enlarged diameter portion located adjacent the second end of the body.
3. A dispenser according to claim 2 wherein the promoting means comprises an enlarged diameter portion of the plunger valve within the enlarged diameter portion of the central passageway.
4. A dispenser according to Claim 2 or 3 comprising means for venting the enlarged diameter portion of the central passageway when the liquid therein reaches a predetermined lower level, and then refilling liquid into the central passageway until an upper predetermined level is reached.
5. A dispenser according to claim 4 comprising means for automatically controlling the means for venting and refilling.
6. A dispenser according to any preceding claim wherein the gun body is transparent to allow visual detection of the liquid level therein.
7. A dispenser according to any preceding claim comprising a liquid gauge mounted to the side of the body and in fluid communication with the central passageway.

8. A liquid dispenser for dispensing small amounts of liquid comprising a gun body having a central passageway which extends therethrough and terminates at a nozzle opening at a first end of the body, means for supplying pressurized liquid to the central passageway, a plunger valve extended through the central passageway from a second end of the body, the plunger valve adapted to move axially along the passageway to open and close the passageway adjacent the nozzle opening, thereby to permit and to prevent, respectively, dispensing of liquid from the nozzle opening and means for moving the plunger located at the second end of the body, the central passageway having an enlarged diameter portion adjacent the second end of the body, the enlarged diameter portion serving as a gas collection chamber, the plunger valve also having an increased diameter within the collection chamber, the surface area of the plunger valve and the surface area of the gun body within collection chamber promoting removal of bubbles from the liquid during intermittent dispensing out of the nozzle opening.
9. A dispenser according to claim 8 wherein the gas collection chamber has an external opening to atmosphere, means being provided for venting the collection chamber to atmosphere to remove gas therefrom.
10. A dispenser according to claim 9 comprising a lower level liquid sensor mounted to the body in fluid communication with the central passageway, an upper level liquid sensor mounted to the body in fluid communication with the central passageway, and means for automatically controlling the level of liquid in the central passageway by adding liquid to the passageway upon actuation of the lower level liquid sensor and until actuation of the upper level liquid sensor, the automatic controlling means being adapted to operate the venting means to vent the collection chamber to atmosphere before adding liquid to the central passageway.

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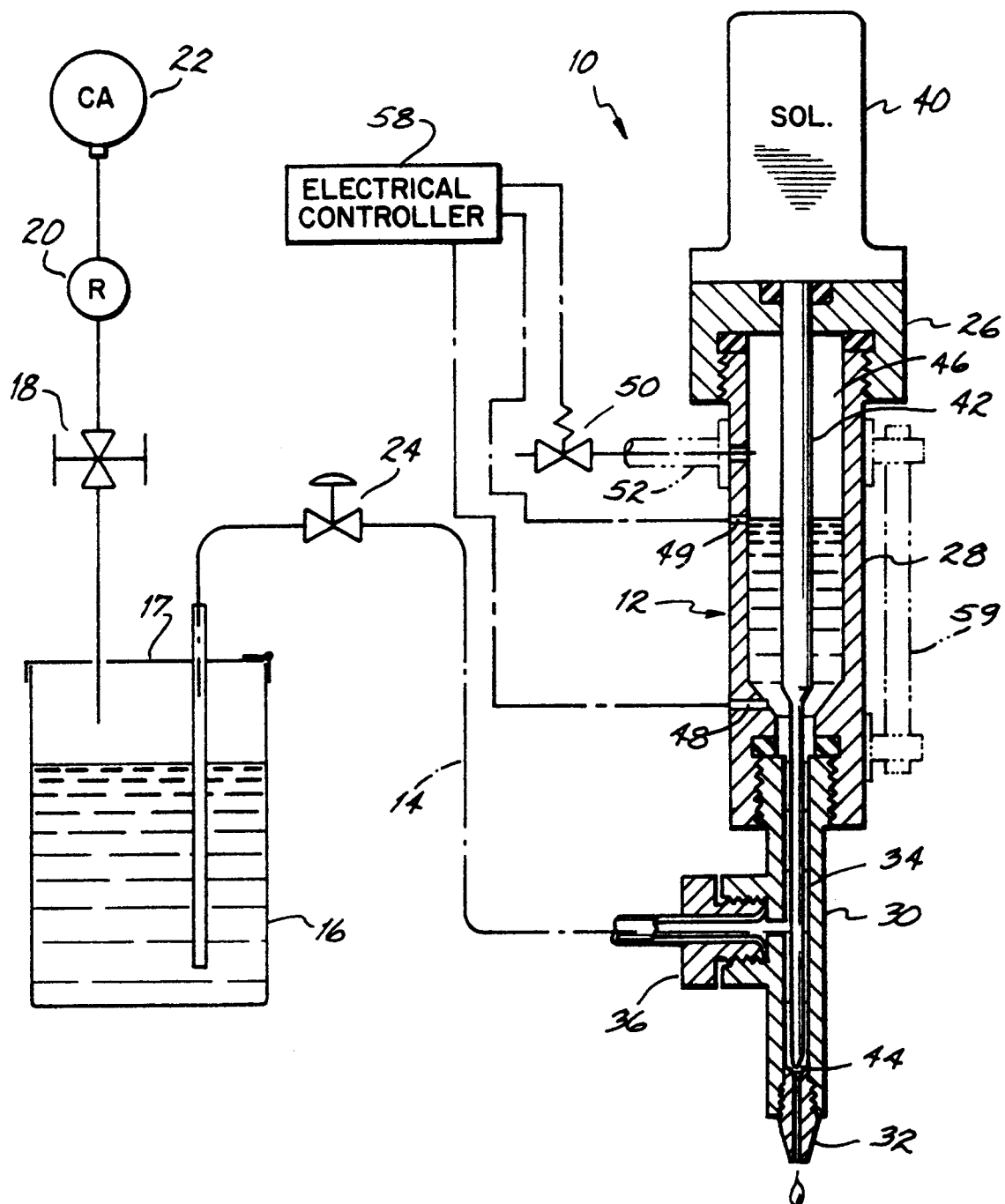
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European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 0419

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.CL5)
X	EP-A-0 270 207 (W.R. GRACE & CO.) * abstract; figures * ---	1-3,8	B67D5/58 B05C11/10
X	DE-A-38 41 474 (MACON GMBH KLEBSTOFF-AUFTRAGSGERÄTE) * the whole document * ---	1-3,8	
A	EP-A-0 375 462 (NORDSON CORP.) * abstract; figures 3,9-11 * -----	1-3,8	
			TECHNICAL FIELDS SEARCHED (Int.CL5)
			B67D B05C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 9 May 1994	Examiner Gino, C
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document			

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