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Robinder

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- [54] **DISPLAY TUBE WITH NEUTRAL DENSITY FILTRATION**
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- [73] Assignee: **Raytheon Company**, Lexington, Mass.
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- [58] Field of Search **313/116, 112, 466, 110; 178/7.85, 7.86; 358/71-73; 220/2.3 A**

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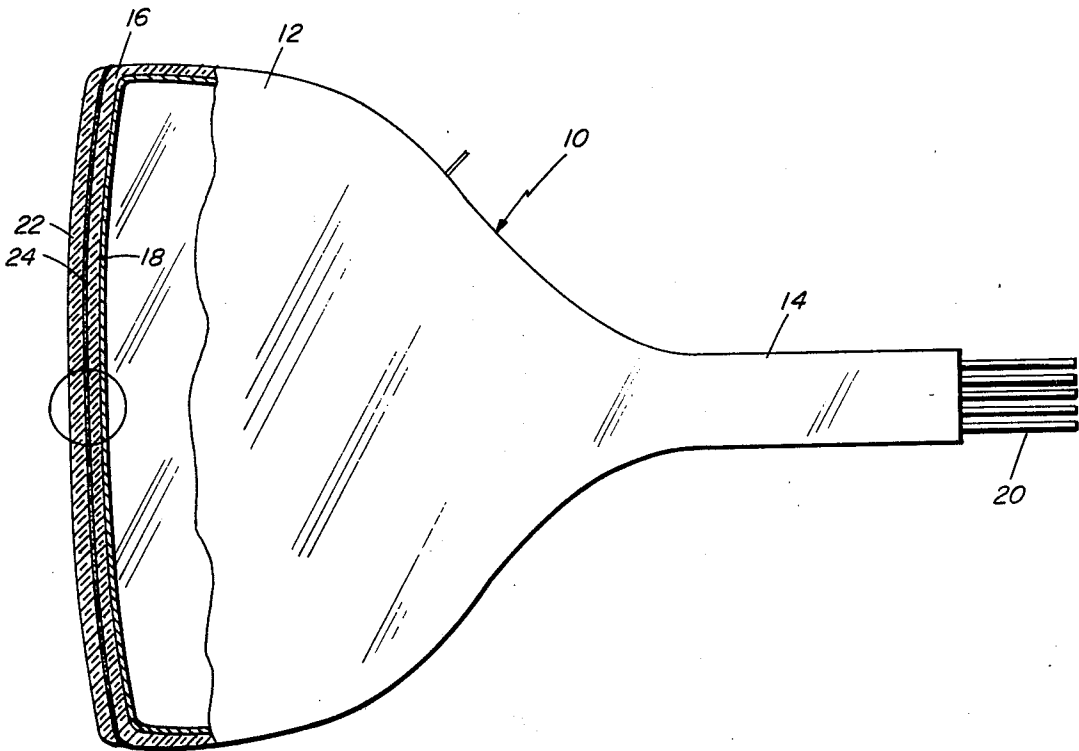
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[57] **ABSTRACT**

A cathode ray display tube having improved viewability under conditions of high ambient illumination levels, this being achieved by providing a tube faceplate and an implosion panel thereover, with a transparent adhesive material between the faceplate and panel having intermixed therein a selected material which provides the adhesive material with selected neutral density filtration characteristics for enhancing contrast in the viewed display.

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10 Claims, 3 Drawing Figures



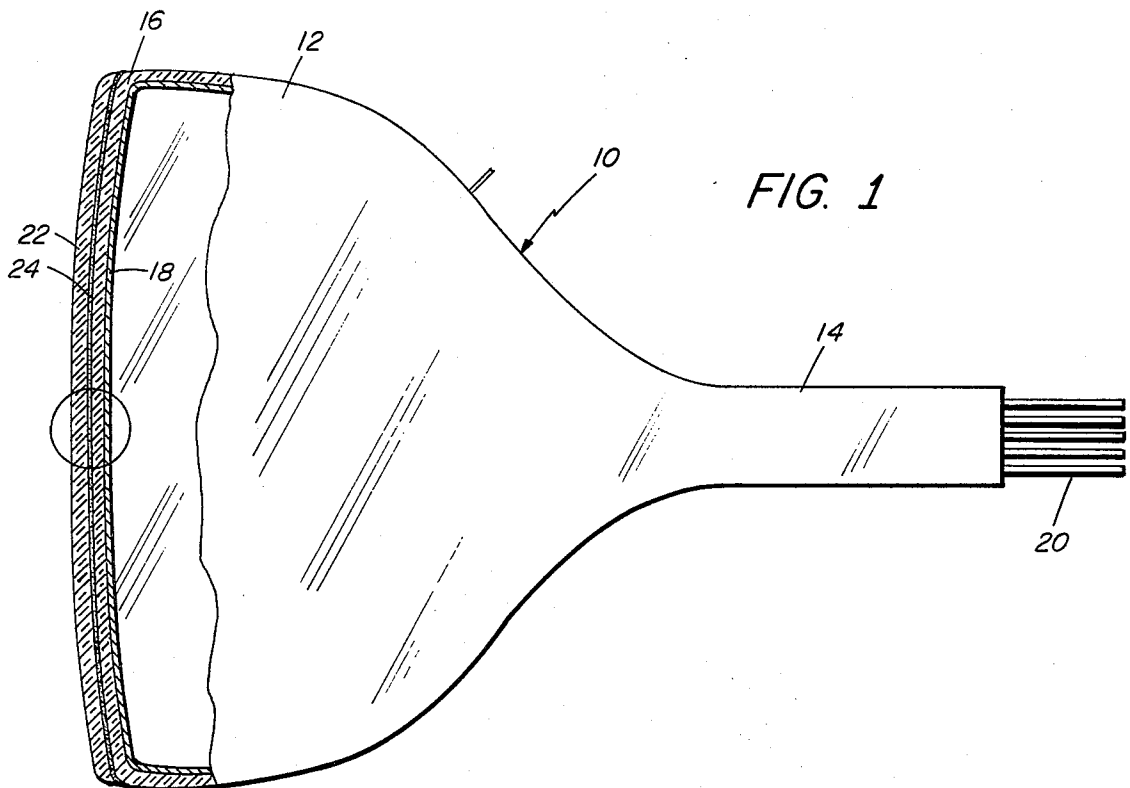
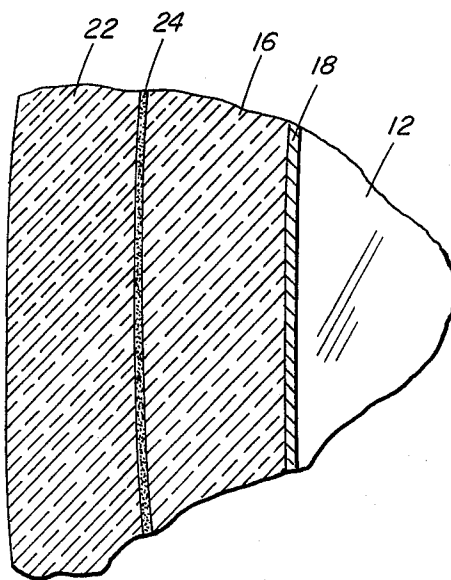


FIG. 2



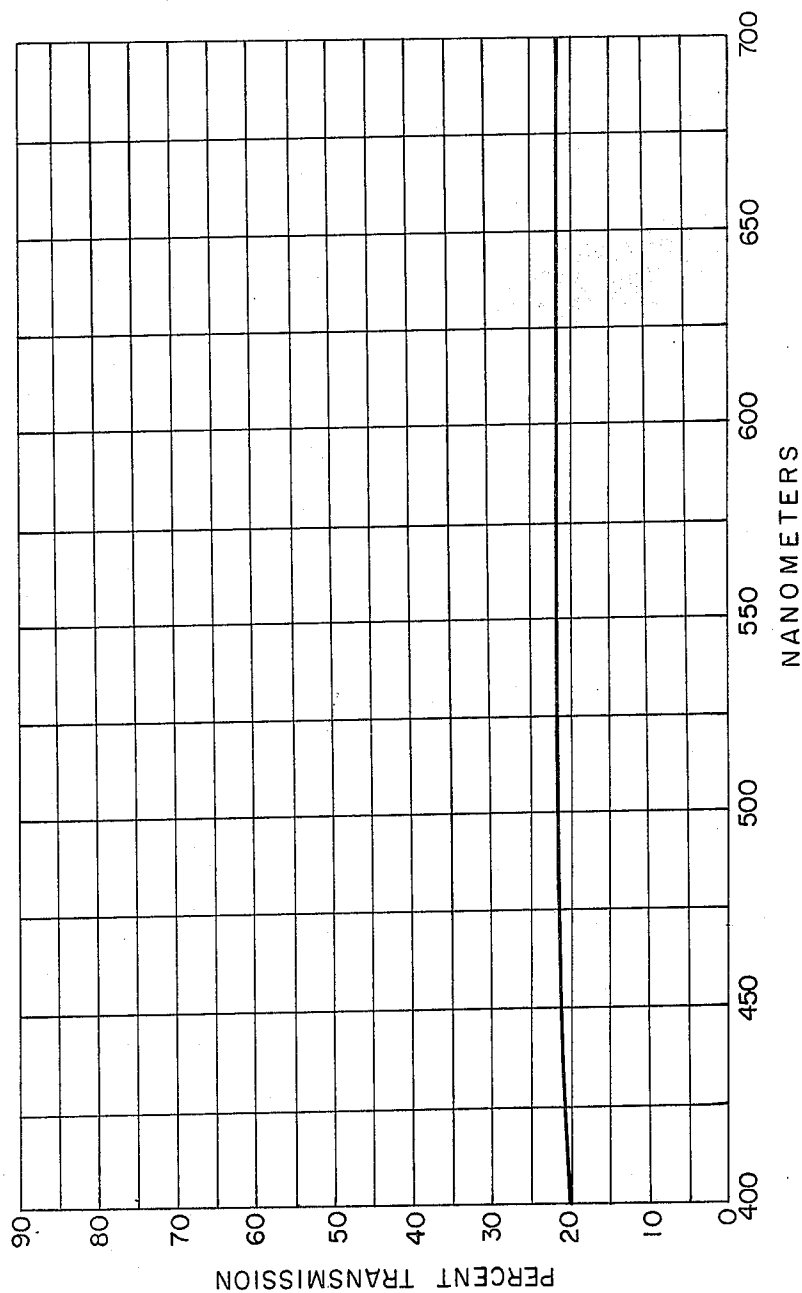


FIG. 3

DISPLAY TUBE WITH NEUTRAL DENSITY FILTRATION

BACKGROUND OF THE INVENTION

In the manufacture and use of a color television type display tube, problems very frequently occur when tubes exhibiting poor contrast are used in areas with high ambient illumination levels. Most known devices employ neutral density filtration in an attempt to achieve good viewability in high ambient illumination conditions. This is done by providing colloidal absorbers such as silver in the glass composition of the tube faceplate or the implosion panel to produce a "gray" or "black" device.

The approach of selective filtration has been used for various special products in the past. Such known approaches include the use of colored glass for either the tube faceplate or the implosion panel, which glass is difficult and expensive to obtain and cannot be readily tailored to possess the exact desired spectral properties. Another approach includes coloration of the bonding material between the faceplate and the implosion panel. This approach has been unsatisfactory since it requires a different color material for each commercially important phosphor screen, resulting in a large inventory of materials.

SUMMARY OF THE INVENTION

The present invention overcomes the foregoing and other disadvantages of known prior art devices by the provision of a cathode ray display tube having improved viewability under conditions of high ambient levels, which improvement is achieved by securing a transparent implosion panel to the faceplate of the tube by means of adhesive material which provides neutral density filtration.

For this purpose the adhesive material is a normally clear transparent material having intermixed therewith a material which provides the desired filtration characteristics without affecting the color of the displayed image. The particular adhesive mixture, furthermore, may be tailored to provide the specific filter density desired for particular individual application requirements.

A particularly suitable filter adhesive is a clear transparent epoxy or polyester containing colloidal graphite or similar carbon suspensions mixed therewith in selected amounts to provide the desired density.

A stock mixture is made using a transparent epoxy or polyester resin such as the epoxy sold by Dow Corning under the designation TV-720. Using the resin as a diluent, a colloidal carbon or graphite suspension is added, such as the carbon material sold as Dag 213 by Acheson Colloids Co. The desired light transmission properties determine the required dilution.

The resultant mixture may be used as adhesive between two substantially parallel adjacent surfaces of a faceplate and an implosion panel and produces a neutral gray filtration which may be tailored to particular requirements. This avoids the previously necessary requirement of stocking relatively large numbers of various density glasses for the purpose.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objectives of this invention will become readily apparent from the following description taken in connection with the accompanying drawings, wherein:

FIG. 1 is an elevational view partly in vertical section of a cathode ray display tube embodying the invention;

FIG. 2 is an enlarged sectional view of a portion of the faceplate of the tube shown in FIG. 1; and

FIG. 3 is a graph illustrating the light transmission characteristics of one embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A cathode ray tube of the display type is indicated at 10 in FIG. 1 and is utilized for providing a visual display which may be viewed in the normal manner of tubes of this type. It is well known that such display tubes are often required to be used under conditions when high ambient illumination levels are present. For example, in the cockpit of aircraft the ambient light often exists at such high illumination levels as to render observation of displays extremely difficult when conventional tube structures are used.

In the present invention viewability of a display is considerably improved even under conditions of high ambient illumination levels. This is achieved by neutral density filtering whereby ambient illumination is decreased while the viewability of the emitted light from the tube is enhanced.

Referring particularly to FIGS. 1 and 2, the tube 10 embodies the usual evacuated envelope which includes a bulb portion 12 and a narrow neck portion 14 at one end thereof. At the other end of bulb portion 12 the envelope is closed by a faceplate 16 which is usually an integral part thereof. The faceplate 16 carries on its inner surface a layer 18 of electron-sensitive phosphor. The faceplate 16 is preferably of glass so that light from the phosphor layer 18 will be transmitted externally of the tube for viewing. The phosphor material in layer 18 may be any of the well-known materials which have been found suitable for the purpose and which comprise relatively closely packed crystals which become fluorescent when bombarded by electrons.

Within the neck portion 14 is positioned a cathode ray gun (not shown) which may be of any suitable construction and which is adapted to be supplied with operating potential through leads or pins 20 which extend through the end of the envelope. Operation of the cathode ray gun will cause the formation of an electron beam which can be made to scan the phosphor layer 18 in the normal manner of tubes of this character. This will cause the phosphor to become luminescent in the areas which are contacted by the scanning electron beam. The resultant light from the phosphor will travel outwardly of the envelope through the faceplate 16 externally of the tube for viewing by an observer.

It has become common practice to provide an implosion panel 22 adjacent the outer surface of the faceplate for safety purposes. Such an implosion panel may be separate from the tube structure but, in accordance with the present invention, is secured directly to the faceplate 16 by means of a layer 24 of suitable adhesive. The adhesive is preferably a clear resin such as an epoxy sold by Dow Corning as Epoxy TV-720, for example.

In a normal tube structure of the character described above, it has been found that ambient light falling on the phosphor layer 18 after passing through the implosion panel 22, resin layer 24 and faceplate 16 will seriously interfere with the visibility of the light image produced by phosphor layer 18. In accordance with the

present invention, ambient light is considerably attenuated by means of neutral density filtering which is effected within the resin layer 24.

This filtering effect is achieved by providing within the normally clear transparent adhesive resin mixture a suspension of colloidal carbon or graphite particles which are distributed substantially uniformly throughout the resin. This produces neutral density filtration within the adhesive layer 24, which filtration density can be tailored for specific applications by control of the amount of carbon used.

While any carbon or graphite materials may be used for this purpose, a particularly satisfactory material is the graphite sold by Acheson Colloids Company as Dag 213. This material is included in the adhesive resin, preferably using TV-720 as the diluent. A desired concentration of this mixture is about 1 percent by volume to produce what we will call a "stock solution." This stock solution is then mixed with resin in selected proportions to provide a resultant adhesive which has the selected light absorption characteristics. For example, the stock solution and resin may be used in equal parts which will produce a neutral density gray filter. In another example, one part of stock solution may be used with nine parts of resin to produce a neutral density filter considerably less dense than the 1:1 resin mixture. Therefore, it is to be understood that any desired ratio of stock mixture to resin may be employed to achieve selected desired results.

This invention can be made by conventional and known tube manufacturing techniques wherein the tube envelope and components are first assembled, evacuated and tested. Following this the implosion panel 22 is placed in overlying relation with the faceplate 16, with suitable spacers therebetween to regulate the size of the shape to be filled with adhesive resin. A securing tape is mounted around the circumference of the two members and after the spacers are removed the tape holds the members in the predetermined spaced relation. Heat of about 60°C is applied and the spaces between the faceplate and panel are filled with resin, after which the final assembly is cooled and the resin is allowed to set.

Referring to FIG. 3, there is shown a typical graph illustrating the spectral light transmission in percent of an adhesive layer 24 which is made by mixing approximately two parts of stock mixture with about three parts of resin. It will be seen that a quite flat curve results, with only a slight dipping between about 400-500 nanometers, thus indicating a neutral gray color with a slight yellow which cannot be detected by the human eye.

During operation of a tube embodying this invention it will be apparent that light emitted from the phosphor layer 18 will pass once through the adhesive layer 24 and a portion of this light emission will be absorbed in accordance with the filtering characteristics of the particular resin mixture employed. However, ambient light will pass through the adhesive layer two times and thus will be attenuated twice the amount of the emission light by the time it reaches the observer's eyes. This, therefore, greatly improves the visibility of the emitted light image being displayed.

From the foregoing it will be apparent that all of the objectives of this invention have been achieved by the structures shown and described. It will be apparent, however, that various modifications of this invention

may be made by those skilled in the art without departing from the spirit of the invention as expressed in the accompanying claims. Therefore, all matter shown and described is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. A display tube comprising an evacuated envelope having a clear transparent faceplate in a wall thereof, a layer of phosphor material adjacent the inner side of said faceplate for generating light in the visible spectrum, a clear transparent protective panel adjacent the outer side of said faceplate, and a bonding material between said faceplate and panel, said bonding material having selected neutral density filtration characteristics in the visible spectrum.

2. A display tube as set forth in claim 1 wherein said bonding material comprises a normally clear transparent adhesive matrix having mixed therewith selected amounts of particulate material which provides desired filtration density without substantially affecting color of the light emitted by said light-generating layer in the visible spectrum.

3. A display tube as set forth in claim 2 wherein said matrix comprises a resin, and said particulate material comprises a colloidal carbon suspension.

4. A display tube as set forth in claim 2 wherein said bonding material is a stock solution of resin containing about 1 percent of colloidal graphite mixed with base resin in amounts of from about 1 part stock solution with from 1 to 9 or more parts of base resin, depending upon the density desired of the resultant bonding material.

5. A display tube as set forth in claim 1 wherein said bonding material has been about 20-22 percent transmission of all wavelengths of light between about 400-700 nanometers.

6. A display tube comprising an evacuated envelope having a clear transparent faceplate at one end thereof, a layer of phosphor on the inner surface of said faceplate for generating light in the visible spectrum, electron beam-producing means in the opposite end of the envelope, said phosphor being responsive upon impingement by electrons from said means to generate said light in the visible spectrum, a clear transparent protective panel adjacent the outer side of said faceplate, and a bonding material between said faceplate and panel, said bonding material having selected neutral density filtration characteristics in the visible spectrum.

7. A display tube as set forth in claim 6 wherein said bonding material comprises a normally clear transparent adhesive matrix having mixed therewith selected amounts of particulate material which provides desired filtration density without substantially affecting color of the light emitted by said light-generating layer in the visible spectrum.

8. A display tube as set forth in claim 7 wherein said matrix comprises a resin, and said particulate material comprises a colloidal carbon suspension.

9. A display tube as set forth in claim 7 wherein said bonding material is a stock solution of resin containing about 1 percent of colloidal graphite mixed with base resin in amounts of from about 1 part stock solution with from 1 to 9 or more parts of base resin, depending upon the density desired of the resultant bonding.

10. A display tube as set forth in claim 6 wherein said bonding material has between about 20-22 percent transmission of all wavelengths of light between about 400-700 nanometers.

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