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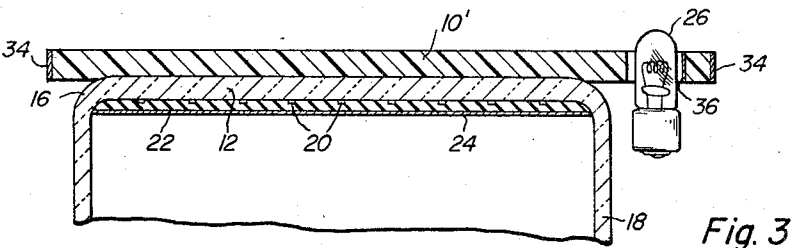
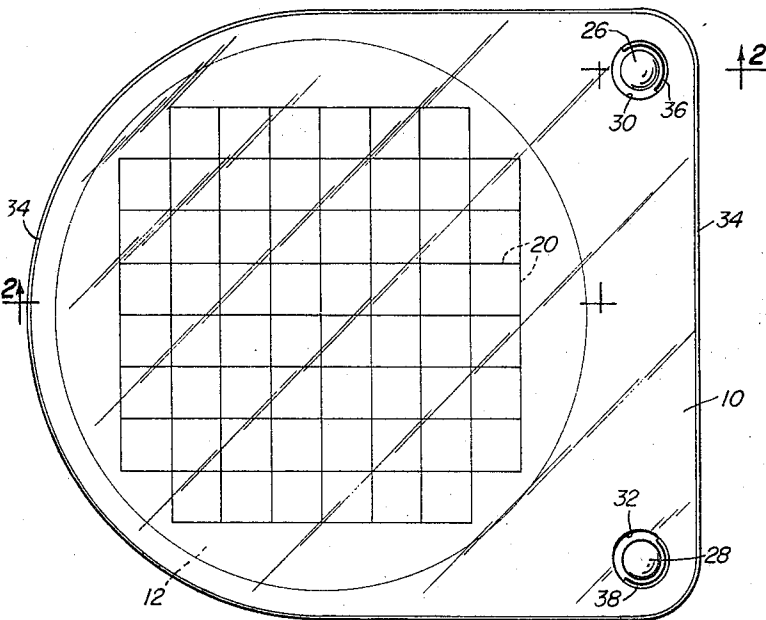
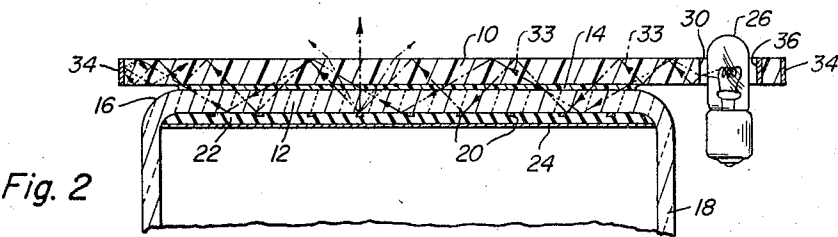
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GRATICULE LIGHTING STRUCTURE

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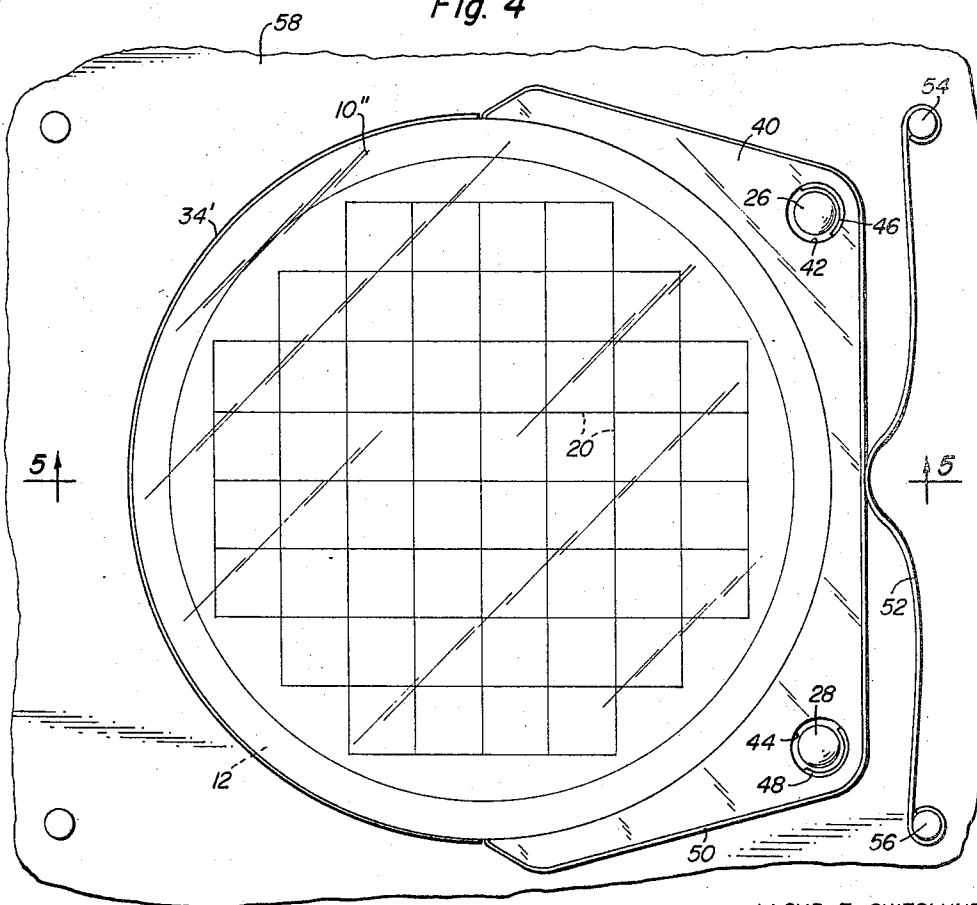
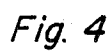
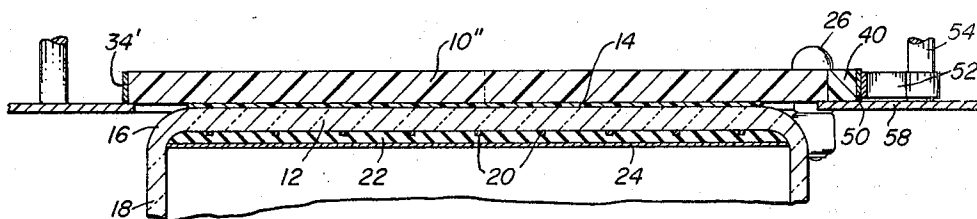


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GRATICULE LIGHTING STRUCTURE

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6 Claims. (Cl. 313—92)

The subject matter of the present invention relates generally to apparatus for illuminating an internal graticule scale on the face plate of a cathode ray tube, and in particular to a graticule lighting structure which transmits light through the front surface of the face plate to a graticule scale provided on the rear surface of such face plate beneath a fluorescent screen, by eliminating any air interface between such face plate and an external light guide supported over the front surface of such face plate.

The graticule lighting structure of the present invention is especially useful when employed in a cathode ray oscilloscope to illuminate the internal graticule of a cathode ray tube having a molded glass face plate, but may also be employed with tubes having flat face plates including those having a flat rectangular face plate sealed to a rectangular funnel envelope portion of ceramic material. Conventional cathode ray tubes have an all glass envelope with circular, molded glass face plate whose cross section has rounded outer edges to provide the envelope with the increased strength required to resist the high temperatures and pressures created during the evacuation process. In order to accurately measure the characteristics of an electrical signal wave form produced on the fluorescent screen of the tube by the electron beam with such tube, it is desirable to provide a graticule scale on the inner surface of such face plate beneath such fluorescent screen. This internal graticule avoids the problem of image parallax which exists when the graticule scale is provided on the exterior of the face plate because such face plate and the fluorescent screen are separated by the thickness of the face plate and thus are not in the same plane. However, previous attempts to illuminate such an internal graticule by "edge lighting" in a conventional tube were unsatisfactory because the rounded front corner at the outer edge of the cross section of the molded face plate reflected the light so that very little of such light entered the face plate. A large amount of the light which did enter the face plate was transmitted down the sides of the tube away from the face plate so that it was not available for illumination of the graticule scale. Also, some of the light entering the face plate was transmitted completely through the rounded corner into the fluorescent screen whose phosphor particles diffuse the light and cause an undesirable bright region at the edge of such screen.

Previous cathode ray tubes have attempted to avoid this problem by employing a black substance for the lines of the graticule scale so that they can be seen against the white or light yellow color of the phosphor material of the fluorescent screen. However, this has not proved to be satisfactory because the fluorescent screen is made to appear as dark as possible during the operation of the tube to provide a suitable background for the wave form trace produced as a line of white light on such screen. Thus, the black line graticule is incompatible with the desired dark background of the phosphor screen and this is especially true when photographing the trace by an oscilloscope camera in substantially complete darkness.

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The present graticule lighting structure involves the employment of a light guide positioned in front of the face plate in such a manner to eliminate the air interface between such members, and has several advantages over previous apparatus for illuminating the internal graticules of cathode ray tubes, including the use of a simple, inexpensive structure which also serves as an implosion shield. This lighting structure illuminates such internal graticule more efficiently and uniformly to produce a brighter graticule image. It also allows the use of illuminated internal graticules in conventional tubes having molded glass face plates by transmitting light through the front surface, rather than the rounded outer edge, of the face plate for illuminating such graticule and reducing the amount of light lost down the side of the funnel portion of the envelope. The present lighting structure also eliminates the bright region produced at the edge of the fluorescent screen by previous graticule lighting structures that transmitted light through the outer edge of the face plate. This is accomplished by not connecting the light guide to the rounded outer edge of the molded face plate, or by providing a light opaque or reflecting strip between the light guide and the face plate along the outer edge in the case of the flat face plate mentioned above.

It is therefore one object of the present invention to provide an improved optical apparatus for illuminating the internal graticule scale on the inner surface of the face plate of a cathode ray tube more efficiently.

Another object of the invention is to provide an improved graticule lighting structure which employs an external light guide supported on the front surface of the face plate of a cathode ray tube to eliminate any air interface between such light guide and such face plate in order to transmit light through the outer front surface of the face plate to illuminate the graticule scale.

A further object of the invention is to provide an improved graticule lighting structure having a simple and inexpensive structure which illuminates the internal graticule of a cathode ray tube more brightly and uniformly.

An additional object of the invention is to provide an improved graticule lighting structure which enables the illumination of an internal graticule scale provided on the inner surface of a molded glass face plate having a rounded outer edge.

Still another object of the present invention is to provide an improved internal graticule lighting structure which reduces the amount of light transmitted down the side of the funnel portion of the envelope away from such face plate and eliminates bright spots in the background illumination of the phosphor screen of such tube.

Other objects and advantages of the present invention will be apparent from the following detailed description of certain preferred embodiments thereof and from the attached drawings of which:

FIG. 1 is a plan view of a cathode ray tube employing one embodiment of the graticule lighting structure of the present invention;

FIG. 2 is a horizontal section view taken along the line 2—2 of FIG. 1;

FIG. 3 is a section view similar to FIG. 2 showing another embodiment of the graticule lighting structure of the present invention;

FIG. 4 is a plan view of a third embodiment of the graticule lighting structure of the present invention; and

FIG. 5 is a horizontal section view taken along the line 5—5 of FIG. 4.

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As shown in FIGS. 1 and 2, one embodiment of the graticule lighting structure of the present invention includes a light guide member 10 in the form of a flat plate of light transparent material which is bonded to the outer front surface of a circular glass face plate 12 by means of an intermediate layer 14 of light transparent bonding material having an index of refraction similar to that of the face plate and light guide. The glass face plate 12 is sealed to a hollow glass funnel 18 by a conventional flame seal to form the envelope of a cathode ray tube.

A plurality of intersecting horizontal and vertical lines 20 are provided on the inner rear surface of the face plate 12 to form a graticule scale beneath a fluorescent screen 22 of phosphor material. These graticule lines may be formed by fused glass frit or light reflecting and diffusing material such as titanium dioxide deposited on the inside rear surface of the face plate, or by grooves which are scribed or etched into such rear surface. A thin electron transparent, light reflecting coating 24 of aluminum or other suitable material may be provided over the fluorescent screen to prevent light from being emitted from the rear surface of the fluorescent screen into the envelope. This light reflecting coating increases the brightness of the wave form trace produced on the fluorescent screen 22 by the electron beam of the cathode ray tube.

The graticule lines 20 are illuminated by light emitted from the filaments of a pair of light bulbs 26 and 28 which are inserted into spaced apertures 30 and 32, respectively, through the light guide member 10. The light emitted by sources 26 and 28 enters the light guide 10 through the sides of the apertures 30 and 32 and is reflected from the flat polished front and rear surfaces of such light guide as indicated by dashed lines 33 until reaching the area immediately above the bonding layer 14. Since this bonding layer has an index of refraction similar to that of the material of the light guide and the face plate 12, no air interface exists between these members so that the light passes from the light guide into the face plate through the bonding layer. When this light strikes the graticule lines 20 a portion of it is then reflected through the front surface of light guide 10 to the observer. It should be noted that the bonding layer 14 does not extend over the rounded outer edge 16 of the face plate so that optical contact between the light guide and the face plate is prevented in this region. As a result, substantially no light passes through the edge of the fluorescent screen to cause an undesirable bright ring around such screen, and very little light is lost by being transmitted away from the graticule 20 down the funnel portion 18 of the envelope. Thus, almost all of the internally reflected light within the overhanging portion of the light guide not in optical contact with the face plate is reflected from the reflector coating 34 into the face plate to balance the illumination of the graticule.

Several different materials may be employed for the light guide 10, the bonding layer 14 and the face plate 12 since the indexes of refraction of these elements do not have to match exactly. For example, the face plate may be made of No. 12 lead glass having an index of refraction of 1.560 and the light guide 10 may be made of the same glass or an acrylic resin, such as methyl methacrylate which has an index refraction of 1.49, and the bonding layer 14 may be made of a transparent flexible material, such as silicone rubber sold by the General Electric Company under the trademark "Silicast" with the designation "LTV-602" which has an index of refraction of 1.406 or the silicone resin sold by Dow Corning Co. under the trademark "Sylgard-182." The bonding material may also be a clear epoxy resin sold by Dow Chemical Company under the designation "E.E.R. 332" for the resin and "D.E.H. 332" for the hardener, and having an index of refraction of approximately 1.4.

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The silicone rubber bonding material referred to above has the additional advantage in that it provides a shock absorbing material between the light guide and the face plate to prevent breakage of such face plate due to a blow on the light guide. Of course, the light guide 10 also functions as an implosion shield to prevent injury to the observer in case the envelope shatters. When this silicone rubber is employed as the bonding material, it is necessary to provide a silicone primer material sold by General Electric Company under the designation "S.S. 4044" as a thin coating on the surfaces of the face plate and the light guide which are contacted by the bonding layer.

In order to increase the efficiency of the graticule lighting structure of FIGS. 1 and 2, a coating 34 of any suitable light reflecting material such as silver or white enamel is provided on the outer edge of the light guide 10. In addition, a portion of each of the side walls of apertures 30 and 32 in the light guide may be provided with reflective coatings 36 and 38 respectively. These coatings 36 and 38 are positioned on the sides of the apertures remote from the face plate to direct more of the light emitted by sources 26 and 28 inward toward such face plate.

FIG. 3 shows another embodiment of the graticule lighting structure of the present invention which is similar to the lighting structure of FIGS. 1 and 2 so that the same reference numerals have been employed for similar parts. In this embodiment of the invention, the light guide 10' may be molded directly onto the front surface of the face plate 12 so that the intermediate bonding layer 14 is eliminated. Thus, the light guide 10' may be made of rigid plastic material such as the acrylic resin referred to above. However, it is also possible to make the light guide 10' out of flexible transparent material which is pressed into intimate contact with the face plate to eliminate any air interface between these members. This flexible light guide may be made of the silicone resin plastic material or the silicone rubber used for the bonding layer 14 of FIG. 1.

A third embodiment of the graticule lighting structure of the present invention is shown in FIGS. 5 and 6 to be similar to the embodiment already discussed with reference to FIGS. 1 and 2 so that the same reference numerals have been employed to identify like parts. The primary difference of this graticule lighting structure is the use of an auxiliary light pipe member 40 to transmit the light emitted from sources 26 and 28 into the light guide 10". The light guide may be formed in a circular shape slightly greater than the diameter of the face plate 12 in which case the light pipe member is provided with a semicircular surface which engages the outer edge of the light guide and has a radius of curvature similar to that of such light guide. The light reflecting coating 34' on the outer edge of the light guide 10" does not extend completely around such light guide beneath the light pipe member 40, but terminates just short of the edge of light pipe.

The light bulbs 26 and 28 are inserted into a pair of circular apertures 42 and 44, respectively, through the light pipe 40 which may be provided with reflecting coatings 46 and 48 over a portion of their inner walls to direct the light from such bulbs through such light pipe into the light guide 10". Another light reflecting coating 50 may also be provided on the outer edge of the light pipe not in contact with the light guide to prevent light from being transmitted outward away from the light guide. The light pipe 40 is resiliently urged into contact with the light guide 10" by means of a leaf spring 52 whose intermediate portion engages the light pipe at a point midway between apertures 42 and 44. The opposite ends of the spring 52 are secured to a pair mounting posts 54 and 56 extending from a support panel 58 on the front of the oscilloscope for securing a bazel cover (not shown) over the light guide and auxiliary

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light pipe to hold such light pipe in proper position. It should be noted that in the embodiment of FIGS. 4 and 5 the light guide member 10" may also be molded directly onto the face plate without the use of bonding layer 14 or such light guide may be made of resilient plastic material which is pressed into intimate contact with the face plate to eliminate any air interface between such members in a similar manner to FIG. 3.

It will be obvious to those having ordinary skill in the art that various changes may be made in the details of the above described preferred embodiments of the present invention without departing from the spirit of the invention. For example, it is conceivable that the intermediate layer 14 between the light guide and the face plate could be made of a transparent liquid such as a silicone grease if it were desirable to employ a rigid light guide not attached to the face plate. Therefore, the scope of the invention should only be determined by the following claims.

I claim:

1. Apparatus for illuminating an internal graticule scale of a cathode ray tube, comprising:

- a cathode ray tube envelope having a light transparent face plate portion at one end of said envelope;
- a graticule scale formed on the inner rear surface of said face plate;
- a light guide member of light transparent material having an index of refraction similar to that of said face plate; and

means for supporting said light guide member adjacent the outer front surface of said face plate to eliminate any air interface between said face plate and said light guide member so that light can be transmitted from said light guide member into said face plate through the front surface thereof.

2. Apparatus for illuminating an internal graticule scale of a cathode ray tube, comprising:

- a cathode ray tube envelope of glass having a light transparent face plate portion at one end of said envelope;
- a graticule scale formed on the inner rear surface of said face plate;
- a phosphor screen supported on the inner rear surface of said face plate over said graticule scale;
- a light guide member of light transparent material having an index of refraction similar to that of said face plate, said light guide member having a smooth front surface;

means for supporting said light guide member on the outer front surface of said face plate to eliminate any air interface between the rear surface of said face plate and the front surface of said light guide member so that light can be transmitted from said light guide member into said face plate through the front surface thereof; and

means for directing visible light into said light guide member to illuminate said graticule scale.

3. Apparatus for illuminating a graticule scale inside a cathode ray tube, comprising:

- a cathode ray tube envelope of glass having a light transparent face plate portion at one end of said envelope;
- a graticule scale formed on the inner rear surface of said face plate;
- a phosphor screen supported on the inner rear surface of said face plate over said graticule scale;
- a light guide member in the form of a rigid plate of light transparent material having an index of refraction similar to that of said face plate; and

a seal of light transparent bonding material attaching said light guide member to the outer front surface of said face plate to eliminate any air interface between said face plate and said light guide member, said bonding material having an index of refraction similar to that of said face plate and said light guide so

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that substantially all of the light within said light guide member is transmitted into said face plate through the front surface of said face plate and the rear surface of said light guide.

4. apparatus for illuminating an internal graticule scale in a cathode ray tube, comprising:

- a cathode ray tube envelope of glass having a light transparent face plate portion at one end of said envelope, said face plate having a rounded outer edge;
- a graticule scale formed on the inner rear surface of said face plate;
- a phosphor screen supported on the inner rear surface of said face plate over said graticule scale;
- a light guide member of light transparent plastic material having an index of refraction similar to that of said face plate;

said light guide member being molded onto the outer front surface of said face plate to eliminate any air interface between said face plate and said light guide member so that light can be transmitted from said light guide member into said face plate through the front surface of said face plate; and

means for directing visible light into said light guide member to illuminate said graticule scale.

5. Apparatus for illuminating an internal graticule scale in a cathode ray tube, comprising:

- a cathode ray tube envelope of glass having a light transparent face plate portion at one end of said envelope;
- a graticule scale formed on the inner rear surface of said face plate;
- a phosphor screen supported on the inner rear surface of said face plate over said graticule scale;
- a light guide member in the form of a rigid flat plate of light transparent plastic material having an index of refraction similar to that of said face plate, said light guide member being shaped to conform to said face plate;

a seal of light transparent bonding material attaching said light guide member to the outer front surface of said face plate to eliminate any air interface between said face plate and said light guide member, said bonding material having an index of refraction similar to that of said face plate and said light guide so that light within said light guide member is transmitted into said face plate through the front surface thereof; and

means for directing visible light into said light guide member to illuminate said graticule scale, said means including an auxiliary light pipe separate from said light guide member, a plurality of light sources positioned in spaced apertures in said light pipe, and means for supporting said light pipe adjacent the outer edge of said light guide member to transmit light from said sources through said light pipe into said light guide member.

6. Apparatus for illuminating a graticule scale inside a cathode ray tube, comprising:

- a cathode ray tube envelope of glass having a light transparent face plate portion at one end of said envelope;
- a graticule scale of fused lines of glass frit coated on the inner rear surface of said face plate;
- a phosphor screen supported on the inner rear surface of said face plate over said graticule scale;
- a thin electron transparent metal layer coated over the rear surface of the phosphor screen to reflect light emitted by said screen and light transmitted to the graticule scale from a source external to the tube envelope;
- a light guide member in the form of a rigid flat plate of light transparent plastic material having an index of refraction similar to that of said face plate, said face plate having a smooth front surface to reflect light therefrom;

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a light reflecting coating on the outer edge of said light guide member;

means for supporting said light guide member adjacent the outer front surface of said face plate to eliminate any air interface between said face plate and said light guide member so that light can be transmitted from said light guide member into said face plate through the front surface thereof; and

means for directing visible light into said light guide member from a source outside of said envelope to illuminate said graticule scale.

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