

Aug. 9, 1966

E. BERGER ETAL

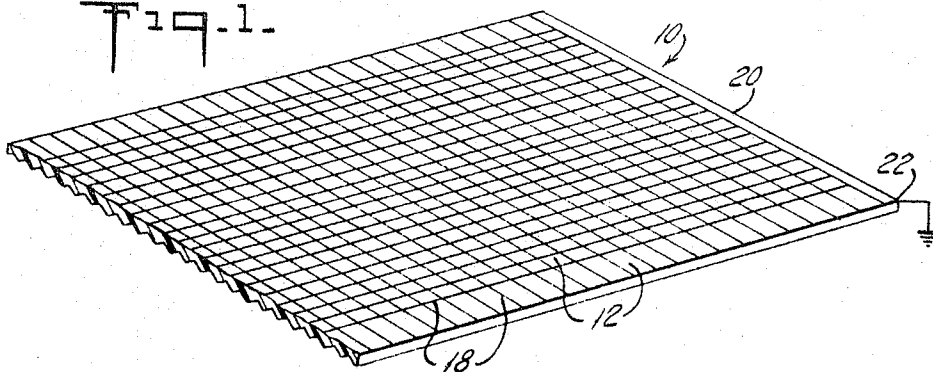
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RADIATION SHIELDING LIGHT TRANSMITTER

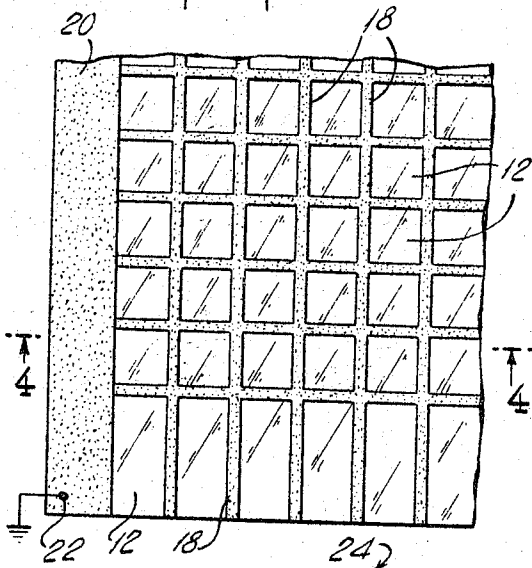
Original Filed Oct. 14, 1964

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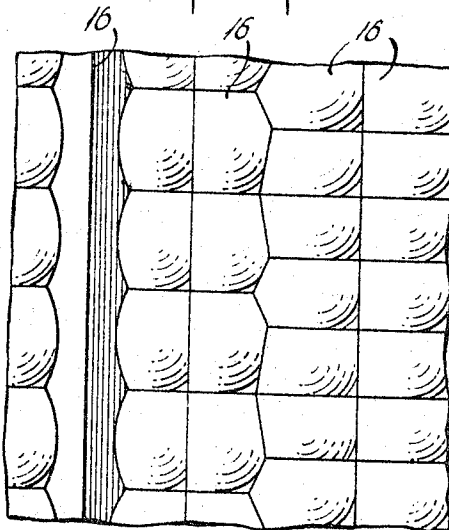
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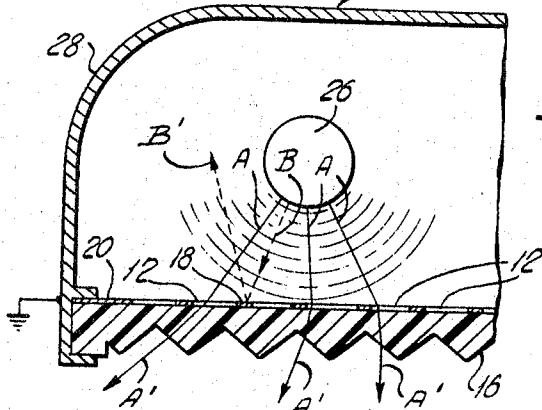
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T19-3.



T19-4.



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Fig. 5.

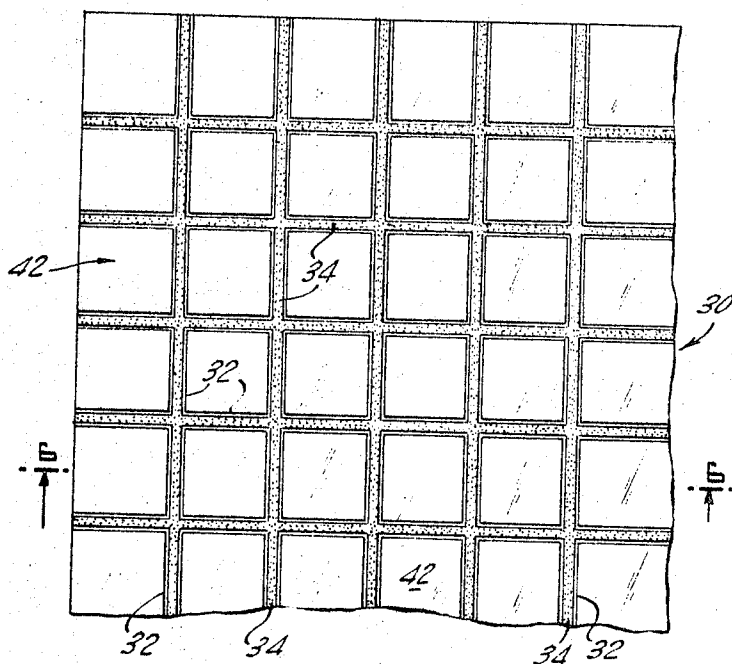


Fig. 6.

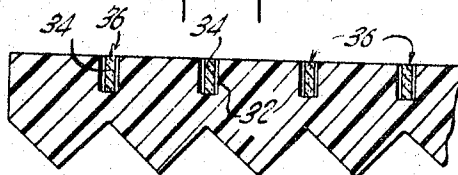


Fig. 6a.

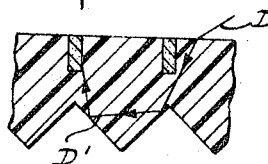
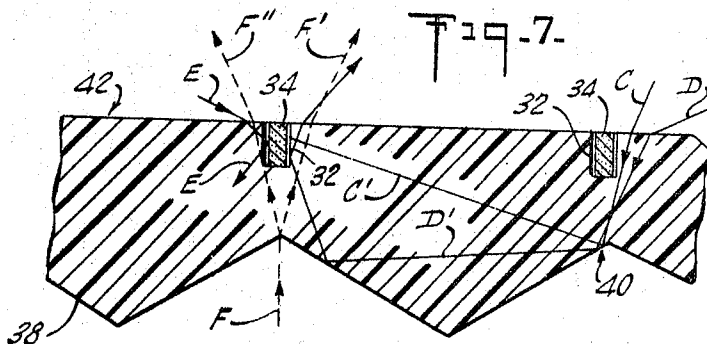


Fig. 7.



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**RADIATION SHIELDING LIGHT TRANSMITTER**  
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Ohio, assignors to Holophane Company, Inc., New  
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Continuation of application Ser. No. 403,806, Oct. 14,  
1964. This application Oct. 27, 1965, Ser. No. 511,561  
4 Claims. (Cl. 174-35)

This is a continuation of application Serial No. 403,806, filed October 14, 1964, now abandoned.

This invention relates to radio frequency shielding light transmitting elements for luminaires having fluorescent tube light sources.

Flourescent lamps are known to generate and radiate energy in the radio frequency (RF) spectrum, and sensitive electronic equipment located within a given radius of a fluorescent lamp is seriously affected by such radiation. Such effects create pronounced difficulties in radio reception and transmission, electronic testing or measuring laboratories, medical electrocardiograph or electroencephalograph installations, recording installations, radio and high fidelity equipment stores, and generally, whenever electronic equipment is used.

In the prior art such difficulties have been avoided by specifying incandescent lighting in locations of the aforementioned type. With a realization that the operating and cost advantages of fluorescent lighting would make it advantageous compared to incandescent lighting, efforts were made to develop means to enable the use of fluorescent lighting in locations where it has not been possible heretofore. United States Letters Patent No. 3,030,435, issued on April 17, 1962, is one result of such efforts, teaching the use of a conductive wire mesh embedded within a plastic light-transmissive panel. While the mesh-embedded panel of the above patent accomplishes the RF shielding function, this construction presents other difficulties when it is desired that the light-transmissive panel be provided with illumination-controlling elements, such as shown in United States Letters Patent No. 2,474,317. The insertion of a wire screen within the panel causes the wire to act in some instances as an additional optical element, the wire acting as a reflector, reflecting light back to the light-incident surface of the panel where it becomes reflected again or transmitted. Thus, embedded mesh causes spurious reflections and transmissions and causes light to be ultimately emitted from the panel at improper and/or glare angles.

A further and coincidental problem of light-transmitting elements which have prismatically formed light emergent surfaces is that although the prisms are effective to "cut-off" light which would otherwise be emitted at glare angles, still, when viewed at certain angles the light is still far too bright and still produces undesirable glare. Such light-transmitting elements conventionally have a flat light-incident surface with the opposed light-emissive surface made up of a plurality of identical intersecting pointed projections which may, for example, have the configuration of cones, pyramids, or the like. The light which reaches the light-incident surface will pass into the light-transmitting element and some of this light will engage the projections at directions which allow part of the light to be reflected within the lens, as is desired, but eventually to be reflected out of the prisms at glare angles. The greater part of such light is initially reflected by the prism surfaces back up to the flat light-incident surface where it is then reflected down onto another projection where a part of the light is refracted out at an undesirable angle and the remainder is internally reflected. This continues for several inches through the light-transmitting element until eventually these rays are all emitted or absorbed by the light-transmitting element. This action

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of the light is what makes the light-transmitting element brighter than desired in the normal viewing angles, or in the so called glare angle zone of 60° to 90° from nadir.

It is an object of the invention to provide an RF shielding light-transmissive element for a luminaire, the element having light-controlling formations thereon.

It is another object of the invention to provide an RF shielding light-transmissive element for a luminaire, which is simple to manufacture and does not require the installation of new processes or new machinery for the manufacture of the basic element.

A further object of the invention is to provide a light-transmissive element which will eliminate objectionable glare of the type referred to above.

It is an object of the invention to provide optical structures and RF shielding structures for overcoming the problems attending and the disadvantages of the prior art approaches to the "glare" and RF shielding problems discussed. This object includes the concept of providing such structures which are not only compatible with one another, but which perform both glare and RF shielding functions simultaneously.

Accordingly, a light-transmissive element of the invention has a flat, smooth light incident surface, and light modifying formations, such as prisms, cones, or the like on its light emissive surface.

The light-incident side of the light-transmissive element is, according to one embodiment of the invention, covered with a conductive gridwork. The element is also provided with a heavy conductive line on one of its sides, electrically joining all the terminations of the grid lines on that side, thus providing a convenient area on the element for making electrical contact for such purposes as grounding.

By having the conductive gridwork on the flat, light-incident surface of the light-transmissive element, it will not interfere with the light passing through the transmitter nor with the functions of the light-controlling elements on the light emergent surface. The conductive gridwork is electrically connected by means of pressure contact or the like with the heavy, conductive line to the grounded metallic housing of the luminaire, or in the alternative, the heavy conductive line may be grounded by a separate grounding lead.

Another advantage of a light-transmissive element provided with a conductive gridwork as just described is that the invention is applicable not only to plastic lenses as in the case where the wire mesh is embedded, but also to glass or other types of light transmitters, because the transmitter can be manufactured by any desired process, the shielding gridwork being deposited thereon subsequently.

According to another embodiment of the invention, and with particular reference to the "glare" problem, the light-transmitting element is formed with a network of grooves extending into the element from its flat, light-incident surface. The sides of these grooves act to reflect near-vertical entering, or internally reflected, light by changing its direction of travel, but otherwise not changing its normal emergent angle.

The grooves may contain an opaque or semi-transparent material, preferably out of optical contact with the groove sides, and, which will absorb the light which is internally reflected at angles at which the groove sides would not perform the reflecting function. Preferably the material in the grooves is, at its upper surface, substantially flush with the light-incident surface of the light-transmitting element.

The grooves are aligned with the valleys defined between the pointed projections at the light-emissive surface of the light-transmitting element so that when viewed

from directly below the grooves and the material, when used, are invisible. In addition the material in the grooves may be colored, such as a pleasant shade of blue, which can be seen when viewed at diagonal angles. Although other colors may be used, blue is preferred because it is restful and pleasing to the eye.

Where simultaneous RF shielding and the redirection and absorption of internally reflected light are desired, the groove material must be electrically conductive and can be electrically connected with a conductor at the light-incident surface which may be grounded, for example, to the metallic housing of the luminaire. In this way, the grooves not only reduce glare from near-horizontal light-rays, but in addition the material in the grooves shields against radio frequency radiation.

Further features and advantages of the invention are to be described in the following detailed disclosure, with reference being had to the appended drawings, wherein:

FIG. 1 is a perspective view of the fragment of a light-transmissive element, in accordance with the invention;

FIG. 2 is a fragmentary plan view of a corner of the element shown in FIG. 1;

FIG. 3 is a fragmentary bottom plan view of the element shown in FIG. 1;

FIG. 4 is a fractionary cross-sectional view of the element shown in FIG. 1 mounted in a luminaire having a fluorescent tube therein;

FIG. 5 is a fragmentary top plan view of another embodiment of a light-transmitting element according to the invention;

FIG. 6 is a transverse sectional view of the light-transmitting element of FIG. 5 taken along line 6—6 of FIG. 5 in the direction of the arrows;

FIG. 6a is a transverse sectional view of a light-transmitting element in accordance with the invention, but modified in the manner of utilizing the groove material; and

FIG. 7 shows part of the structure of FIG. 6 on an enlarged scale and illustrates how the structure of this embodiment is capable of shielding against undesirable light-ray radiations.

Referring now to the figures, the light-transmissive element 10 is shown having a light-incident surface 12, and a light-emissive surface 14. The light-emissive surface 14 is provided with light-controlling cone formations 16 for cutting off high angles of light.

Disposed on the light-incident surface 12 are a plurality of grid members 18 of an electrically conductive material, such as conductive silver or the like. The elements 18 criss-cross each other, and are of a thickness small enough to allow passage of the bulk of the light incident upon the surface.

The grid members 18 are in electrical contact with each other at their crossing points. The ends of the grid members 18, adjacent the edges of the element 10, are electrically connected on one or more sides of the element by a conducting member 20 which is grounded as at 22. The grid elements 18 and the conducting member 20 may be deposited on the light-incident surface 12 by any known means such as silk screening, painting, spraying, decalomania, or the like. The conducting element 20 is grounded at one or more points 22.

In FIG. 4 a luminaire 24 is shown with a fluorescent lamp 26 within a luminaire housing 28. The lamp emits light rays A and B and simultaneous RF radiation indicated by broken lines.

Light rays A, which are shown to impinge upon the light-incident surface 12 between the conducting grid members 18, pass into the interior of the element 10, while light ray B impinging upon the grid elements 18, is reflected upwardly. The RF radiation indicated by the broken lines is attenuated by the conductive grid elements, grounded through the point 22, so that only visible radiation is transmitted through the element 10 in the form of the light rays A' guided into useful directions by

means of the light-controlling formations 16 on the light-emissive surface 14 of the element.

A further factor determining the size and also the spacing of the criss-crossing grid elements 18 depends on the RF bands emitted by the fluorescent lamp, and the particular frequency desired to be attenuated by the conductive pattern.

Referring now to FIGS. 5-7, a light-transmitting element 30 is shown which may be identical at its outer periphery with the light-transmitting element 10 of FIGS. 1-4 and which may be mounted in a very same way in a housing 24 of a luminaire so as to receive light from a source such as the fluorescent lamp shown in FIG. 4. However, the light-transmitting element 30 is formed at its light-incident surface 42 with a plurality of grooves 32 which extend into the element 30 for a considerable substantial depth, as is apparent in FIGS. 6 and 7, and within the grooves 32 is located a light reflective and electrically conductive material 34 having a relatively low reflection factor, which will not only shield against radio frequency radiation but which will also shield against light-ray radiation at angles which otherwise would produce undesirable glare. All rays which are reflected from the sides of the grooves merely have their direction altered from right to left or vice versa. Such direction change does not affect the overall function of the lens panel. Rays which strike the sides of the grooves in near-horizontal directions, however, are not reflected, but are transmitted through the sides and if no material is placed in the grooves, this light continues on unaltered in direction. This is the light which ultimately is emitted, bit by bit, into glare angles and is therefore undesirable. By placing into the grooves some material which absorbs part or all of the near-horizontal rays, the glare angle light is reduced or eliminated.

The light-transmitting element 30 has material 34 located in the grooves 32 in such a way that the material 34 has, at the transmitter's light-incident surface 42, an upper surface 36 which forms a grid as shown in FIG. 5, and this grid is, as is the grid in FIGS. 1-4, flush with the light-incident surface 42 and at this surface is flat and in the form of elongated narrow intersecting bands.

The element 30 has light-controlling elements 38 at its light-emergent surface, and these elements 38 may be in the form of substantially conical projections similar to the projections 16 shown in FIGS. 3 and 4, or these projections 38 may have the configuration of pyramids. In any event, the pointed projections 38, which form the light-controlling elements, are all identical and intersect each other to form between themselves elongated intersecting rows of valleys 40, in the same way as the projections 16 of FIGS. 3 and 4, and the grid of grooves 32 is aligned with the intersecting valleys. The valleys 40 thus are in alignment with and located directly beneath the grid of grooves 32 and thus beneath the network of material 34 which has its upper surface 36 flush with the light-incident surface 42 of the element 30.

Referring to FIG. 7, light rays such as the rays C and D enter into the material of the light-transmitting element 30, which may be made of glass, plastic, or the like, at such an angle that when they strike a surface of a projection 38, they will be directed either to an opposite surface of the same projection, as ray D', or directly back up to the light-incident surface 42, as ray C'.

Thus, it will be seen that the ray D, D', D'' of FIG. 7 will strike the surfaces of the projection 38 which then reflects upwardly at a relatively sharp angle back toward the light-incident surface 42. On the other hand, ray C, C' extends from its initial reflection with the projection 38 at a relatively flat angle back toward the surface 42. A ray such as the ray C which misses the opposed surface of the pointed projection would ordinarily continue on to be reflected again internally by the incident surface 42. Such twice reflected light generally strikes the pro-

jections at the light-emergent surface again, but in directions which allow part of the light to be refracted out of the projection at glare angles. Even so, the greater part of such light is again reflected up to the surface 42 and down to another pointed projection where again a small part is refracted out at a high angle and a remainder is again internally reflected. This action continues for several inches through the light-transmitting lens until eventually the rays are all emitted or absorbed by the lens. Such behavior of the light makes the light-transmitting lens brighter than desired in the normal viewing angles, or in the so-called glare angle zone of 60° to 90° from nadir.

The structure of FIGS. 5-7 will reduce this objectionable light considerably by the presence of the grid of grooves of the invention. The material 34 in the grooves of FIGS. 5, 6 and 7, is an opaque material which does not make optical contact with the sides of the grooves. With this construction, near-horizontal rays such as the rays of the type indicated at C' will be intercepted and absorbed in part or entirely by the material. Other rays, such as the rays D, D', D'' which normally are reflected upwardly into the fixture and E-E' which are normally refracted or reflected in useful directions, merely have their direction changed when reflected by the groove as shown at D'' and as at E'.

Inasmuch as the grid follows the pattern made by the valleys of the pointed projections, when viewing the light-transmitting lens from directly below, the grid is obscured by the refracting action of the pointed projections, shown by the viewing lines F-F'-F''.

As shown in FIGS. 5, 6 and 7, the material 34 which fills the grooves 32 is relatively rigid network of opaque bars, set into the grooves. Where the material is to be transparent or semi-transparent, it can be composed of granular material suitably bonded and can be provided with a color, as pointed out above, so that when viewed from diagonal angles, a pleasant shade will appear to the eye of the observer. A very pleasing color is blue.

When transparent or semi-transparent material is used, it is best to provide for shrinkage of the material depositing it in the grooves so that it will be, for the most part, out of optical contact with the groove sides and this permits the groove to perform the above functions. In the case of optical contact of the groove and groove material, as shown in the modification of FIG. 6a, rays such as D' would be absorbed in the material. Of course, some contact of the material with the sides should be permitted in any case so as to ensure stability of the material in the groove.

Moreover, it is not essential that the pointed projections 38 of conical or pyramidal configuration be formed as extending outwardly of the light-emergent surface. For example, the bottom surface of the light-transmitting element 30 can be provided with conical or pyramidal depressions which extend onto the element from its bottom surface. In such an instance, the sides of these depressions are the light-controlling, prismatic portions similar to the light-emergent sides of projections 38.

Where granulated material is used, it may be composed of particles of silver or other electrically conductive material. Thus, by making the material 34, and the grooves 32 not only opaque or semi-transparent, so that it will absorb light-ray radiation which otherwise would produce objectionable glare, but also electrically conductive by using a material such as silver or any other similarly electrically conductive material, this material 34 can also act as a shield for radio frequency radiation in the same way as the grid of FIGS. 1-4, and thus it is possible to provide, with the single structure shown in FIGS. 5-7, not only shielding of radio frequency radiation

but also of light-ray radiation at angles which would produce objectionable glare. Of course, it is this latter construction which is preferred, namely the construction where the material 34 in the grooves 32 is in fact electrically conductive as well as either opaque or semi-transparent so that the single grid of material 34 in the grooves 32 will perform both the function of shielding against radio frequency radiation and the function of shielding against glare-producing light-ray radiation.

Furthermore, instead of filling the grooves with a granulated material 34, which may be united with a suitable binder for example, it is possible to form a relatively rigid network of bars which are simply set into the grooves and these bars may be electrically conductive.

Thus, the invention provides shielding of light ray radiation and RF shielding via electrical conductive grid means either atop the lens or disposed within the grooves. In this latter instance, the electrical conductive material may be reflective to a certain degree and in contact with the groove sides to some extent so that light and RF shielding are both accomplished.

It is to be understood that a particular embodiment of the invention has been described, and, therefore, its full scope is to be interpreted from the appended claims.

What we claim is:

1. A radiation shielding light transmitting element comprising a light incident surface, a light emergent surface, light controlling means on said light emergent surface for directing light passing through said element, a grid of electrically conductive bars supported on said light incident surface and which expose a considerable portion of said light incident surface between said bars, and means for grounding said grid, said light controlling means comprising a plurality of prisms forming a network of valleys aligned with said bars.

2. A radiation shielding light transmitting element comprising a flat light-incident surface and an opposed light-emergent surface, light controlling means on said light-emergent surface for directing light passing through said element, a grid of electrically conductive bars which are flush with said light-incident surface, and means for grounding said grid, said light controlling means comprising a plurality of prisms forming a network of valleys aligned with said bars.

3. A radiation shielding light transmitting element comprising a flat light-incident surface and an opposed light-emergent surface, light controlling means on said light-emergent surface for directing light passing through said element, a plurality of intersecting grooves extending into said element from said light incident surface, a grid of electrically conductive bars disposed in said grooves and having an upper surface approximately flush with said light-incident surface and means for grounding said grid, said light controlling means comprising a plurality of prisms forming a network of valleys aligned with said grooves.

4. The element of claim 3 wherein said bars are substantially out of contact with the sides of said grooves.

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