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Houston

[11] **3,783,298**

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[54] **X-RAY IMAGE INTENSIFIER INPUT PHOSPHOR SCREEN AND METHOD OF MANUFACTURE THEREOF**

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[52] **U.S. Cl.** ..... **250/483,** 250/213 VT, 250/486

[51] **Int. Cl.** **H01j 1/62**

[58] **Field of Search** ..... 250/80, 213 VT, 483, 250/486; 313/92

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Primary Examiner—Archie R. Borchelt
Attorney—John F. Ahern et al.

[57] **ABSTRACT**

The surface of a waffle-like silicone resin and granular phosphor mixture substrate forms an array of cells for the support for the input transparent phosphor screen of an x-ray image intensifier tube. The solid projecting silicone resin-granular phosphor walls substantially reduce degradation of image resolution and contrast due to lateral scattering of light in the transparent phosphor and thereby permits use of a thicker phosphor screen for higher x-ray absorption, and, or higher image resolution. The method of fabricating the phosphor screen includes the intermediate step of forming a rubber replica of a metal master of the waffle surface. The rubber replica is coated with the granular phosphor-silicone resin mixture and a vacuum is drawn between the rubber replica and face plate of the x-ray image intensifier tube for causing adhesion therebetween.

22 Claims, 8 Drawing Figures

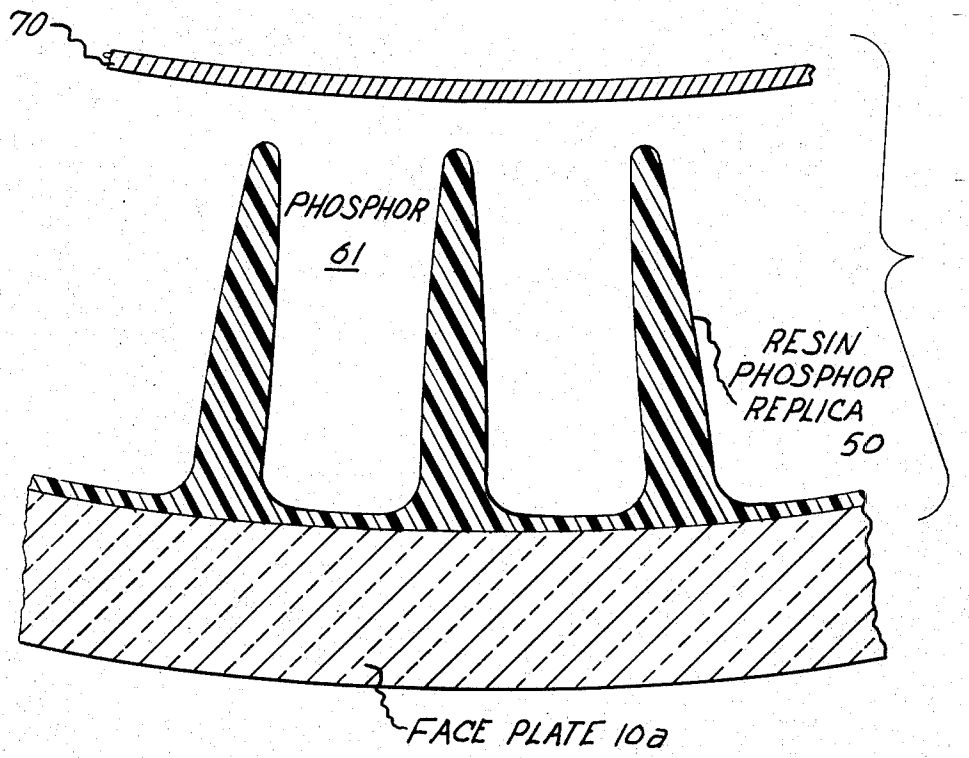
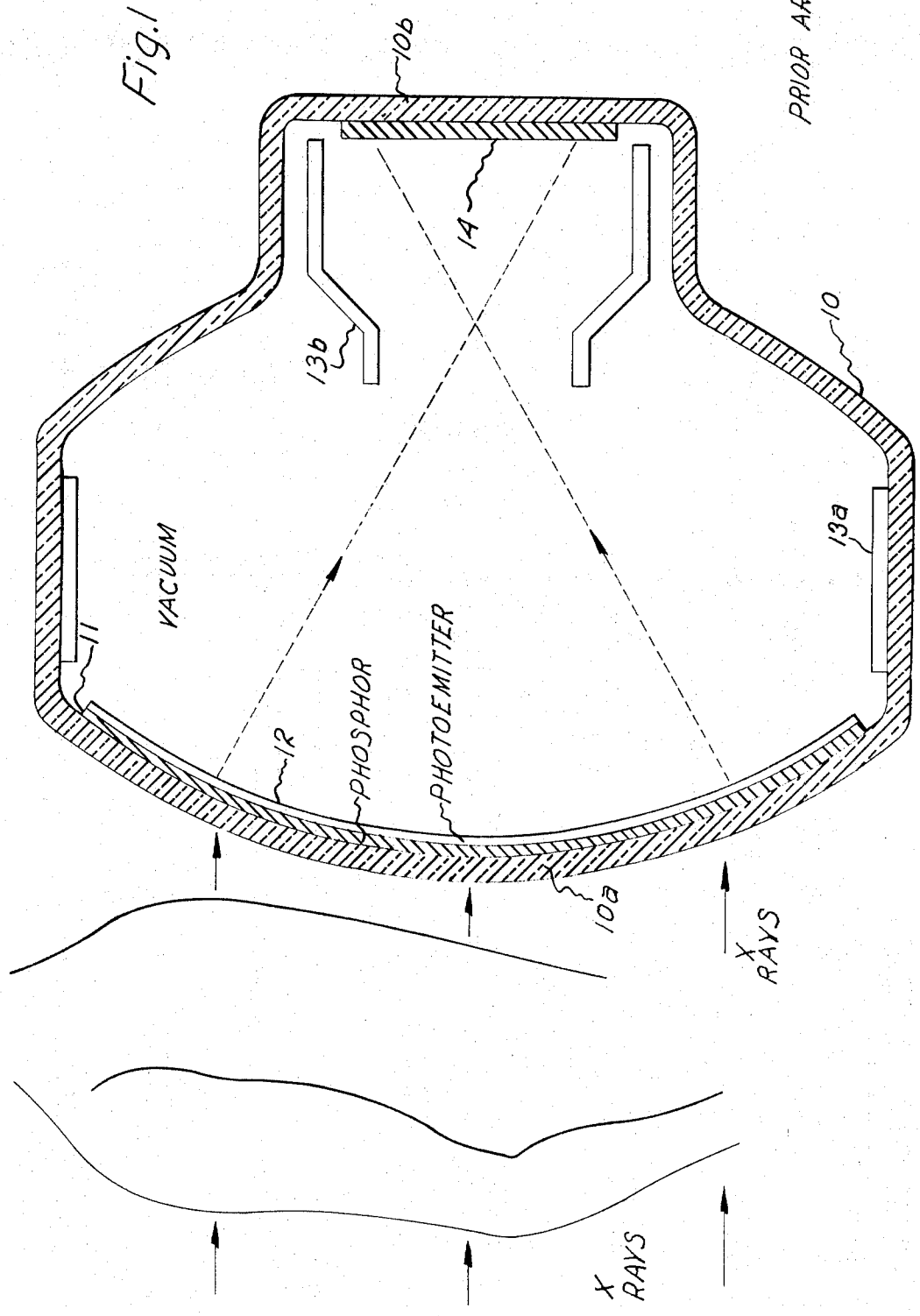


Fig. 1

PRIOR ART



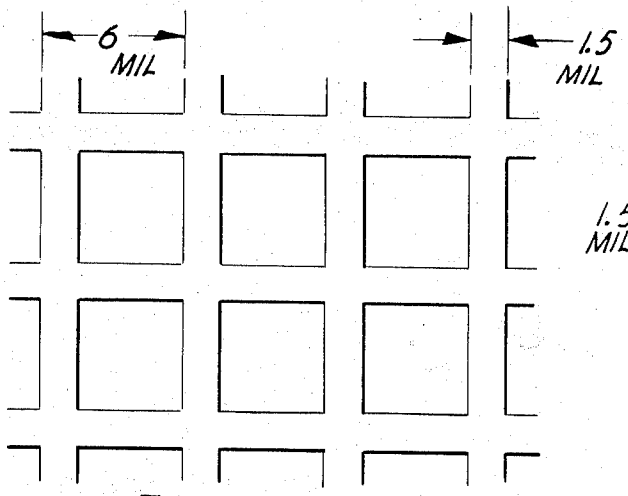


Fig.2a

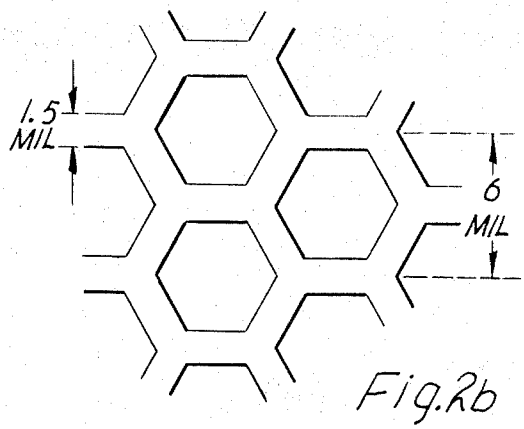


Fig.2b

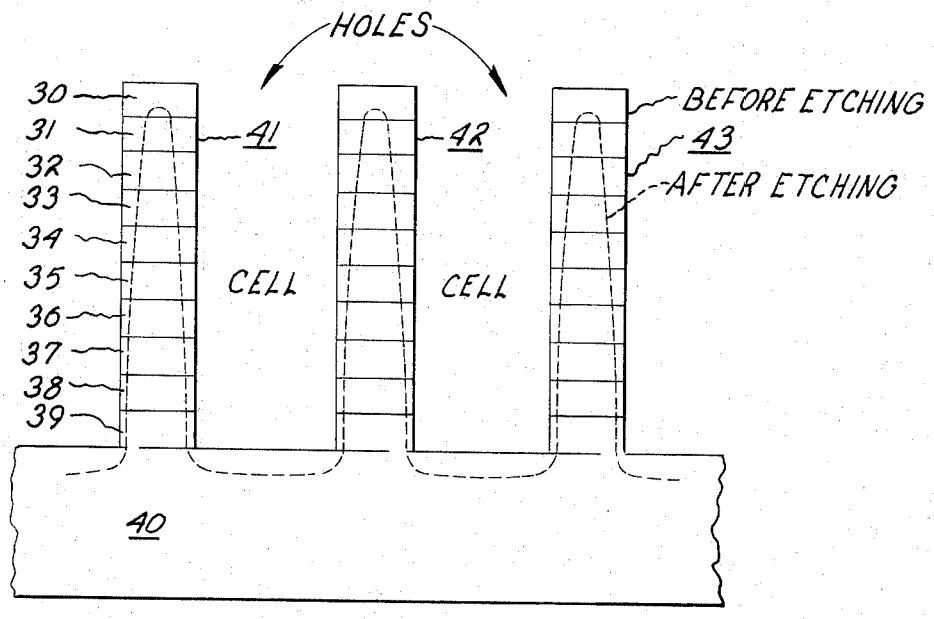


Fig.3

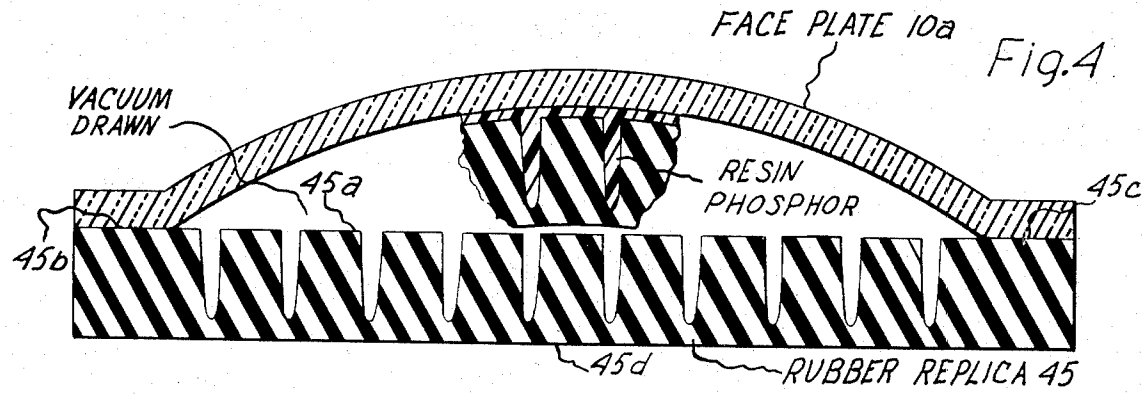

FACE PLATE 10a
VACUUM DRAWN
45a
RESIN PHOSPHOR
45c
45b
45d
RUBBER REPLICA 45

Fig.4

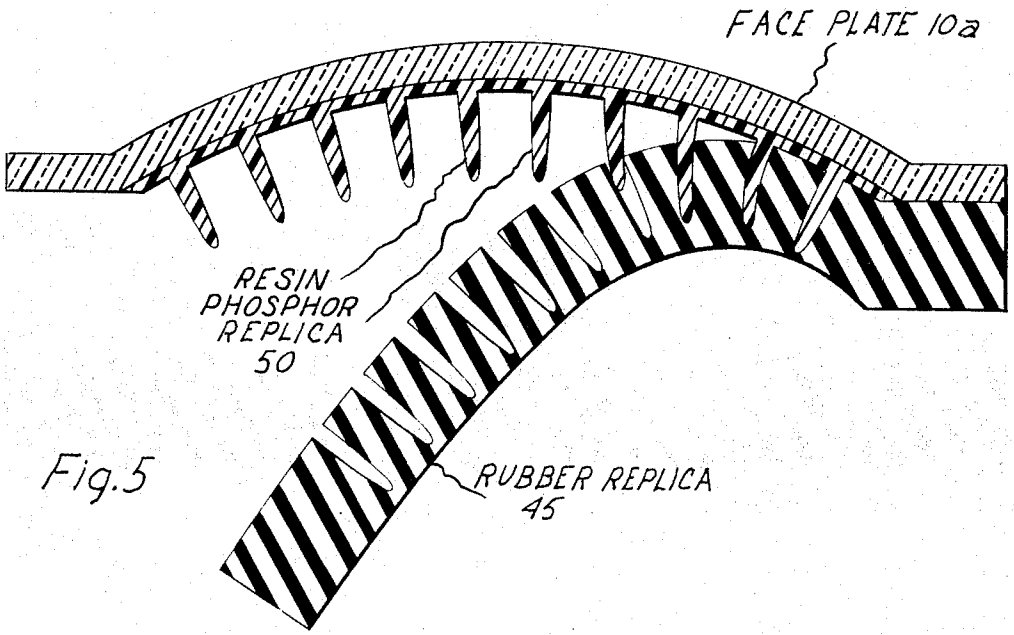

FACE PLATE 10a
RESIN PHOSPHOR REPLICA 50
RUBBER REPLICA 45

Fig.5

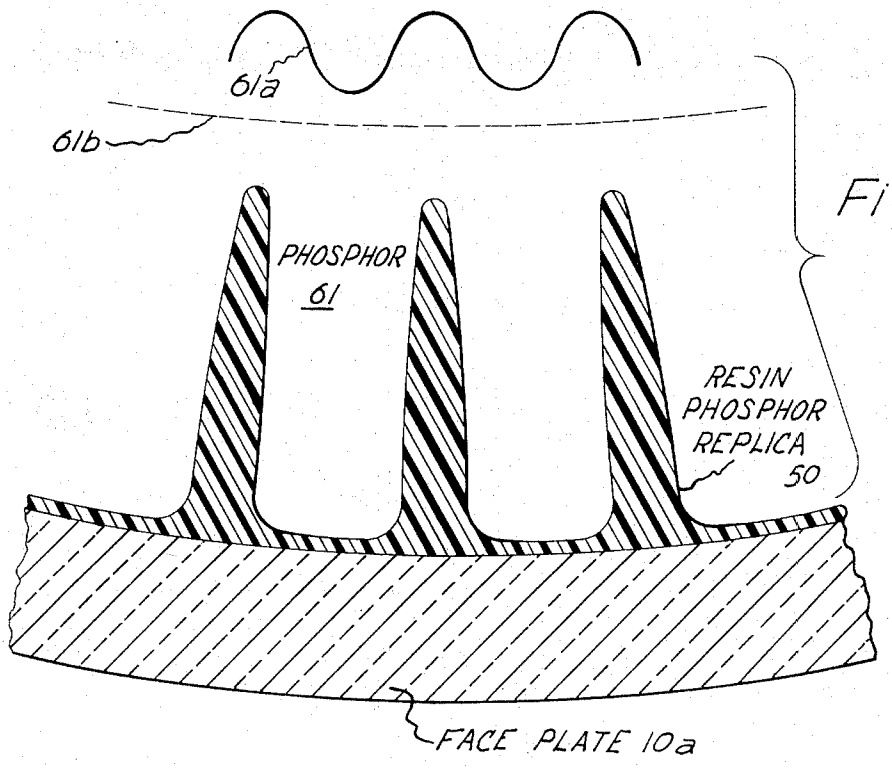

61a
61b
PHOSPHOR
61
RESIN
PHOSPHOR
REPLICA
50
FACE PLATE 10a

Fig.6

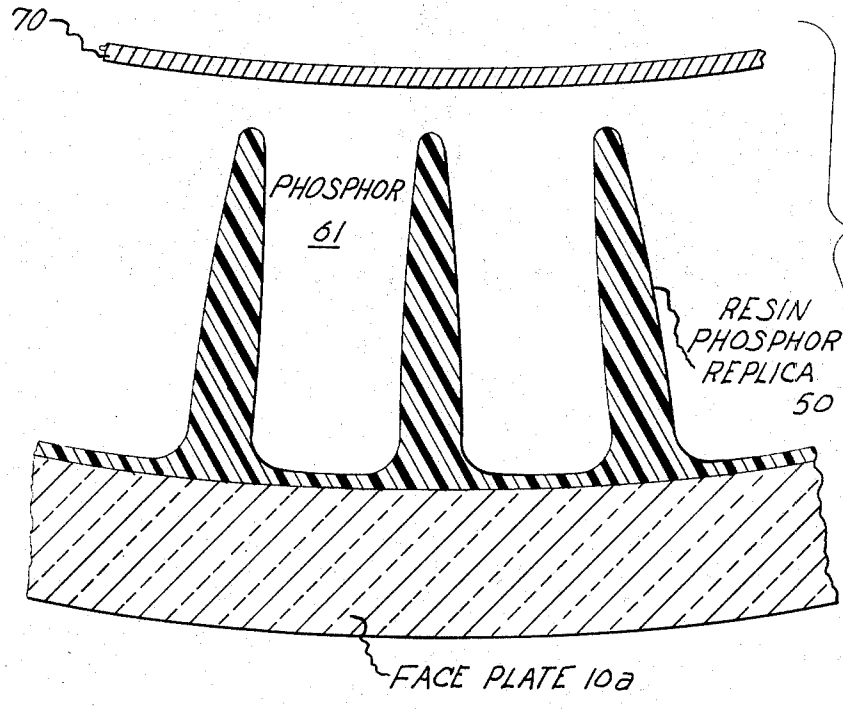

70
PHOSPHOR
61
RESIN
PHOSPHOR
REPLICA
50
FACE PLATE 10a

Fig.7

X-RAY IMAGE INTENSIFIER INPUT PHOSPHOR SCREEN AND METHOD OF MANUFACTURE THEREOF

My invention relates to an x-ray image intensifier tube, and in particular, to the phosphor screen structure at the input end of the tube and method of manufacture thereof.

The x-ray image intensifier tube is especially useful in the medical field for obtaining brighter x-ray images, particularly the images of body organs which generally are of low contrast. Conventional x-ray image intensifiers employ in the input end thereof a uniform layer of a dense high atomic number phosphor for absorbing the incident x-rays which have traversed through a patient's body. The x-ray photon is absorbed in the phosphor layer and light photons in the order of 1,000 light photons for each x-ray photon are generated in the phosphor layer and emitted in all directions from the point of x-ray photon absorption. A thin photoemitting coating deposited on the surface of the phosphor layer emits photoelectrons in response to light photons incident thereon. The photoelectrons are accelerated and electron-optically focussed onto a second phosphor screen at the output end of the image intensifier resulting in a brighter image than at the input phosphor screen.

The thickness of the phosphor layer in conventional image intensifiers is typically 5 to 12 mils and is a compromise between a thick layer necessary for high x-ray absorption and a thin layer necessary for high image resolution (a 12 mil thick layer yields a resolution of 40 to 50 line pairs per inch), resolution and contrast being degraded due to lateral light scattering within the phosphor layer. As a result, the typical 5–12 mil thickness phosphor layer in conventional x-ray image intensifier tubes has a relatively low x-ray absorption in the order of 15 to 40 percent of the incident rays. Obviously, it would be highly desirable to employ a thicker phosphor layer in the input end of the x-ray image intensifier tube to thereby increase the x-ray absorption (and thus the sensitivity) but less loss in resolution and local contrast than occurs in conventional image intensifiers, or alternatively, use a conventional thickness phosphor layer but with increased resolution.

Therefore, one of the principal objects of my invention is to provide a new and improved x-ray image intensifier tube having an input phosphor screen which simultaneously can achieve both high x-ray absorption and high image resolution, and the method of manufacture thereof.

Another object of my invention is to provide a relatively thick input phosphor screen with means to substantially reduce degradation of resolution and local image contrast due to lateral light scattering in the phosphor and the method of manufacture thereof.

A further object of my invention is to provide a low cost fabrication processs for manufacturing the improved input phosphor screen.

Briefly stated, and in accordance with my invention, I provide an x-ray image intensifer input phosphor screen wherein a transparent phosphor layer is deposited in the cells formed by solid wall-like projections on a waffle-like reflective silicone resin-granular phosphor substrate. The cells form an array of equal size squares of hexagons and the transparent phosphor layer extends outward slightly beyond the ends of the resin-phosphor wall projections. The other side of the resin-phosphor substrate is smooth and adhered to the x-ray image intensifier tube face plate which may be formed of glass or a low atomic number metal such as aluminum. The outer surface of the transparent phosphor layer, spaced from the resin-phosphor substrate, is smooth and substantially parallel to the major surface of the face plate and a thin film of a photoemitter material is deposited thereon. The transparent phosphor layer can be relatively thick and thus obtain increased sensitivity and the resin-phosphor cell walls substantially reduce degradation of image resolution and contrast due to lateral scattering of light in the phosphor.

My x-ray image intensifier input phosphor screen is fabricated by the following method. Sheets of metal mesh are formed by photoetching thin metal sheets to produce an array of small holes in the mesh having a square or hexagonal shape. The sheets of metal mesh are superimposed in precise hole alignment and diffusion bonded to a heavy planar metal substrate to thereby obtain a waffle-like surface wherein the wall projections which define an array of cells are each approximately 1.5 to 2 mil wide and the cell width is about 4 to 5 mils. The walls of the cells are then thinned to approximately 1 to 1.5 mil width by chemical etching and this metal substrate having a waffle-like surface is used as a master from which silicone rubber replicas are made. Each silicone rubber replica has the wall indentation surface thereof coated with a mixture of silicone resin and granular phosphor and such coated surface is drawn toward the concave side of the x-ray image intensifier face plate. Upon hardening of the silicone resin, the silicone rubber replica is removed, and the silicone resin-granular phosphor structure has the solid wall-like projections of the metal master and is adhered to the face plate. The array of cells formed by the solid wall projections of the silicone resin-granular phosphor replica are then filled with a transparent phosphor material which extends slightly beyond the ends of the projecting walls and forms a smooth outer surface upon which a thin uniform coating of a photoemitter material is deposited to form the photocathode of the x-ray image intensifier tube.

The features of my invention which I desire to protect herein are pointed out with particularity in the appended claims. This invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawings wherein like parts in each of the several figures are identified by the same reference character, and wherein:

FIG. **1** is an elevation sectional view of a conventional x-ray image intensifier tube;

FIGS. **2***a* and **2***b* are top views of two geometries of an array of cells formed by the waffle-like surface on a metallic substrate utilized in fabricating a master in accordance with my invention;

FIG. **3** is an elevation sectional view of bonded sheets of metal mesh which form the waffle-like surface illustrated in FIGS. **2***a*, **2***b*, but to a larger scale, and also indicates the thinned walls of the cells occurring after a subsequent etching process;

FIG. **4** is an elevation sectional view, to the same scale as FIG. **1**, of a silicone rubber replica of the master illustrated partially in FIG. **3**, retained on the x-ray

image intensifier tube face plate, and a silicone resin-granular phosphor coating on the rubber replica;

FIG. **5** is an elevation sectional view of the silicone resin-granular phosphor replica subsequently formed on the face plate in FIG. **4**, and also shows the silicone rubber replica being peeled from the silicone resin-granular phosphor replica;

FIG. **6** is an elevation sectional view, to a larger scale than FIG. **5**, of the silicone resin-granular phosphor replica formed in FIG. **5**, and a transparent phosphor layer deposited on the replica waffle surface; and

FIG. **7** is an elevation setional view, of the input end structure of my image intensifier tube as shown in FIG. **6** after the transparent phosphor surface has been smoothed and a photoemitter coating deposited thereon.

Referring now in particular to FIG. **1**, there is shown a conventional x-ray image intensifier tube comprised of a glass envelope **10** having an input end (face plate) **10***a* which has a uniform phosphor layer **11** of thickness in the range of 0.005 to 0.012 inch deposited on the inner surface thereof. The phosphor may be zinc cadmium sulfide or cesium iodide as typical materials onto which a thin film **12** of photoemitter material is deposited of thickness of approximately 100 Angstroms. The photo-electrons emitted by the photoemitter coating **12** are focussed by electrode **13***a* maintained at a potential of several hundred volts and are accelerated to approximately 25 kilovolts by mean of electrode **13***b* (connected to a suitable D.C. voltage source) at the output end of the image intensifier tube, the electrodes being suitably shaped to provide electron-optical focussing of the accelerated photoelectrons onto a second uniform phosphor screen (layer) **14** deposited on the inner surface of the glass envelope at the output end **10***b* thereof. The image appearing on the second phosphor screen **14** is a brighter version of the image on the first phosphor screen **11** and can be viewed directly by the physician or be subjected to further processing. The paths of two photoelectrons between the photoemitter coating **12** and the second phosphor screen **14** are indicated by dashed line and arrowheads. As stated hereinabove, the thickness of the input phosphor screen **11** in conventional x-ray image intensifier tubes is a compromise between a thick screen for high x-ray absorption and thin screen for high resolution which is determined primarily by laterial light scatter in the phosphor.

My invention provides a new and improved high resolution x-ray image intensifier input phosphor screen which avoids the compromise between the thick and thin phosphor screen by the use of a waffle-like silicone resin-granular phosphor substrate wherein olid wall projections thereof substantially prevent degradation of resolution and local image contrast due to lateral scattering of light in the phosphor. My invention permits the use of a thicker phosphor screen for achieving higher x-ray absorption without the attendant degradation of resolution and contrast obtained in conventional image intensifiers, or a phosphor screen of conventional thickness but with a significantly higher resolution. The waffle-like silicone resin-granular phosphor substrate is readily achieved by a fabrication process to be described hereinafter which results in consistently equal size solid wall projections defining an array of equal size cells of very small size in the order of 5 mil width.

This invention is distinguished in at least the following five respects from a related invention described and claimed in my concurrently filed patent application Ser. No. 254,100 wherein wall-like projections of a waffle-like substrate are (1) hollow, the entire substrate is (2) a very thin (3) corrugated layer of (4) metal, and (5) requires an additional intermediate step in fabrication to produce a plastic replica on which the final metal replica is formed.

The fabrication process is initiated by selecting sheets of a metal suitable for photoetching such as nickel or stainless steel in the order of 1 or 2 mils thick. This relatively small thickness is chosen since it is easier and more precise to photoetch holes with a depth at least a factor of two smaller than the hole diameter. An identical pattern (array) of holes is etched through each sheet. The etched holes in the metal mesh sheets preferably have a square or hexagonal shape as illustrated in FIGS. **2***a* and **2***b*, respectively, with a center-to-center hole spacing of approximately 6 mils and separation (wall thickness of approximately 1.5 to 2 mil as indicated on the drawing. The holes are of equal size and equally spaced from each other and form an array of identical rows and columns of holes to maximize the hole area in the mesh. Other shape holes, such as triangular or circular could be used, however, such shaped holes produce less open area in the mesh.

Upon completion of the photoetching step, the sheets of metal mesh are superposed in precise hole alignment to form an assembly of approximately 10 mils height as one example, the sheets of metal mesh **30, 31, 32** – – – and **39** being stacked on a heavy planar substrate **40** of the same metal as the mesh and subsequently being diffusion bonded thereto. The approximately 10 mil thick stock of metal mesh is diffusion bonded by bolting the mesh assembly between two massive planes of metal, the upper one of which is thinly coated with an oxide such as MgO to prevent sticking, and is assembly is heated to a suitable temperature (e.g, approximately 1,000°C when bonding nickel or stainless steel) in a hydrogen atmosphere or vacuum to accomplish the diffusion bonding. The diffusion bonding results in a "waffle-like" structure having a surface illustrated by the heavy solid line in FIG. **3** wherein the projecting walls **41, 42, 43** from the surface of substrate **40** are rectangular in the section taken vertically through the projecting walls. The space between the surrounding walls and substrate **40** will be hereinafter described as a cell and it is obvious that the diffusion bonding step results in a plurality of identical walls wherein FIG. **2***a* or FIG. **2***b* represent the top view of the cell structure shown in elevation sectional view in FIG. **3.** The walls **41, 42, 43** of the cells are then thinned to approximately 1 to 1.5 mil thickness by a chemical etching process to produce the master substrate structure indicated by dashed line in FIG. **3.** The thinned walls are substantially thicker than the corresponding thinned walls described in my aforementioned concurrently-filed application Ser. No. 254,100 since the granular phosphor portion of the solid walls in the final structure is both reflective and generates light photons which contribute to the light generated in the adjacent phosphor layer whereas in Ser. No. 254,100 such walls are hollow metallic and merely light-reflective but do not generate their own light.

The array of cells formed by the waffle-like surface of the metal master structure in FIG. **3** after the chemi-

cal etching process could be filled with a phosphor material to form a phosphor screen, however, the process hereinabove described is relatively expensive and in accordance with my invention, I fabricate many inexpensive silicone resin-granular phosphor replicas of such original master whereby the cost per x-ray intensifier tube will be small. Also, at some stage in the process it is necessary to sag the planar surface of substrate **40**, that is, to obtain it in a concave-shape conforming to the shape of the face plate **10***a* of the image intensifier tube.

In order to replicate the master illustrated in FIG. **3**, an intermediate step of making one or more silicone rubber replicas is utilized. The silicone rubber replica is fabricated by vacuum impregnation wherein the master is covered with a layer of liquid silicone rubber (e.g., General Electric RTV–11) to which a small amount of a suitable curing catalyst has been added. The coated master is then placed in a vacuum chamber for a few minutes in order to pump away all air bubbles and insure that the silicone rubber contacts all the crevices of the master. The rubber is then allowed to cure for an appropriate period, e.g., 2 hours, in order to form an elastic, rubbery solid. The silicon rubber replica is approximately 50 mils thick in order to remain somewhat flexible so that it can be subsequently easily removed by peeling from the silicone resin-granular phosphor replica to be described hereinafter.

Referring now to FIG. **4**, the wall indented side **45***a* of the silicone rubber replica **45** is substantially uniformly coated with a mixture of a silicone resin and a light colored (preferably white) granular phosphor such as silver-activated zinc cadmium sulfide or terbrium-activated gadolinium oxysulfide. The phosphor is of small grain size to obtain increased light scattering and light reflection characteristics, small grain size being defined herein as particle diameter less than 0.1 mil. The mixture is in the ratio of 3 to 7 parts phosphor to one part resin by weight. Silicone resin is selected as an organic binding agent which has the useful properties of withstanding a baking temperature of approximately 250°C and having an index of refraction intermediate the indices of a white grandular phosphor and vacuum. The resin-phosphor mixture is worked into the 1–1.5 mil indentations of the rubber replica **45**. The face plate **10***a* of the image intensifier tube is then placed over the rubber replica **45**, positioned in its proper orientation, and the two margins **45***b*, *c* along the wall indented side **45***a* of the rubber replica are suitably retained against corresponding planar margins of the concave face plate **10***a*. The entire assembly is then placed within a chamber wherein a vacuum is drawn between the rubber replica **45** and face plate **10***a* thereby pressing the rubber replica toward the concave face plate (as shown in part) to produce a silicone resin-granular phosphor replica **46** of the FIG. **3** master waffle-like surface except that the resin-phosphor replica **46** is curved into the concave shape of the image intensifier tube face plate **10***a* rather than being planar. The resin-phosphor coated rubber replica and face plate assembly is then baked at approximately 250°C to harden the silicone resin.

Upon hardening of the silicone resin, the silicone rubber replica **45** is removed therefrom by peeling it from the resin-phosphor replica **46** as shown in FIG. **5**, and the resin-phosphor replica and face plate assembly is additionally air baked at 300°C and then vacuum baked at 280°C to outgas and cure the silicone resin. The rubber replica may be reused to form additional resin-phosphor replicas. The face plate **10***a* is fabricated of glass or a low atomic number metal such as aluminum.

After the final silicone resin baking step, the resulting structure consists of the silicone resin-granular phosphor replica adhered to the concave side of the image intensifier face plate **10***a* as illustrated in FIG. **6** wherein the solid wall projections of the resin-phosphor replica **46** extend normal to the surface of face plate **10***a*. The thickness of the base portion of the resin-phosphor replica is not critical and is generally in a range of 1 to 3 mils. The array of cells formed by the resin-phosphor replica waffle-like surface are filled with a suitable transparent phosphor material using conventional techniques, the phosphor layer **61** extending beyond the ends of the wall projections of the resin-phosphor replica **46**. The phosphor **61** can be evaporated cesium iodiode (CsI) phosphor as one typical example. Evaporation of the CsI from vertically above the resin-phosphor replica **46** results in the outer surface of the phosphor layer **61** having the undulating form **61***a* shown in FIG. **6** due to the projecting walls of the resin-phosphor replica. The uneven surface **61***a* of the phosphor outer surface is mechanically polished in a dry box, since CsI is a relatively soft material, to obtain the smooth surface **61***b* shown in dashed line. If the undulations are not so severe as to upset either the electron-optics or the formation, and, or surface resisitivity of the photocathode (to be described hereinafter), then it may not be necessary to smooth out such undulations. The phosphor layer **61** is approximately **12** mils thick as on typical example, and obviously can be made thicker if higher x-ray absorption is desired.

Referring now to FIG. **7**, a thin uniform coating of a suitable photoemitter material **70** is deposited on the smooth surface **16***b* of the phosphor layer **61** during the evacuation of the image intensifier tube to form the photocathode of such image intensifier tube. The photoemitter material may be of the common types known as S–20 (a compound of antimony, cesium, sodium and potassium) or S–11 (a compound of cesium, antimony and oxygen) as two typical examples and is a very thin coating in the order of 100 Angstroms. If desired, an isolating layer of transparent alumina, as one example, may be deposited between the phosphor **61** and photoemitter **70** layers in order to isolate the alkali metal of the photoemitter material from the phosphor, however, such isolating layer is not essential to the successful operation of my input phosphor screen.

The wall-like projections of the resin-phosphor replica **46** extend normally through at least 50 percent of the phosphor layer **61** thickness, and as shown in FIGS. **6** and **7**, typically extend through approximately 80 percent of the phosphor layer. The effect of the relatively highly light-reflective wall projections is to substantially reduce lateral scattering of light in the phosphor layer **61** and thereby substantially reduce degradation of image resolution and contrast due to such cause. Obviously, the metal master can be made with more sheets of the metal mesh to thereby obtain a resin-phosphor replica having wall projections of greater height whereby a thicker phosphor layer **61** can be utilized for increased x-ray absorption, and thus increased sensitivity, or, the same thickness phosphor layer can

be used and the further extending wall projections further improve the resolution. It should also be noted that the base portion of the resin-phosphor replica (i.e., the floor portion of each cell which interconnects the solid wall projections), being fabricated of a light-reflective material, provides a means for reflecting light photons which are originally emitted toward the face plate **10**a, back toward the photoemitter layer **70.** Thus, a separate light-reflective coating between the face-plate **10***a* and phosphor layer **61** is not required in my invention, although it is generally utilized in conventional x-ray image intensifiers.

From the foregoing description, it is apparent that my invention attains the objectives set forth and makes available a new and improved x-ray image intensifier tube which has an input phosphor screen that simultaneously achieves both high x-ray absorption (and thus high sensitivity) and high image resolution as well as providing a method of manufacturing such input phosphor screen. The method of manufacturing the input phosphor screen is a low cost fabrication process due to the use of a silicone rubber replica which permits fabrication of many inexpensive silicone resin-granular phosphor replicas of the original master. The light-reflective solid projecting walls of the resin-phosphor replica prevent degradation of image resolution and local image contrast due to lateral scattering of light in the phosphor layer and thereby avoid phosphor layer thickness compromise in conventional x-ray image intensifier tubes between high x-ray absorption and high image resolution. It will be apparent to those skilled in the art that the waffle-like surface on the resin-phosphor replica which constitutes the essence of my invention may take other forms than that specifically illustrated and described above. Also, the support for the input phosphor screen, herein described as the face plate, may be slightly spaced from the input window of the tube glass envelope. Thus, it is to be understood that changes may be made in the particular embodiment of my invention as described which are within the full intended scope of the invention as defined by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An improved x-ray image intensifier input phosphor screen comprising

a concave-shaped face plate of uniform thickness forming a support for the input phosphor screen of an x-ray intensifier tube,

a silicone resin-granular phosphor substrate member having solid wall-like projections forming a waffle-like surface on a first major side thereof, a second major side of said substrate member being a smooth surface parallel to the inner surface of said face plate and connected thereto,

a transparent phosphor layer deposited in cells formed by the waffle-like surface on the first side of said substrate member and being of sufficient thickness to extend slightly beyond the outer ends of the wall-like projections thereof to form a second surface concave-shaped and substantially parallel to the inner surface of said face plate, and

means deposited on the second surface of said phosphor layer for producing emission of photoelectrons therefrom in response to x-ray photons passing through said face plate and being converted to light photons in the phosphor layer, the wall-like projections also converting primary x-rays absorbed therein into light photons which contribute to the overall efficiency of said input phosphor screen, the wall-like projections substantially reducing degradation of image resolution and local image contrast due to lateral scattering of the light in the phosphor layer thereby permitting use of a thicker phosphor layer for higher x-ray absorption and resultant higher sensitivity and, or for obtaining higher image resolution.

2. The x-ray image intensifier input phosphor screen set forth in claim **1** wherein

the first side of said substrate member having floor portions interconnecting the wall-like projections to define the waffle-like surface, the floor portions being parallel to the second side.

3. The x-ray image intensifier input phosphor screen set forth in claim **2** wherein

the substrate member floor portions are of uniform thickness in the range of 1 to 3 mils.

4. The x-ray image intensifier input phosphor screen set forth in claim **2** wherein

the wall-like projections of the substrate member are of thickness in the range of approximately 1 to 1.5 mils.

5. The x-ray image intensifier input phosphor screen set forth in claim **1** wherein

the inner surface of said face plate is connected to the second side of said substrate member by means of adherence with the silicone resin thereof for bonding the adjoining surfaces.

6. The x-ray image intensifier input phosphor screen set forth in claim **1** wherein

said face plate is fabricated of aluminum.

7. The x-ray image intensifier input phosphor screen set forth in claim **1** wherein

said face plate is fabricated of glass.

8. The x-ray image intensifier input phosphor screen set forth in claim **1** wherein

said face plate is fabricated of a low atomic number metal.

9. The x-ray image intensifier input phosphor screen set forth in claim **1** wherein

said phosphor layer comprising cesium iodide.

10. The x-ray image intensifier input phosphor screen set forth in claim **1** wherein

said phosphor layer comprises a transparent phosphor material.

11. The x-ray image intensifier input phosphor screen set forth in claim **1** wherein

the granular phosphor of said silicone resin-granular phosphor substrate member is of small grain size of particle diameter less than 0.1 mil to obtain increased light scattering and light reflection characteristics.

12. The x-ray image intensifier input phosphor screen set forth in claim **2** wherein

the floor portions on the first side of said substrate member each being square shaped.

13. The x-ray image intensifier input phosphor screen set forth in claim **2** wherein

the floor portions on the first side of said substrate member form equal size squares separated by equal size said wall-like projections.

14. The x-ray image intensifier input phosphor screen set forth in claim **2** wherein

the floor portions on the first side of said substrate member each being hexagon shaped.

15. The x-ray image intensifier input phosphor screen set forth in claim **2** wherein

the floor portions on the first side of said substrate member form equal size hexagons separated by equal size said wall-like projections.

16. The x-ray image intensifier input phosphor screen set forth in claim **1** wherein

the wall-like projections of said substrate member extending normal to the inner surface of said face plate and outward in a direction away therefrom.

17. The x-ray image intensifier input phosphor screen set forth in claim **16** wherein

the wall-like projections each extend outward approximately 10 mils.

18. The x-ray image intensifier input phosphor screen set forth in claim **16** wherein

the wall-like projections each have a thickness dimension of approximately 1 to 1.5 mils.

19. The x-ray image intensifier input phosphor screen set forth in claim **2** wherein

the floor portions on the first side of said substrate member each have a width dimension of approximately 4 to 6 mils.

20. The x-ray image intensifier input phosphor screen set forth in claim **15** wherein

the hexagon shaped floor portions each having a width dimension of approximately 4 to 6 mils.

21. The x-ray image intensifier input phosphor screen set forth in claim **1** wherein

the wall-like projections of said substrate member extend into the phosphor layer at least halfway therethrough.

22. The x-ray image intensifier input phosphor screen set forth in claim **1** wherein

the wall-like projections of said substrate member extending through approximately 80 percent of the phosphor layer, and having a relatively high light reflectivity for directing the light photons generated in the phosphor layer toward the photoelectron producing means.

* * * * *