Sept. 20, 1960 J. J. TOROK 2,953,483

METHOD AND APPARATUS FOR APPLYING COATINGS TO SELECTED AREAS OF ARTICLES

Filed Aug. 13, 1956 4 Sheets-Sheet 1

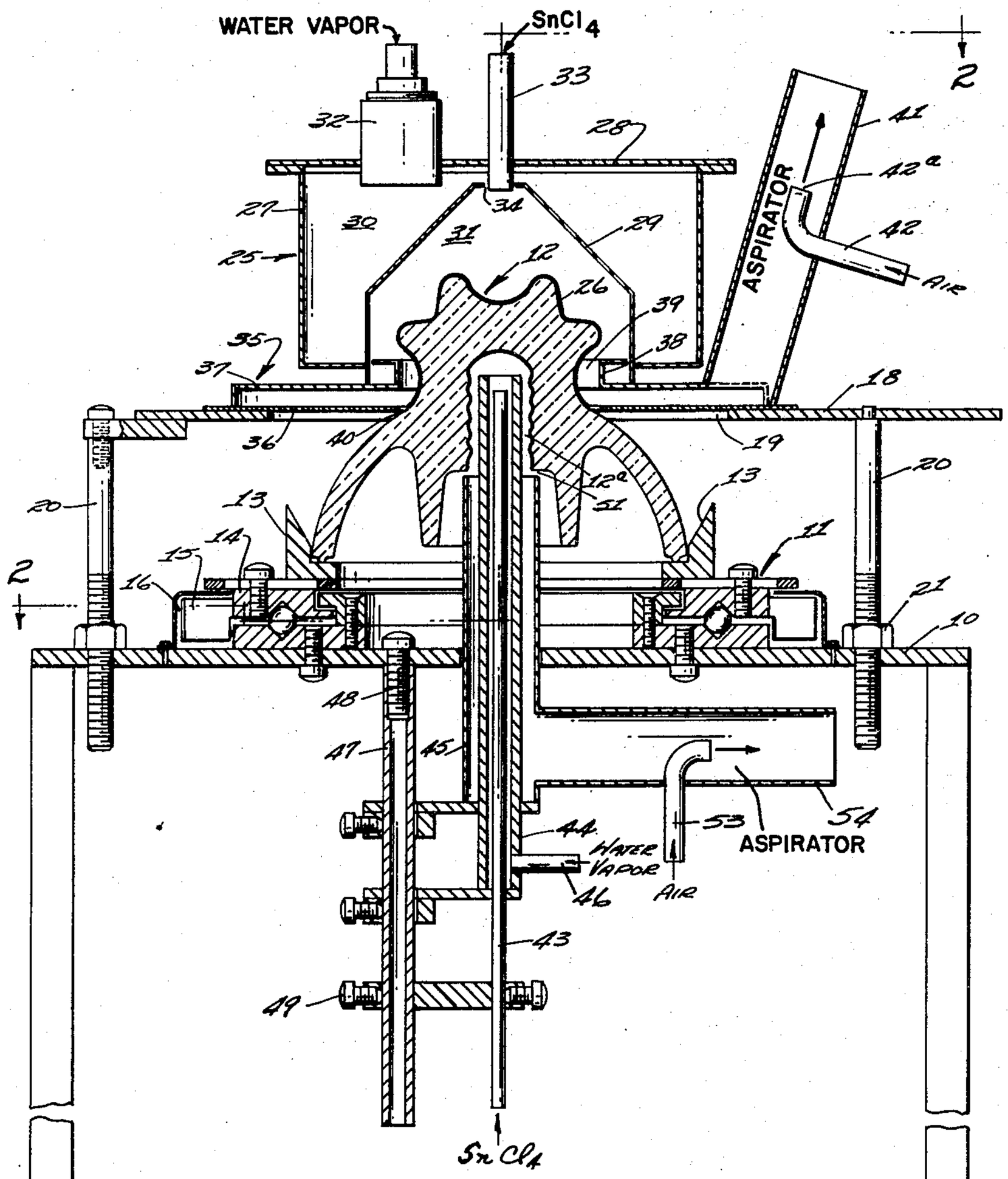

Fig 1

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Filed Aug. 13, 1956 4 Sheets-Sheet 2

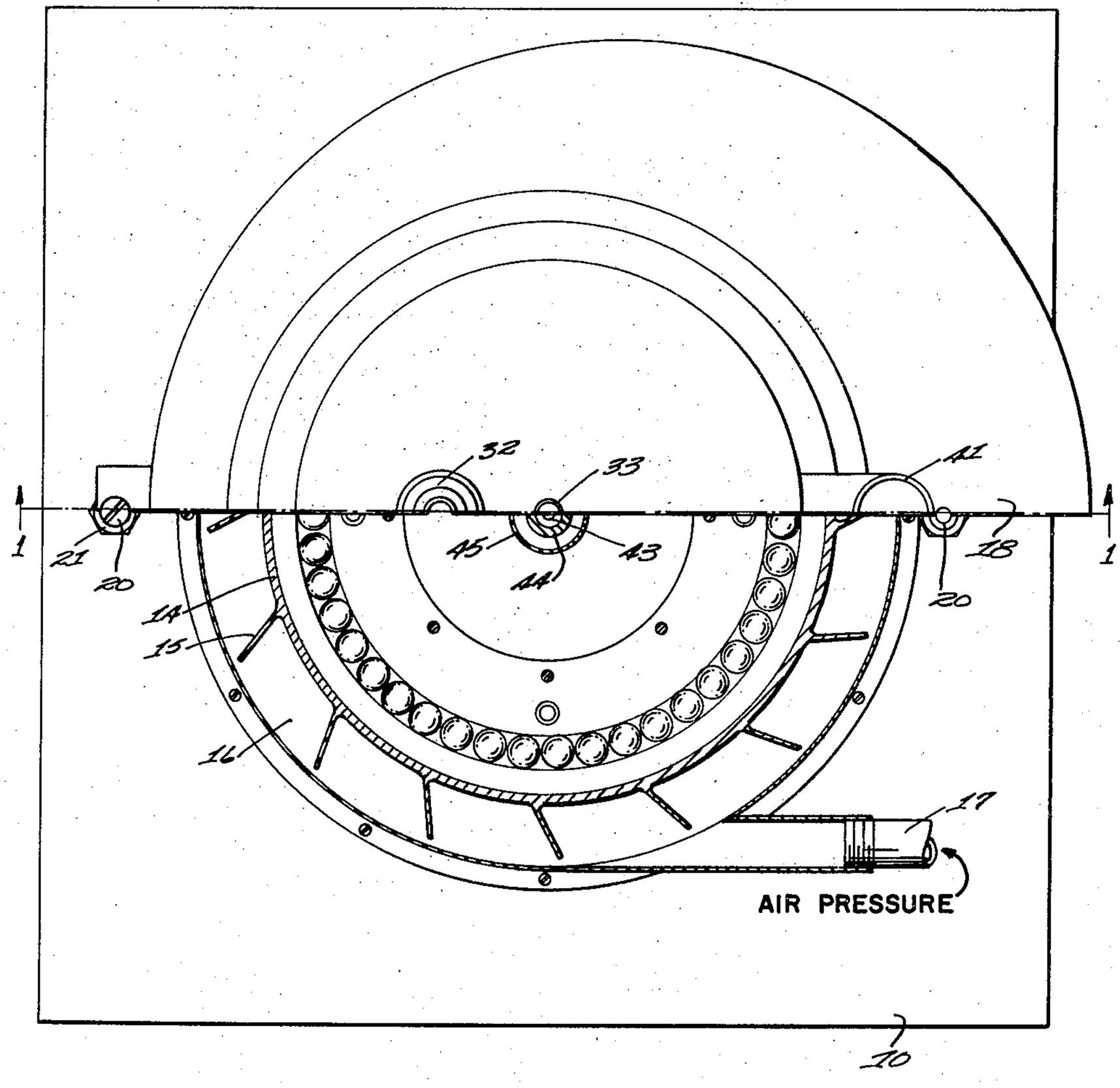

FIG. 2

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METHOD AND APPARATUS FOR APPLYING COATINGS TO SELECTED AREAS OF ARTICLES

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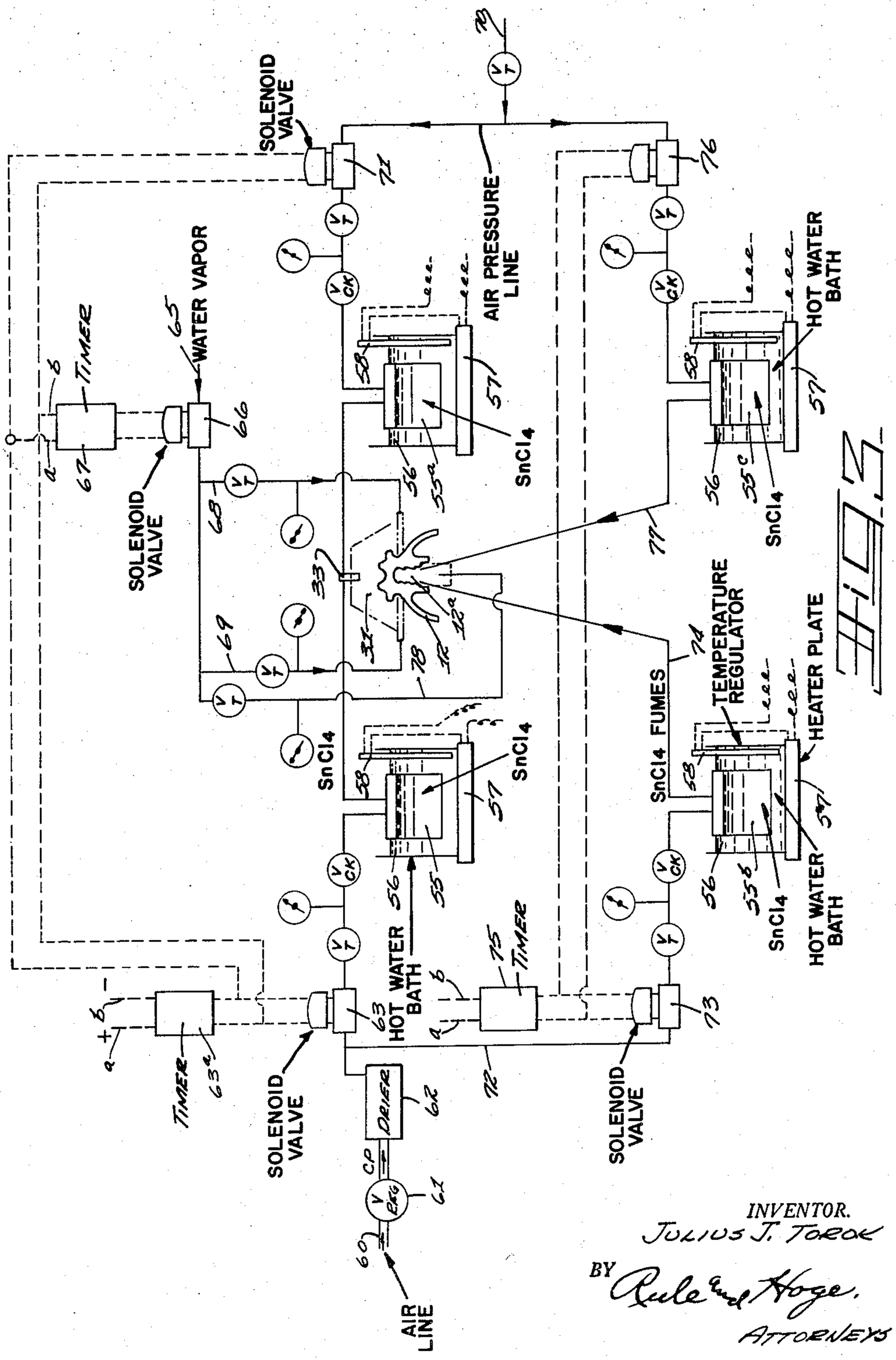

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METHOD AND APPARATUS FOR APPLYING COATINGS TO SELECTED AREAS OF ARTICLES

Filed Aug. 13, 1956 4 Sheets-Sheet 4

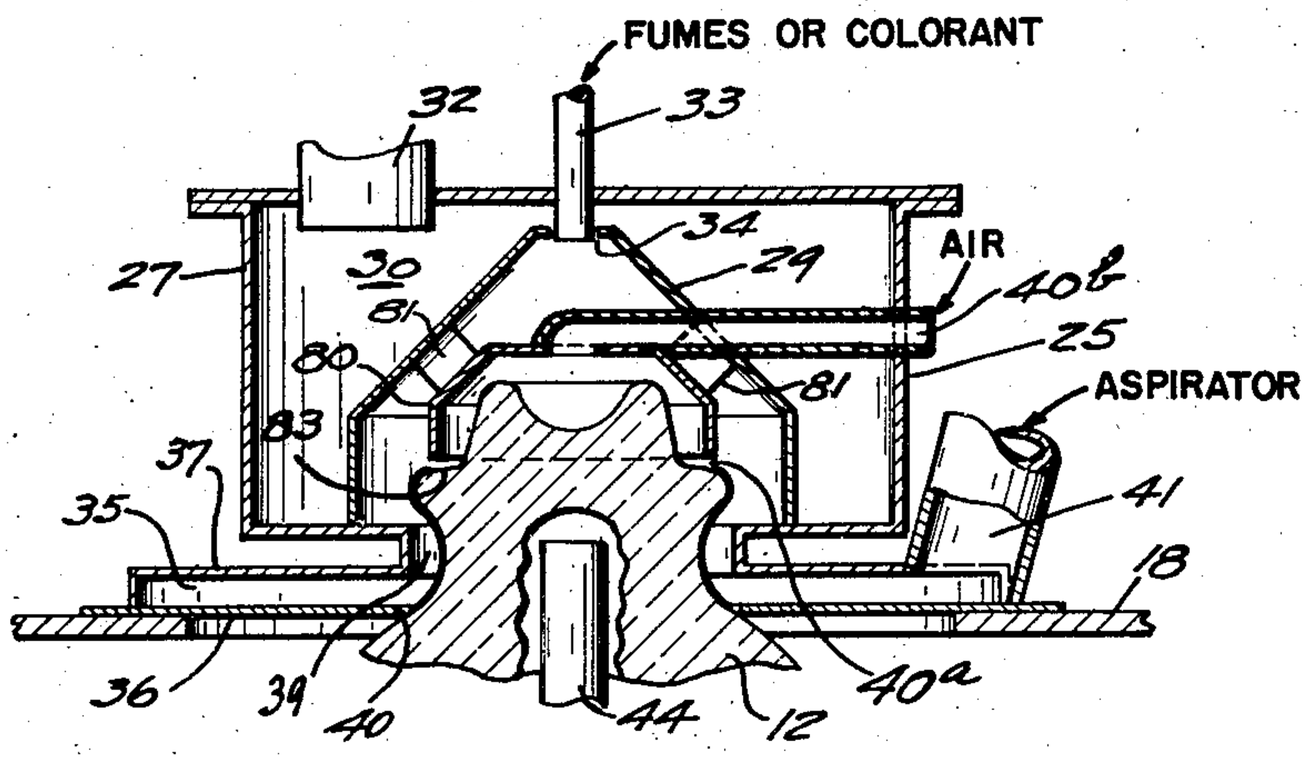

FIG 4

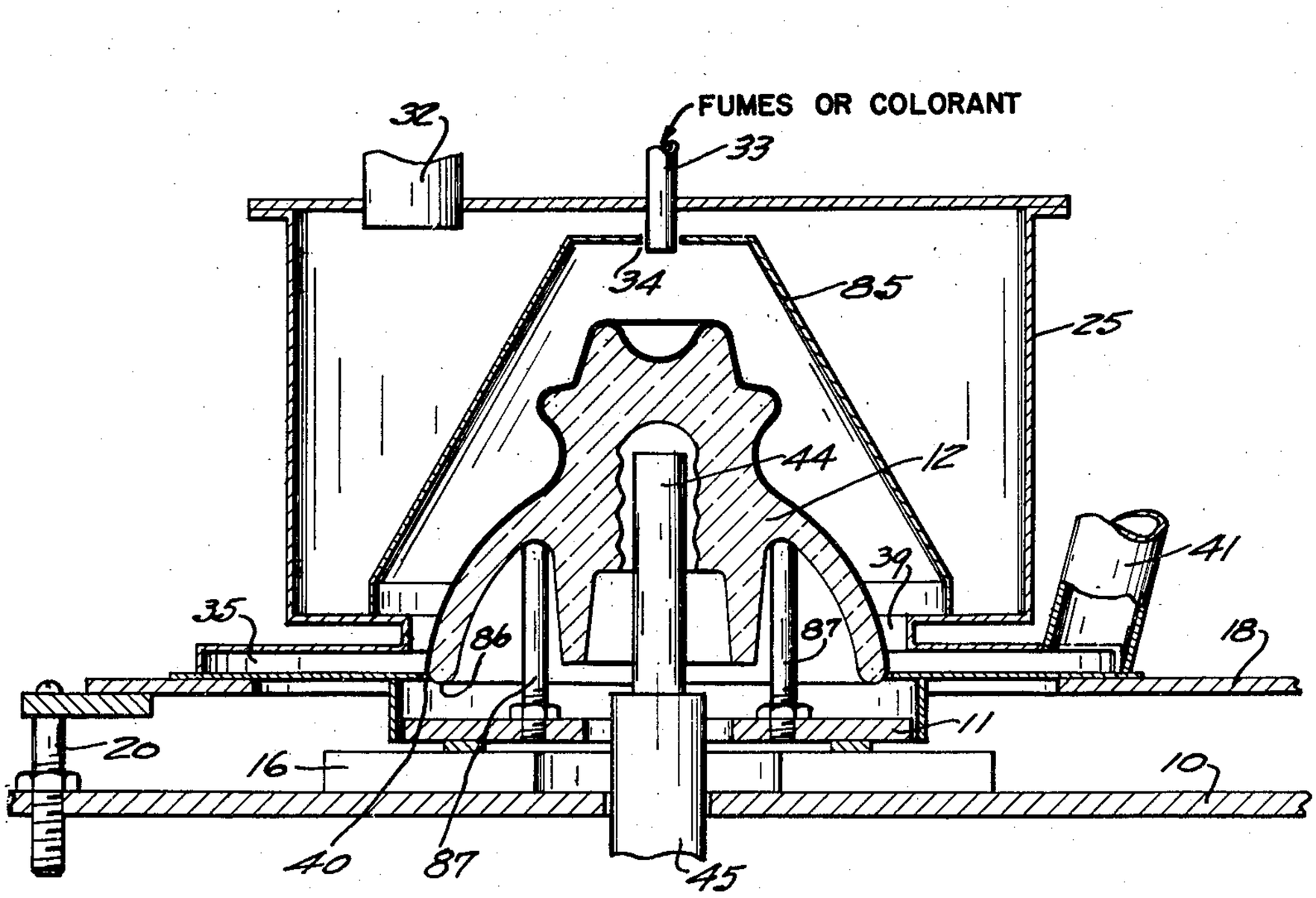

FIG 5

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Patented Sept. 20, 1960

2,953,483

METHOD AND APPARATUS FOR APPLYING COATINGS TO SELECTED AREAS OF ARTICLES

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Filed Aug. 13, 1956, Ser. No. 603,740

16 Claims. (Cl. 117—212)

My invention relates to a method and apparatus for applying coating materials to restricted surface portions of various types of articles. As an example the application of electrically conducting coatings to restricted surfaces areas of parts or articles or the application of other types of coating to restricted surface areas. The invention is of use, for example, in providing a thin coating over restricted surface areas of glass or ceramic articles such coating being of the type which is applicable in fume or film forming.

The method here involved is particularly adaptable for the application of coatings to restricted areas of articles such as limited top or bottom surface portions of an article, the application of bands of material thereon or the overall coating of an article. Various types of materials may be utilized such as the fumes from organic materials, for example, fumes from metallic salts or compounds of either the non-ferrous or ferrous groups of oxides, sulphates, chlorides, etc., or the fuming upon surface areas of organic or inorganic materials such as silicone or polyethylene compositions in their various forms. Various materials may be deposited upon such surface areas through being air borne in accordance with this present invention.

As here illustrated and described, the invention provides a method and apparatus for applying to power insulators, for example, a conductive or other coating covering portions of the exterior surface of the insulator head and also coating the wall surface of the usual pin hole. Such a coating may, for example, serve as a means to prevent the formation of radio interference at these points.

The conductive coatings, for example, may be provided through the use of tin, with or without antimony added or the combination therewith or the separate application of iron or indium, etc., and also through the use of other organic or inorganic materials.

In the present instance the descriptive matter herein will describe the application of the fumes of stannic chloride to restricted portions of glass insulator.

Stannic chloride ($SnCl_4$-fuming-anhydrous liquid) fumes, when combined with water vapor and simultaneously directed against a hot glass surface at a temperature between the annealing and softening temperatures of the glass, coat the glass with an iridescent, electrically conductive film. The present invention provides a method and means for applying such conductive films to hot glass insulators and limiting the area covered to very precise boundaries or cut off points. The high requirements of flashover and radio interference levels establish these boundaries very precisely. Conductivity deviations from these boundaries will adversely affect either the flashover values or the radio interference levels. A primary object of the present invention is to provide a method and means for meeting these exacting requirements.

In practicing the present invention, there is provided an apparatus including means for mounting insulators for rotation about a vertical axis. A mask or hood encloses

the portion of the insulator which is to be coated and there is provided means for conducting the anhydrous stannic chloride and water vapor through separate channels to the hood or mask, where they are mixed and brought into contact with the hot glass, thereby depositing an electrically conductive film on the exposed surface of glass. The exhaust gases are withdrawn by suction applied at the boundary line between the coated and uncoated surfaces of the glass. The wall surface of the usual pin hole extending upwardly within the insulator is treated in a similar manner by introducing the stannic chloride and the water vapor through concentric tubes extending into the pin hole and exhausting the gases by suction through an exterior concentric tube.

This application discloses subject matter also disclosed and claimed in the copending application of John Kozak, for Apparatus for Applying Coatings to Insulators, Serial No. 530,299, filed August 24, 1955, now U.S. Patent No. 2,867,551.

Referring to the accompanying drawings:

Fig. 1 is a sectional elevational view of apparatus for practicing the present invention, the section being taken at the line **1—1** on Fig. 2;

Fig. 2 is a part sectional plan view at the line **2—2** on Fig. 1; and

Fig. 3 is a diagrammatic view of the apparatus.

Fig. 4 is a partial sectional elevational view showing the application of a stripe of coating; and

Fig. 5 is also a partial sectional elevational view showing the overall coating of an article.

Referring particularly to Figs. 1 and 2, a framework for supporting the insulator during the coating operation comprises a table or platform **10** on which a carriage **11** is mounted for rotation about a vertical axis. The insulator **12** is placed on a holder **13** on the carriage and centered thereby. The carriage includes a ring **14** formed with vanes **15** which travel in an annular channel **16**. Air under pressure is supplied through a pipe **17** communicating with the channel **16** for driving the carriage.

A horizontal plate **18** is mounted over and spaced above the platform **10** and is formed with a central opening **19** through which the insulator extends. The plate **18** is carried on posts **20** adjustable up and down and held in adjusted position by nuts **21** threaded on the posts.

A mask **25** is placed on the platform **18** and encloses the upper portion of the insulator which is to receive the electrically conductive coating **26**. The mask comprises an outer cylindrical wall **27** and top cover plate **28**. An inner wall **29** divides the mask into an outer chamber **30** and an inner chamber **31**. The water vapor is supplied to the outer chamber **30** through a head **32** and the stannic chloride fumes are supplied through a duct **33** to the inner chamber **31**. The inner wall **29** is of frustoconical form comprising upwardly convergent wall portions and has an opening at the upper end into which the duct **33** protrudes. This provides a restricted annular opening **34** surrounding the duct **33**. Water vapor entering the chamber **31** through opening **34** mixes with the stannic chloride fumes. This mixture coming in contact with the hot glass forms a conducting coating **26** on the insulator surface.

Below the chamber **30** is a slot-like duct **35** forming an annular passageway in communication with the inner chamber **31**. The duct **35** includes a bottom plate **36** and an upper plate **37**. The plate **37** has a central opening through which the insulator head extends and is formed with an upwardly extending rim **38** providing an annular passageway **39** from the inner chamber **31** to the duct **35**. The lower plate **36** is formed with an opening contoured to the shape of the insulator and pro-

viding a restricted passageway 40 between the plate and the insulator and extending throughout the circumference of the insulator. This passageway 40 permits an inflow of air into the duct 35 at the lower line of the coating 26, as presently described.

The flow of the mixed gases through the chamber 31 is produced by an aspirator comprising an upwardly and outwardly inclined pipe 41, the lower end of which opens into the duct 35. An air pressure pipe 42 extends into the pipe 41. Air under pressure supplied through the pipe 42 is discharged through the upwardly directed nozzle 42a and produces a moderate suction within the outer pipe 41, thereby causing a flow of the mixed gases from the inner chamber 31 through the passageway 39 and the duct 35. This suction is sufficient to draw a greater volume of gas through the exhaust pipe than that of the gases supplied to the mask through the duct 33 and head 32, so that there is an inflow of air through the restricted opening 40. This prevents the coating material 26 from being carried below the opening 40 and thus determines the line of cut-off or boundary of the coating material.

The insulator 12 is formed with a central opening 12a, referred to as a pin cavity or pin hole, formed with screw threads for mounting on a threaded pin. The walls of the opening are coated with a conductive material in substantially the same manner as above described in reference to the exterior coating 26. The means for circulating the stannic chloride fumes, water vapor and exhaust gases in coating the pin hole walls includes an assembly of concentric tubes. This assembly comprises a central tube 43 through which the stannic chloride vapors are conducted, a tube 44 through which the water vapor flows and an exhaust tube 45. Water vapor enters the tube 44 through an inlet pipe 46. The tubes 43 to 45 are carried on a stationary rod 47 connected by a bolt 48 to the platform 10. The several tubes are individually adjustable up and down and held in adjusted position by clamping screws 49. The tubes 43 and 44 extend upwardly into the pin hole 12a. The outer tube 45 terminates just below the lower end of the pin hole so that there is provided an annular passageway 51 through which air enters the exhaust tube or aspirator 45. Air under pressure is supplied through a pipe 53 which discharges within the exhaust tube 54 extending from the tube 45. This aspirator operates in substantially the same manner as that above described comprising the exhaust pipe 41 and pressure pipe 42.

Referring to the diagram (Fig. 3), the stannic chloride is placed in containers 55, 55a, 55b, and 55c. The material in each of these containers is heated and maintained at a constant temperature by means of a water bath 56 in which the container is immersed. Each water bath is heated by an electric plate 57, the temperature of the water being regulated and held constant by a temperature regulator 58. Air for carrying the stannic chloride fumes from the container 55 to the chamber 31 is supplied through an air line 60. The air under pressure passes through a constant pressure outlet valve 61 and through a drier 62. Calcium sulphate or other suitable drying material is contained within the drier 62. The dry air passes through a solenoid valve 63, controlled by a timer 63a, before entering the container 55. The stannic chloride fumes are conducted from the container 55 to the chamber 31. The water vapor is conducted through a pipe line 65, solenoid valve 66 controlled by a timer 67, and through branch lines 68 and 69 which extend to the chamber 30 of the mask where the water vapor combines with the stannic chloride fumes as above described.

Stannic chloride fumes may be generated and supplied from the container 55a in the same manner as described in connection with container 55. The dried air is supplied to the container 55a through a pressure line 70 extending through a solenoid valve 71 to the container 55a. The valve 71 is controlled by the timer 63a.

Stannic chloride fumes are supplied to the pin cavity 12a from the containers 55b and 55c. A branch line 72 extends from the drier 62 through a solenoid valve 73 and thence to the container 55b. The fumes from this container are conducted through a line 74 to the pin hole 12a. The solenoid valve 73 is under the control of a timer 75. Dry air is supplied to the container 55c through the air line 70 and a solenoid valve 76, the solenoid of which is connected in parallel with that of the solenoid valve 73 and under the control of the timer 75. The fumes from the container 55c are conducted through a line 77 to the pin hole 12a. Water vapor is conducted to the pin hole 12a through a branch line 78 extending from the line 65.

The timers 63a, 67 and 75 are connected through mains *a* and *b* to any suitable source of current supply, and are adjusted to effect the flow of the gases and vapors in the order of sequence and for the time intervals hereinafter specified.

The conductive coating process comprised in the present invention is essentially one of chemical reactions and as such the three factors of quantity of fumes, glass temperatures and length of time of application are interdependent. However, there is an optimum combination which will give the broadest working limits with the least amount of handling and conditioning.

Temperatures

In practicing the invention for coating insulators of the type shown, proper temperature conditions are best obtained directly after the insulators are taken from the molds on the automatic press molding machine. At this time the glass is well above the annealing temperature and is hotter at the core than at the outer surface so that the surface temperatures decrease very slowly, thus insuring a favorable temperature condition over a comparatively broad period of time. This time is such that the insulators can be cooled for as much as thirty seconds on the usual cooling bucks before the surface temperatures are reduced to a minimum level. Higher temperatures resulting from reheating as by means of high pressure flame burners will still result in acceptable coatings. If the insulator is kept on the cooling buck too long, the drop in temperature is such that the resistivity of the applied coating may approach 10^8 ohms, which is deemed too high for a working limit.

Timing

The range of the fuming time may be from a fraction of a second to approximately 10 seconds. With a given flow of fumes and fixed glass temperatures, it is found that the shortest fuming times within this range will yield coatings of high resistivity which may be above satisfactory resistivity levels. Lengthening of the time decreases the resistivity below 1000 ohms level. Resistivity within the range of about 10,000 to 100,000 ohms is found to give the most satisfactory results.

As the fuming time is increased, a point is reached at which the surface becomes hazy or milky in appearance. Subsequent heat processes and hard weathering will then cause the conductive coating to peel or scale so that the surface resistivity is variable and rises abruptly. When this point is reached, the coatings are considered unsatisfactory.

In practicing the invention on a commercial scale, it is found that satisfactory results are obtained when the length of the fuming time is within the range of 1 to 4 seconds, the upper limit being set in practice by the time available in the cycle that must match that of the press by which the insulators are molded. The actual time during which the masks are in place is from 1 to 3 seconds longer to permit the aspirators to remove the fumes, thus avoiding violation of the boundaries or cut-off points.

Quantity of fumes

Fuming stannic chloride ($SnCl_4$—anhydrous) has an appreciable vapor pressure even at room temperatures. Passing dry air over the surface of stannic chloride at such temperature will pick up enough of the vapor to coat a limited area of glass in a few seconds. However, for practical purposes in which a repeating cycle is employed and appreciable areas are to be coated, it is necessary to heat the stannic chloride to assure a constant and uniform supply of the fumes. This is accomplished by immersing the stannic chloride container in a constant temperature water bath as above described and illustrated in Fig. 3. The temperature of this water bath should be so set as to give a coating having as low a resistance as possible without fogging and flaking. This temperature is found to be approximately 150° F. with the pressure of the constant pressure regulator **61** set at 2 to 6 pounds per square inch.

In the use of the apparatus such as shown in Fig. 3, the aspirator air should be turned on from 2 to 5 seconds before the stannic chloride and water vapor, thereby removing vapor which might coat undesirable areas as the insulator is being set in place.

The stannic chloride must be joined by the water vapor to form the conductive coating. The water vapor is obtained by passing compressed air over water heated to 150° F. The air passing over the heated water becomes saturated and in this condition is carried to the mixing point where it joins the stannic chloride, the mixture being then directed against the hot glass to form the conductive coating thereon. A regulated air pressure of 5 pounds has been found to be satisfactory for this purpose.

The purpose of passing air through the drier **62** is to remove all water vapors before the air contacts the stannic chloride so that no hydrolysis can occur in the container **55**. The drying agent may be the calcium sulphate marketed by the Fisher Scientific Company under the trade name of "Drierite." Formation of minute crystals in the drier chamber is evidence that the drying agent is becoming ineffective and should be rejuvenated. "Drierite" has a coloring agent added which turns pink when it becomes saturated and must be rejuvenated. Thus its condition can be determined by its color as well as by the formation of such crystals.

The preceding material constitutes a complete disclosure of the application of conductive coatings using the material stannic chloride in vapor form. However, it is not contemplated that this application is limited to the use of this method for the application only of conductive coatings as it is within the purview of this invention to apply any and all kinds of film or vapor type coatings regardless of whether they are obtained from an organic or inorganic base.

As mentioned above, this method may be utilized in the application of colors to vitreous articles either as an overall color upon an article or for example, a stripe. As illustrated in Fig. 4 the apparatus has been altered slightly over that shown in Fig. 1 in order to provide a condition whereby a stripe of color may be applied to the outside of an article, for example, an identification stripe on an insulator. In order to accomplish this a hood **80** has been provided within the wall **29** and is supported therefrom by strip spacers **81** positioned around and attached to the outer circumference of the member **80** and the inner surface of wall **29**. This hood **80** is so adapted as to be slightly spaced from the shoulder portion **83** of the insulator **12** and provide an opening **40a** through which air from duct **40b** may be drawn to provide a condition whereby the coating may end at a sharp line along the shoulder **83**. Thus the upper end of the insulator is protected from any contact with the coloring fumes or media. The rest of this mechanism operates in the same manner as previously described herein and as illustrated in Figs. 1 and 2.

The fumes or colorant will as usual enter through the duct **33** and are then drawn down around the hood **80** over the outer surface area of the insulator between openings **40a** and **40** both of which are adapted to permit the entrance of outside air and sharply cut off the application of fumes or color at these separate levels. Thus a stripe is provided around the circumference or outer area of the insulator or other article in a restricted area by and through the suction provided at openings **40** and **40a** through the aspirator connections provided by the duct **35** and pipe **41**.

In Fig. 5 the mechanism has been again slightly altered to provide a condition whereby the entire outer surface area of the insulator or other article may be completely coated with a color or coating as may be desired. This is accomplished by providing a different type of hood **85** which accommodates the full length of the article to be coated. Otherwise the structure of this apparatus remains approximately the same as previously described in connection with Fig. 1. However, it will be noted that the orifice **40** is brought to a position at the lower end of the flange or bottom **86** of the article to thus permit outside air to enter at this point and the suction to become effective and define a sharp edge to the color or coating. This likewise is accomplished through the drawing of air through the aspirator pipe **41** and duct **35**.

If it is desired to coat the inside surface areas of the article at the same time as the outer surface areas are being coated or at a different time, then the exhaust tube **45** is lowered with respect to the vapor conducting tube **44** and to a height which will permit the fumes to flow along the inner surface areas of the insulator prior to being drawn outwardly through both of the pipes **41** and **54** (see Figs. 2 and 5). In this particular instance the insulator is shown in Fig. 5 as mounted upon a plurality of pins **87** so that a minimum of supporting contact is obtained between the pins and the surface of the insulators, thus permitting these areas to be coated with fumes with a minimum of uncoated area. It should be apparent that under these circumstances the withdrawal of air at the opening **40** by means of the aspirator pipe **41** will thus cause the fumes passing from duct **44** to flow around and coat the entire inner surface areas of the insulator and at the same time prevent the coating material from flowing up over the outer surface areas thereof.

In both of the above described modifications of the apparatus, the article will be rotated in order that all of the surface areas will be thoroughly exposed to the application of the fumes regardless of whether it is an overall coating or merely a stripe or spot coating.

As to the application of a color, if for example the fuming material happens to be stannic chloride or stannous oxide, then either the time interval of application or the concentration of the solution or both will of course control the amount of deposition of the material. The amount of deposition will control the depth or thickness of color and depending upon the time, the color using these materials will progress from an iridescent to a deep blue.

The thickness of the film may be gauged by the apparent color of the film caused by interference of light reflected therefrom. As the thickness of the film increases its apparent color changes and the order or succession of the colors with increasing thickness is analogous to that of the well known Newton rings described in "A Treatise on Light," by R. A. Houstoun, Longmans Green & Co., Ltd., page 147, as follows:

1st order—white, yellow, red.
2nd order—violet, blue, green yellow, red,
3rd order—purple, blue, green yellow, red,
4th order—greenred,
5th order—greenish-blue, red,
6th order—greenish-blue, pale red,
7th order—greenish-blue, reddish-white

The above described coatings may of course be produced from other materials than the stannic chloride or stannous oxides and in particular, other colors may be produced from the many materials which are capable of being applied in fume or film form, such as the various metallic salts, as for example, iron chloride, indium, barium chloride and bismuth nitrate.

In addition certain silicone compositions either clear or colored may be utilized as protective coatings and may be applied as previously described herein or by certain alterations in the ducts **33** and **44**. For example, these ducts may have a spray or atomizing nozzle mounted in the exit ends thereof to provide a fine vapor mist capable of being picked up and drawn over and upon the surface of the insulator or other article through the suction created by the aspirator pipes **41** and **45**.

The use of the terms "gas," "vapor" or "fume" in claims of this application should be construed to include the gaseous, liquid or fine particle forms of coating materials.

Modifications may be resorted to within the spirit and scope of my invention.

I claim:

1. The method of coating a prescribed surface portion of a glass article with an electrically conductive film, said method comprising confining the portion of the article comprising said prescribed surface portion within a confining chamber formed by a mask, introducing metallic salts, fumes, and water vapor into said chamber, mixing said fumes and vapor within said chamber, and bringing the mixture into contact with said surface portion while the latter is at a high temperature and thereby producing said coating on said prescribed surface portion, exhausting mixed gases from said chamber by suction through a restricted passageway defining the boundary line of said prescribed surface portion and concurrently producing by said suction a flow of air over the surface area of the article adjoining the said prescribed portion and thereby preventing the coating medium from contacting the surface of the insulator beyond said boundary line.

2. Apparatus for treating a prescribed surface area of an electrically insulating surface with an electrically conducting coating medium and thereby forming an electrically conductive surface film covering said prescribed area, said apparatus comprising a mask forming a confining chamber, means for supporting the mask in position to enclose said prescribed area within said chamber, means for introducing a water vapor and fumes of a metallic salt through separate inlet openings into said chamber and mixing them within the chamber and circulating them through the chamber and in contact with said prescribed area, said circulating means comprising an aspirator, means forming a channel extending along the border line of said restricted area and opening into said chamber and said aspirator, said mask formed to provide a restricted passageway extending along said border line, and opening directly into said channel, said aspirator thereby causing an inflow of air through said restricted passageway and thereby preventing the coating medium from contacting the surface beyond said border line.

3. Apparatus for coating a portion only of an article with a coating film, which apparatus comprises a support for the article, a hollow mask forming a confining chamber, means for supporting the mask in position to enclose the said portion of the article within said chamber, said mask being formed with an opening to receive said portion, said opening being contoured to the shape of the article and providing a pair of spaced apart restricted passageways surrounding the article and thereby forming border lines of the surface portion to be coated, and means for causing a circulation of the coating medium within said chamber in contact with the surface area between said openings, and means for concurrently

producing an inflow of air through both said restricted passageways and thereby preventing the coating medium from contacting the article beyond said border lines.

4. The apparatus defined in claim 3 including means for inducting the fumes from metallic salts through said mask into the said chamber, and means for conducting water vapor to the mask and mixing said water vapor and fumes within said chamber to produce said coating medium.

5. The apparatus defined in claim 3 including means for rotating the article relative to the mask about an axis while the coating medium is being applied thereto.

6. The apparatus defined in claim 5, said article being formed with an inner opening concentric with said axis, and means for applying to the wall surfaces of said inner opening a coating medium similar to that applied to said surface portion.

7. Apparatus for coating a restricted portion of a glass article with a protective film, said apparatus comprising a support for the article, a hollow mask forming a confining chamber enclosing said restricted portion, the mask having a bottom opening through which said portion is extended, said opening shaped to provide a restricted passageway surrounding said portion, means for introducing a coating medium in the form of a gas or vapor into said chamber, means for comprising an aspirator for causing a circulation of the coating medium through said chamber and for causing an inflow of air through said restricted passageway and thereby preventing the coating medium from contacting the surface of the glass beyond the mask, and means providing a channel extending from said chamber and from said restricted passageway to the aspirator through which said inflowing air is withdrawn without circulation in said chamber, and through which channel the coating medium is exhausted from said chamber.

8. The apparatus defined in claim 7, means for rotating the article about an axis during the said coating operation, said article being formed with an upwardly extending interior opening portion, said opening being concentric with said axis of rotation, concentric tubes extending upwardly into said opening, and means for causing an upward flow of film forming fumes and water vapor through said tubes respectively into said opening.

9. The apparatus defined in claim 8, including a conduit in the form of a pipe surrounding said concentric tubes, the upper end of said pipe terminating adjacent to the lower end of said opening and an aspirator in communication with said conduit and by which an inflow of air into said conduit at the upper end thereof is produced while the coating medium is flowing through said concentric tubes.

10. The method of coating a prescribed surface area of an article, which method comprises introducing into a confining chamber formed by a mask, that portion of the article comprising said prescribed area, causing circulation of a coating medium in the form of fumes within and through said chamber and withdrawing the circulating medium from said chamber by an outward flow at the border line of the prescribed area, and simultaneously withdrawing a counterflow of atmospheric air through a restricted passageway adjacent said article defining said border line and mingling it directly with the said outwardly flowing coating medium, thereby preventing the coating medium from contacting the said surface area beyond the said border line.

11. The method defined in claim 10, said method comprising mixing the fumes of organic coating materials with a vapor within said mask to form said coating medium and applying mixture to the prescribed surface area while the latter is at a temperature conductive to creating adherence between said coating and said surface area.

12. The method of coating a prescribed surface por-

tion of a glass article with a protective coating film, said method comprising confining the portion of the article comprising said surface within a confining chamber formed by a mask, introducing silicone fumes and water vapor into said chamber, mixing said fumes and vapor within said chamber, and bringing the mixture into contact with said surface while the latter is at a high temperature and thereby producing said coating on said prescribed surface area, exhausting the mixed gases from said chamber and concurrently withdrawing a counter-flow of air through a restricted passageway at an edge of said chamber adjacent said article defining the boundary line of said prescribed area, and mixing the air directly with the exhausted gases and thereby preventing the coating medium from contacting the surface of the insulator beyond said boundary line.

13. Apparatus for coating a prescribed surface area of an insulator with an electrically conductive film, said apparatus comprising a rotatable carriage for supporting the insulator, a hollow mask, means for mounting the mask with the head of the insulator projecting upwardly through a bottom opening formed in the mask, said mask including an inner wall dividing the interior of the mask into an inner chamber and an outer chamber, said inner wall formed with an opening providing communication between said chambers, means for introducing metallic fumes into the said inner chamber, means for introducing water vapor into the other chamber, and means for withdrawing mixed gases from said inner chamber and thereby causing a flow from the outer chamber into the inner chamber and circulation of the mixed gases in contact with the surface of the insulator within said mask, the said bottom opening through which the insulator projects into the mask being contoured to form a narrow passageway surrounding the insulator at the border line of the coated area, the means for circulating the mixed gases comprising an aspirator by which mixed gases are drawn from the mask and by which air is drawn through said narrow passageway, thereby preventing the coating material from contacting the glass beyond said passageway, and means providing a channel extending from said narrow passageway to the aspirator through which air is conducted from said passageway without entering said chambers.

14. The apparatus defined in claim 13, the said carriage for the insulator being mounted for rotation about a vertical axis, the said carriage being formed with vanes projecting outwardly from its periphery, and a conduit through which air under pressure is applied to said vanes for rotating said carriage.

15. The apparatus defined in claim 13 including a container for stannic chloride, means providing an air line extending through said container to the inner chamber and through which air is conveyed to said chamber and through which metallic fumes are conducted from the container to the said chamber, and means for conducting water vapor to the said other chamber and mixing it with said fumes within the said inner chamber and thereby forming an electrically conducting coating on the surface with the insulator within the said chamber, and means for heating the said container and stannic chloride therein, the said air line including a solenoid valve, and a timer operatively connected to the solenoid valve and operable periodically to open and close the air line.

16. The apparatus defined in claim 13 including a container for retaining a metallic salts composition, a bath in which the container is immersed, means for heating said bath and thereby heating the composition, means providing an air line extending through said container and to the said surface of the insulator, a water vapor line extending to the insulator and through which water vapor is conducted and mixed with fumes of said composition, solenoid valves disposed in said air line and said water vapor line, and electric timers in circuit with the valve solenoids and controlling the operation of the solenoid valves.

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