

[54] **METHOD FOR COATING ONLY THE CONVEX MAJOR SURFACE OF AN APERTURED MASK FOR A CATHODE-RAY TUBE**

[75] Inventor: **Bradford Knox Smith**, Lititz, Pa.
[73] Assignee: **RCA Corporation**, New York, N.Y.
[22] Filed: **Dec. 23, 1971**
[21] Appl. No.: **211,476**

[52] **U.S. Cl.**..... **117/101**, 117/33.5 C, 117/102 R,
117/104 R, 117/105.4, 118/318, 313/85 S,
313/92 B
[51] **Int. Cl.**..... **B44d 1/08**
[58] **Field of Search**..... 117/101, 102 R, 104 R,
117/105.4, 33.5 CM, 94; 313/85, 85 S, 92 B;
96/36.1; 118/318, 55

[56] **References Cited**
UNITED STATES PATENTS

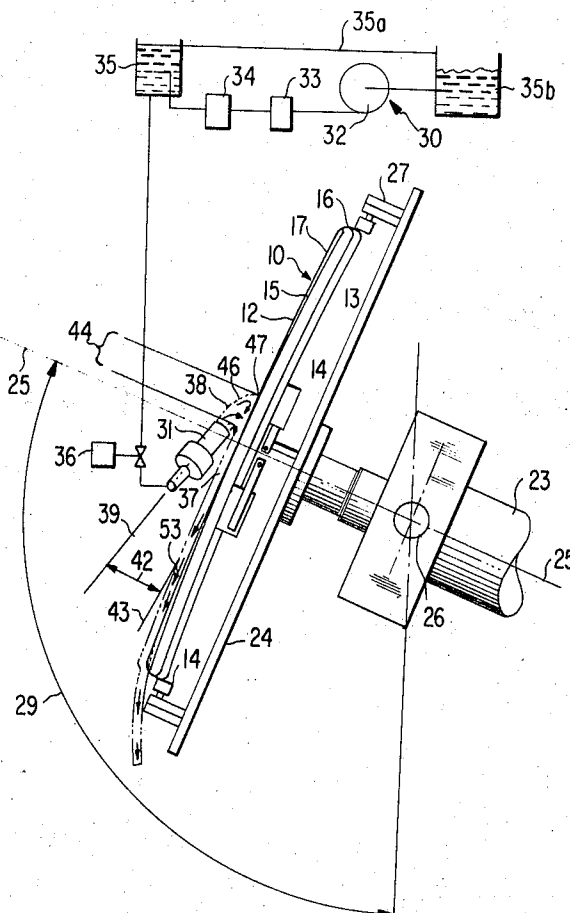
3,653,901	4/1972	Etter.....	117/33.5 CM
3,652,323	3/1972	Smith.....	117/101
3,343,198	9/1967	Pekosh.....	96/36.1
3,653,941	4/1972	Bell et al.....	117/101
3,070,441	12/1962	Schwartz.....	96/36.1

Primary Examiner—Michael Sofocleous
Assistant Examiner—William R. Trenir
Attorney, Agent, or Firm—G. H. Bruestle; L. Greenspan

[57] **ABSTRACT**

A method for coating the convex major surface of a curved apertured mask for a cathode-ray tube including coating portions substantially filling and completely closing the final-sized apertures without coating the opposite concave major surface. The mask is rotated about an axis substantially normal to and passing through the central portion of the mask at a rotation rate insufficient to cause liquid coating material to fly off the surface by centrifugal force, the axis being inclined at about 100° to 130° measured from a vertical downward 0° reference. A stream of liquid material in excess of the amount required to coat the mask is projected into an upward trajectory and into contact with the convex surface of the rotating mask. The stream contacts the mask on an area above the axis with the stream substantially at the top of its upward trajectory, making an angle of less than 15° with a tangent to the contacted area. The excess liquid coating is allowed to drain from the rotating mask by gravity. After at least one revolution, the stream is removed from contact with the rotating mask, and the mask rotation is increased to a rotation rate sufficient to cause excess liquid to fly off the mask surface by centrifugal force.

7 Claims, 5 Drawing Figures



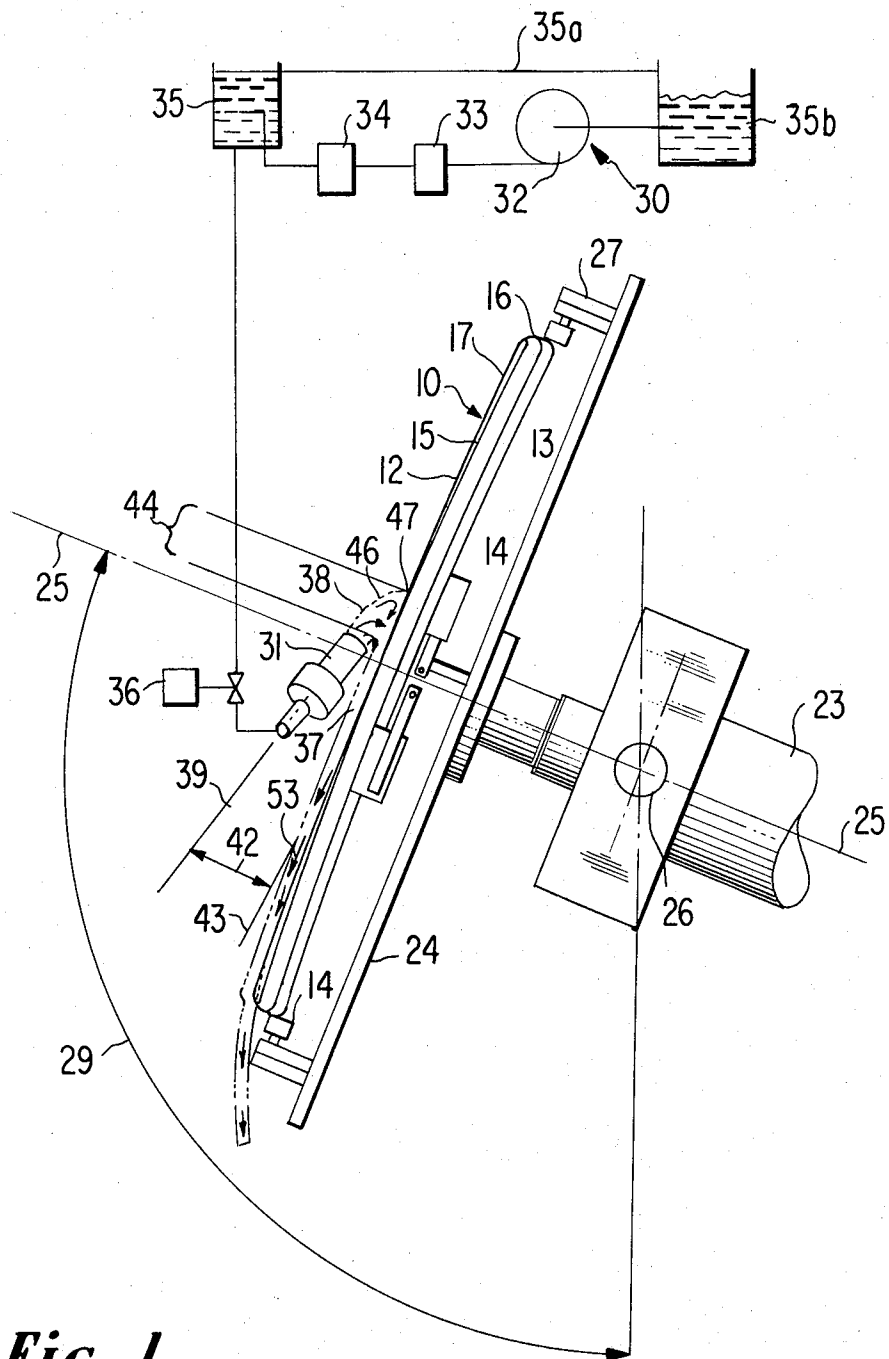


Fig. 1

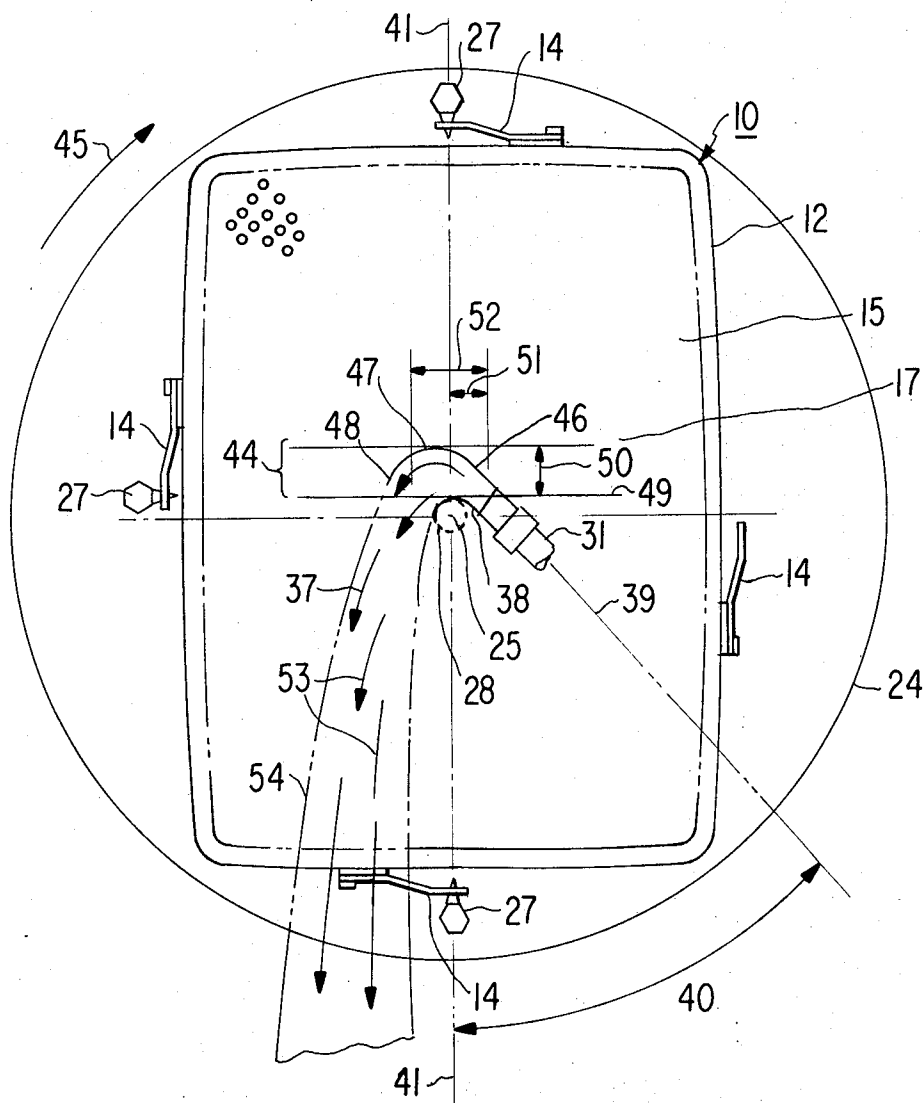


Fig. 2

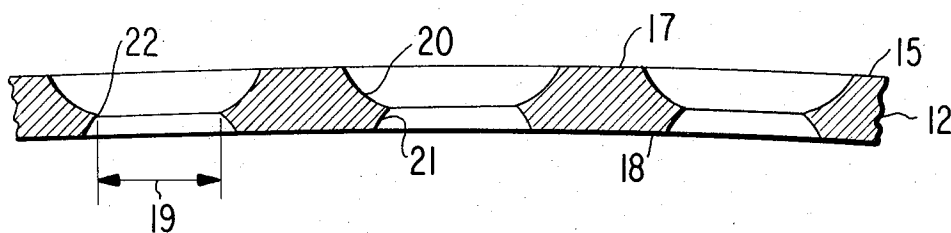


Fig. 3

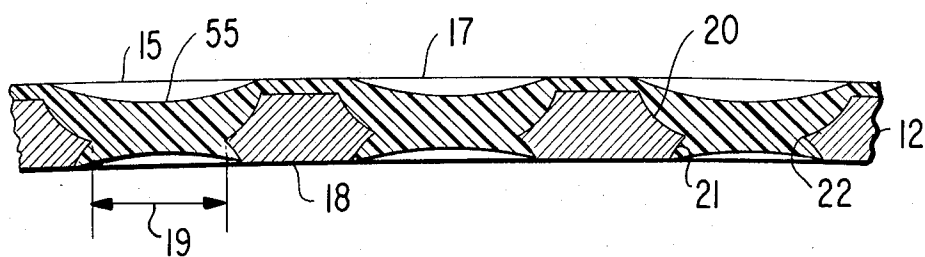


Fig. 5

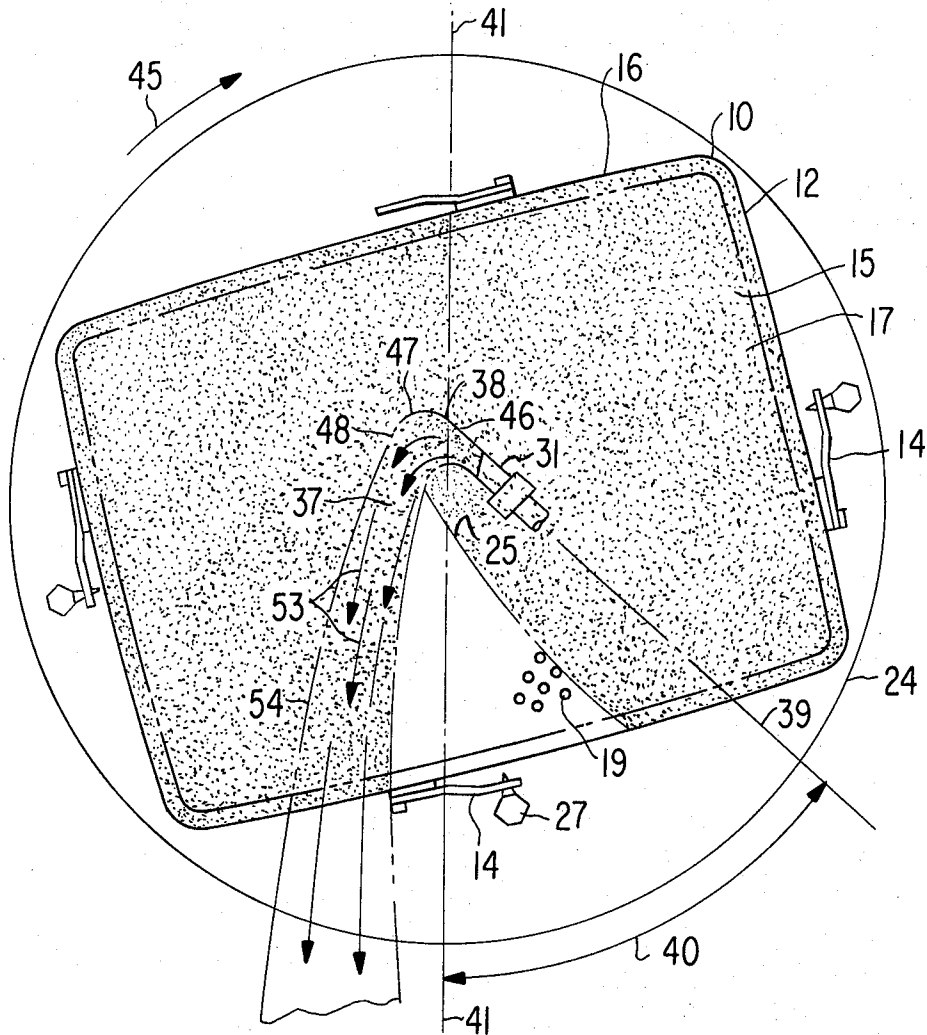


Fig. 4

METHOD FOR COATING ONLY THE CONVEX MAJOR SURFACE OF AN APERTURED MASK FOR A CATHODE-RAY TUBE

BACKGROUND OF THE INVENTION

This invention relates to a novel method for coating a convex major surface of an apertured mask for a cathode-ray tube without coating the opposite concave major surface thereof and particularly, but not exclusively, to a novel method for coating only the convex major surface of an apertured mask for a color television picture tube.

In the manufacture of an apertured-mask color television picture tube, it is desirable to use the curved apertured mask as a photographic master to produce the viewing screen structure. In producing some types of viewing screen structures, it is necessary to reduce temporarily the mask aperture size. This may be done by applying a coating over the apertured mask to produce thin membranes completely closing the mask apertures. These membranes are then opened at the central portions thereof to produce smaller temporary apertures. It is very important that the coating include thin membranes completely closing each aperture which are substantially uniform in thickness to permit the subsequent production of temporary apertures of the desired sizes.

In one prior method for producing membranes, liquid coating material is simultaneously applied to both major surfaces of an apertured mask by immersion. Ideally, this process produces membranes of uniform size closing each of the final-sized apertures. In practice, the liquid material on the concave major surface may flow into and collect between the mask skirt and the frame. This may prevent uniform spreading of the liquid material on the concave major surface producing nonuniform membranes at some of the apertures. This may subsequently result in variations in the size of the temporary apertures produced from the nonuniform membranes.

In another prior method, liquid coating material is applied to only the convex major surface of the apertured mask by contacting a portion of the convex major surface of the mask against the surface of a liquid coating material contained in a tank. In this prior method, it is necessary to contact the mask lightly against the liquid surface to prevent liquid flow through the apertures. The mask is tilted and rotated at a similar light contact force to coat the remainder of the convex major surface. While this prior method can produce uniform coatings on the convex major surface without flowing through the mask apertures, it is a difficult process to control. Variations in the pressure of the liquid on the mask may force the liquid through the apertures and partially coat only portions of the opposite concave major surface. In addition, the liquid forced through may collect between the mask skirt and frame as in the immersion method mentioned above. These and other effects produce nonuniform membranes and improper sizes of temporary apertures formed therefrom.

SUMMARY OF THE INVENTION

The novel process for coating a convex major surface of an apertured mask for a cathode-ray tube including coating portions substantially filling and completely closing the final-sized apertures comprises:

1. rotating said mask about an axis substantially normal to and passing through the central portion of the mask at a rotation rate insufficient to cause liquid coating material to fly off the surface by centrifugal force, the axis being inclined at about 100° to 130° from vertical, and continuing said rotating through the following steps (2) through (6);

2. projecting a stream of liquid coating material into an upward trajectory;

3. contacting the convex surface of the rotating mask on an area above the central axis with the stream at substantially the top of the upward trajectory thereof, the stream making an angle of less than 15° with a tangent to the contacted area of the mask;

4. continuing steps (2) and (3) through at least one revolution of the mask, and the amount of contacting material is in excess of the amount required to coat the mask;

5. permitting excess material to drain from the mask by gravity;

6. removing the stream from contact with the surface;

7. and then increasing the rotation rate of the mask to cause excess liquid coating material to fly off the mask surface by centrifugal force.

The novel method produces a liquid coating only on the convex major surface of a curved mask. The combination of stream trajectory, mask rotational speed, and stream contact angle permits the mask to be coated on the convex major surface only, including a uniform filling and a complete closing of the apertures. The liquid coating material does not flow through the apertures, thereby the opposite concave major surface remains uncoated. This results in more uniform membranes at all the apertures and subsequently results in the formation of temporary apertures of desired size. The liquid coating material does not collect between the mask and the frame. Finally, the novel method is well adapted to continuous automated manufacturing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional side elevational view of a dispense station illustrating a preferred embodiment for practicing the novel method.

FIG. 2 is a front view of the apertured mask positioned on the dispense station of FIG. 1 as viewed perpendicularly to the plane of the mask illustrating the flow of the liquid stream.

FIG. 3 is an idealized fragmentary sectional view of an apertured mask.

FIG. 4 is the view of FIG. 2 at a later time illustrating the liquid stream advancement over the rotating mask.

FIG. 5 is an idealized fragmentary sectional view of an apertured mask immediately after the step of coating the mask by the novel method, the coating substantially filling and completely closing each of the final-sized apertures.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1 and 2 illustrate an apertured-mask assembly 10 positioned in a dispense station 11. The mask assembly 10 is of a generally rectangular configuration and includes a mask 12, a frame 13 welded to the mask 12, and four frame support members 14 welded to the frame 13. The mask 12 includes a curved portion 15

and a peripheral skirt 16 for overlapping engagement with the frame 13. The mask 12 is formed of a conducting material such as steel approximately 0.006 inch thick. A typical mask assembly is described in U.S. Pat. No. 3,585,431 to Kenneth A. Long.

Referring to FIG. 3, the curved portion 15 of the mask 12 is comprised of a convex outer surface 17 and a concave inner surface 18 and contains an array of final-sized apertures 19 therein. Each of the apertures 19 shown in FIG. 3 may be of the double truncated-spherical shape having a large-diameter, spherical-shaped cup 20 in the convex outer surface 17 and a small-diameter, spherical-shaped cup 21 in the concave inner surface 18. The two cups 20 and 21 intersect at a knife edge 22 (shown in FIG. 3) defining the final-sized aperture 19. For example, for a 25VBAP22 color television picture tube, the final-sized apertures 19 have a maximum diameter of about 0.013 inch at the knife edge 22, about 0.021 inch at the intersection of the large cup 20 and the convex outer surface 17, and about 0.016 at the intersection of the small cup 21 and the concave inner surface 18. The center-to-center spacing of the apertures 19 is about 0.025 inch.

The mask assembly 10 is shown in FIG. 1 positioned on a carrier 23 of a continuous processing machine (not shown). The carrier 23 includes a mask holder 24, rotating means (not shown) for rotating the mask holder 24 about a central axis 25 and tilting means (not shown) for rotating the mask holder 24 about a horizontal axis 26. The mask holder 24 includes three support posts 27 for holding and orienting the mask assembly 10 with the central portion 28 of the mask 12 preferably aligned with the central axis 25. The mask holder 24 is shown positioned at a tilt angle 29 of about 110° with respect to the vertical downward position designated 0° tilt angle.

FIG. 1 also schematically illustrates a liquid dispense system 30. The dispense system 30 includes a dispense nozzle 31 with an orifice having a diameter of about 0.5 inch, a high-volume low-speed pump 32, a heater 33, a filter 34, a head tank 35, an overflow line 35a, a sump tank 35b, and a solenoid flow control valve 36. It is preferred that the head tank 35 is positioned about 2 feet above the dispense nozzle 31 to supply the liquid to the dispense nozzle 31 at a constant head of less than 5 psi. It is preferred that the dispense nozzle 31 delivers a limp liquid stream 37. A limp liquid stream 37 is a stream which flows in an upward arcing trajectory 38 less than 10 inches in length measured along a horizontal line (90° from vertical) through the orifice as will be described.

Referring to FIG. 2, the dispense nozzle 31 is positioned in front of the convex outer surface 17 of the mask 12. The axis 39 of the dispense nozzle 31 is positioned at an angle 40 of about 30° from a vertical axis 41 as viewed perpendicularly to the plane of the mask holder 24. Referring to FIG. 1, the dispense nozzle 31 is positioned at an acute contact angle 42 with respect to a tangent line 43 to the mask 12 at the center of the contact area 44 of the liquid stream 37 with the mask 12. The preferred contact angle 42 is about 5°.

EXAMPLE: The novel method may be practiced at the above-described dispense station as follows. Provide a mask assembly 10 mounted to rotate about a central axis 25 normal to and passing through the central portion 28 (shown in FIG. 2) of the mask 12. In the preferred method, a mask assembly 10 is positioned on

the mask holder 24 with the convex outer surface 17 facing towards the dispense nozzle 31 with the mask holder 24 and dispense nozzle 31 positioned as previously described.

The mask holder 24 with mask assembly 10 is rotated about the central axis 25 inclined at about 110° from a vertical downward 0° reference position at a rotation rate insufficient to cause liquid coating material to fly off the convex outer surface 17 by centrifugal force. It is preferred that the mask holder 24 is rotated about the central axis 25 at about 4 revolutions per minute in the direction shown by the arrow 45 (FIG. 2).

A stream 37 of liquid coating material is projected from the dispense nozzle 31 in an upward arcing trajectory 38 by operating the flow control valve 36. The liquid coating material is comprised preferably of an organic polymer and a vehicle therefor. It is preferred that the total volume of the stream of liquid coating material is comprised of about 15 volume percent polyvinyl alcohol, 75 volume percent water and about 10 volume percent ethylene glycol. It is preferred that the stream of liquid coating material have a viscosity of about 20 to 30 centipoises.

The orifice of the dispense nozzle 31 directs the stream 37 in an upward trajectory 38. The trajectory 38 is comprised of an upward portion 46, a top or maximum height portion 47, and a downward portion 48. The preferred trajectory 38 occurs with the axis 39 of the dispense nozzle 31 positioned at a 30° angle 40 with the vertical axis 41 and at a 5° angle 42 with the tangent line 43 as described. In the preferred upward trajectory 38, the upward portion 46 rises about 2 inches vertically from a horizontal line 49 through the nozzle axis 39 and the center of the orifice as shown by the vertical dimension 50 in FIG. 2. The stream 37 contacts the convex outer surface 17 of the mask 12 at the top portion 47 at a horizontal distance of about 2¼ inches measured along the horizontal line 49 as shown by the first horizontal dimension 51 in FIG. 2. The stream 37 then falls in the downward portion 48 of the trajectory 38 to flow across the horizontal line 49. The total length of the trajectory 38 is the distance measured from the center of the orifice along the horizontal line 49. In the preferred embodiment the total length of the trajectory is less than 4 inches as shown by the dimension 52 in FIG. 2.

Immediately upon exit from the dispense nozzle 31, the stream 37 maintains a laminar upward flow without diverging near the beginning of the upward portion 46 of the trajectory 38. Near the top 47 of the trajectory 38, and prior to contact of the stream 37 with the mask 12, the stream 37 is diverged about twice its previous width at the dispense nozzle 31. Upon contact of the stream 37 with the convex outer surface 17, the stream 37 further diverges or spreads into a sheet of liquid flowing over the convex outer surface 17. The sheet of liquid then flows across the mask 12 in the downward portion 48 of the trajectory 38, and continues flowing downward in the direction shown by the arrows 53 in FIGS. 2 and 4 draining off the lowermost edge of the convex outer surface 17.

The liquid coating material flows to the edge of the convex outer surface 17 and then drains off the mask 12 as by gravity. Some of the coating material may flow axially along the peripheral skirt 16 of the mask 12 and drain off the sheared edge of the skirt 16 as by gravity. The amount of axial flow along the skirt 16 is deter-

mined at least by the surface characteristics of the skirt 16. Where the skirt surface is rough, it is believed minimum axial flow along the skirt 16 is obtained.

The stream 37 contacts the convex outer surface 17 on a contact area 44 above the central portion 28 of the mask 12 substantially at about the top 47 of the trajectory 38 substantially as shown in FIGS. 1 and 2. It is preferred that the contact area 44 be on a rotating portion of the mask 12 about 1.0 inch vertically above the rotational central axis 25. If the stream 37 strikes less than 1 inch from the central axis 25 within the central portion 28, near the stationary rotational central axis 25 of the mask 12, buildup of the liquid coating material may occur at the central portion 28.

The stream 37 contacts the mask 12 with substantially a zero vertical velocity component perpendicular to the convex outer surface 17 because it contacts substantially at the top 47 of the trajectory 38. The horizontal velocity component of the liquid stream 37 at the stream contact area is substantially parallel to the convex outer surface 17 and substantially equal to the rotational velocity of the convex outer surface 17 at the contacted area. The liquid stream 37 after contacting the convex outer surface 17 generally flows downward as by gravity and drains off the lowest edge of the convex outer surface 17 as shown by the flow arrows 53 in FIGS. 1 and 2.

The mask rotation is continued for at least one revolution to provide a continuous coating over the outer convex surface 17. The rotation of the mask 12 causes the front edge 54 of the liquid stream 37 to advance over the convex outer surface 17 as shown in FIG. 4. The combination of the liquid stream 37 flows over the convex outer surface 17, and the rotational advancement of the convex outer surface 17 into the liquid stream 37 provides a continuous coating free of voids. Once a void is created, a wetted path is established and the void is difficult to coat even on subsequent passes. It is therefore very desirable to apply the liquid stream 37 in a continuous even flow at substantially uniform rotational speed.

The stream 37 is then removed from contact with the mask 12 while continuing to rotate the mask 12. This is accomplished by operating the flow control valve 36 to turn off the stream 37 flow from the dispense nozzle 31. The rotational speed of the mask 12 is then increased to cause excess coating material to fly off the convex outer surface 17 by centrifugal force. It is preferred that the rotational speed be increased to about 75 to 200 RPM for about 1 minute.

The mask 12 with the coating 55 (shown in FIG. 5) may then be dried by heating to form membranes (not shown) completely closing the final-sized apertures 19. The mask 12 may optionally be dried and removed from the holder 24, or the holder 24 with mask 12 having the coating 55 may be used on a continuous processing machine where the mask 12 is continuously processed to open temporary apertures smaller than the final-sized apertures in the coating 55.

GENERAL CONSIDERATIONS

Although the mask 12 is tilted at about 110° in the Example, other tilt angles may be used. The minimum tilt angle is where the tangent to the lowest edge of the mask convex outer surface 17 is substantially vertical or where adhesive forces permit Coanda attachment of the stream to the mask 12. The maximum tilt angle is

where gravity forces on a particular viscosity liquid stream do not cause the stream to flow in a downward direction across the mask 12. The practical range of tilt angles with presently used masks is about 100° to 130°.

The dispense nozzle angle 40 is also chosen to be about 30° for convenience in providing a limp stream 37 flowing in an upward trajectory 38. Again, this angle is important in providing the desired limp stream 37. The preferred angle 40 is within the range of 10° to 80°. An upward stream is desired to permit contact of the mask substantially at the top 47 of the upward trajectory 38. With the stream contacting the mask 12 at the top 47 of the trajectory 38, vertical velocity components normal to the convex outer surface 17 are minimized.

The contact angle 42 of the stream 37 with the mask 12 is not critical but is preferably less than 15°. It is necessary only that, for a particular size of final-sized aperture 19, the stream strike the aperture 19 indirectly. At a contact angle 42 near 0° (tangent to the contact area 44) a stream 37 may have a tendency to bounce rather than contact and attach to the surface with a Coanda effect. As the angle 42 increases, the stream 37 may be directed into the apertures 19, enhancing the possibility of the stream 37 flowing through the apertures 19. With a particular coating material, a particular contact angle 42 may perform better than other contact angles. With the aperture mask for the 25VBAP22 color television picture tube described, the aperture proportions and spacing do not provide sufficient nonapertured surface for the stream 37 to reliably attach to the surface 17 at a coating viscosity below 20 centipoises.

Although it is preferred that the stream 37 contact the mask 12 about 1.0 inch above the central axis 25, a practical range with presently used masks is at least about 0.5 to 2.5 inches. The actual distance is determined by the width and flow characteristics of the stream 37. The main consideration is that the liquid coating be applied by the stream 37 in a sufficient amount to flow over the central portion 28 of the mask 12 providing a coating of a desired thickness thereon.

Although the mask is rotated at about 3 RPM in the Example, presently used masks may rotate within the range of 2 to 6 RPM. The speed must only be insufficient to cause the liquid coating material to fly off the mask 12 by centrifugal force, permit uniform coating application, and provide a coating of a sufficient thickness. The flow rate and rotational speed determine the amount of liquid coating material flowed over the mask 12. It is necessary only that a sufficiently thick coating be applied since excess liquid coating material is removed from the mask 12 by draining during the high speed rotation.

The liquid coating material is preferred to be comprised of one or more organic film-forming polymeric materials and one or more liquid vehicles therefor. It is preferred that the viscosity of the liquid coating material is in the range of 10 to 50 centipoises, the particular viscosity range being determined by mask size. The aperture diameter, the surface characteristics of the mask, and the rotational speed of the mask in combination with the viscosity must be selected to prevent the stream 37 from flowing through the final-sized apertures 19. The preferred combination of parameters pre-

viously described provides the desired coated mask shown in FIG. 5.

The apertures are described in relation to the apertured mask of a cathode-ray tube where the final-sized apertures 19 are round. The novel method may also be used with masks having slot-shaped apertures, or other aperture shapes.

I claim:

1. In the manufacture of a cathode-ray tube comprising a curved apertured mask having a convex major surface and an opposite concave major surface, the method of applying a coating on said convex major surface to substantially fill and completely close the final-sized apertures without coating said opposite concave major surface comprising
 - a. rotating the mask about an axis that is substantially normal to and passes through the central portion of said mask, said axis being inclined at about 100° to 130° from a vertical downward position, at a rotation rate insufficient to cause liquid coating material to fly off said surface by centrifugal force, and continuing said rotating through the following steps b) through f)
 - b. projecting a stream of liquid coating material into an upward trajectory, said liquid coating material having a viscosity in the range of 10 to 50 centipoises,
 - c. contacting the convex surface of said rotating mask on an area above said axis with said stream at substantially the top of said trajectory, said stream making an angle of less than 15° with a tangent to said convex surface,
 - d. continuing said steps b) and c) through at least one revolution of said mask during which the amount of contacted material is in excess of the amount needed for applying the coating,

- e. permitting excess liquid coating material to drain from said rotating mask by gravity,
- f. removing said stream from contact with said surface,
- g. then increasing the rotation rate of said mask to cause excess liquid coating material to fly off said convex major surface by centrifugal force,
- h. and then drying the coating material retained on said mask.
2. The method defined in claim 1 wherein said stream is projected into said trajectory at an angle of about 10° to 80° with a downward vertical axis in the plane of said mask.
3. The method defined in claim 1 wherein said stream is projected into said trajectory at an angle of about 30° with a downward vertical axis in the plane of said mask.
4. The method defined in claim 1 wherein said trajectory is less than 4 inches in length measured along a horizontal line in the plane of said mask.
5. The method defined in claim 1 wherein said area contacted by said stream is greater than 1.0 inch above said axis and less than where said stream would not flow downward over said convex major surface of said mask.
6. The method defined in claim 1 wherein said stream after contact with said mask flows substantially in the direction of said rotation of said mask and thereafter flows vertically downward by gravity forces, the edge of said stream flow continuously advancing over said convex major surface of said mask during said mask rotation.
7. The method defined in claim 1 wherein said rotation rate recited in step a) is in the range of 2 to 6 revolutions per minute.

* * * * *

40

45

50

55

60

65