Sept. 21, 1954 J. L. SWITZER 2,689,917

FLUORESCENT DISPLAY DEVICE

Filed Dec. 28, 1949 2 Sheets-Sheet 1

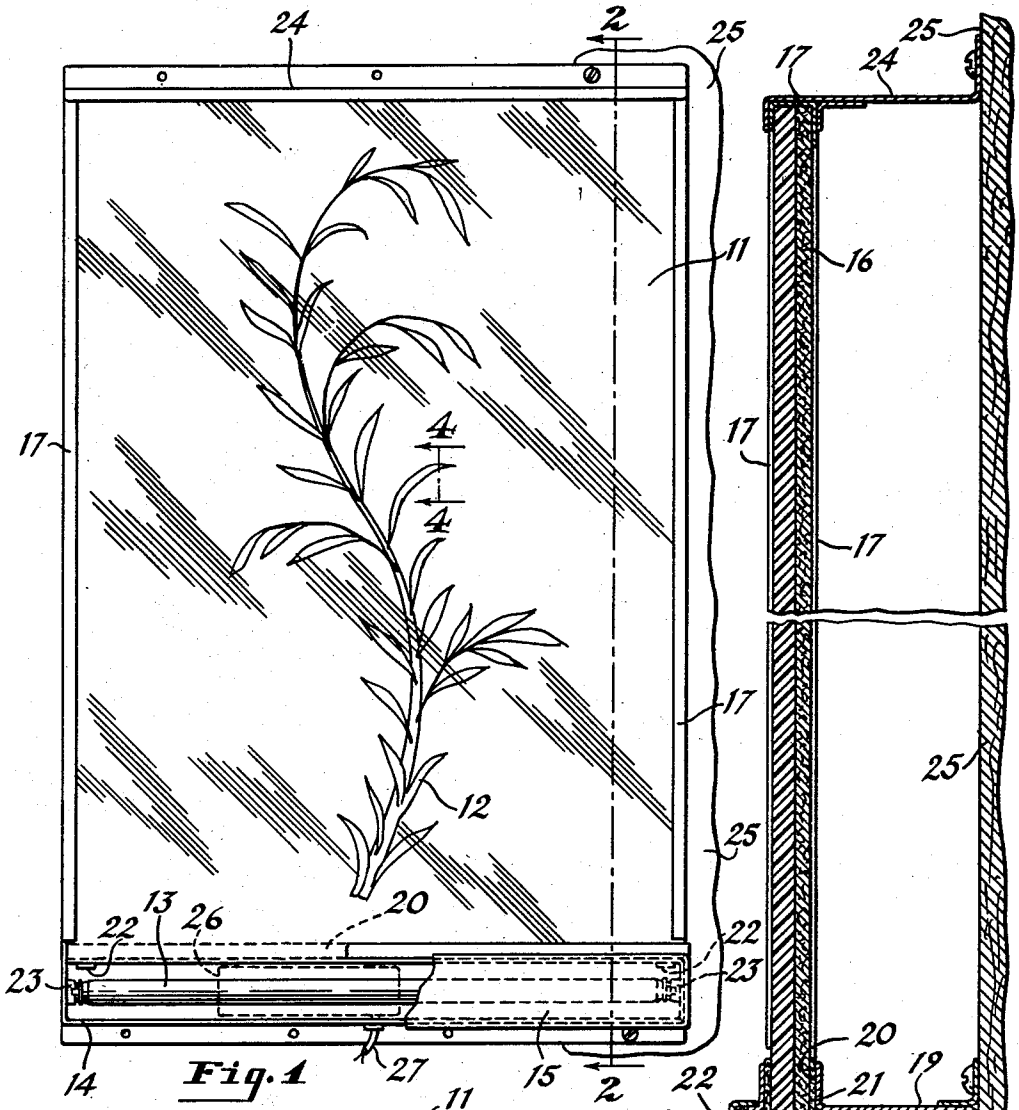

Fig. 1

Fig. 2

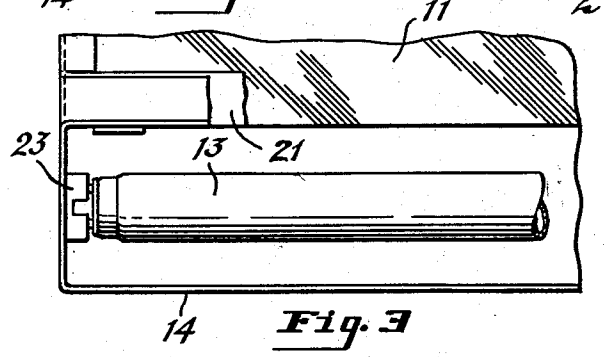

Fig. 3

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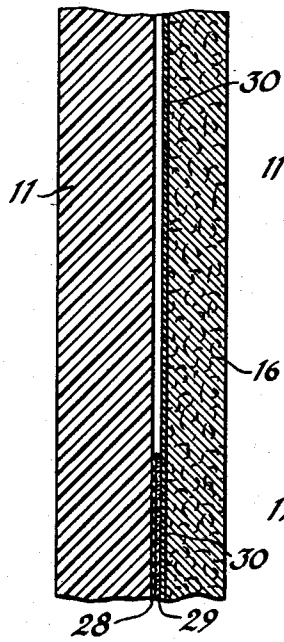

Fig. 4

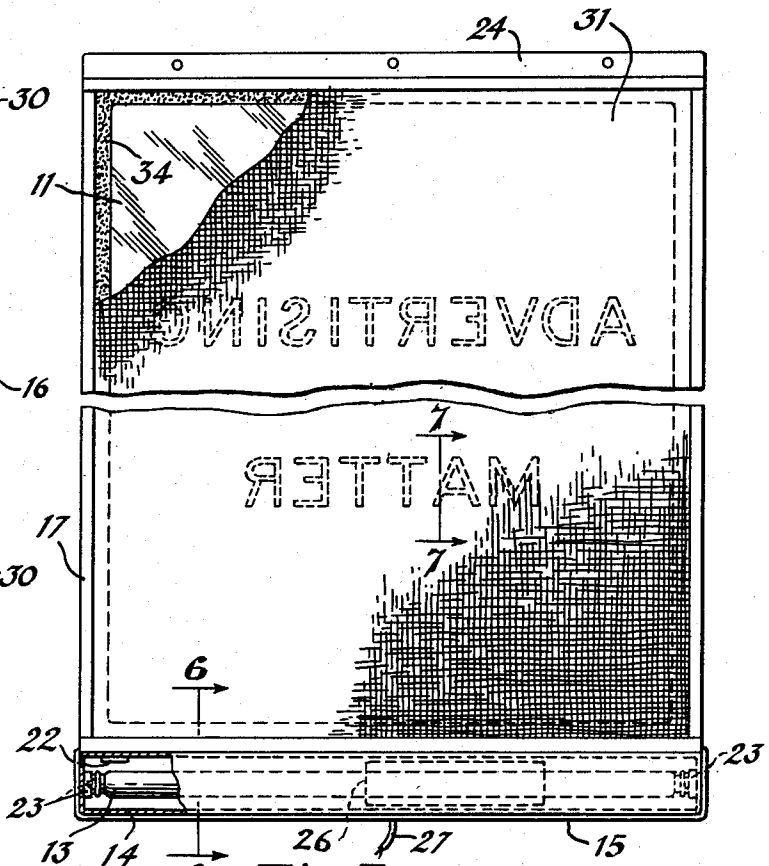

Fig. 5

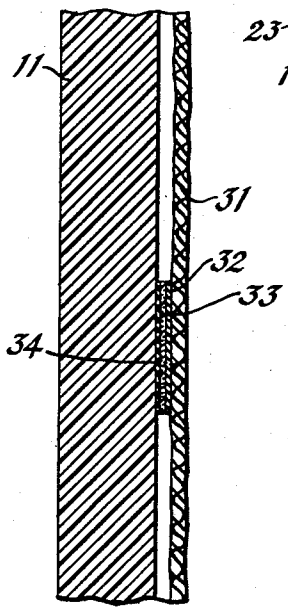

Fig. 7

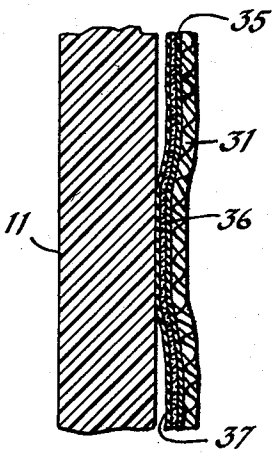

Fig. 8

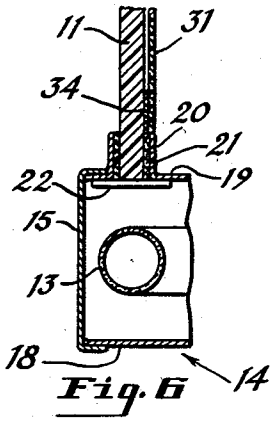

Fig. 6

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UNITED STATES PATENT OFFICE

2,689,917

FLUORESCENT DISPLAY DEVICE

Joseph L. Switzer, Cleveland Heights, Ohio

Application December 28, 1949, Serial No. 135,388

14 Claims. (Cl. 250—71)

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This invention relates to fluorescent display devices or signs in which the symbols or other indicia comprise fluorescent materials and more particularly to such signs which are illuminated by a source of fluorescigenous radiations disposed at the edge of the display or sign.

Fluorescent displays and signs are highly desirable since they give greater brilliance of colors, greater color contrasts and more pleasing effects than conventional, non-fluorescent signs which selectively absorb and reflect different wavelengths of incident visible light.

Previous efforts to provide inexpensive, efficient and simple fluorescent signs have failed either because the devices are too complicated and expensive due to the need for a large source of fluorescigenous radiations or because the ultimate effect of the displays are not unlike the usual non-fluorescent signs.

It is generally desirable to direct the light beam onto a sign at as small an angle of incidence as conveniently possible to obtain the greatest amount of illumination, whether the sign is made of non-fluorescent or fluorescent materials. In the latter case, of course, a source of fluorescigenous radiations is used. All commercial sources of this type normally emit both visible light and "black light" or ultraviolet light. When a fluorescent sign is illuminated with both types of light, much of the visible light will be reflected in the usual manner not only from the fluorescent materials on the sign but also from the non-fluorescent materials which are generally used for background portions of the sign. This results in a low contrast ratio between the different portions of the sign thus destroying a major part of the effectiveness of the fluorescent sign.

On the other hand when only ultraviolet light is to be used for illumination, the source of radiations must be provided with filters for blocking out the visible light. These filters however, also block out as much as 50% of the desired ultraviolet radiations. Thus, to obtain the requisite amount of illumination, a much larger source of radiations is needed, which obviously increases installation and operating expense of the display device. Furthermore, since as small an angle of incidence as possible is required for normal viewing of the sign, it will be seen that large overhanging structures are necessary for proper positioning of the larger source of radiations and larger filters with respect to the display.

Another disadvantage of fluorescent signs in which the radiations are directed toward the sign at as small an angle of incidence as possible is

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that some of the ultraviolet radiations are reflected to the eye of an observer. These reflected ultraviolet radiations cause the eye, which is susceptible to them to fluoresce to such an extent that the appearance of the sign is foggy and hazy.

Display devices and signs according to the present invention overcome these various disadvantages and provide displays in which the contrast ratios are of a high order and which can be brilliantly illuminated by small commercial sources of fluorescigenous radiation without the need for filtering out the visible radiations.

It is an object of the present invention to provide an edge-lighted fluorescent sign which utilizes both ultraviolet light and visible light while at the same time obtaining a high contrast ratio and great brilliance.

According to the present invention symbols or other indicia made of a fluorescent composition or material are disposed in optical contact with the rear surface of a transparent panel. A small but efficient commercial source of radiations having wave lengths from about 3500 Å. to about 4500 Å. is disposed at one edge of the panel so that the radiations will pass longitudinally through the panel while being internally reflected at the surfaces thereof. An example of a source of radiations which has been found to be very efficient and effective in the present invention is a fluorescent tube known as the type 360 BL tube manufactured by the General Electric Company. This tube produces radiations in the violet-blue portion of the visible spectrum and also "near" ultraviolet radiations, i. e., near the visible portion of the spectrum. The radiations emitted by this tube have wave-lengths varying from about 3500 Å. to about 4500 Å., a great proportion of the radiations being in the ultraviolet range and having a wave length of 3650 Å. This tube is not equipped with filters for eliminating the visible radiations.

All of the radiations pass through the panel and strike the fluorescent indicia which is in optical contact with a surface of the panel and are converted to those wave-lengths in the visible spectrum which are characteristic of the particular fluorescent material upon which the light impinges.

The fluorescent materials which may be employed in the present invention are compounds which are known as daylight fluorescent compounds. These compounds project visible light of a predominant wave band or color when excited by visible and invisible radiations of a shorter wave length than the predominant wave band.

These colors are very bright due to the fact that they selectively reflect a substantial proportion of the dominant wave band which is present in the incident visible light and, in fluorescent response to the shorter wave lengths of incident light, emit light of substantially the same wave band as is selectively reflected. The sum of the reflected and emitted light in the predominant wave band constitutes the projected light, which may be greater than the total amount of light of the dominant wave band which is present in the incident light. Thus, such compounds may project as much as 120 to 130% of the red light which is present in incident white light. Heretofore, dyes or pigments which reflected as much as 60% of the red light in the incident white light were regarded as extremely brilliant red materials. Such compounds are described in application No. 575,364, filed January 30, 1945, by Joseph L. Switzer and Robert C. Switzer.

Perhaps one of the greatest advantages to be derived from the present display device is the fact that there can be no reflected or emitted light whatever from the area surrounding the indicia. These areas, of course, are free from all kinds of material, i. e., they are constituted solely by the clear uncoated transparent panel so that all the radiations are internally reflected within the panel in these areas thus rendering the so-called "background" areas completely light-free and thus invisible to an observer.

The present invention, therefore, provides a sign or display in which the indicia has the greatest possible contrast with the background areas and in which the indicia has a brilliant appearance, composed essentially of pure colors. The effect is comparable to the effect obtained when bright sunlight shines directly through stained glass windows.

If desired the indicia may be composed of a single fluorescent material so that a monochromatic sign is obtained. This might be suitable when lettering and words are to be displayed. However, by using a variety of different fluorescent materials any desired object or scene can be provided in brilliant colors. Practically any shade of color can be provided by mixing different materials. Signs or displays of this type are exceedingly lifelike and possess a warmth and depth of color not obtained in other kinds of signs.

The fluorescent materials may be coated directly onto the rear surface of the transparent panel in the desired pattern or they can be applied to a flexible sheet of fabric or paper or the like located behind the panel. In the latter case the fluorescent materials may be affixed to the sheet in patterns and these patterns placed in optical contact with the panel or the materials may be affixed to a substantial area of the sheet and the pattern formed by placing only portions of the coated area in optical contact with the panel. In any event only those portions of the sheet disposed in optical contact with the surface of the panel will be illuminated. The remaining portions of the sheet, which are not in optical contact with the panel, whether coated with fluorescent material or not will not be illuminated by the radiations transmitted through the panel as described above. They would, of course, be illuminated by extraneous visible light which might strike the front of the panel at a small angle of incidence.

The invention will now be described in greater detail with reference to the accompanying drawings, in which,

Figure 1 is a front view of a display device according to the present invention, with a portion broken away to show the source of illumination,

Figure 2 is an enlarged vertical cross-section of the device taken along lines 2—2 of Figure 1,

Figure 3 is an enlarged front elevation of a portion of the device with cover removed to show source of illumination,

Figure 4 is an enlarged cross-section of a portion of the panel showing fluorescent material applied thereto,

Figure 5 is a rear elevation of a modified form of the device, partly broken away to show various details,

Figure 6 is an enlarged cross-section of a part of the device, taken along the line 6—6 of Figure 5,

Figure 7 is an enlarged cross-section of a portion of the panel taken along line 7—7 of Figure 5,

Figure 8 is an enlarged cross-section of a portion of a modified panel for use in the display device.

Acording to the modification shown in Figures 1 to 4, inclusive, the display device comprises a panel 11 of glass, transparent plastic material or other clear transparent material capable of transmitting radiations within the range of from about 3500 Å. to about 4500 Å. A design or other indicia 12 is provided on the back of the panel 11 as described more fully hereinafter. A light source 13 emitting fluorescigenous radiations, as, for example, the type 360 BL tube previously mentioned, is located near the lower edge of the panel 11 within a housing 14 having a removable cover 15 as shown in Figure 2.

The panel 11 is provided with an opaque backing member 16 which shields the panel 11 from extraneous light coming from behind the device. A U-shaped frame 17 holds the panel 11 and backing member 16 securely together to form a panel unit thus protecting the indicia on the rear surface of the panel 11. The frame 17 extends across the top of the panel and down the sides to a point near the bottom edge of the panel 11. This frame in addition to securing the panel unit together also prevents the escape of visible light from the sides and top of the panel.

The housing 14 includes a bottom portion 18 and a top 19 which is provided with a longitudinally extending flanged slot 20 adapted to receive the lower edge of the panel and backing member 16 as shown. A resilient packing 21 is provided between the panel unit and the flanges of the slot 20 to preclude the escape of light except through the panel 11. Spaced stop members 22 are secured to the underside of the top 19 of housing 14 beneath the slot 20 to limit the distance the panel unit can be inserted into the slot. The tube 13 is located centrally beneath the bottom edge of panel 11 and is secured in place by conventional sockets 23 at the ends of the housing 14.

The top of the panel unit is held in place by a bracket 24 provided with a channel adapted to receive the top of the frame 17. The bracket 24, and the housing 14 may be secured, as shown, by any conventional means to a support, such as a wall 25 or the like.

The conventional electrical equipment for fluorescent tubes such as the electrical ballast 26 and cable 27 are disposed within the housing as shown.

The radiations from the tube 13 which enter

the bottom edge of panel 11 pass through the panel, being internally reflected from the surfaces of the panel, until they strike the indicia 12 provided on the rear surface of the panel as illustrated in Fig. 4.

Referring now to Figure 4 the rear surface of the panel 11 has a layer of fluorescent material 28 applied directly to the surface so as to be in optical contact with the panel, i. e., so there is no film of air therebetween. It is highly desirable to also apply a layer 29 of white material such as white paint on the layer 28. This extra layer improves the luminescence of the display by reflecting visible light which is emitted by the fluorescent material. It will be clear that both layers 28 and 29 must be in the form of the indicia. The backing member 16 generally consists of a dark material or is coated with a layer 30 of dark colored material, such as flat black paint or the like, which reflects as little light as possible, so that extraneous visible light accidentally falling upon the display device will not reduce the contrast with the indicia. Since the dark layer 30 is not in optical contact with the panel 11, there being at least a film of air therebetween, the passage of the radiations within the panel 11 will not, of course, be interrupted as when they strike the fluorescent layer 28 which is in optical contact with the panel.

The modification shown in Figures 5 to 7 inclusive differs from the first modification only in the manner in which the indicia are disposed in optical contact with the panel 11. The other elements of the device including the source of radiations 13 and associated elements are the same as in Figures 1, 2 and 3.

In this modification, however, the indicia are not applied directly and permanently to the panel 11 but rather are applied to a flexible sheet which is removably affixed to the panel 11. Referring specifically to Figure 7 a flexible sheet 31 composed of paper or fabric or the like is provided with a base layer 32 of reflective material such as white paint in the form of the desired pattern. A layer 33 of fluorescent material, also in the form of the pattern, is superimposed on the reflective layer 32 and then a layer 34 of a pressure-adhesive substance, such as the so-called "rubber cement," is applied on the fluorescent layer 33. The uncoated portions of the sheet 31 are preferably of a dark non-reflective color.

This sheet can be affixed to the back of the panel 11 simply by applying pressure so that the indicia will adhere to the panel. Since no film of air is between the surface of the panel and the fluorescent layer 33, said layer is in optical contact with the panel and will function as in the previously described modification. To more securely fix the sheet to the panel a band of adhesive material may be applied all around the edges of the panel.

One great advantage of this type of arrangement is that the sheet may be quickly and easily removed and another sheet having different indicia substituted therefor.

This modification also enables one to provide a sign or display which can be seen from both sides. For example, if a transparent sheet or film is used in place of fabric or paper 31 and if the reflective layer 32 is omitted, the visible light emitted by the fluorescent material will be projected not only through the panel 11, as shown in the drawings, but also rearwardly through the transparent sheet, thus making the indicia visible from the back also.

A third modification of the present invention is shown in Figure 8. Here the sheet 31 is provided with layers of reflective material 35, fluorescent material 36 and adhesive material 37 over substantial areas of the sheet, and not merely at the location of the desired indicia. In order to obtain optical contact at the desired points so as to produce the desired display, the sheet is pressed onto the panel at those points where luminescence is desired to form the pattern or sign. This arrangement has the advantage that the display may be changed merely by stripping the sheet from the panel and applying pressure a second time at those areas which constitute the new indicia. This system is, of coures, most suitable where substantially monochromatic displays are preferred. When colored pictures or scenes are desired the type of indicia described in connection with Figures 4 and 7 are required.

In each of the above modifications, the panel 11 through which the radiations are transmitted by internal reflection to the fluorescent material, is preferably formed of a solid, hard, clear material capable of transmitting radiations having wave-lengths lying within the range extending from about 3500 Å. through the major proportion, and preferably through the entire visible light spectrum. The panel may be made of glass or a hard synthetic polymeric or plastic material. Most common glasses have satisfactory radiation transmission characteristics as well as certain organic polymers such as polymethyl methacrylate, cellulose acetate, polystyrene, other vinyl polymers, etc.

The fluorescent materials which may be employed in the present invention may be of various kinds. In general, they comprise a carrier material having dispersed therein or thereon one or more substances capable of fluorescing and emitting visible light when exposed to radiations having wave-lengths lying between 3500 Å and 4500 Å.

Those fluorescent materials which are disclosed in application Serial No. 455,610, filed August 21, 1942, by Joseph L. Switzer, Robert C. Switzer, and Richard A. Ward, U. S. Patent No. 2,417,384, of Robert C. Switzer, and application Serial No. 575,364, filed January 30, 1945, by Joseph L. Switzer and Robert C. Switzer, are particularly satisfactory. These applications disclose fluorescent materials which comprise carriers having dispersed therein organic compounds which fluoresce brightly in daylight. Such materials also emit brilliant visible light when exposed to radiations of wave-lengths lying in the range extending from about 3500 Å. up to about 4500 Å., and hence are excellently adapted to use in the present invention.

The following organic dye compounds may be employed. The fluorescent color for each compound is also indicated.

Meta diethylaminophenol phthalein hydrochloride	Red
Meta diethylaminophenol succein hydrochloride	Red
Meta monethylaminophenol phthalein hydrochloride	Orange
The ethyl ester of meta monobutylaminophenol phthalein	Orange
Meta aminophenol phthalein hydrochloride	Yellow green
Di (para dimethylaminophenyl) ketone imine hydrochloride	Yellow green

2,3, diphenyl N-phenyl quinoxalonium sulphate	Green
p,p' Di [p'' (p''' aminobenzoylamino) benzoylamino] stilbene. o, o' di [sodium sulphonate]	Blue
Meta mono-ethylaminophenol phthalein	Orange
Meta monoethylaminophenol phthalein ethylester hydrochloride	Orange
Diamino stilbene - di - sulphonic acid (sodium salt)	Blue-white
2, amino, 9(4' aminophenyl) acridonium nitrate	Yellow-green
4, amino 1,8 naphthal p-xenylimide	Yellow-green
2, [4' amino 8' carboxynaphthyl (1')] benzimidazole sodium sulfonate	Green
Di (dimethylaminophenyl) phenyl amino naphthyl methene chloride	Green
4 methyl, 7 hydroxy coumarin sodium salt	Blue

Such compounds may be dispersed or dissolved in suitable carrier materials which are highly transparent to radiations of wave-lengths lying between about 3500 Å. and about 4500 Å. and which have indices of refraction similar to those of glass or synthetic resins used as the panel material. Such carrier materials may be certain soluble or thermoset organic polymeric materials, noncrystallized saccharides and noncrystallized polyhydric alcohols. Examples of suitable soluble polymeric materials useful as carriers are polymerized methyl-, ethyl-, and butyl methacrylates, polystyrene, polyvinyl acetate, cellulose acetate, ethyl cellulose, and similar compounds. Examples of suitable thermoset polymeric compounds are polymerized melamine formaldehyde resins, polymerized urea formaldehyde resins particularly alcohol-modified urea formaldehyde resins containing no plasticizers, and similar compounds. Examples of suitable saccharides and polyhydric alcohols are glucose and sorbitol.

As set forth in application Serial No. 455,610, the fluorescent material constitutes a solidified carrier material having dispersed therein at least one such fluorescent organic compound in a concentration of not more than five per cent for blue-emitting compounds to not more than one per cent for red-emitting compounds. Particularly good results are obtained when one uses a maximum concentration of from .025 gram for compounds emitting yellow-green light and .015 gram for compounds emitting red light, per cubic centimeter of carrier material; the thickness of the layer of fluorescent material being such that the weight of the fluorescent compound per square centimeter of surface does not exceed .0005 gram for each spectral wave band of light emitted.

Fluorescent compositions may be applied in the form of coatings. If the carrier is a soluble compound, the material may be mixed in suitable proportions with a suitable volatile solvent to form a liquid coating material which may be applied by painting, printing, or screening processes. Evaporation of the solvent leaves a solid layer of fluorescent material.

If the carrier is a thermoset plastic material, partially polymerized carrier material, or the reactants necessary to produce the polymer, and the fluorescent compound in proper concentration, are incorporated in a suitable liquid which is applied to the surface. The resulting coating is baked to remove any volatile liquids present and to form a layer of fluorescent composition containing the fluorescent compound dispersed in a thermoset polymer.

The fluorescent compound may be incorporated in sheets of organic material, such as fabric or paper sheets or the like instead of being dispersed in carriers. Such fluorescent sheets may be of the type described in U. S. Patent No. 2,417,384, of Robert C. Switzer. Such dyed sheet materials are particularly well suited for use as the flexible sheet illustrated in Fig. 8.

Inorganic fluorescent pigments may be employed instead of organic fluorescent compounds. Examples of suitable inorganic pigments are the activated alkaline metal sulphides. These pigments may be dispersed in a liquid carrier and applied to the desired base in the manner indicated above.

The carrier material for the fluorescent dye or pigment may be such that it is tacky and will have adhesive properties. A flexible sheet having one or more areas coated with such fluorescent material may be employed in the devices described in connection with Fig. 5 to Fig. 8.

However, it is more advantageous to employ a separate layer of permanently tacky, pressure adhesive material over the fluorescent material, as described above with relation to Figs. 5–8.

The elongated body through which the radiations are transmitted by internal reflection may have other forms than that of a rectangular panel shown in the illustrated embodiments. For example, the panel may be V-shaped in vertical cross section with the radiations passing into the thicker end of the panel and being internally reflected from the converging surfaces until the angles of incidence become less than the critical angle of reflection. The radiations will then pass through a surface of and out of the panel in a relatively wide area. The fluorescent material may be disposed in optical contact with the surface of the panel, either in the area where the radiations pass through the surface, or in the area where there is normally internal reflection of the radiations. By this means, a greater intensity of radiation and fluorescence may be obtained at points remote from the source of radiation than can be obtained with panels having parallel sides or an added pleasing effect can be obtained in the form of a glow or haze at the top of the display at an area substantially removed from the source of radiations.

While the fluorescent material has been disclosed as being coated on a surface of the panel or disposed on a flexible sheet adjacent the panel, the fluorescent material may also be disposed in recesses or channels formed in a surface of the panel to provide unusual effects when irradiated.

The present invention thus provides display devices which overcome the shortcomings of prior devices illuminated by fluorescigenous radiation, and make possible for the first time a compact, inexpensive, efficient display device in which the patterns are formed of fluorescent materials irradiated by fluorescigenous radiation to emit brilliant, glowing visible light of many colors.

Various modifications may be made in the devices described above without departing from the spirit of the present invention. The scope

of the present invention is defined by the appended claims.

What is claimed is:

1. A fluorescent display device comprising a transparent panel capable of transmitting fluorescigenous radiations and having opposed continuous surfaces, a source of unfiltered fluorescigenous radiations disposed adjacent the edge of said panel so that said unfiltered radiations may be transmitted without interruption through the panel by internal reflection from the surfaces thereof, and fluorescent material in optical contact with selected areas of one of said opposed continuous surfaces of the panel whereby visible radiations are emitted from said material when excited by the fluorescigenous radiations and a substantial portion of said emitted visible radiations pass without internal reflection through the areas of the opposed surface opposite said selected areas to which the fluorescent material is in optical contact.

2. A device as claimed in claim 1 wherein the fluorescigenous radiations from said source include radiations having wave lengths within the range of from about 3500 Å. to 4500 Å.

3. A device as claimed in claim 1 wherein the fluorescent material is applied directly to the surface of the panel.

4. A device as claimed in claim 1 and further comprising a light reflective material superimposed on the fluorescent material in optical contact with said panel.

5. A device as claimed in claim 4 and further comprising a backing sheet of dark color disposed behind said panel and said fluorescent material and light reflective material.

6. A device as claimed in claim 1 wherein said panel is composed of glass.

7. A device as claimed in claim 1 wherein said panel is composed of a clear, transparent plastic material.

8. A device as claimed in claim 1 wherein the fluorescent material is responsive to daylight.

9. A fluorescent display device comprising a transparent panel capable of transmitting fluorescigenous radiations and having opposed continuous surfaces, a source of fluorescigenous radiations disposed adjacent the edge of said panel, so that said radiations may be transmitted without interruption through the panel by internal reflection from the surfaces thereof, a flexible sheet of dark color disposed behind said panel, fluorescent material affixed to said sheet and facing said panel, a pressure adhesive material superimposed on said fluorescent material for adhesion to said panel at selected areas so that said fluorescent material will be in optical contact with said panel at said selected areas, whereby visible radiations are emitted from said material when excited by the fluorescigenous radiations.

10. A device as claimed in claim 9 wherein said fluorescent material is affixed to said sheet only at said selected areas.

11. A device as claimed in claim 9 further comprising a light reflective material disposed between said fluorescent material and said flexible sheet.

12. A device as claimed in claim 11 wherein the light reflective material, the fluorescent material and the adhesive material are affixed to the flexible sheet and are superimposed on each other in the order named only at said selected areas.

13. A device as claimed in claim 9 wherein the fluorescent material and the adhesive material substantially cover said flexible sheet and wherein said adhesive material is adhered to said panel only at selected areas.

14. A device as claimed in claim 9 wherein the fluorescent material is responsive to daylight.

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