United States Patent

Ng et al.

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[45] **May 23, 1972**

[54] **MEANS FOR ACHIEVING A CONTROLLED GRADIENT DENSITY COATING ON A LIGHT ATTENUATION MEDIUM**

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[73] Assignee: **GTE Sylvania Incorporated,** Seneca Falls, N.Y.

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[52] **U.S. Cl.** **118/9,** 118/48, 355/1

[51] **Int. Cl.** **C23c 13/08**

[58] **Field of Search** 118/7, 8, 48–49.5, 118/504, 505, 301

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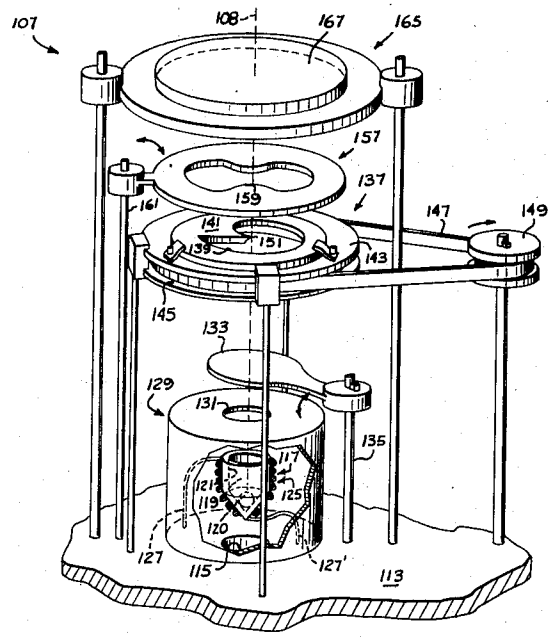
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[57] **ABSTRACT**

Means and process are disclosed for disposing a patterned light attenuating coating of a differential density on a substantially transparent optical medium, used in the optical system for photo-forming the windowed interstitial web portion of a color cathode ray tube composite screen structure. The apparatus comprises a hermetic chamber wherein there is included a vaporizing source, a rotatable first pattern mask, a movable second pattern mask, support means for positioning the optical medium, and optical means for monitoring the deposition of coating thereon. The apparatus enables the deposition of a nonsymmetrical coating formed to modify the photo-exposure illumination from the photo-exposure light source.

7 Claims, 10 Drawing Figures



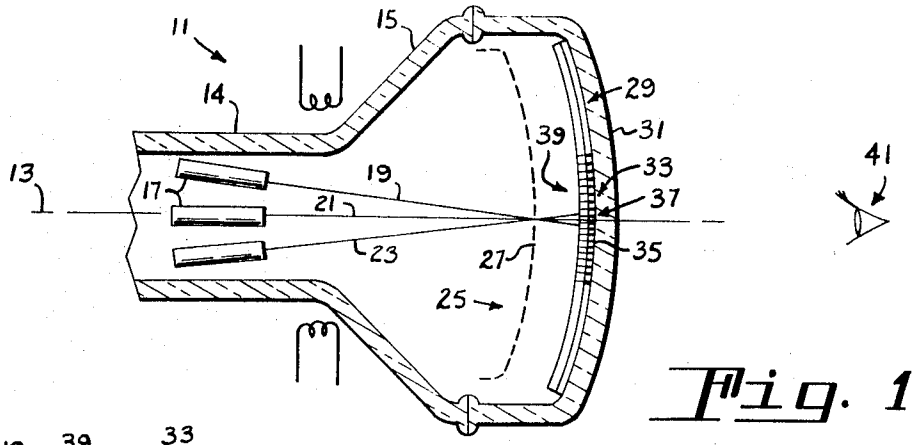


Fig. 1

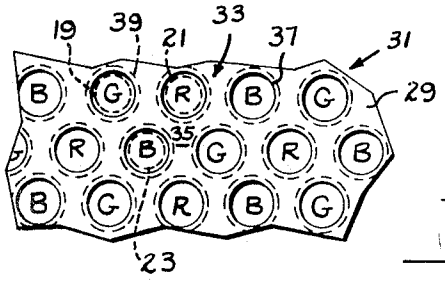


Fig. 2

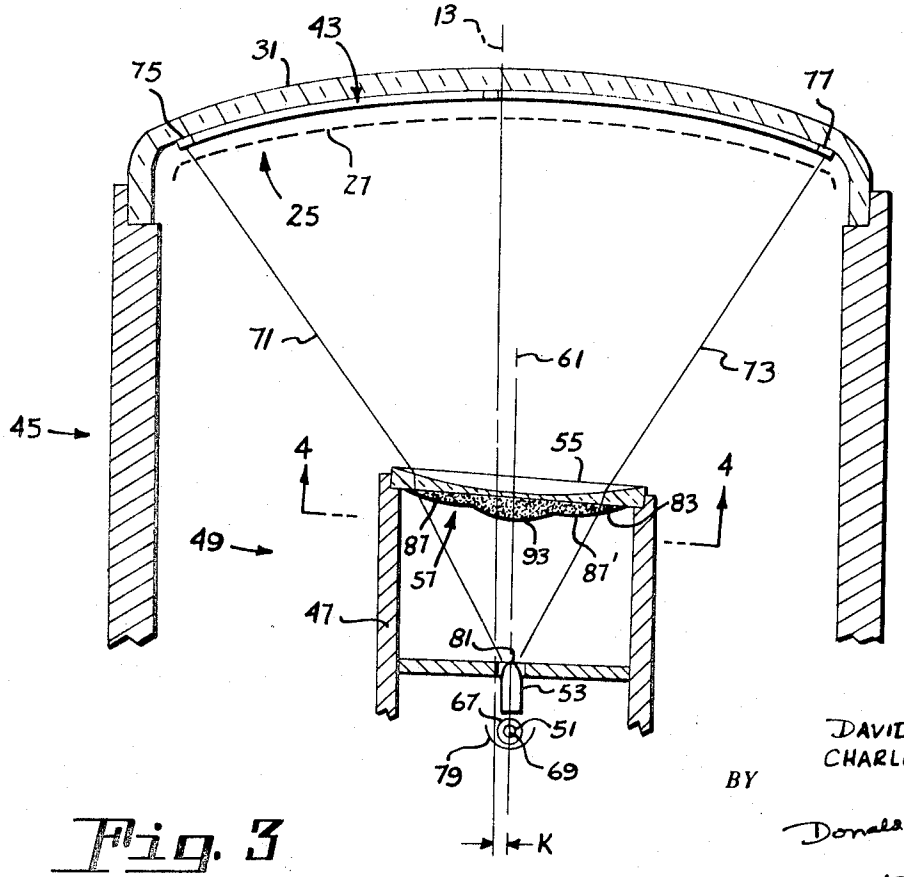


Fig. 3

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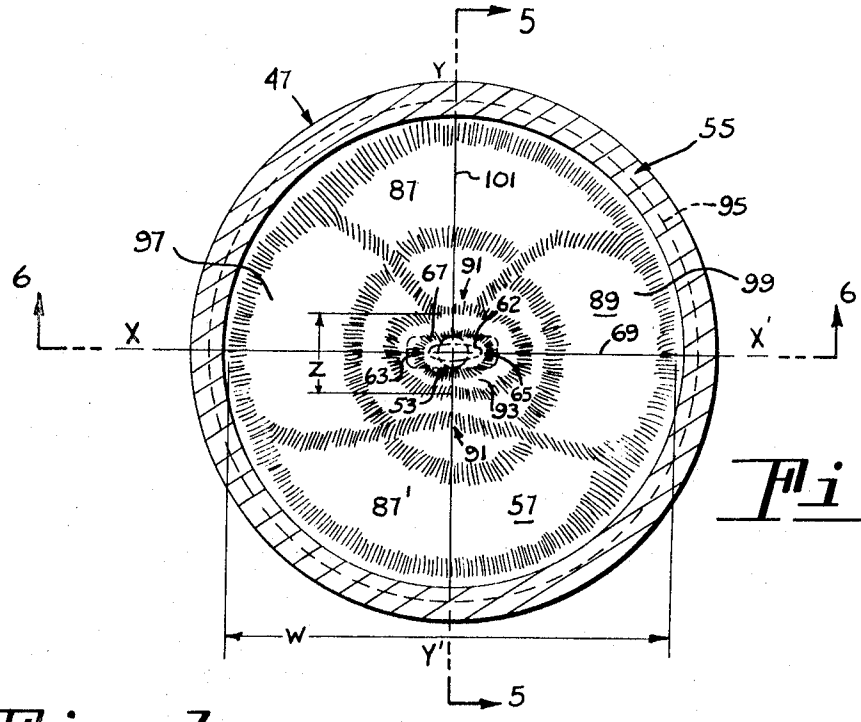
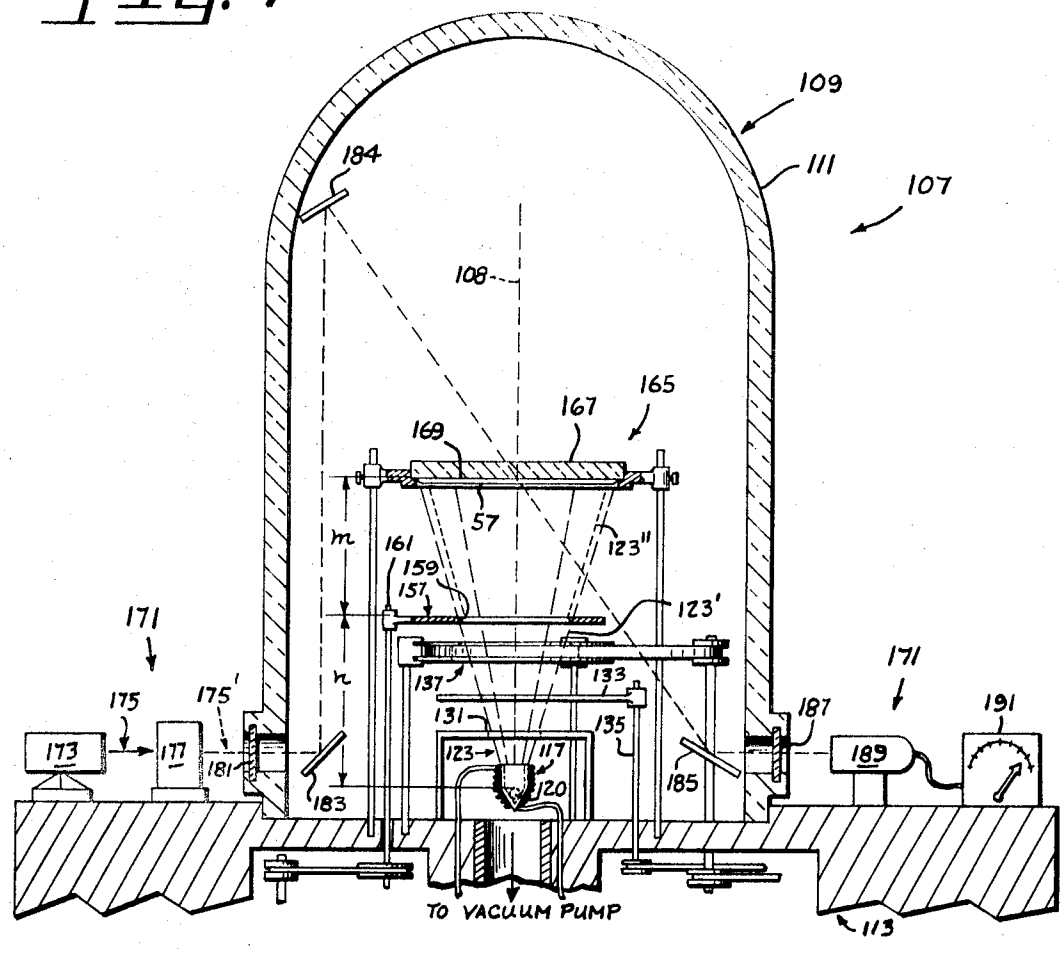

5
47
Y
55
87
101
95
97
99
6
6
X
X'
89
67
91
62
69
Z
63
65
53
93
91
87'
57
W
Y'
5

Fig. 4

Fig. 7


109
111
107
184
108
165
167
169
57
123"
m
161
159
157
123'
171
171
h
137
133
131
135
187
191
175
175'
173
177
181
123
117
120
183
185
189
TO VACUUM PUMP
113

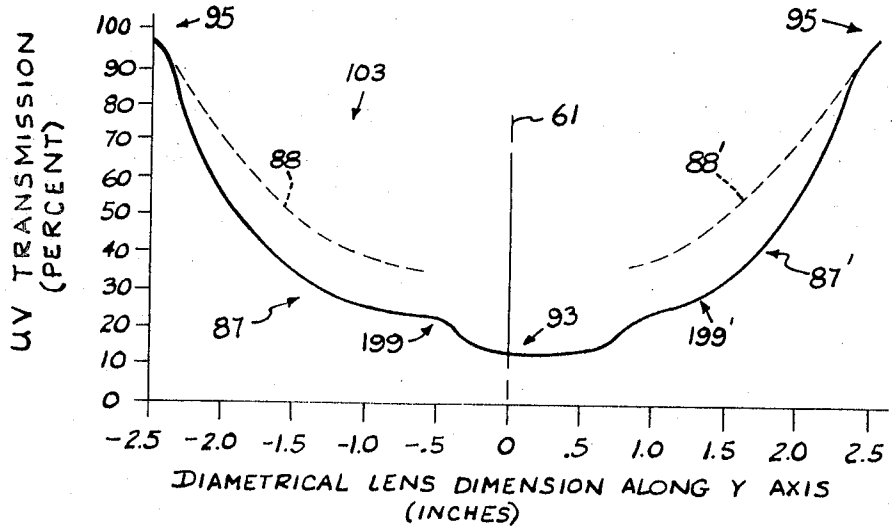


Fig. 5

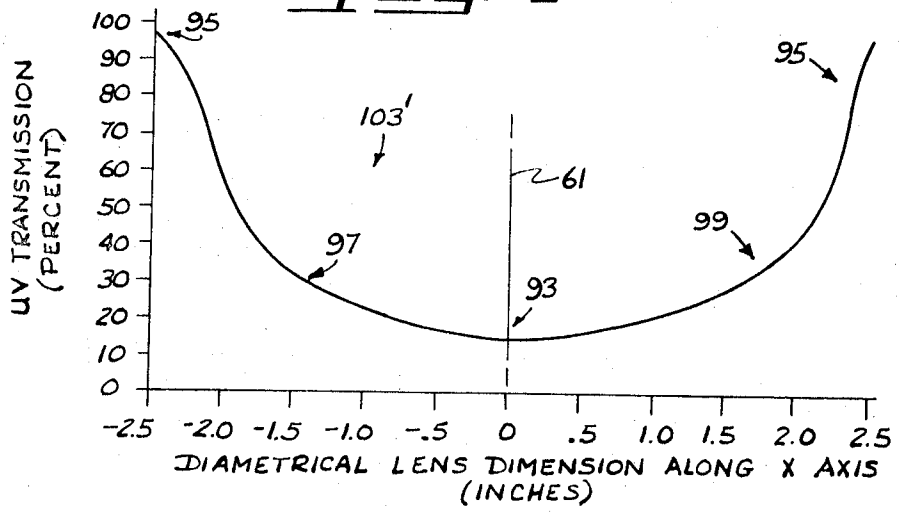


Fig. 6

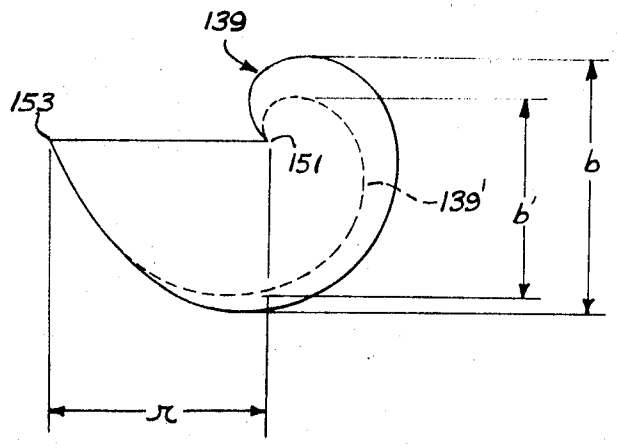


Fig. 9

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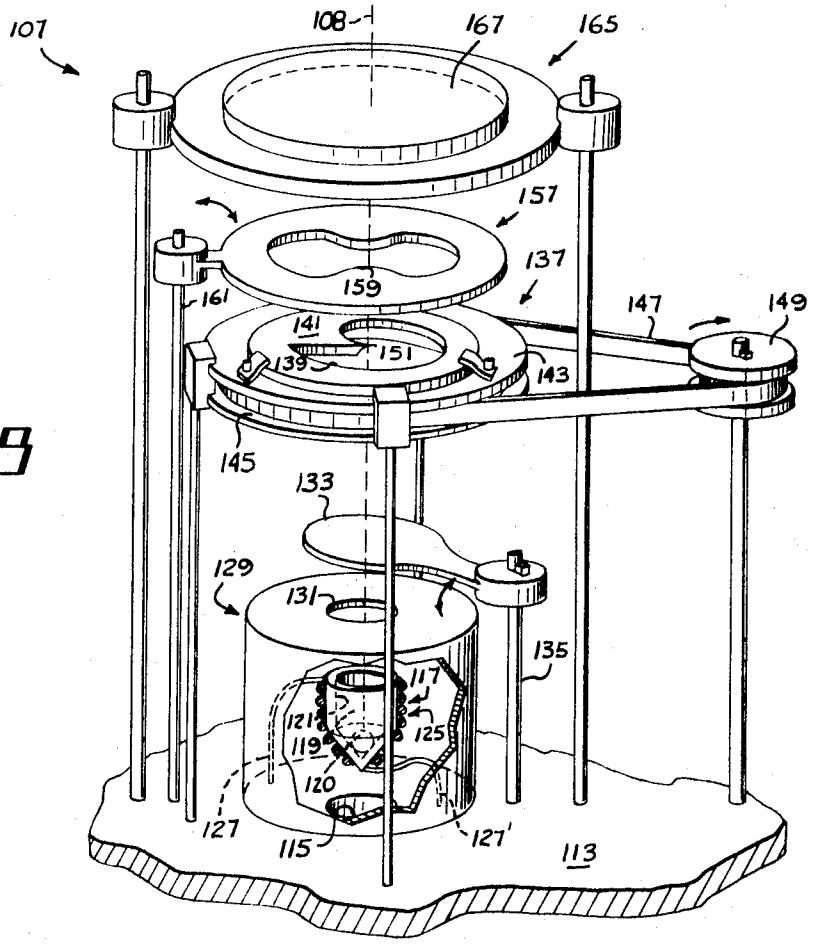

107
108
167
165
157
159
137
161
147
149
141
151
139
143
145
133
129
131
135
117
121
125
119
120
127
115
127'
113

Fig. 8

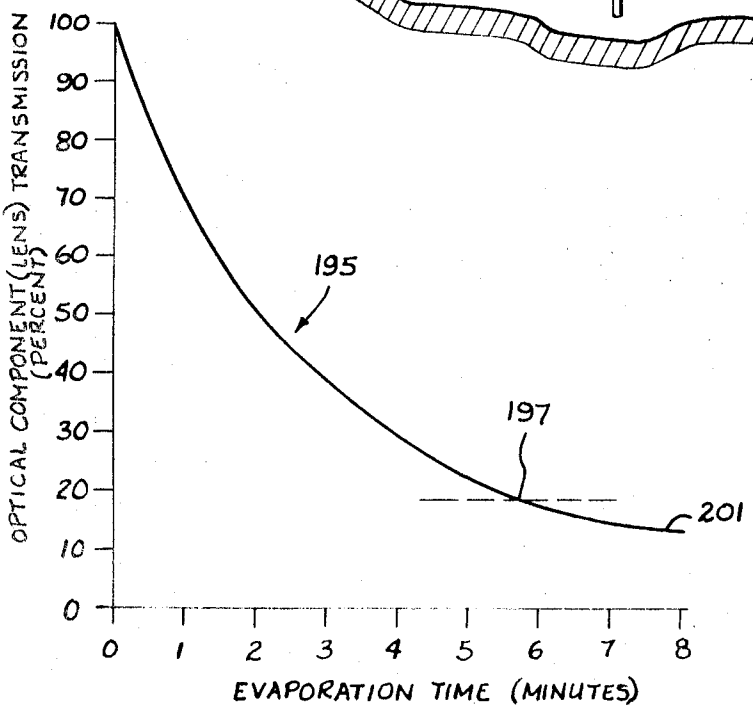

OPTICAL COMPONENT (LENS) TRANSMISSION (PERCENT)
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
EVAPORATION TIME (MINUTES)
195
197
201

Fig. 10

MEANS FOR ACHIEVING A CONTROLLED GRADIENT DENSITY COATING ON A LIGHT ATTENUATION MEDIUM

CROSS-REFERENCE TO RELATED APPLICATION

This application contains matter disclosed but not claimed in a related U.S. Pat. application filed concurrently herewith and assigned to the assignee of the present invention. This related application is Ser. No. 86,123, filed Nov. 2, 1970 titled: "An Improved Optical System For Forming A Windowed Web In A Color Cathode Ray Tube Screen Structure."

BACKGROUND OF THE INVENTION

This invention relates to cathode ray tubes and more particularly to the means and process for disposing a discrete light attenuating coating on an optical medium utilized in an optical system for photo-forming a color cathode ray tube composite screen structure.

Cathode ray tubes capable of presenting multi-color display imagery, such as those utilized in color television applications, conventionally employ patterned screens which are comprised of an orderly array of separate color fields formed of repetitive groups of related hue-emitting phosphor materials. As an example, in the well-known shadow mask type of tube construction, the color screen pattern is conventionally made up of a vast multitude of discrete dots formed of selected cathodoluminescent phosphors which are usually arranged in triad relationship. Such dots upon selective electron excitation, emit predetermined additive primary hues to produce the desired color imagery. Associated with the screen within the tube envelope, is a foraminous structure or shadow mask having multitudinous apertures therein. Each of these apertures is related to a specific grouping or triad of dots comprising the color screen pattern, and spaced therefrom in a manner to enable the selected electron beams, traversing the apertures, to impinge the proper dots therebeneath.

To enhance color purity, improve brightness and accentuate contrast of the color screen image, an advantageous composite screen structure has been developed, wherein a dot-defining interstitial spacing is provided between the individual dots in the form of an opaque light-absorbing material. In essence, each of the phosphor dots comprising the screen pattern is encircled or defined by a substantially dark interstitial encompassment which collectively forms a multi-opening pattern or windowed webbing having substantially opaque interstitial connections. It is imperative that these definitive windows be of proper sizes and in precise orientation with reference to the individual phosphor dots at the areas of respective beam impingement.

Fabrication of the windowed interstitial webbing is accomplished either before or after phosphor screening by several processes wherein photo-deposition techniques play a prominent role. The exposure devices and associated optical systems employed in fabrication of the windows resemble those utilized in phosphor dot formation. Conventionally, these include an exposure light source and a refractive component or lens oriented in a manner to provide light optics intended to substantially duplicate the electron optics of the operating tube. It has been found that the optical preciseness necessary for fabricating the desired window pattern of the composite screen structure is not inherently available in the usual phosphor screening exposure systems. This lack of optical precision is sometimes evidenced by the non-uniformity of the electron-excited white field in various portions of the windowed screen in an operating tube. Such off-white areas are found to be due to a subtractive effect produced by a smaller than desired size of one of the related tri-dot windows, i.e., red, blue, or green in certain areas of the screen. The presence of this smaller window also aggravates misregistration or eclipsing of the impinging beam by a portion of the opaque interstitial material defining the window which adds to the undesirable off-white effect. Thus, the phosphor defining windows become additional determinant factors influencing the

contrast, brightness and color quality of the excited screen area. This emphasizes the fact that advancement in the art of producing improved color cathode ray tubes brings with it an imperative need for improved precision and refinement in screen fabrication means and techniques.

In the windowed-structure color screen, it is desired to have a variable gradient of window sizes from center to edge of the screen, and in addition, the windows should be of substantially equal size in annular orientation progressively about the central axis of the screen. The coated optical components commonly utilized in the window exposure optical systems usually employ light attenuation coatings having substantially symmetrical light transmission characteristics, i.e., a plot of percent light transmission versus distance from center to edge of the coated optical component varies inversely as the square of the distance from the source. A common type of apparatus for disposing such light attenuation coating may utilize a diametrically controllable iris mask which usually does not readily lend itself to the deposition of a differential nonsymmetrical pattern.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to reduce the aforementioned disadvantages and to provide an improved means and process for achieving a controlled gradient density attenuating coating on an optical medium employed in an optical system for photo-forming a color CRT composite screen structure.

The definition of the term "density" as used herein refers to the opaque quality of the coating.

The foregoing objects are achieved in one aspect of the invention by an improved means and process for vapor disposing a light attenuating coating of a controlled gradient density on a substantially transparent optical medium. The technique involves positioning the to-be-coated optical medium in a hermetic chamber in a manner that a metal vaporizing source is oriented in spaced relationship with the side of the medium to be coated. Positioned intermediate the vaporizing source and the medium are two pattern masks. A rotatable first pattern mask having a defined opening therein is spacedly positioned above the vaporizing source to initially modify the vapor beam passing therethrough. A movable second pattern mask having a differently defined opening therein is located above and in spaced relationship with the rotatable mask in a manner to enable insertion and removal of the second mask into and out of the modified vapor beam to effect secondary modification of the beam. Operationally, when the vapor deposition through the rotatable first pattern mask exhibits light attenuation of a predetermined level, the fixed pattern of the second mask is moved into the modified vapor beam to further control the vapor deposition and provide the desired composite nonsymmetrical attenuation coating pattern on the optical medium.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view of a color cathode ray tube of the shadow mask type employing a windowed composite screen;

FIG. **2** is an enlarged fragmentary view of the screen as seen through the viewing panel by an observer;

FIG. **3** is a plan view of an exposure apparatus employed in photo-forming the multiple window portion of the composite screen structure;

FIG. **4** is a plan view of the coated optical medium utilized in the exposure apparatus taken along the line **4—4** of FIG. **3**;

FIGS. **5** and **6** are profile representations of the UV transmission of one embodiment of the composite attenuation coating disposed on the surface of the optical medium taken along the lines **5—5** and **6—6** of FIG. **4**;

FIG. **7** is a cross-sectional view of the apparatus for vapor disposing the light attenuating coating on the optical medium;

FIG. **8** is an isometric view detailing certain of the cooperating means shown in FIG. **7**;

FIG. **9** is a plan view illustrating an embodiment of the configurative opening in the rotatable first pattern mask; and

FIG. 10 is a profile representation of the light transmission of the attenuation coating at substantially the central portion of the optical medium during formation of the coating pattern thereon.

DESCRIPTION OF THE PREFERRED EMBODIMENT

For a better understanding of the present invention, together with other and further objects, advantages and capabilities thereof, reference is made to the following specification and appended claims in connection with the aforedescribed drawings.

The need for and utilization of a specialized nonsymmetrical composite pattern of light attenuation coating is presented as a background for adequately considering the means and process of achieving the desired discrete coating pattern.

With reference to the drawings, there is shown in FIG. 1 a conventional shadow mask type of color cathode ray tube **11** having a central axis **13** therethrough. Suitably positioned within the neck portion **14** of the envelope **15** are three electron guns **17** oriented, for example, substantially 120° apart and equally spaced about the central axis **13** to provide a delta arrangement of electron beams **19**, **20** and **21**, respectively. The several beams are directed to converge at the apertured shadow mask **25**, and thence pass through the apertures **27** therein to discretely impinge the composite screen structure **29** spaced therebeneath. The composite screen **29**, which is disposed on the interior surface of the viewing panel **31** comprises a multiple window pattern **33** formed of an opaque interstitial webbing **35** that discretely defines the multitudinous window areas **37**. Disposed relative to the window areas **37** are a multitude of triadically arranged dots **39** of red, blue, and green color-emitting electron responsive phosphor materials.

Since the tube axis, and panel axis are substantially coincidental, it seems expedient for clarification to denote these respective axes as the central axis **13**.

With particular reference to FIG. **2**, an enlarged fragmentary section of the screen is illustrated as seen from the viewpoint of an observer **41**, facing the front of the view panel **31**. The phosphor areas available for utilization informing the visible display, on the composite screen **29**, are determined by the respective areas of the defining windows **37** in the interstitial webbing **35**. The geometry of the tube **11** is such that the three electron beams **19**, **21** and **23** make landings to form a substantially triadical formation on the screen. One such grouping is shown in FIG. **2**. To adequately utilize the beam landings, the respective phosphor window areas **37** should coincide therewith. As previously mentioned, such was not always true especially when the optical system conventionally utilized for phosphor dot exposure was used for window fabrication. Often a resultant difference in size of one of the windows in the triad was evidenced in certain portions of the screen.

It has been found that the smaller sized window in the triads can be increased as desired to equal or be proportional to the other window areas in the respective triadical groupings. This is accomplished by incorporating an improvement in the optical system employed in photo-forming of the multiple window pattern. The improvement is in the form of related light attenuation coating patterns of differential nonsymmetrical density that are disposed relative to the lens in the optical system to discretely effect the exposure illumination passing therethrough. This provides a variable gradient of screen window sizes from center to edge of the screen and effects substantially constant window sizes in annular orientation progressively about the central axis **13**.

Optical exposure means, such as that shown in FIG. **3**, is employed to photo-form the multiple window pattern of the opaque interstitial web of a composite color cathode ray tube screen structure. The basic features of the optical system are similar to those disclosed in U.S. Pat. No. 3,509,802, issued to Glen A. Burdick and assigned to the same assignee as the present invention. Another related optical system is disclosed in U.S. Pat. No. 3,448,667 issued to H. E. Smithgall and assigned to the same assignee as the present invention.

Prior to the exposure of each of the respective window patterns, the inner surface of the viewing panel **31** is coated with a light hardenable photosensitive substance **43** such as dichromate sensitized polyvinyl alcohol. The apertured shadow mask **25** is temporarily positioned in spaced adjacency with the sensitized panel, whereupon the mated mask-panel assembly is positioned on the exposure apparatus **45**. Within the exposure apparatus, there are means **47** for predeterminately positioning an optical system **49** comprising: a primary source of exposure illumination **51**, an associated light source collector rod **53**, a modified plano-concave lens **55**, and a two pattern composite light attenuation coating **57** disposed relative to a surface of said lens **55**. For purposes of illustration, the profile of the composite lens coating **57** is exaggerated in FIG. **3**. Actually, the composite coating is of substantially neutral density, for example, a thin vapor disposed metallic coating of a suitable metal or alloy having varied thickness and exhibiting discrete degrees of opacity. This metallic coating should be of a neutral density within the spectrum of light utilized in photo exposure, and exhibit stability under atmospheric conditions. Nickel-chromium alloys, such as Inconel, which is available from the International Nickel Company, Inc., New York, N.Y., have been found suitable for this usage. Since the index of refraction of the thin deposit is nowhere near that of glass, its refractive interference pattern is considered minimal.

In the light exposure procedure, discrete areas of the coated panel are subjected to light radiated from the primary light source **51** which is attenuated by the coating **57**, refracted by the lens **55**, and directed through the mask apertures **27**. The discrete areas of the photosensitive coating **43** which receive the exposure light radiation are light polymerized or hardened and adhere to the inner surface of the panel **31** forming a first pattern of the subsequent window area. With the shadow mask still in place, the above-described procedure is twice repeated to dispose each of the related two remaining window patterns making up the triadical groupings. For the separate exposure of each of the respective window patterns, the optical system **49** is shifted substantially 120° about the central axis **13**.

After the three respective window patterns are thus exposed and polymerized, the shadow mask **25** is removed and the exposed coating **43** suitably developed to remove the web-like unpolymerized interstitial area. This development step provides a polymerized window pattern in the format of multitudinous polymerized areas surrounded by a connected web pattern of substantially bare glass. Following development, the patterned panel is overcoated with an opaque colloidal suspension of graphite, and then treated with an appropriate degrading agent and rinse to effect removal of the polymerized window pattern format. This degradation and removal of the polymerized window areas also loosens and removes the associated graphite which is disposed thereon. Thus, there is produced an opaque interstitial web having multitudinous windows therein in the form of discretely defined bare glass areas. It is on these window areas that the respective color-emitting phosphor materials are subsequently conventionally disposed by techniques known to the art to complete the windowed screen structure.

In greater detail, the optical system **49** is designed to provide deposition of the window pattern in a manner that the respective electron beams in the operating tube will impinge thereinto. The system, having an axis **61**, which is laterally offset from the central axis **13** by the distance *k*, incorporates therein a primary exposure light source **51** in the form of an elongated luminous arc **62** emanating between the electrodes **63** and **65** in a mercury vapor lamp **67**. An example of a conventional lamp is type BH6 which emits a high value of UV radiant energy in the 300–400 nanometer (nm) range. The primary light source **51** has a longitudinal axis **69** that is oriented substantially normal to the optical system axis **61**. The light collector **53** is a conduit means such as a quartz rod which collects and transfers, by internal reflections, a portion of the nonsymmetrical radiant energy produced by the source **51**. Light emanating from the collector rod **53**, as for example

attenuated rays represented by lines **71** and **73**, ultimately reach the photosensitized coating **81** to photo-form like peripheral window areas **75** and **77**, respectively; they being diagonally opposite areas of the screen. Even though a substantially concave-shaped reflector **79** is utilized, the exposure radiant energy emanating from the terminal end **81** of collector rod **53** is substantially of an elongated pattern. Since the intensity of the exposure illumination varies as the inverse square of the distance between the source and point of exposure, discrete compensation is required to attain annular uniformity of light intensity from the nonsymmetrical light source.

To compensate for the nonsymmetrical pattern of illumination, a discretely formed composite light attenuation coating **57** is disposed relative to a surface of the lens **55** in a manner to affect the exposure light transmitted therethrough. As illustrated in FIGS. **3** and **4**, the composite light attenuation coating **57** is disposed in substantially the form of two superjacently related patterns directly on the surface of the lens **55**, as, for example, by vapor deposition. Since the structure and detailed orientation of the lens **55** do not substantially influence the desired functioning of the discretely disposed coating **57**, specific details of the lens or optical medium construction are eliminated from this specification and drawings relating thereto. The lens **55** has X and Y axes and a center plane therethrough substantially coincident with the Y axis and normal to the plane of the X and Y axes. The lens **55** is oriented in the optical system with its X axis substantially parallel with the longitudinal axis **69** of the elongated light source **51**. The composite light attenuation coating **57** on the planar surface **83** of the lens **55**, substantially covers the whole of the optical utilized surface in a differential density deposition of two related coating patterns. This discrete attenuation provides control of the exposure illumination in a manner to produce substantially constant window sizes for all three colors in annular orientation progressively about the central axis of the screen, and additionally effects a variable gradient of window sizes in a radial direction from the center to the periphery of the color screen structure. Considered as a whole, the composite attenuation pattern exhibiting differential translucency has been determined through extensive experimentation to achieve the desired compensation for the nonsymmetrical illumination emitted by the elongated source. Since the lens **55** is of high UV transmissive optical glass, the UV attenuation of the glass per se is of very low order, and is considered minimal in this instance.

With reference to FIG. **4**, the first attenuation pattern of the composite coating **57** is comprised of substantially two parts **87** and **87'**, which affect primarily the Y axis region of the lens **55**. The density of this coating pattern decreases in a gradual manner from the central region of the lens to the periphery thereof. The related second attenuating pattern of the composite coating **57** is generally of a gradual heavier density than that exhibited by the first pattern, and is in substantially the generic form of a modified lemniscate **89**. The major dimension W of this lemniscate formation is oriented substantially in the lens transverse region related to the X axis thereof. The minor dimension "Z" is oriented across the waist section **91** of the lemniscate substantially coincident with the Y axis of the lens **55**. The heaviest or most opaque coating deposit of this second attenuation pattern **89** is substantially in the central area **93** of the lens **55** in the general region intersected by the axis of the optical system **61** with the density decreasing gradually outward therefrom to the periphery **95**. This lemniscate coating formation **89** is formed on the lens **55** with substantially equi-sized lobe portions **97** and **99** disposed on either side of the center plane **101**. The areas of heaviest coating density of the first attenuating pattern **87**, **87'** are adjacent the waist section **91** of the modified lemniscate formation **89**.

With reference to FIG. **5**, there is shown an exemplary profile **103** of the UV transmission of the composite attenuation coating **57** as evaluated relative to the center plane **101** along the Y axis of the lens **55** which, in this instance, has a five inch diameter. As portrayed, disregarding the reflective factor of the glass, the differential ultraviolet transmission of the coating per se ranges from substantially 98 percent at the periphery **95** of the lens to substantially 16 percent in the center lemniscate area **93**. The waist **91** of the lemniscate formation of coating **89** is evidenced as extending from substantially from −0.4 to +0.8 inches of the diametrical lens dimension. Similarly, exemplary FIG. **6** illustrates a UV transmission profile **103'** of the same composite attenuation coating **57** relative to the X axis of the same lens **55** as shown in FIG. **5**. Across the lens on this axis, the differential UV transmission of the typical coating embodiment increases from substantially 98 percent at the periphery of the lens to substantially 16 percent in the central area **93**. In this profile the expanse of greater attenuation in the lemniscate formation of coating **89** is evidenced with relationship to the major dimension "W" thereof as extending from substantially −1.0 to +1.0 inches of the diametrical lens dimension.

Deposition of the related discrete patterns comprising the composite light attenuation coating **57** is achieved by employing the vapor coating apparatus **107** illustrated in FIGS. **7** and **8**. The apparatus, which has a vertical axis **108**, includes an encompassing hermetic chamber **109** having a dome portion **111** and a matching base portion **113**. Evacuation means (not shown) is connected therewith by conduit means **115** to achieve a predetermined degree of vacuum therein.

A metal vaporizing source or crucible **117** is oriented on the apparatus axis **108** within the chamber **109**, by means not shown, relative to the chamber base portion **113**. The vaporizing crucible **117**, being of a ceramic material such as alumina, is formed to have a bottom portion **119** internally shaped substantially as a cone wherein the evaporable metal **120** is contained in substantially axial orientation to provide a uniform vapor stream from a quasi-point source. Upstanding from the peripheral circumference of the cone-shaped bottom **119** is a substantially cylindrical sidewall portion **121** that opens in an upward direction to form and direct a diverging vapor beam **123** thenceward. Contiguously associated with the crucible **117** is a controlled electrical heating means **125** in the form of a coiled conductor having connective leads **127**, **127'** extending without the chamber **109** to suitable control means, not shown.

Surrounding the crucible **117** is a vapor shield **129** having a top oriented opening or port **131** of a size to permit the vapor beam to project therefrom. Associated with the port of the shield is a movable shutter means **133** positioned relative to the port opening **131** to provide projection control of the vapor beam **123**. The shutter is supported on a movable shaft **135** which permits external control of desired shutter positioning.

A rotatable first pattern mask **137** is spaced within the chamber above the vaporizing source **117** in substantially the path of the vapor beam **123** to initially modify the beam passing therethrough. The first mask pattern **139** is a discretely shaped configurative opening formed in a thin rigid material, such as a metal plate **141**. This plate, in turn, is suitably affixed to a rotatable supporting rim **143** having a circumferentially oriented groove **145** therein to accommodate the driving belt **147** of rotational linkage means **149**. With particular reference to FIGS. **8** and **9**, the first mask pattern is shown to be substantially formed as an altered cardioidal figure having a vertex **151** and a distal point **153** defining the maximum radius *r* from the vertex which is oriented on the apparatus axis **108**. The term "altered cardioidal figure" is intended to include a hybridity of cardioidal and Archimidian spiral figures and modifications thereof. The significance of utilizing this type of figure will be described subsequently.

In the chamber **109**, immediately above the first pattern mask **137** and related thereto is a movable second pattern mask **157** which has a second mask pattern **159** therein formed as a discretely shaped opening markedly differing from the first mask pattern **139**. For example, this second mask pattern **159** is shown as a modified lemniscate configura-

tion. This second pattern mask **157** is suitably supported in a movable shaft **161** which facilitates predeterminate insertion and removal of the second pattern mask into and out of the initially modified vapor beam **123'**. Insertion of this pattern into the beam effects secondary modification of the beam **123'**.

Oriented spacedly above the movable second pattern mask **157**, within the chamber, are adjustable support means **165** fashioned to provide accurate positioning of an optical component or medium **167**, such as a lens or optical plate, to suitably receive the vapor deposition patterns on the under surface **169** thereof.

The distance between the evaporable metal **120** and the under surface **169** of the optical component **167** is shown in FIG. **7** as "$m + n$". The distance n being that between the evaporable metal **120** and the movable second pattern mask **157**, and the distance m being that between the second pattern mask **157** and the surface **169**. It has been found advantageous to locate the second pattern mask at a position whereof n is substantially within the range of substantially 60 to 75 percent of the combined distance "$m + n$" to provide desired feathering transition of the attenuating patterns comprising the composite attenuating coating **57**.

Optical monitoring means **171** are oriented to direct a collimated beam of light into the chamber in a manner to substantially intersect the apparatus axis **108** at the plane of the positioned optical component **167**. In greater detail, the optical monitoring means **171** comprises a source of radiant energy **173**, such as a low voltage helium-neon laser generator capable of continuous operation. The collimated beam of predetermined radiant energy **175** projected therefrom is immediately directed into a timed beam interruptor or chopper **177** which pulses the radiant energy to a modulated beam **175'**, as for example, 330 cycles/second. This pulsed beam is projected through an optical port **181** into the interior of the chamber **109**. Within the chamber are cooperating beam reflective means, such as mirrors **183**, **184**, and **185**, which are angularly and relatedly positioned by individual means, not shown, to direct the modulated beam **175'** in a manner to impinge and traverse the positioned optical component **167** at substantially the axis of the apparatus **108**. The modulated beam after traversing the optical component **167** impinges mirror means **185** and is directed through an exit optical port **187** in the chamber into beam receptor means **189** which is tuned to respond to the frequency of the modulated beam. Since the beam receptor is tuned to a particular frequency, ambient and other extraneous beams of light, such as light from the vaporizing source, are not accepted by the receptor unit. Associated with the receptor means **189** are beam interpretive means **191** for measuring the intensity of the emergent beam after passing through the attenuating coating **57** disposed on the under surface of the optical component **167**.

In accomplishing the coating process, the optical medium **167** such as a lens **55** is positioned on the support means **165** in a manner that the axis of the lens substantially coincides with the axis of the coating apparatus **108**. A portion of suitable evaporable metal **120**, such as the aforementioned Inconel, is placed in the vaporizing crucible **117**, and the shutter **133** closed to initially control the vapor stream and prevent the projection of possible vapor contaminants that may be expelled during the early stages of heating. The hermetic chamber **109** is closed and the evacuation means activated to achieve a vacuum of substantially 10^{-6}Torr, whereupon heating of the crucible **117** is initiated. Rotation of the first pattern mask **137** is started; the speed of rotation is not critical but should be constant. A low r.p.m. is preferred to reduce the possibility of initiating vibrations in the apparatus. The second pattern mask **157** is moved to an off-axis inactive position. When the temperature of the crucible **117** has reached the desired operating level, as for example 1,800°–2,000° centigrade, the shutter **133** is opened and the vapor beam permitted to project to the optical medium **167**. Passage of the vapor beam **123** through the moving configurative opening **139** of the rotating first pattern mask **137** modifies the vapor stream and produces a symmetrical first deposition pattern **87**, **87'** on the optical medium **167** which is illustrated in FIG. **4** as lens **55**.

In FIG. **9**, two related shapings of the first mask pattern **139** and **139'** are shown having breadths b and b' respectively. As positioned in the apparatus **107**, the vertex **151** is oriented on the axis **108**. As the first pattern mask **137** rotates, the distal point **153** of the pattern influences the peripheral deposition on the lens. With reference to FIGS. **4**, **5** and **9**, use of the altered cardioidal mask figure **139** having a breadth b would substantially produce the first coating pattern **87**, **87'** on the lens **55**, the transmission profile of which is shown in FIG. **5**. In contrast therewith, use of a further altered mask figure **139'** representing a smaller opening would result in a profile of decreased slope such as indicated by lines **88**, **88'** in FIG. **5**. Thus, the slope of UV transmission of the first coating pattern is determined by the defined configuration of the pattern in the first rotatable first pattern mask **137**.

Upon opening of the shutter **133**, operation of the optical monitoring means **171** is initiated, and the intensity of the modulated light beam **175'** passing through substantially the axis of the medium **167** (**55**), is received by beam receptor means **189** and interpreted by means **191**. In referring to FIG. **10**, there is shown a progressive light transmission profile **195** of the central portion of the coating disposed on the medium or lens **55**. The monitoring means **171** is previously calibrated at 100 percent transmission when the modulated beam **175'** traverses the uncoated lens medium. Thus, as the coating **57** is disposed on the under surface **169** the light transmission decreases as the evaporation time increases. When the monitoring means **171** indicates the lens to have a central light area transmission within the range of substantially 16 to 20 percent, the second pattern mask **157** is inserted into the modified vapor beam. A preferable point of insertion **197** is shown at approximately 18 percent transmission. This stage of operation is illustrated in FIGS. **7** and **8**. In the embodiment shown, the second pattern mask **157** represents a modified lemniscate configurative opening **159**, but such is not to be considered limiting. In FIG. **5**, the insertion of the second pattern mask is indicated on the transmission profile as indicated at substantially points **199**, **199'**. The evaporation of the metal **120** is continued until the central area light transmission of the optical medium is within the range of substantially 10 to 15 percent. A preferable point of discontinuance **201** is shown at approximately 12 percent transmission, at which time the shutter **133** is closed and the apparatus properly deactivated.

Thus, there is described an improved means and process for achieving a controlled gradient density coating on a light attenuation medium advantageously employed in an optical system for photo-forming a color CRT composite screen structure.

The composite light attenuation coating thus disposed provides discrete control of the exposure illumination to effect substantially constant window sizes for all three colors in annular orientation progressively about the central axis of the CRT screen, and additionally provides a variable gradient of window sizes in a radial direction from center to periphery of the screen structure.

While there have been shown and described what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

1. An apparatus for vapor disposing a light attenuating coating of a controlled gradient density on a substantially transparent optical medium, said apparatus having a vertical axis and comprising:

a hermetic chamber having a dome portion and a base portion capable of being separated therefrom to facilitate access to the interior of said chamber, said chamber having evacuation means connected therewith to achieve a predetermined vacuum therein;

a metal vaporizing source in the form of a crucible positioned on said axis within said chamber and relative to said base portion, said crucible opening in an upward direction to form and direct a diverging vapor beam thenceward, said vaporizing source having controlled heating means associated therewith to vaporize the evaporable metal placed therein;

a rotatable first pattern mask spaced within said chamber above said vaporizing source in substantially the path of said vapor beam to initially modify said beam passing therethrough, said first mask pattern being a discretely shaped configurative opening substantially formed of an altered cardioidal figure having a vertex oriented on said axis and a distal point defining the maximum radius from said vertex;

a movable second pattern mask oriented in said chamber in spaced relationship above said rotatable mask in a manner to facilitate predeterminate insertion and removal of said second pattern mask into and out of said initially modified vapor beam to effect secondary modification of said beam, said second pattern being a discretely shaped elongated opening differing from said first pattern opening;

support means for positioning said optical medium within said chamber at a location spaced above said movable pattern mask; and

optical monitoring means oriented to direct a beam of light into said chamber during evaporation in a manner to substantially intersect the axis of said apparatus at the plane of said positioned optical component.

2. The apparatus for vapor disposing a discrete light attenuating coating on a substantially transparent optical medium according to claim 1 wherein the vaporizing crucible has a bottom portion internally formed substantially in the shape of an open cone with a substantially cylindrical sidewall portion upstanding from the peripheral circumference thereof, said cone shaped bottom providing a substantially quasi-point source of evaporation.

3. The apparatus for vapor disposing a discrete light attenuating coating on a substantially transparent optical medium according to claim 1 wherein the vaporizing crucible is substantially surrounded by a vapor shield having a top oriented opening of a size to permit said vapor beam to project therefrom, said vapor shield having an associated movable shutter means positioned relative to the top opening thereof to provide projection control of said vapor beam.

4. The apparatus for vapor disposing a discrete light attenuating coating on a substantially transparent optical medium according to claim 1 wherein the discretely shaped second pattern opening is substantially formed as a modified lemniscate figure.

5. The apparatus for vapor disposing a discrete light attenuating coating on a substantially transparent optical medium according to claim 1 wherein said movable second pattern mask is positioned within the range of substantially 60 to 75 percent of the distance between the evaporable metal and the surface of the optical medium upon which said coating is disposed.

6. The apparatus for vapor disposing a discrete light attenuating coating on a substantially transparent optical medium according to claim 1 wherein said optical monitoring means comprises a radiant energy source means oriented to project a collimated light beam of predetermined intensity in a manner to impinge and traverse said positioned optical medium at substantially said axis, and beam receptor means being oriented to receive and interpret the intensity of the emergent beam upon passage through said optical medium.

7. The apparatus for vapor disposing a discrete light attenuating coating on a substantially transparent optical medium according to claim 6 wherein the radiant energy source has a timed beam interruptor associated therewith to modulate said collimated light beam, and wherein said beam receptor means is tuned to respond to the frequency of said modulated beam.

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