

May 2, 1944.

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2,347,671

ULTRAVIOLET FLUORESCENT INSTRUMENT ILLUMINATION

Filed Dec. 26, 1940

3 Sheets-Sheet 1

FIG. 2.

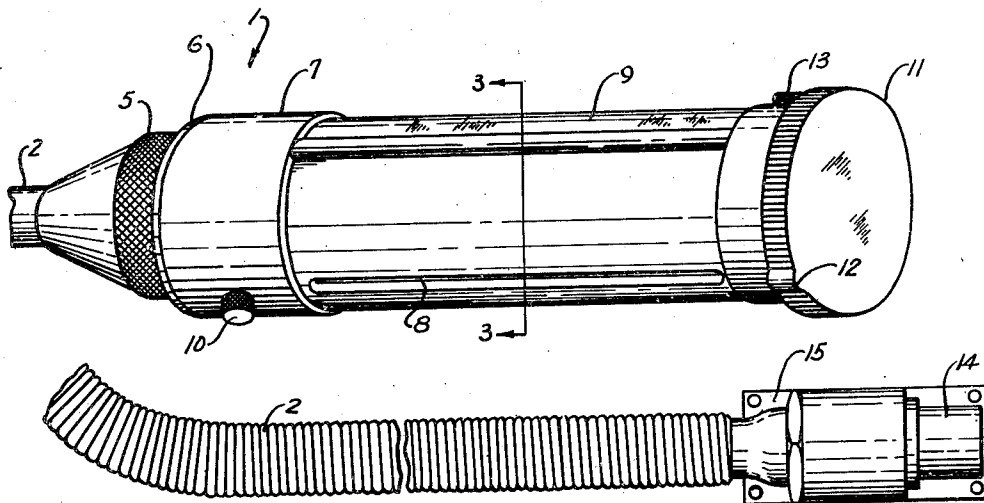


FIG. 3.

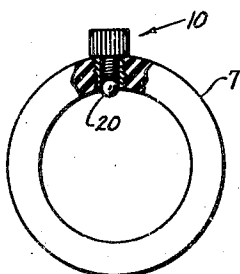
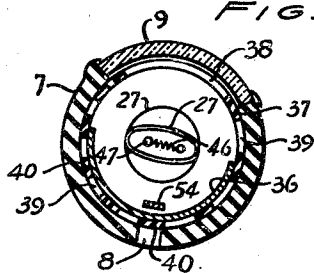
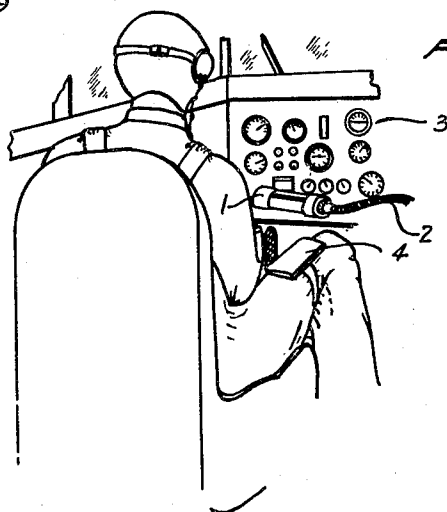


FIG. 4.

FIG. 1.



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3 Sheets-Sheet 2

FIG. 5.

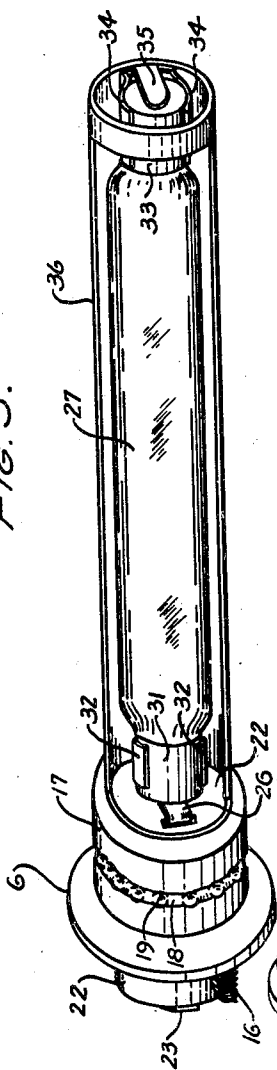


FIG. 7.

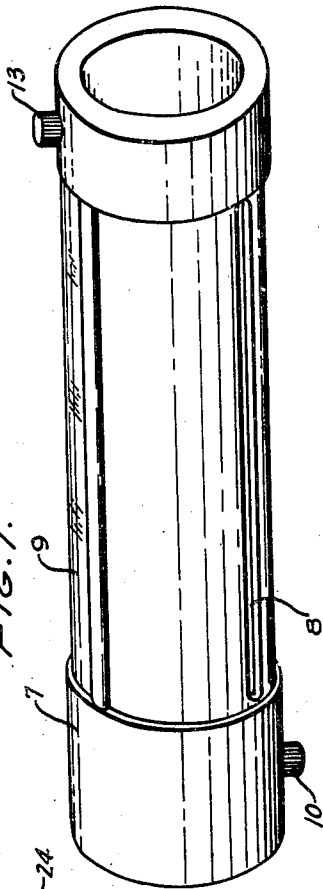
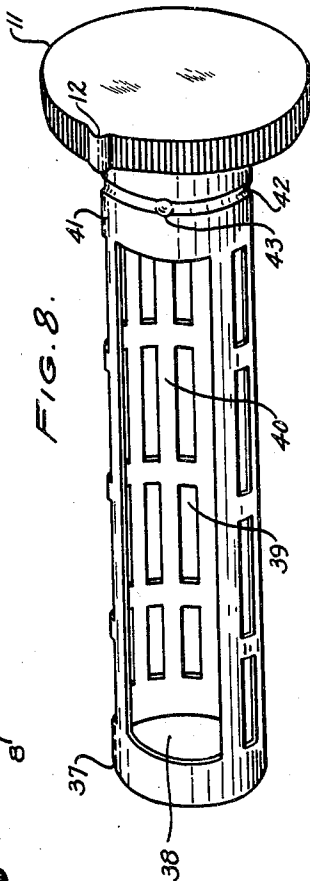


FIG. 8.



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3 Sheets-Sheet 3

FIG. 9.

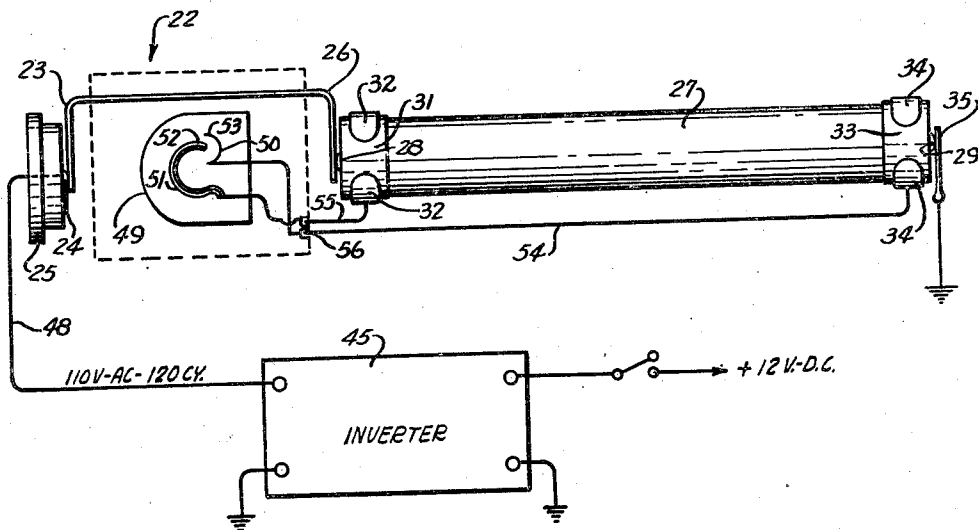
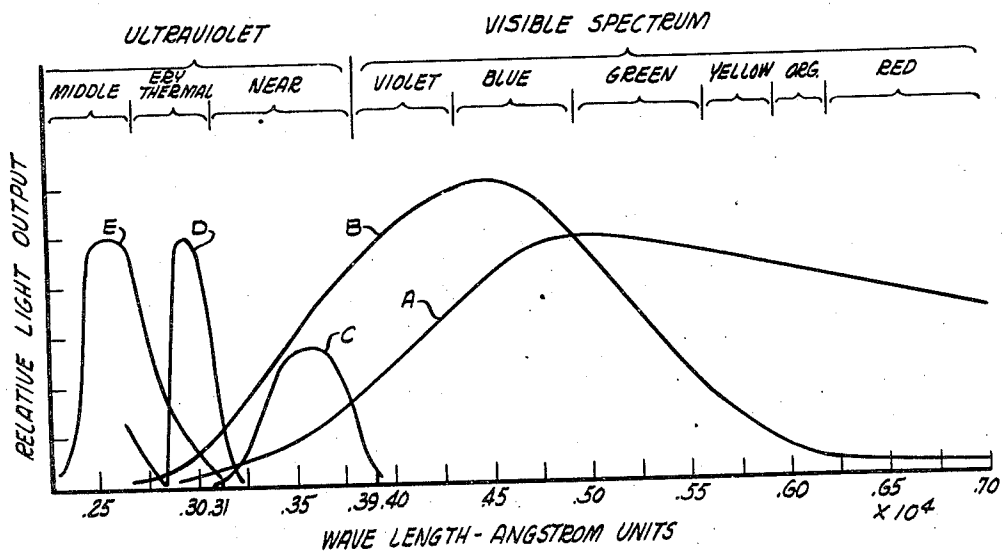


FIG. 10.



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UNITED STATES PATENT OFFICE

2,347,671

ULTRAVIOLET FLUORESCENT INSTRUMENT
ILLUMINATION

Arnold D. Dirksen, Dayton, Ohio

Application December 26, 1940, Serial No. 371,819

3 Claims. (Cl. 240—8.16)

(Granted under the act of March 3, 1883, as
amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to the art of floodlighting instrument panels with invisible ultraviolet light to activate fluorescent material on indicators and markings to make the same visible in the dark.

In view of the ever-increasing speeds of modern aircraft, and the constant increase in both commercial and military night flying, the problem of providing improved instrument lighting on airplanes is of prime importance in the interests of safety. This problem has two aspects: the rendering of clear and sharp definition of the indicators and markings, and at the same time the maintaining of a low general level of illumination in order to avoid a dangerously long accustoming period for the pilot's eyes between instrument and contact flying at night.

Where instruments are lighted individually by visible light, or where the instrument panel is floodlighted with visible light, the conditions of adequate instrument definition and short accustoming period are mutually inconsistent, and both conditions must be compromised to the satisfaction of neither. Thus it has been found that with visible light the illumination level necessary to render the instruments easily readable results in an accustoming or accommodation period, when the pilot looks out into the darkness, which is inconsistent with safety at present night flying speeds. To better satisfy the above conditions the expedient of coating indicators and markings with radium paint has been tried, but has proved unsatisfactory because without activation the radium paint fails to produce sufficiently bright or clear cut indications of the indicator positions and dial markings. The activation of radium markings by ultraviolet light has been proposed and tried prior to the present invention, but without a high degree of success. Because of the electrical power limitations on airplanes, and for other reasons, the conventional sources of ultraviolet radiations have been particularly unsatisfactory in known prior art installations.

For instance, incandescent lamps operated at over voltage have been proposed. Such an installation is unsatisfactory for the present purpose because of the short life of the lamps, the low efficiency of ultraviolet generation, and the resulting large power requirements. Likewise, argon lamps have been proposed. Here again

the ultraviolet light from a lamp of small size was found to be of too low intensity to serve the purpose. Raising the level of ultraviolet illumination from this type of lamp results in increased power consumption and produces a blue haze in the cockpit which becomes objectionable after prolonged flying.

Other conventional sources of ultraviolet light are objectionable because of power requirements, the bulk and weight of the apparatus required, and also in many instances because of the nature of the energy radiated. In the latter respect some ultraviolet sources are objectionable because their radiation spectrum includes the erythermal and middle ultraviolet ranges, the former producing skin-tanning effects, and the latter having sterilizing properties. These types of light cannot be used in an airplane cockpit or cabin.

It is therefore the general object of the present invention to provide improved instrument illumination for use in airplanes and the like which will fulfill the conditions stated above, and which will not be subject to the objections pointed out.

A particular object is to provide improved fluorescent instrument lighting for an airplane instrument panel or the like through the use of non-harmful invisible light, the level of intensity of the visible light from the fluorescent effects being low enough to avoid dangerously long accustoming periods for the pilot's eyes when shifting from the lighted instrument panel to outside darkness.

A further object is to provide a small and compact lighting unit capable of floodlighting an instrument panel with near-ultraviolet light within a band of wave lengths between violet light and harmful ultraviolet light, which unit may be operated with a relatively small amount of power from an airplane battery or the like.

A still further object is to provide a lighting unit capable of producing light having a spectral band consisting predominately of blue, violet, and near-ultraviolet light, said unit being provided with means for floodlighting an area with near-ultraviolet light of controllable intensity, and with means for floodlighting an area with predominately blue light.

These and other objects will become apparent from the following description, taken in conjunction with the drawings wherein is illustrated details of a preferred embodiment of the invention, and the mode of operation thereof.

The preferred form of lamp hereinafter shown

and described possesses certain novel features which have not been claimed in the present application, these features forming the subject matter of certain of the claims contained in my co-pending joint application Serial Number 576,730 filed January 31, 1941, and entitled "Ultraviolet instrument light."

In the drawing:

Figure 1 is a fragmentary perspective view illustrating a preferred manner of mounting the lamp unit of the present invention in the cockpit of an airplane.

Figure 2 is a perspective view of the lamp unit and support, portions of the latter being broken away.

Figure 3 is a cross-sectional view taken on the line 3-3 in Figure 2.

Figure 4 is an end view of the exterior casing, with certain parts shown in section.

Figure 5 is a perspective view illustrating the lamp base with the lamp in place therein, certain parts being broken away to disclose other parts.

Figure 6 is a perspective view of a contact carrying end cap, removed from the base.

Figure 7 is a perspective view of the exterior casing of the lamp unit, removed from the base.

Figure 8 is a perspective view of the light controlling shutter, removed from the casing.

Figure 9 is a schematic diagram of the lamp circuit.

Figure 10 is a graph showing a number of light intensity curves in comparative relation through a wide range of wave lengths.

In Figure 1, the lighting device 1 of the present invention is illustrated as supported by a flexible conduit supporting member 2 in operative position in the cockpit or cabin of an airplane. The flexible support 2 is secured at one end, not shown, to any convenient point on the fuselage of the airplane so that the device 1 may be swung into the approximate position illustrated between the pilot and the instrument panel 3. The instruments on panel 3 have indicators and markings coated with radium paint or other fluorescent material in a manner well known in the art, and such material is adapted to be activated by ultraviolet light so as to fluoresce sufficiently to produce bright and clear-cut indications of readings when activated as described.

The lighting device 1, presently to be described in detail, is adapted to floodlight the instrument panel 3 with near-ultraviolet light so as to activate the fluorescent materials on the various instruments, the position of the device 1 preferably being forward of the pilot and relatively close to the instrument panel 3 so that none of the direct rays of the near-ultraviolet light will be directed into the face of the pilot. By means of the flexible support 2 the device 1 may be moved to the most convenient position so as not to obstruct the view or operations of the pilot, and at the same time provide sufficient activation for the fluorescent material on the various instruments. In addition, to special adjustments of the device 1 within the cockpit, a further adjustment is provided within the device for regulating the intensity of the near-ultraviolet light to give the desired level of illumination for any selected position of the device. The device 1 is further provided with a window or other means for floodlighting a desired area within the cockpit with blue light. The blue light may be directed as desired toward the instrument panel 3 or certain other parts of the cockpit and is particularly useful for reading

maps such as the map 4 shown in the customary position on the pilot's right knee.

Alternately, the device 1 may be mounted upon the control column or other convenient support within the cabin, or it may be built into any convenient part of the interior of the cabin where it can perform its intended functions. In a large cabin, a plurality of lighting devices 1 may be provided, either on flexible mounting means as shown, or built into the structure of the airplane in suitable locations as described. In all cases, the devices should be capable of directing the ultraviolet light output away from the pilot's face and toward the instrument panel, and should also be capable of directing a beam of visible blue light to various parts of the interior of the cabin when desired. The ultraviolet light emitted by the device 1 is, of course, invisible and produces a visible effect only when it falls upon some fluorescent material, but it must not be directed toward a person's face, as this would cause an objectionable fluorescence in the eyes. The blue light is preferably a very dark blue containing much violet so that at no time will there be produced a relatively high level of illumination which would result in a dangerously long accustoming period for the pilot's eyes, when he looks out into the darkness in night flying.

The external parts of the lighting device and flexible support 2 are illustrated in greater detail in Figure 2. One end of the flexible support 2 is attached to a bracket 15 which is adapted to be secured to the interior of the cockpit or cabin, the bracket 15 being provided with a socket 14 for making the necessary electrical connections for energizing the lamp. The other end of the flexible support 2 is secured to the device 1 by means of a screw-threaded union 5 engaging a base portion 6. The interior parts of the device are enclosed in a generally cylindrical casing 7 provided with a longitudinal slot 8 and a window 9 of ultraviolet filter glass the characteristics of which will be presently described.

Casing 7 is mounted for rotation upon the base 6 and carries a post 10 to serve as an indication of its rotational position. A light shutter is provided within the casing 7 to regulate the intensity of near-ultraviolet light transmitted through window 9, this shutter being rotatably mounted within the casing 7 and manipulable by means of a knob-like disc 11 closing the end of the casing 7 as shown. Knob 11 is provided with a projection 12 which may be turned relatively to a second post 13 on the casing 7 to obtain a predetermined setting of the shutter.

In Figures 5 to 8, various parts of the lamp are illustrated separately in positions corresponding to their assembled positions. In all the views corresponding reference numerals indicate identical parts of the structure. The base 6 is provided with a threaded portion 16 for receiving the union 5, and with a cylindrical portion 17 for rotatably mounting the casing 7. A groove 18 containing spaced indentations 19 is provided in the manner shown on the cylindrical portion 17 and cooperates with a spring urged ball detent 20 projecting from the interior surface of the casing 7. The ball detent is shown in Figure 4 and is carried upon the inner end of the post 10 in such a manner that in mounting the casing 7 upon the cylindrical portion 17 the ball will snap into the groove 18 and may then be caused to click from one indentation 19 to the next as the casing 7 is rotated with respect to the base 6. In this manner, the ball detent 20 performs the double function of securing the casing 7 against casual axial

displacement from the base 6 and of holding the casing 7 in a selected rotative position on the base 6.

Base 6 is hollow and holds therewithin a removable housing 22 containing a lamp starting device to be presently described. The housing 22 is provided on one end with a resilient contact 23 adapted to engage a contact element 24 on an insulating disc 25 which closes the open end of the threaded portion 16 when the union 5 is screwed into place. The contact member 23 in the present embodiment is a strip of metal which extends through the housing 22 so as to terminate on the other end of the housing in a resilient contact 26 which serves as a center contact for the lamp 27.

The lamp 27 is provided with a base on each end, each base having two contacts thereon. In the present embodiment one of the contacts is a centrally located metallic button in the end of the tube and the other contact is a metallic collar around the end portion of the tube. The metallic collar 31 is engaged by the spring clip contact 32 which supports one end of the lamp, the central contact button 28 being engaged by the spring contact 26. The base on the other end of the lamp is similarly constructed and comprises the metallic collar 33 carried by the spring clip contacts 34, and a central contact button 29 bearing against a spring contact 35. Thus the lamp 27 is supported at its ends by the spring clips 32 and 34, which are in turn insulatingly mounted upon a supporting member 36 extending axially from the base 6. The supporting member 36 is generally semi-cylindrical in shape so as to partially enclose and protect the lamp 27 and is of a radius of curvature less than the inside radius of the cylindrical casing 7. The interior surface of the semi-cylindrical member 36, behind the lamp, may be provided with light reflecting material if desired.

Thus it is seen that the base member 6 carrying the assemblage shown in Figure 5 is mounted upon a supporting means which may be constituted by the flexible support 2, or by a rigid bracket secured in a convenient location. The cylindrical casing 7 is rotatably carried by the cylindrical surface 17 in the manner described and completely encloses the lamp 27, thus permitting the window 9 and slot 8 to be rotated so as to direct either the near-ultraviolet light from the window 9 or the blue light from slot 8 in different directions, within limits.

The light shutter is illustrated in Figure 8 and comprises a generally cylindrical cage-like element 37 extending from the inner face of the knob-like disc 11. This cage closely surrounds the support 36 inside of the casing 7 and has windows of progressively varying sizes through which the light must pass between the lamp 27 and the window 9. Cage 37 is provided with a large opening 38 substantially coextensive with the window 9 for passing the full intensity of the light from the lamp 27. The remainder of the cylindrical surface of the cage 37 contains smaller openings 39 which become progressively narrower in one direction around the said cylindrical surface, as shown in Figures 3 and 8. Thus by rotating the knob 11 and the cage 37 with respect to the window 9, the intensity of the near-ultraviolet light may be varied at will through a wide range of values. Each of the longitudinal ribs 40 between the openings 39 constitutes a shutter bar for closing the slot 8 so that blue light may be shut off in a plurality of positions of the cage 37.

The action of the shutter with respect to the window 9 and slot 8 is illustrated in Figure 3.

As has been stated, the internal diameter of the cylindrical cage 37 is such as to fit over the semi-cylindrical support 36; and in a similar manner, the external diameter of the cage 37 is of a size to produce a sliding fit inside of the cylindrical casing 7. Cage 37 is provided with a cylindrical surface 41 adjacent the knob 11, said cylindrical surface having a groove 42 therearound carrying a plurality of indentations 43 in a manner similar to the groove 18 and the indentations 19 on the cylindrical surface 17. When the shutter device of Figure 8 is assembled within the casing 7, a spring pressed detent on the inner end of post 13, similar to the ball detent 20 on the post 10, snaps into the groove 42 and is adapted to frictionally engage the indentations 43 when the post 13 is caused to pass thereover. This cooperation is designed to assist in preventing unintentional axial displacement of the light shutter and to assist in obtaining preselected rotative positions for the said shutter, in the same manner as the cooperation described between the casing 7 and the support 6. The projection 12 on the knob 11 is significantly located with respect to the indentations 43 so that the angular position of the projection 12 with respect to the post 13 will be indicative of the position of the windows in the cage 37 with respect to the window 9 and the slot 8.

In Figure 9, there is shown by schematic diagram a preferred circuit for starting and operating the lamp 27. The lamp 27 is of the mercury vapor type having a filament 46 carried by electrode posts 47 in each end of the tubular envelope. It has been noted that each end of the lamp carries two external terminal contacts. The specific forms of the external terminals are not material to the invention, the type shown being preferred, however, in the present embodiment. One of the posts 47 in each end of the tube is connected with one of the lamp terminals, and the other post 47 is connected to the other lamp terminal, by means of the contact buttons 28, 29, and the metallic collars 31, 33, to provide an energizing circuit for the two filaments 46.

The source of power comprises the airplane battery which in the present instance is indicated by the 12 volt D. C. supply. This supply is changed by an inverter 45, the details of which do not constitute a part of the present invention, into 110 volts A. C. at preferably 120 cycles, and this output is conveyed to the lighting device 1 through a conductor 48 which passes through the lamp support and makes electrical contact with the contact strip 23 by means of the contact element 24 on the disc 25.

The numeral 49 indicates a neon glow starting switch in the housing 22, the action of which will now be described. Starting switch 49 comprises a first electrode 50 of the approximate shape illustrated and a second electrode 51 comprising a bi-metallic element extending into proximity with the first electrode. These elements are inclosed in an envelope containing an atmosphere of neon gas. When a potential of 110 volts is applied to the circuit shown in Figure 9 to start the lamp 27, the neon lamp 49 will glow with substantially the full potential thereacross, as the discharge path in the mercury vapor lamp 27 in a cold condition constitutes an open circuit and the voltage drop in filaments 46 is small in comparison with the voltage drop in neon lamp 49. This starting

circuit is applied through the lead 55 from the spring clip contact 32, and the lead 54 from the spring clip contact 34, these leads being carried by supporting member 36 and terminating in a detachable connection 56 with the housing 22, as illustrated. For a short interval of time the heat from the neon glow causes a movement of the free end 52 of the bi-metallic strip 51 until it makes contact at a point 53 on the electrode 50. This action short circuits the neon lamp 49, permitting the current at full voltage to pass through the lamp filaments 46. During the time the lamp filaments 46 are in series circuit with the neon lamp 49, throughout the preliminary operation just described, the voltage drop in the lamp 49 is sufficient to prevent the filaments 46 from becoming incandescent.

The flow of full voltage starting current through the filaments 46, as just described, is only momentary because the bi-metallic electrode 51 quickly breaks contact at the point 53 in the absence of heat from the neon glow, and returns to the original position shown. When the circuit is broken at points 52, 53, a reactance coil in the high voltage circuit, and preferably contained within the inverter 45, produces an inductive surge which assists in striking an arc in the lamp 27 between the two filament electrodes 46. Thereafter, the circuit for the continued operation of the lamp 27 is maintained through the center contact buttons 28, 29 of the tube, and contact elements 26 and 35; and the neon starting lamp 49 remains inoperative so long as a discharge is taking place in the lamp 27. The electrodes in the neon glow starting switch 49 are spaced so as to require approximately 110 volts impressed thereon to initiate a glow discharge, hence will draw no current when the lamp 27 is operating because the output circuit 48 of the inverter has a characteristic such that the potential is reduced to approximately 55 volts when the lamp 27 is in operation. The specific type of starting device, and the values of voltage, disclosed herein are merely illustrative of a preferred embodiment, and are in no way intended as limitations in the practice of the invention.

Lamp 27 may be designated as a blue fluorescent gaseous mercury vapor lamp which has a fluorescent material applied as a coating on the inside of the lamp envelope. This coating has the characteristic of transforming the short ultraviolet rays of 2537 A. of the mercury vapor light into near-ultra-violet, violet and blue light which results in a relatively high efficiency light output with respect to power consumption. In Figure 10 there are illustrated comparative curves for various types of light energy radiation to show the relationships of the light outputs with the light output of the present device. Curve A represents the average spectral distribution of natural daylight, and curve B represents the light output from the fluorescent coating in the lamp 27. It will be seen that the light represented by curve B is predominately blue and violet with a considerable component of near-ultraviolet and negligible amounts of erythermal and middle ultraviolet. At the other end of the spectrum it will be seen that there is likewise a negligible amount orange and red light emitted, and a small proportion of green and yellow light.

The filter glass 9 is designed to transmit light having the characteristics of curve C, this curve

representing the nature of the near-ultraviolet light which is projected upon the instrument board when the lamp 27 is in operation behind the filter glass 9 in the lighting device of the present invention. It will be seen that the curve C contains only a negligible amount of visible violet light, substantially no light in the erythermal portion of the ultraviolet, and none in the middle portion of the ultraviolet, which distribution is desired because radiant energy below the near-ultraviolet is considered harmful under continuous exposure. The light curve for the band of near-ultraviolet passed by the filter 9 extends from 3100 A. to 3900 A., having a peak at approximately 3500 A., and, as substantially no visible light is transmitted, there is accomplished the effective elimination of objectionable blue haze which accompanies the ultraviolet light from certain known lighting devices. The limit of the visible spectrum is considered to be 3900 A.

Curve D represents the light from a typical sun tan lamp designed to produce a maximum erythermal effect, which curve lies almost wholly outside of the curve B for the lamp 27, and is even more remote from the curve C for the filter glass 9. Curve E represents the light from a typical germicidal or sterilizing lamp and it is seen that both the curve B for the lamp 27 and curve C for the filter glass 9 are safely removed therefrom.

By reason of the fact that the peak of the curve B for the lamp 27 is situated well down in the blue part of the spectrum and contains relatively little yellow and green light, the cockpit illumination obtained through the slot 8 when the latter is open will be of a sufficiently low level of intensity that the accustoming period for the pilot's eyes when he looks out into the darkness will be held to a practical minimum. If the light intensity of the curve B is more than that necessary for reading maps or the like, the amount of light passing through the slot 8 may be readily reduced by slightly rotating the shutter device 37.

The embodiment illustrated has a number of particular advantages for its intended use. The use of a fluorescent type of lamp permits an elongated tubular light source which is advantageous for improved floodlighting and is well adapted for directional radiation which is of prime importance in keeping the light out of the eyes of persons in the cockpit or cabin. The lamp occupies a relatively small space for its light output and, when mounted in an elongated tubular housing of the type illustrated, the lighting device is well adapted to be built into the control pedestal or other existing part of the cockpit.

The various parts of the lighting device are of rugged construction and are easily removable for replacement without the use of tools and without removing the base 6 from its supporting means. The shutter 37 is readily withdrawn from the casing 7 by means of the knob 11, by snapping the ball detent on the post 13 out of the retaining groove 42. Similarly, the casing 7 may be readily removed from the base 6 by snapping the ball detent 20 on post 10 out of the groove 18. When the shutter 37 and the casing 7 have been removed, the lamp 27 is exposed as it appears in Figure 5 and may be conveniently withdrawn from the clips 32, 34 for replacement. The lamp starting switch 49 is a self-contained unit within the cylindrical casing 22 which may be with-

drawn from the open end of the threaded portion 16 by unscrewing the union 5. It is noted that the electrical connections to the lamp and starting switch are established automatically when these elements are placed in position in the device.

While I have shown and described but a single embodiment of my invention for purposes of illustration, it is to be understood that it is capable of many modifications, and changes therefore in construction and arrangement may be made which do not depart from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. The method of illuminating portions of an instrument panel having fluorescent indicia capable of activation by ultraviolet light comprising generating ultraviolet radiation, transforming said radiation into light having a spectral band substantially entirely included in the range between three thousand and six thousand Angstrom units, filtering out of said band all wave lengths outside of the range between approximately three thousand one hundred Angstrom units and three thousand nine hundred Angstrom units, floodlighting said panel with light within said last-mentioned range to activate said fluorescent indicia, and making available light from said above described spectral band of three thousand to six thousand Angstrom units for selective directional illumination of controllable intensity.

2. In a system for illuminating portions of an instrument panel having fluorescent indicia capable of activation by ultraviolet light, means

for generating ultraviolet radiation, means for transforming said radiation into light having a spectral band substantially entirely included in the range between three thousand and six thousand Angstrom units, means for filtering out of said band all wave lengths outside of the range between approximately three thousand one hundred Angstrom units and three thousand nine hundred Angstrom units, means for floodlighting said panel with light within said last-mentioned range to activate said fluorescent indicia, and means for transmitting a directional beam of light of controllable intensity from said above described spectral band of three thousand to six thousand Angstrom units to illuminate non-fluorescent objects.

3. In a system for illuminating portions of an instrument panel having fluorescent indicia capable of activation by ultraviolet light, a mercury vapor lamp, fluorescent material associated with said lamp and capable of transforming the mercury vapor light energy into light energy having a spectral band covering a range from approximately three thousand to approximately six thousand Angstrom units, an opaque cover for said lamp, a window in said cover capable of transmitting light only within a range of wave lengths between approximately three thousand one hundred Angstrom units and three thousand nine hundred Angstrom units, means for directing light transmitted by said window toward said panel for activating said fluorescent indicia, and another window in said cover for transmitting said whole spectral band to illuminate non-fluorescent objects.

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