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FILTER DARKROOM LIGHT

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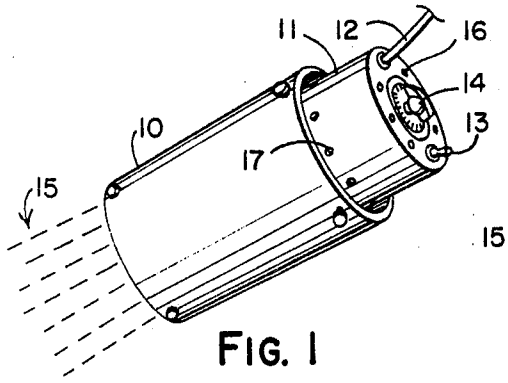


FIG. 1

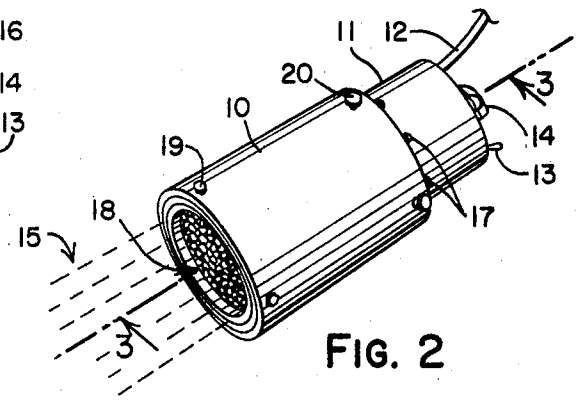


FIG. 2

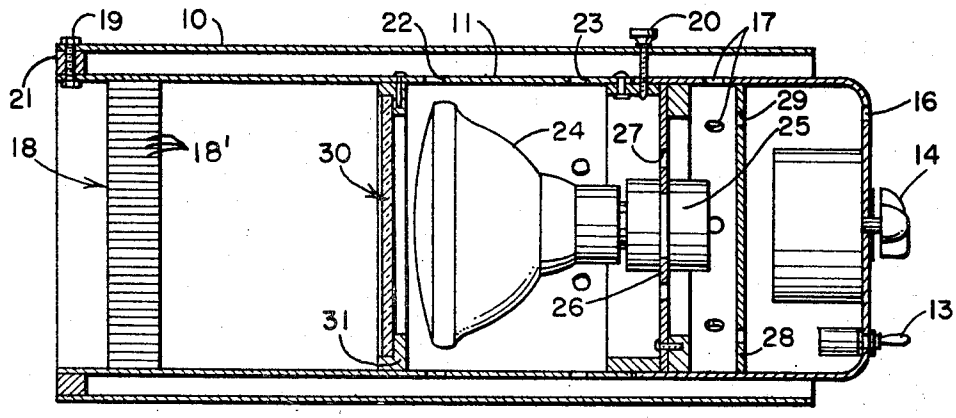


FIG. 3

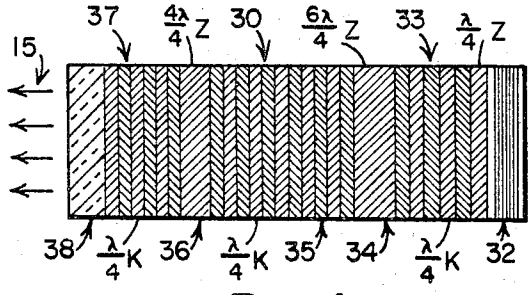


FIG. 4

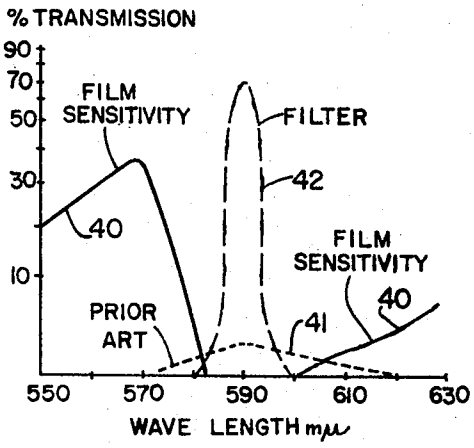


FIG. 5

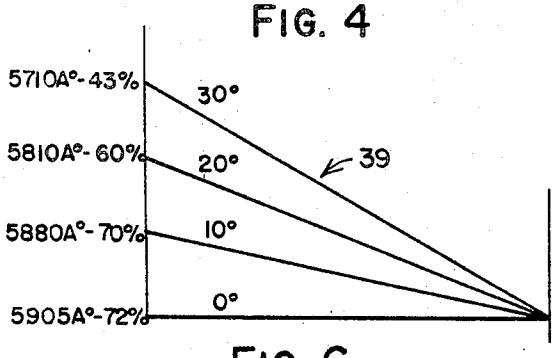


FIG. 6

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FILTER DARKROOM LIGHT

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ABSTRACT OF THE DISCLOSURE

A safe light for photographic darkrooms is provided in the form of a double walled cylindrical holding structure incorporating a light source, filter, and a honeycomb structure defining straight parallel passages for limiting the angle of divergence of the output light. The filter includes a first piece of glass having a multi-layer dielectric coating and a dichroic filter positioned on the opposite side of the multi-layer dielectric coating so that the coating is sandwiched between the glass and dichroic filter. The coating reflects light radiation falling outside a given spectral pass band for which film being processed is relatively insensitive. Thus a large degree of illumination is provided for working on the film with minimum risk of damaging the film itself.

This invention relates to an improved safe light primarily useful in darkrooms and film processing plants.

It is well known that many black and white and color photographic films exhibit low sensitivity responses at certain spectral wave lengths. Illuminating means for providing sufficient light for workers during the processing or developing of such film should accordingly be designed to emit light of radiation having wave lengths to which the film is relatively insensitive. In this respect, a sodium vapor type lamp could very effectively be used in darkroom applications as a suitable safe light since many photographic films have a low sensitivity response at the spectral frequency of the sodium lines. However, the initial investment in a sodium vapor lamp and the relatively short lifetime of the bulb makes its use in many instances unsatisfactory from an economical standpoint.

An alternative to the use of a relatively expensive sodium lamp would be to provide a conventional tungsten type lamp in combination with some type of absorbing medium to block light radiations harmful to the film. In this respect, there has heretofore been provided one type of safe light including an absorbing type filter. However, the pass band of this filter is defined by employing high absorption materials with the result that a broad pass band results that can well overlap into sensitive spectral regions of the film. In addition, the light intensity is relatively low, usually less than 10%.

If a high efficient multi-layer dielectric filter should be used with a conventional lamp, a problem arises in that any defined pass band tends to shift as a function of the angle of incidence of the light from the light source striking the filter. The end result is again a possible overlapping of the pass band with sensitive spectral regions of the film.

With the above in mind, it is a primary object of the present invention to provide a vastly improved safe light particularly useful in photographic darkrooms in which the foregoing problems are overcome.

More particularly, it is an object to provide a safe light which provides a substantially higher degree of light intensity than has heretofore been available without the risk of damaging the film being processed.

Other objects are to provide a high intensity safe light which is substantially less expensive to maintain than presently available safe lights of comparable efficiency and is of substantially longer life thereby minimizing replacement expenses.

Briefly, these and many other objects and advantages of this invention are attained by combining a conventional light source with a filter means positioned relative to the source to filter light from the source. The filter means defines a narrow spectral pass band of high transmission for light radiation of wave lengths in the pass band and negligible transmission for light radiation of wave lengths outside the pass band. The spectral pass band itself falls within a band of light radiation to which most photographic film is substantially insensitive. In addition, absorption type filtering is not utilized in the band pass region so that high intensity radiation is passed by the filter and a high degree of illumination is available to the worker.

To avoid shifting of the spectral pass band as a consequence of light passing through the filter at angles of incidence deviating from the normal angle of incidence, the safe light, in its preferred embodiment, further includes a light angle limiting means. This means functions to limit the angle of light passing from the safe light structure with respect to the axis of the light beam, to a value less than a given angle.

A better understanding of the invention will be had by now referring to a preferred embodiment thereof as illustrated in the accompanying drawings, in which:

FIGURE 1 is a rear perspective view of the safe light;

FIGURE 2 is a front perspective view;

FIGURE 3 is an enlarged cross section in the direction of the arrows 3—3 of FIGURE 2 showing some of the basic components making up the safe light with other components in full lines;

FIGURE 4 is a highly diagrammatic illustration of the multi-layer dielectric filter means used in the structure of FIGURE 3;

FIGURE 5 is a curve of the transmission characteristics over various wave lengths of the filter in FIGURE 4 superimposed on a film sensitivity characteristic plot and on a prior art filter curve; and,

FIGURE 6 is a diagram useful in explaining the transmission characteristics of the filter as a function of the angle of incidence of light on the filter.

Referring first to FIGURE 1, the safe light comprises a holding structure in the form of coaxially positioned outer and inner cylindrical casings **10** and **11**. As shown, there is provided a lead in wire **12** for connecting a source of electrical energy such as conventional 110 volt 60 cycle power to a suitable lamp within the inner casing **11**. Also illustrated in FIGURE 1 is a switch **13** for turning the safe light on and off and a rheostat **14** for adjusting the intensity of the light.

As will be evident from both FIGURES 1 and 2, light from the safe light passes from the opposite end of the housing as indicated at **15**. Heat generated by the light source in the housing is dissipated by the provision of suitable air holes in the inner casing **11**, such as indicated at **16** and **17**. Also visible in FIGURE 2 is a light angle limiting means in the form of a honeycomb structure **18** defining a plurality of longitudinal passages in the front portion of the holding structure. Suitable screws **19** and **20** hold the casings in coaxial relationship to each other.

Referring now to the detailed cross section of FIGURE 3, it will be noted that the screws **19** cooperate with an annular spacing ring **21** to hold the outer casing **10** in proper coaxial, spaced relationship with respect to the inner casing **11** to define an annular air space therebetween. The screws **20** also cooperate in holding the other end of the outer casing **10** in proper, coaxially spaced relationship relative to the inner casing and also permit communication of the annular space between the casings with the atmosphere.

The inner casing **11** includes additional air holes **22** and **23** circumferentially spaced about the casing for permitting air circulation to the annular space between the casings and thus to the atmosphere.

A light source in the form of a conventional bulb such as a tungsten bulb **24** is incorporated in the inner casing **11** and supported in a suitable socket **25** mounted on a supporting plate **26**. The supporting plate **26** includes air holes **27** and cooperates with a second plate **28** having air holes **29** to provide a light partition. In this respect, the holes **27** are staggered with respect to the holes **29**, and these latter holes are circumferentially staggered relative to the holes **16** and **17** in the extreme rear of the inner casing so that proper air circulation can take place without any straight line pass being defined to the exterior of the holding structure. As a consequence, light is blocked from passing out through these holes.

In a similar manner, the positioning of the holes **22** and **23** in the inner casing **11** are such that any light passing through these holes will be blocked by the surrounding outer casing **10**.

A filter means **30** is supported in the inner casing on a mounting ring **31** in front of the lamp **24**. The light angle limiting means **18** described in FIGURE 2, in turn, is incorporated in the inner casing towards the front end of the casing for receiving light from the filter **30**. The plurality of longitudinally extending straight, parallel passages defined by the honeycomb structure **18** are shown at **18'**. It will be evident that light passing into each passage at an angle greater than a given angle will be blocked from passing through the passage. The structure **18** thus serves in one respect as a light collimating means.

Referring now to FIGURE 4, a preferred type of filter making up the filter means **30** described in FIGURE 3 is shown in detail. Basically the filter means includes a dichroic filter **32** which may comprise nineteen alternate layers of dielectric material coated on a suitable glass substrate. Following this dichroic filter is a second glass substrate upon which are coated alternate layers of dielectric material indicated generally at **33**. In the particular filter shown, these layers constitute, respectively, quarter wave length thick coatings of zinc sulfide and sodium aluminum fluoride, commonly referred to as cryolite. The quarter wave length zinc layers are indicated as $\lambda/4Z$ while the cryolite layers are indicated by $\lambda/4$ K.

It will be noted that a total of six layers are provided on the substrate end glass of the dichroic filter **32**. Following these six layers is a spacer layer **34** of zinc sulfide, preferably six-fourths of a wave length in thickness as indicated. This spacer layer, as is well known to those skilled in the art, controls the width of the pass band of the overall filter.

Following the spacer layer **34** are further alternate layers of zinc sulfide and cryolite as indicated at **35**. Eleven such layers are shown followed by another spacer layer **36** of zinc sulfide of 4/4 wave length thickness. Finally, there are provided six alternate layers of zinc sulfide and cryolite following the spacer layer **36**. The opposite or left end of the filter as illustrated in FIGURE 4 terminates in an absorbing medium **38**, preferably a piece of glass such as commercially available "Corning 3482." This glass is impregnated with a suitable dye designed to absorb radiation of wave lengths shorter than 560 millimicrons.

Light from the bulb **24** of FIGURE 3 first passes through the dichroic filter **32** and then through the multilayer filter to exit as at **15** from the absorbing glass piece **38**. Essentially, the alternate layers of dielectric material constituting the multi-layer coating, reflect radiations of wave lengths on either side of a defined spectral pass band.

With particular reference now to FIGURE 5, there is illustrated by the solid lines **40** the film sensitivity over a range of wave lengths of a class of photographic films with which the safe light of this invention may be used. Also illustrated is a dotted curve **41** indicative of prior art type absorption medium used in conjunction with a conventional lamp for safe light purposes, and a dashed line curve **42** defining the band pass characteristics of the filter of this invention for comparison purposes.

With respect to the prior art absorption characteristics as indicated by the dotted curve **41**, it will be evident that any pass band involved is relatively broad and that the transmission of radiation to which the film is relatively insensitive is less than 10%. It will also be clear that as a consequence of the broad width and shallowness of this pass band characteristic, there is overlapping onto the film sensitive regions defined by the solid curves **40** on either side of this pass band.

On the other hand, it will be clear that the extremely narrow pass band characteristic of the filter described in FIGURE 4 and as indicated by the dashed curve **42** provides for well over 50% transmission for radiation of wave lengths falling outside the sensitive wave lengths defined by the solid curve **40**. The pass band **42** has relatively sharp cut off characteristics so that there is substantially no serious overlapping of the film sensitive curves.

From the curve **42**, it will be evident that radiation of wave lengths between approximately 580 and 600 millimicrons will be transmitted by the filter and the radiations of wave lengths between 589 and 592 millimicrons will be passed to an extent considerably greater than 50%. Transmission of radiations of wave lengths lying outside these values, on the other hand, is considerably less than 10%.

As a consequence, it will be clear that a relatively high intensity light is provided without risk of damaging the film so that a marked improvement is provided over any prior art type of safe light presently available.

Referring now to FIGURE 6, there is illustrated a series of straight lines **39** angulating from a single point to the right. The line designated 0° corresponds to light radiation striking the filter at a normal angle of incidence; that is, the filter surface is perpendicular to the axis of travel of the light. For the particular filter described in FIGURES 4 and 5, there will be provided substantially 72% transmission of radiation of wave lengths in the neighborhood of 5905 A. However, for light striking at an angle of incidence of 10°, it will be noted that 70% transmission results for radiations of wave lengths in the neighborhood of 5800 A. units. For incidence angles of 20° and 30°, the transmission is progressively less as shown and it will be noted that the wave lengths transmitted, in turn, become progressively shorter.

In essence, as the angle of incidence increases, the spectral pass band shifts towards the shorter wave lengths. As a consequence, and again with reference to FIGURE 5, this shifting of the spectral pass band towards the shorter wave lengths can result in possible overlapping of the film sensitivity spectral regions indicated by the curves **40**.

In accordance with a feature of this invention it is desirable as a result of the foregoing phenomenon to limit the angle of light passing from the housing structure described in FIGURE 3 to an angle relative to the light axis or axis of the housing structure of 10° or less. This angle limitation is effected by the several straight line passages defined by the honeycomb structure **18** as described heretofore in conjunction with FIGURE 3.

From the foregoing description of the safe light of this invention, its operation will be evident.

With the wires **12** connected to a suitable power outlet, the lamp **24** is energized by closing the switch **13**. The degree of illumination may be readily controlled by the rheostat **14**. The housing structure itself is oriented so as to direct the light beam **15** onto various items or film with which a worker or film processor may be dealing. As a result of the filtering characteristics described, there will be a relatively high degree of illumination without fear of damaging any film being processed.

Heat generated by the lamp is properly dissipated by convection air currents passing through the various air holes described. By providing the double casing structures **10** and **11**, there are defined suitable air passages for proper air circulation without in any way permitting light from the lamp **24** from escaping through the casing structures other than out the front wherein its angle from the desired directional axis of the light is limited by the honeycomb structure **18**. In addition, the double casing structure permits handling of the safe light without the operator burning himself inadvertently, the outer casing **10** remaining considerably cooler than the inner casing.

Should the light bulb burn out, the bulb itself may be easily and inexpensively replaced with a similar commercially available tungsten bulb. The bulb itself is the only major element subject to maintenance, the filter and light angle limiting means constituting passive components in the structure.

From the foregoing description, it will be evident that the present invention has provided a greatly improved safe light particularly useful in photographic darkrooms and other film processing plants wherein all of the various objects set forth heretofore are fully realized.

While the preferred embodiment of the invention has been described with respect to film processing, it will be evident that the safe light may be used in other applications involving items sensitive to certain light radiations. The invention accordingly is not to be thought of as limited to the specific embodiment set forth for illustrative purposes.

What is claimed is:

1. A safe light comprising, in combination: a holding structure; a light source mounted in said holding structure; a filter means positioned in said holding structure to filter light from said source such that light from said filter means is predominantly defined by a given spectral pass band, said filter means including at least one piece of glass having a multi-layer dielectric coating, and a dichroic filter positioned on the opposite side of said multi-layer dielectric coating so that said coating is sandwiched between said glass and dichroic filter for reflecting light radiation falling outside said given spectral pass band to thereby define said pass band; and light angle limiting means positioned in said holding structure to limit the angle at which light can pass from said holding structure to a given angle whereby said safe light may be used to illuminate safely items predominantly sensitive to light radiation falling outside said given spectral pass band and relatively insensitive to radiations falling within said spectral pass band.

2. A safe light according to claim **1**, in which said holding structure comprises outer and inner casings in coaxial relationship to define an air space between the inner wall of said outer casing and the outer wall of said inner casing, said light source being mounted in said inner casing, said inner casing including air holes communicating with said air space to permit air circulation to said air space, said air space communicating with the exterior atmosphere at a point positioned relative to said air holes such that light from said light source passing through said air holes is blocked by said outer casing.

3. A safe light according to claim **1**, in which said light angle limiting means comprises a plurality of straight, parallel, passages of given longitudinal extent such that light entering one end of each passage at an angle to the longitudinal axis of said passage greater than said given angle, is blocked by said passage from passing therethrough.

4. A safe light according to claim **3**, in which said given angle is approximately 10°.

5. A safe light according to claim **1**, in which said glass in said filter means exhibits a relatively high absorption cross section for light radiation of wave lengths shorter than the wave lengths in said given band.

6. A safe light according to claim **1**, in which said pass band includes light radiations of wave lengths between 580 and 600 millimicrons, said items constituting photographic film to be processed.

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