Feb. 10, 1970 L. O. UPTON 3,494,326

SPIN-COATING MACHINE

Filed Feb. 1, 1968 3 Sheets-Sheet 1

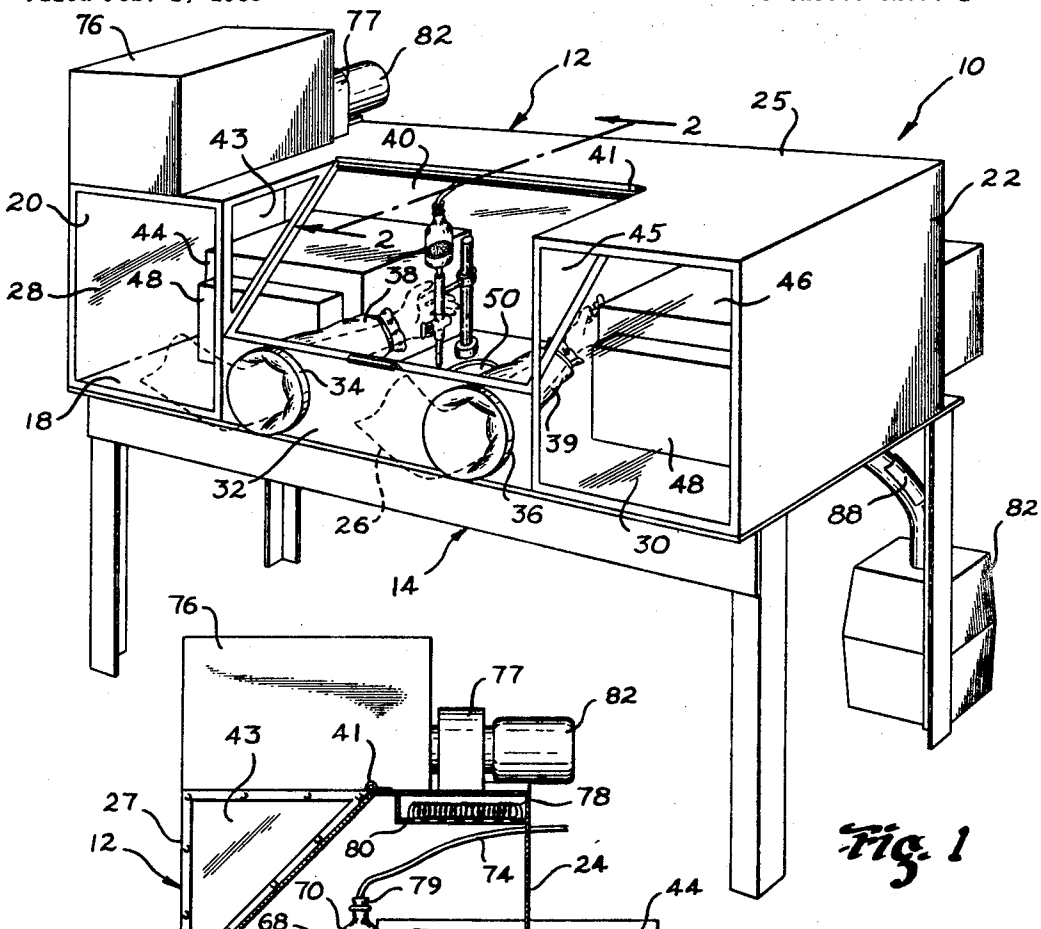

Fig. 1

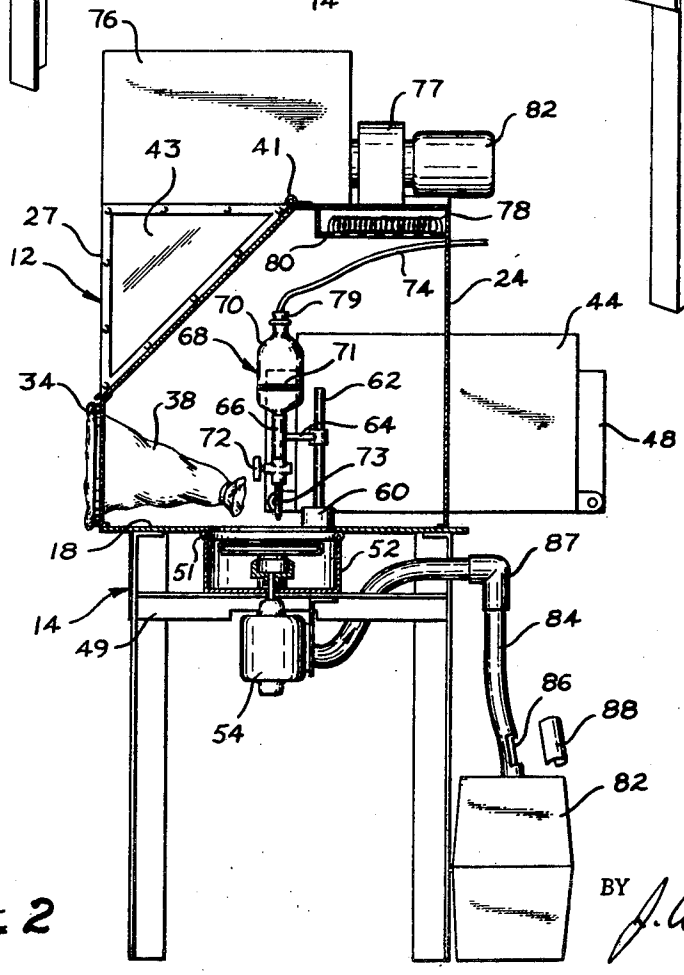

Fig. 2

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SPIN-COATING MACHINE

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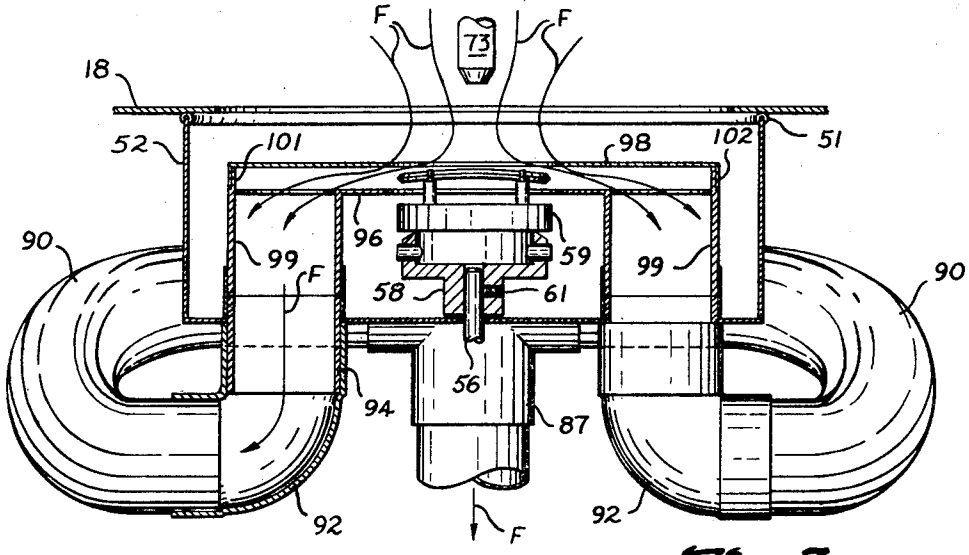

Fig. 3

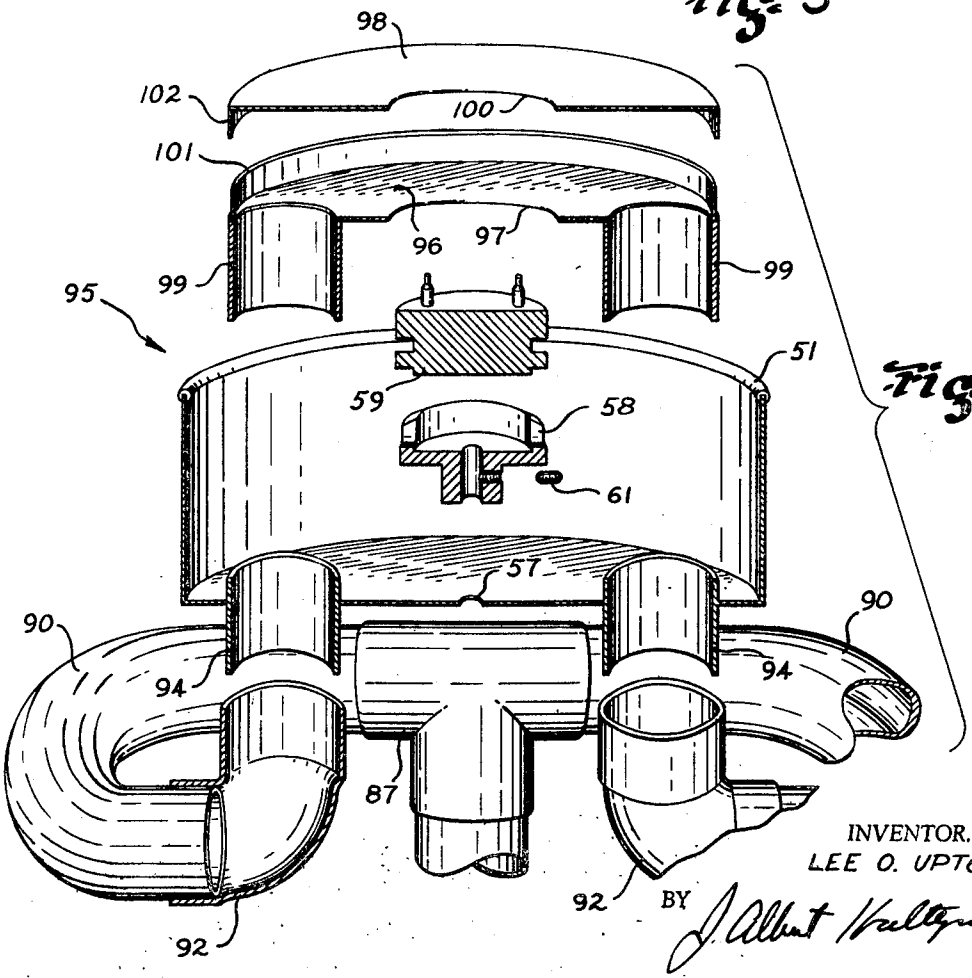

Fig. 4

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SPIN-COATING MACHINE

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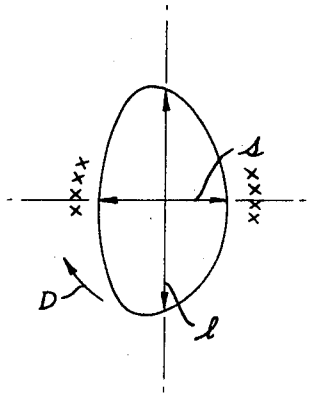

Fig. 5

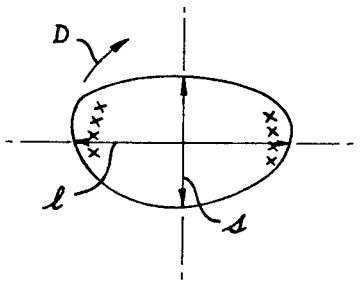

Fig. 6

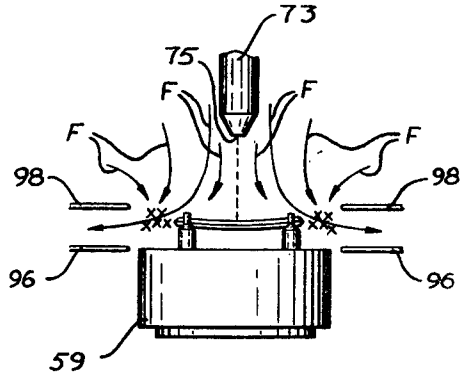

Fig. 7

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United States Patent Office 3,494,326
Patented Feb. 10, 1970

3,494,326

SPIN-COATING MACHINE

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Filed Feb. 1, 1968, Ser. No. 702,297
Int. Cl. C23c *13/08*; B05c *11/12*
U.S. Cl. 118—50 1 Claim

ABSTRACT OF THE DISCLOSURE

An improved device for applying coating solutions to spectacle lenses. The device includes an adjustable lens holder rotatably mounted in a sealed, glass-walled compartment, a coating applicator, and means for introducing filtered, dehumidified air under pressure into the compartment. A vacuum chamber connected to a vacuum device is positioned around said lens holder. When in operation, a controlled air flow is maintained around the vicinity of the spinning lens, as a result of the pressure differential created between the positive pressure within the compartment and the vacuum in the area of the spinning lens. By use of this invention, the problem of speckling or mottling lenses is eliminated. The sealed chamber includes glove means sealingly secured to openings in the chamber wall and permitting operator-manipulation within the chamber. At least one oven is incorporated into the structure defining the compartment and includes plural door means whereby entry into the oven can be from both within said without the compartment.

Field of the invention

Apparatus for spin-coating lenses and filters, including a controlled air flow in the area of the spinning lens.

Description of the prior art

Lenses and filters have in the past been spin-coated by depositing on the center of the article to be coated a predetermined amount of the coating material and spinning the lens or filter to produce a thin film, as is shown in British patent specification 571,238. Prior art devices present problems in uniformly coating certain elongated lens shapes especially when the concave side of a lens is being coated. Many of today's lenses, especially those used in women's spectacles, are designed with a short axis and a long axis. As a result, the liquid coating material applied to the surface and spun off at the short axis is picked up along the surface of the long axis as the lens rotates, causing speckling or mottling of the surface along the long axis. By providing a pressure differential in accordance with this invention, a controlled air flow in the area of the spinning lens is produced so that material spun off is drawn clear of the surface to be coated and the problem of speckling or mottling is eliminated.

Summary

A spin-coating machine including a sealed compartment and means for introducing filtered, dehumidified, heated air under a positive pressure into said compartment and a vacuum cavity producing a pressure differential in the area of the spinning lens for controlled withdrawal and flow of said air around the spinning lens.

It is an object of this invention to provide an improved device for spin-coating lenses by providing an environment free of dust and water vapor.

It is a further object of this invention to provide an improved device whereby the problem of speckling or mottling of the coated lens is eliminated by a controlled air flow around the spinning lens.

Brief description of the drawing

FIG. 1 is a perspective view of an embodiment of the invention.

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1 with the operator removed.

FIG. 3 is an enlarged cross-sectional view of the vacuum chamber of the invention.

FIG. 4 is an exploded perspective cross-sectional view of the vacuum chamber as shown in FIG. 3.

FIG. 5 is a top view in diagrammatic form showing the flow of coating material.

FIG. 6 is a diagrammatic view similar to FIG. 5 but showing the lens in a position one-quarter of a revolution from the position shown in FIG. 5.

FIG. 7 is a side view of a spinning lens showing diagrammatically the controlled air flow that results from the invention.

The spin-coating machine of this invention consists of a booth generally indicated by the numeral **10**, comprising a sealed compartment **12** supported by bench **14**. Compartment **12** is built up from floor **18**, side walls **20**, **22**, rear wall **24**, top cover **25** and front wall **27**. Front wall **27** facing operator **26** is provided with two vertical glass panels **28** and **30**. Separating glass panels **28** and **30** is a vertical metal sheet **32** having formed therein two openings **34** and **36**, which are fitted with gauntlets **38** and **39**. These may be made of parachute nylon or other light impervious sheet fabric material. Said gauntlets are tightened to operator **26** at the wrists and provide a means whereby operator **26** can extend both hands into the interior of compartment **12** while maintaining said compartment in a sealed condition. Directly above metal sheet **32** carrying gauntlets **38** and **39** is located movable glass cover **40**, which slopes backward at an angle of about 45° and is hingedly joined by hinge **41** to top **25** of compartment **12**. A sealing material such as foam rubber is applied about the periphery of cover **40** to provide a tight seal between cover **40** and the adjacent edges of the frame in which it sits. Integrally joined to glass panel **28** and top **25** is glass side panel **43** and joined in the same manner to glass panel **30** is glass side panel **45**. Located on each side of said gauntlets, so placed to be conveniently reached by said operator, are ovens **44** and **46**, constructed of monolithic insulating refractory blocks, and heated by wire-wound heating units. In a typical embodiment said heating units are so positioned on the top and bottom of the oven as to provide for a uniform distribution of heat. Hingedly located on the front and back of said oven is framed door **48** also insulated with a monolithic refractory material. In a typical embodiment, both ovens protrude through rear wall **24** as is shown in FIG. 2. Lenses placed in an oven after being spin-coated, through the front door, can be removed by the operator from the rear door without entering into compartment **12** through either cover **40** or gauntlets **38**. Formed in floor **18** intermediate between said gauntlets is aperture **50**. Located directly beneath said aperture and symmetrically oriented with respect thereto is spin pan **52** having the general shape of a cylinder.

Spin pan **52** is supported by brace **49** and sealed to the underside of floor **18** of compartment **12** by gasket **51**. Located beneath spin pan **52** is electric motor **54** having a rotatable shaft **56** extending through aperture **57** formed in the center of said spin pan. Fixedly attached to shaft **56** as by set screw **61**, is chuck **58**, designed to receive lens holder **59** such as that described in U.S. Patent No. 3,336,902, assigned to the assignee of the instant application.

An electrical speed control device for said rotating

haft, not shown, is located on a rear wall of said compartment within said operator's reach, and is capable of providing various speeds of rotation of motor **54** within the range of 100 to 4,000 revolutions per minute, as elected by the operator. Secured to floor **18** is mounting lange **60**. Positioned in said flange is standard **62** having pivotally joined thereto arm **64** which has attached hereon clamp **66**. Said clamp provides means for securely holding coating solution applicator **68** at the desired elevation and orientation over the lens chuck. Said applicator is generally comprised of tank **70** fitted with ilter **71**. Tank **70** is fused to stopcock unit **72**, which tself is fused to stem **73** having formed therein a suitably sized orifice **75**. A pressure pump, not shown, is connected by means of air line **74** to tank **70** by means of rubber stopper **79**. Proper pressure is applied to the iquid in said tank by means of an adjustable manually-operated pressure reducing valve, now shown. When said stockcock is turned on, liquid coating materials are metered by pressure applied to said tank through said air ine.

Secured to top **25** is housing **76** which houses a standard room dehumidification unit mounted above a dust filter, both not shown. Mounted adjacent to housing **76** is blower **77** operated by motor **82**. Said blower pulls air hrough the dust filter and the dehumidifier. The dust-ree, dehumidified air is thus blown through an aperture, not shown, in top **25** onto heating coils **78** mounted on baffle **80**. A thermostat, not shown, is provided to control he temperature of the heated air within said compartnent. This mechanism supplies dehumidified, dust-filtered, heated air under a moderate degree of pressure into the compartment.

Located beneath said compartment is a suction device, such as a vacuum cleaner indicated by the numeral **82**, having a hose **84** which is connected to a T-joint **87**. Formed in said hose beneath said T-joint is suction bypass vent **86** over which is frictionally fixed rotatable vent cover **88**. Attached to T-joint **87** are two suction hoses **90** which are attached to elbows **92**. The base of said spin pan has formed therein ducts **94** over which is received elbow **92**. So designed to be received by said ducts **94** is a vacuum chamber, generally indicated by the numeral **95**. Said chamber includes a bottom circular plate **96** having an outer flanged rim **101**, a central aperture **97** and two ducts **99** which extend in an opposite direction from said rim and are coupled to ducts **94** in said spin pan. Vacuum chamber **95** has an upper disc-like plate **98** having formed therein a central aperture **100** corresponding to aperture **97** on lower plate **96** and having an outer flanged rim **102** which is telescoped over rim **101** on lower plate **96**. The vacuum chamber, when connected to the vacuum device as described above, causes a high velocity air flow from the inside of the closed booth over the surface of the spinning lens. The air flow has a large radial component of motion for a purpose which will be described.

A slight positive pressure is maintained within the booth by adjusting the influx of air from blower **77** with relation to the exhaust of air caused by vacuum device **82**.

In prior art spin-coating devices, serious problems resulted when attempts were made to uniformly coat elongated lens shapes, which are currently employed in a majority of women's spectacles. The problem is especially acute when coating the concave side of the elongated lens. As is shown diagrammatically in FIGS. 5 and 6, the liquid coating material which is applied to the center of the spinning lens can result in an uneven coating. As the lens is spinning the coating material deposited on the center of the lens is spread out radially until spun off by centrifugal force at the edge of the lens. In FIG. 5 the letters *x* are intended to represent droplets of coating material flung off the short axis of the spinning lens. When a lense spins at 3600 revolutions per minute, a complete revolution is made in 1/60 of a second, and the thin liquid coating centrifugally thrown from the center of the lens to its periphery at short axis *s* is picked up by long axis *l* as it passes through the air 1/240 of a second later. In FIGS. 5 and 6 the arrow lettered D indicates the direction of rotation of the spinning lens. This results in speckling or mottling of the surface along the long axis, represented by the letter *x* in FIG. 6. By use of the instant invention, the problem of speckling the surface along the long axis has been overcome. By providing a positive pressure within the booth and suction concentric to the spinning lens, two important results are obtained. First, the dry, filtered, dehumidified air under positive pressure within the compartment prevents the introduction of dust and water vapor within the booth which would, if present, prevent high quality coatings, and, second, the controllable pressure differential results in a controlled air flow which carries away droplets of the coating material spun off the surface along the short axis as is shown diagrammatically in FIG. 7 before speckling or mottling of the surface along the long axis can result. In FIGS. 3 and 7 the arrows labelled F indicate the direction of the controlled air flow resulting from the pressure differential. When in operation, the pressure differential is controlled by means of vent **86**, previously described, over which is frictionally fixed rotatable vent cover **88**. While I am, at present, uncertain as to the reason the radial air flow entirely eliminates the redepositing of liquid droplets along the long axis of the lens, exhaustive tests have shown that in fact no such droplets are re-deposited. Although it is not my intention to be restricted to a particular theory, it is believed that the flow of air over the surface of the lens tends to lift the droplets just enough that they clear the long axis and are then carried off by the force of the flowing air before the droplet can redeposit on the spinning lens. The pressure differential is adjusted to produce an air flow over the spinning lens having a velocity fast enough to carry away droplets flung off at the surface along the short axis before being picked up at the surface along the long axis.

Operation

Lenses to be coated are placed within the compartment through cover **40**. Coating material is placed within tank **70** by access through the same cover **40**. With a supply of uncoated lenses within said compartment and with said tank filled with a coating material, the cover is closed. Further access into said compartment is accomplished by the operator inserting his hands through gauntlets **38** and **39**. A lens to be coated is placed on said lens holder, washed by squirting a lens cleaning solution from a squeeze botle, and rotated at 3600 revolutions per minute until dry. Coating applicator **68** is then positioned over the center of the lens, the stopcock is then turned one-half a turn, and a predetermined amount of coating material is deposited on the lens by a regulated pressure applied along air line **74** as previously described. The lens is then spun at 3600 revolutions per minute until evenly coating and partially dried, removed and placed on a rack, which is not shown, and the rack, when filled, is placed within one of said ovens, which has been preheated, and baked. The oven is then cooled and the coated lenses are removed by an operator from the rear of the oven. The speed at which a lens is spun, baking time, baking temperature, cooling time and cooling temperature are factors which are dependent on the nature of the coating solution used and are no part of the present invention.

I claim:

1. A spin-coating machine comprising:

(a) a generally sealed compartment;

(b) an adjustable lens holder mounted on a motor driven vertically disposed shaft and adapted to secure a horizontally arranged lens;

(c) nozzle means located in an upper portion of the chamber, in general alignment with said shaft whereby coating fluid may be dispensed centrally upon the upper face of said lens;

(d) means providing a flow of filtered, dehumidified and heated air into said compartment and directed generally centrally upon said coated surface;

(e) means to effect a vacuum in said chamber and comprising a conduit system having an intake which includes a pair of horizontally arranged concentric ring-plate elements disposed respectively above and below said secured lens and the internal diameters of which approximate the diameter of said lens, whereby said air flow is drawn peripherally from said lens;

(f) at least one oven means incorporated into the structure defining said chamber and including door means on both inner and outer oven walls whereby said oven may be entered from both within and external of said chamber;

(g) glove means sealingly secured to openings in a wall of said chamber whereby an operator may

manipulate both the structure and lens within said chamber without breaking the chamber seal.

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U.S. Cl. X.R.

118—52