

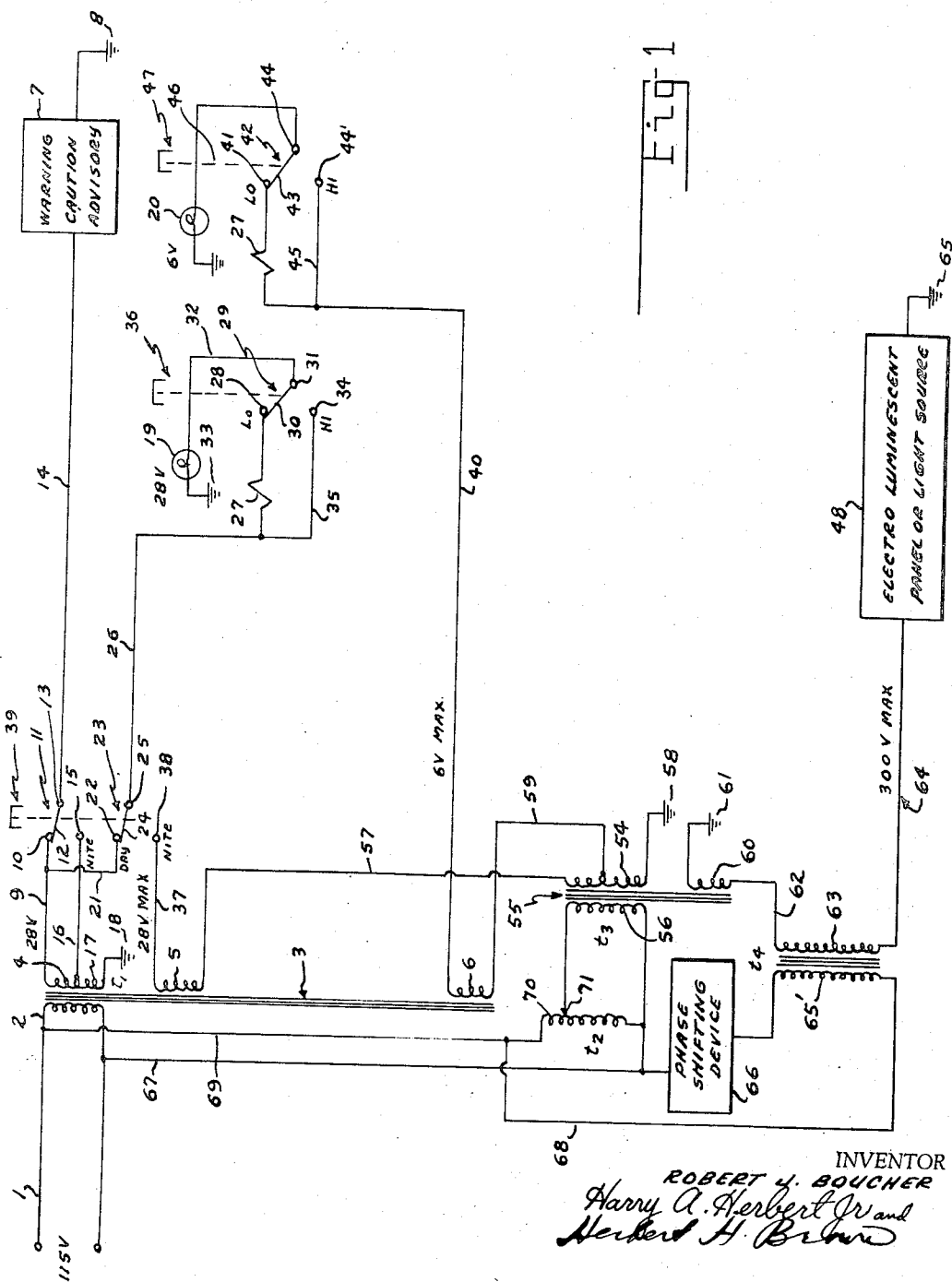
April 2, 1968

R. J. BOUCHER
NONLINEAR LIGHTING CONTROL

3,376,471

Filed Sept. 9, 1965

3 Sheets-Sheet 1



ATTORNEYS

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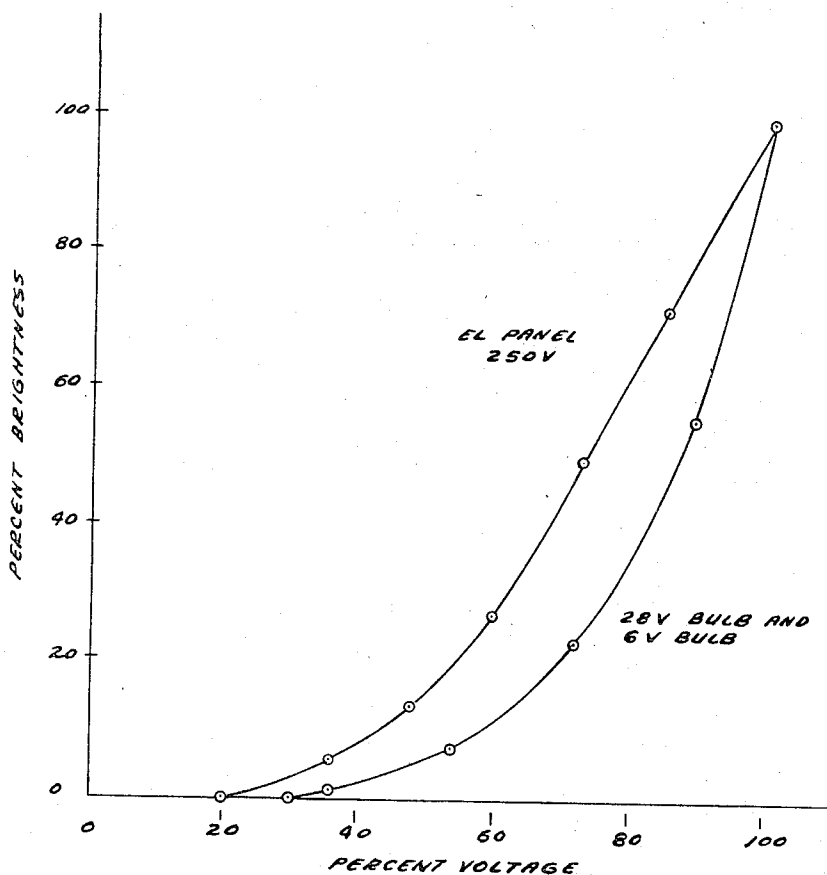


Fig. 2

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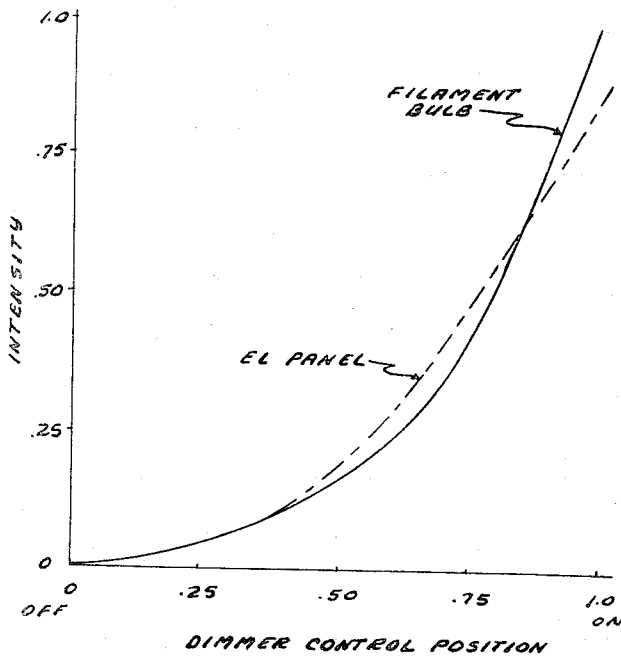


Fig-3

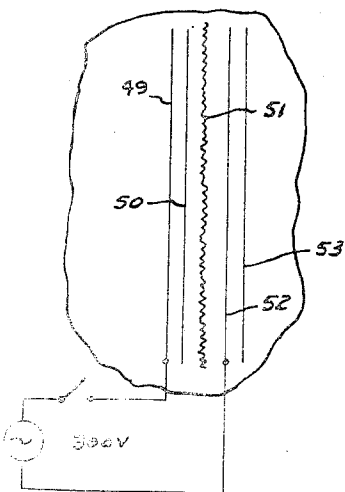


Fig-4

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NONLINEAR LIGHTING CONTROL

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ABSTRACT OF THE DISCLOSURE

In order to cause the brilliance-voltage ratio of the lights of the bulb (filament) and luminescent (cold glow) types to coincide with respect to one another over the dimming range and thus obtain the same percentage dimming when the voltage is decreased, a transformer system is employed to provide the proper voltage to each type of light. The bulb type is fed from the secondary of a transformer and the luminescent type is fed, in part, from a second transformer, and in part, from a third transformer, all connected back to a single source of alternating current. A phase-shifting device is placed in the primary of the third transformer for altering the phase relation between the voltage and current to the aforementioned part of the energy supplied to the luminescent group. In this manner, the brilliance-voltage ratio of the latter is brought into coincidence with that of the bulb type.

The present invention relates to a light dimming system, more particularly as it pertains to the cockpit of an airplane. Various types of lamps are employed, such as, 6 volt tungsten bulbs which are generally used to spot the individual instruments and the warning caution advisory panels. Twenty-eight volt tungsten bulbs are also used for lighting up larger areas where certain operational functions are to be performed. Many of the modern type planes utilize the "cold glow" form of illumination in addition to the incandescent bulbs for lighting up the instruments, as well as the flat panel indicating signs. This glow form of light is known as "electroluminescence." These panels are generally operated for full glow at 250-300 volts A.C.

It is desirable on occasion, especially during night operation, to dim the light emanating from the bulbs, also to reduce the glow of the various panels and this dimming control should, for practical reasons, be lodged in a single unit operable by the pilot.

However, certain difficulties have attended the attainment of an equal and proportionate change in the brilliancy of the lights as a whole, including the glow type, for each and every change in the percentage voltage applied to the lights. This difficulty is caused by the fact that while lights of the bulb type have the same

percent brilliance
percent voltage

characteristic with respect to one another, the characteristic of the electroluminescent sources of light is different from the tungsten bulb type. In addition, both types have nonlinear operating curves which further complicate the dimming operation.

It will be understood that the ideal situation would be to change the percent brilliance of the lights as a whole precisely in accordance with the particular percent voltage applied to the lights as a whole, and this proportional change in luminescence should extend evenly throughout the entire range, from full brightness to the desired degree of dimming. In this way, no particular light or group of lights, regardless of their luminescent quality or type, would outshine the other lights at the

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dimmed end of the luminescent range. I am aware that various circuits and structures including ganged nonlinear potentiometers and ganged nonlinear variable transformers have been used to bring the luminescent characteristic of the two types of lights, i.e. tungsten bulbs and electroluminescent panels, into substantial coincidence. But systems and structures of this type dissipate considerable power and, in addition, require complicated circuits, which while satisfactory in operation do not constitute the ideal arrangement.

The primary object of the invention is to provide a relatively simple and inexpensive way of dimming, by the use of a single control, a system of lighting which employs lights of different luminescent nonlinear characteristics, and thus to obtain the same proportional change in luminescence throughout the dimming range.

Another object is to provide an improved system for controlling the luminescence of lights of multivarious types and different lighting characteristics within a range from full brilliance to a desired low value by regulating the voltage on a percent basis in order to control the degree of luminescence of the light sources in the same proportional manner. To be more specific, when the voltage on the lights reduced 50 percent for example, the light of the electroluminescent panels and also of the tungsten lights is reduced in the same proportional amount, i.e., 50 percent, notwithstanding the normal nonlinearity of each of the bulbs and EL panel brightness characteristics.

A further object is to translate the nonlinear brightness curves of tungsten and electroluminescent panel lights to substantially matching linear characteristics.

A still further object of the invention is to provide this proportional change in brightness or dimming effect of an aggregation of lights each having their own peculiar brightness curve and to effect this result in a highly efficient low power-consuming operation. A further and more specific object of the invention is to provide an improved system of the type referred to which does not require ganged nonlinear potentiometers or ganged nonlinear transformers or any other power dissipating means; nor does the improved system necessitate power amplification between the control means and the lamp load.

The objects are obtained in brief by dividing the voltages applied to the bulb and the electroluminescent types of lights and operating by means of a phase displacement between the divided voltage and the voltage applied to the lights in such a way that the brightness characteristic of the various lights, which are normally nonlinear and nonconforming to one another, are now straightened into a linear formation which substantially coincide with one another, at least within the range of the applied voltage. The lights are controlled by a single control element and through the interposition of improved transformer arrangement and phase displacement feature described hereinafter, the brightness characteristics are straightened out to a substantially linear pattern which conform with one another throughout the voltage reduction range to obtain a "straight line" dimming effect. The lights as a whole are caused to give off a reduced luminescence in accordance with the proportional change of the applied voltage.

The invention would be better understood when reference is made to the following description and the accompanying drawings in which

FIG. 1 is a schematic diagram of a preferred form of a circuit for carrying out my invention;

FIG. 2 represents a chart depicting a typical relationship between the voltage applied to bulbs of the incandescent filament type and to the electroluminescent type in terms of the respective degrees of brightness; while

FIG. 3 shows a similar characteristic between the lights before subjected to the voltage conditions in accordance with the principles of my invention. In FIG. 3, the ordinate and abscissa have been placed on a different numerical basis than in FIG. 2; and

FIG. 4 depicts a broken-away section of a typical electroluminescent panel which gives off a perceptible glow when excited by electric potential.

Referring to FIG. 1, the main or line voltage for energizing all of the lights is indicated at 1 and is generally 115 volts A.C. This line voltage is fed into the primary 2 of a transformer having a core 3 and a secondary winding 4. In addition to winding 4, there are two other secondary windings 5 and 6 arranged about the core 3 in a lengthwise direction. The usual warning advisory panel found in the cockpit of planes is indicated at 7 and is grounded at 8. A conductor 9 is taken to the upper contact 10 of a switch generally indicated at 11 having a blade 12 which swings about a swivel 13. A conductor 14 connects the swivel to the warning caution advisory 7. The lower contact 15 of the switch is connected through a conductor 16 to an intermediate tap 17 on the secondary winding 4. The purpose of the switch 11 will be pointed out hereinafter. The lower terminal of the secondary 4 is grounded at 18.

The bulb lights

Typical types of bulb lights for cockpit and instrument illumination are shown at 19 and 20, both of which may be of the incandescent type employing 28 volts and 6 volts energy, as indicated. The energizing circuit for the 28 volt bulb is taken from a conductor 21 connected to the secondary 4 to the upper contact 22 of the switch generally indicated at 23 and has a blade 24 which is swingable about the element 25. A conductor 26 is connected from this element by passing through a resistor 27 to the upper contact 28 of a switch, generally indicated at 29, and a conductor 32 taken from the last-mentioned contact to the 28 volt bulb 19 then to ground 33. The switch 29 can be swung to contact a lower element 34 and a conductor 35 interconnects with the conductor 26. A push button member, generally indicated at 36, can be employed which upon pressing downward will cause the blade 30 to swing about its pivot 31 and contact the element 34. A part of the voltage applied to the bulb 19 is obtained through the secondary winding 5 which, as explained hereinbefore, is energized by the primary coil 2. A conductor 37 connects the upper end of the winding 5 to a lower contact member 38 of the switch 23. The blade 24 of the said switch is operated by any suitable form of push button structure generally indicated at 39 and the switch blade 12 is connected to the same button structure.

Thus, by pressing on the button 39 the switch blade 12 makes connection with the contact element 15 and will also cause the blade 24 to contact the element 38. The switching arrangement should preferably be such that one push button is used to press the blades downwardly and a companion button is employed to cause each of the blades 12 and 24 to return to their upper position. It will be understood that the push buttons 36, 47 are for the purpose of testing each of the 6 volt and 28 volt bulbs used in the cockpit panel or elsewhere, the group of which are typified by the single illustrated units. The legend "Day" is applied to the upper contact 10 of the switch 11 to indicate that when the blade 12 is in its upper position, full potential is applied to the bulbs of the warning caution advisory panel.

This circuit can be traced through the secondary 4, conductor 9, blade 12, conductor 14, then through the panel to ground 8. When the blade 12 is swung to its lower position so as to make contact with 15 then a reduced voltage is applied to the panel 7, this voltage being obtained from the intermediate tap 17 on the secondary 4 through the conductor 16, the blade 12 and the con-

ductor 14 through the panel to ground 8. The lower contact member is designated "Nite" and the pilot will swing the blade from the daytime position to the "Nite" position bringing a lower voltage to the bulbs of the panel 7 for night time control.

The legend "Day" is applied to the upper contact member 22 and the legend "Nite" is applied to the lower contact so that when the blade is in its upper position, energy is supplied through the conductor 21 to blade 24, conductor 26, then either through the resistance 27 or direct, depending upon the position of the blade 30, to the typical light 19. The pilot, during night time, would normally swing the blade 24 downward to contact the element 38 in which case a connection is established from the secondary 5 through the conductors 37, 26, then either through the resistance 27 or direct through the conductor 35 to the light 19, depending upon the position of the blade 30. Thus, up to this point, I have described a control of the typical bulb or bulbs to which potential of various amounts can be applied, depending upon the position of the switches 24, 29 and 42.

The bulb 20, which is representative of all the 6 volt bulbs used in the system, has a circuit somewhat similar to that of the 28 volt bulb except that its connections do not pass through the switching arrangement 11, 23 and the potential applied to the bulb 20 is obtained in part from the secondary winding 6. A conductor 40 connects one end of the winding 6 to a branched circuit, one branch of which passes through the resistance 27 to the upper contact 41 of a switch, generally indicated at 42, of which the blade 43 can swing about contact member 44. In its lower position, the blade 43 makes connection with a contact 44' which is connected through 45 to the conductor 40. A mechanical connection indicated at 46 is taken from the blade 43 to a push button structure 47 which is similar to that described in connection with the buttons 36, 39. Thus, when potential from the transformer secondary 6 is applied to the conductor 40, and assuming that the switch 42 is in its upper position as shown, current will flow through the resistance 27, through the switch, and thence through the bulb 20 to ground. The effect of the resistance is to cause a reduction in potential. The switch in its lower position applies full potential of conductor 40 to the bulb 20. Here, as was explained in connection with 28 volt bulb, the pilot can apply the full potential to the bulb 20 when the switch is in its lower or "Hi" position or can apply a lower voltage through the interposition of the resistance 27 to obtain a voltage step-down effect when the blade is in its upper position.

It will be understood that the use of the push buttons 36, 47 is for the purpose of testing the operability of each tungsten bulb, both under high and low voltage conditions through the use of the switches 29, 42 as an element of precaution, since some of these bulbs may be used in the "warning caution advisory" panel and other emergency warnings.

The switches 11 and 23 are employed merely to apply fixed high and low voltages to the bulbs depending upon night and day operation. However, the subject of the present invention relates to a continuous dimming of the lights, regardless of the testing devices mentioned or the abrupt change in voltage applied to the lights, for night and day operation. The improved dimming effect can be used at any time during night or day and is characterized by a continuous change in luminosity obtained through a unitary control operated by the pilot. This dimming effect and the requisite system is described hereinafter.

The dimming circuit

As pointed out hereinbefore, in addition to the bulbs of the incandescent type, the instrument panel as a whole, may employ a number of electroluminescent lights which may be in the form of stiff panels or even composite coatings on the instrument dial faces or around the face in

various locations. These panels or coatings have the faculty of giving off a strong glow when actuated by high voltage. A typical form of such a light is shown in FIG. 4, although I do not wish to be limited to this form. As shown, reference character 49 designates a metal substrate which may constitute aluminum as a stiff backing or as a coating. There is a dielectric layer 50 on the aluminum which may conveniently be formed of the oxide. A layer of a luminescent material 51, such as zinc chromate or a phosphorus compound, may be deposited on the dielectric. A transparent conductive coating 52, such as gold, is applied to the luminescent material and finally a transparent protective layer 53, such as clear varnish, can be applied. When A.C. potential of the order of 300-400 is applied between the conductive plates or coatings 49, 52, the luminescent material gives out an intense glow. This cold lighting effect is useful in illuminating the instruments and particularly, when employed in flat panel form, such as over the emergency indicators—low fuel, engine on fire, no oil pressure, etc. These panels may be used as an alternative to the incandescent bulb type of light but most likely, the two types are used together, each to its own position and purpose.

Quite often, the pilot desires to dim in a continuous manner all of the lights in the cockpit including the glow lights in order to eliminate the possible error by severe contrast with that emanating from the exterior of the plane, such as airport lights, runway illumination, etc. The acuity of vision of the pilot for objects outside of the plane including lighted objects is enhanced when the degree of lighting within the cockpit is no greater than the light from the exterior object reaching the pilot. It is further to his advantage to be able to lower the lights within the cockpit in a continuous manner to a precise degree depending upon the brightness of the external ambient light. The main purpose of this invention is to disclose the manner in which this can be accomplished by a single control under the guidance of the pilot. However, the main difficulty is that when using light of a radically different type such as those of the tungsten bulb type and the electroluminescent type in a single lighting system, any change in potential applied to the bulb type light to cause reduced luminescence will not generally cause the same degree of reduced luminescence in the glow light so that the latter might outshine the dimmed light of the bulb type and destroy the overall effect of the dimming operation. This difficulty is shown by use of a graph in FIG. 2 in which the abscissa is marked off in percent voltage from 0 to 100 and the ordinate indicates the percent brightness from 0 to 100. Thus, as expressed in the graph, if the percent voltage applied to the overall lighting effect is reduced from 100 (full potential) by 50 percent (50 percent potential) each of the 28 volt and 6 volt bulbs will show a percent brightness of approximately 5 percent; whereas, the glow lights at the same percent voltage decrease will show a percent brightness of possibly 12 percent—a difference of 7 percent. This, obviously, would permit the electroluminescent light to outshine the bulb lights by 140 percent. This difference in percent brightness becomes even greater when the dimming effect constitutes a reduction of 20 percent in the voltage as is clearly shown on the graph. As further indicated, the characteristics of the electroluminescent tube is of a curved characteristic and that of the incandescent bulb type light is also curved but even in more pronounced manner. It is, therefore, difficult to ascribe to both types of light a characteristic in which the luminosity of the lights will respond continuously as a linear relation and the brightness characteristics of the lights will coincide with one another so that a 20 percent reduction of potential applied to the lights in the aggregate will cause an overall reduction of 20 percent in the percent brightness of every light of the group.

In accordance with the principles of my invention, I bring about this coincidence of shape in the respective

characteristics by the use of a supplemental voltage which has a phase displacement with respect to the line or main voltage and supplements the voltage applied to the respective lights by this phase displaced voltage in such a way as not only to straighten out the brightness characteristics of the two types of lights but also to cause them to coincide within the range of light to which the pilot wishes to dim the luminosity of the cockpit. As shown in FIG. 1, the supplemental voltage applied to the 28 volt bulb (element 19) is obtained from a secondary 54 of a transformer indicated generally at 55 and having a primary winding 56. The conductor 57 is connected at one end of the secondary 54 and the lower end of the latter is grounded at 58. Thus, the full voltage of the secondary winding 54 is added to the voltage induced in the secondary 5 and applied through conductors 37 and 26 to the bulb 19, assuming that the switch 23 is in its lower position. For example, assuming that the bulb 19 requires 28 volts, the secondary 5 will provide 8.4 volts and the secondary 54 will provide 19.6 volts to make up the full 28 volts.

The supplementary voltage for the 6 volt bulb 20 is obtained through the lower portion of the secondary 54 from which a conductor 59 is taken to add potential to the secondary winding 6 and thus provide 6 volts maximum through the conductor 40 to the bulb, assuming that the switch 42 is in its lower position. As explained above, when the switch is in its upper position, this potential is reduced in a stepped manner due to the presence of the resistance 27. The lower portion of the secondary 54 would supply 4.2 volts and the secondary 6 would supply 1.8 volts to make the 6 volt maximum. In addition, to the winding 54, the transformer 55 carries still another winding at 60. This winding is grounded at 61 and passes through a conductor 62 to the secondary 63 of a coil to a conductor 64 and, thence, to the electroluminescent panels or lights 48. The latter is grounded at 65. A primary coil 65' is in inductive relation with secondary coil 63. It is the purpose of my invention to supply the electroluminescent lights with a potential that is out-of-phase from the potential applied to the light bulbs 19, 20. This is accomplished by the use of any form of phase-shifting device which is well known in the art and is indicated at 66. A conductor 67 is taken from the line to the phase-shifting device and, thence, to the primary coil 65'. A conductor 68 connects with the lower end of the primary 65' and passes through a conductor 69 to the other side of the line. Thus, the potential supplied to the secondary 63 is out-of-phase with the potential supplied to the secondaries 5, 6, 54 which supply the voltage to the tungsten filament bulbs. In the case of a typical electroluminescent panel or light having a brightness characteristic as shown on FIG. 2, I have found that a phase displacement of approximately 60° is satisfactory.

The electroluminescent panels obtain their potential, not only from the out-of-phase potential at 63 but also from the in-phase potential at 54 to deliver 300 volts maximum to each panel or light. In order to control the dimming of the light aggregate from a single position within the cockpit, I provide a simple autotransformer 70 having an adjustable tap 71 and thus control the voltage applied to the primary 56 and the secondaries 54, 60. Since these secondaries supply the remaining parts of the voltage of which the other parts are supplied by the secondary coils 5, 6 and 63, any control of the potential in primary coil 56 at the tap 71 will control the supplemental voltage applied to each of the bulb type lights and the electroluminescent lights in the same percent.

The movement of the tap 71 can be translated into a variable and continuous movable "Dimmer Control Position" between 0 and 1 as shown in FIG. 3. The intensity of each of the two types of lights may also be charted from 0 to 1 and shown on the ordinate of this

figure. It will be noted that the phase shift of the potential applied by the primary 65' to the electroluminescent panel and the interaction of this out-of-phase potential on the remaining parts of the transformer system are such as to straighten out tremendously the brightness characteristic of the electroluminescent panel and also to straighten, at least to some extent, the characteristic of the bulb lights within a reasonable dimming limit. Consequently, the pilot will have under his control, a dimming dial (adjustable tap 71) movable substantially all the way from full potential indicated by the "0-Off" position in the figure to the "1.0-On" position which represents the extreme dimming effect desired. The transformers are so connected that full brightness corresponds to 100 percent voltage on the bulbs and zero brightness corresponds to 30 percent voltage on the bulbs. The voltage control operates linearly between those limits. The EL panel voltage limits are set to 92.5 percent and 20 percent, respectively, and corresponding to 85 percent and zero brightness, respectively.

The nonlinear variation is obtained by adding the bias and variable voltage out-of-phase by 60°. If for any other bulb panel combination, another curve is desired, this angle can be changed by suitable connection of the bias transformer.

Any percentage change in the applied voltage to the lights in the aggregate will cause approximately the same percentage as to the change in brightness as to all of the lights. I have obtained satisfactory results by employing this 60° out-of-phase voltage with respect to the transformer winding 60, and have found that under these circumstances using the typical types of tungsten lamps and electroluminescent panels, at every stage of the dimming operation from the position 0 to 1, as shown in FIG. 3, a corresponding reduction percentage-wise in brightness is obtained from all the lights in the aggregate. Thus no set of lights could outshine the other set considered on a proportional or relative basis at any position of the dimmer control exercised at the tap 71.

Using an out-of-phase voltage at the transformer 65' with respect to the line voltage and a typical 60° phase angle, I append the following mathematical description:

Let the bulb voltage be V_b
 Let the EL voltage be V_e
 Let the control position of t_2 be ϕ
 Let the phase difference between T_3 and T_4 be ϕ (in this case 60 degrees)

Then

$$V_b = V_1 + \phi V_2$$

where

V_1 = output of t_1

V_2 = maximum output of t_3 for bulb winding

and

$$V_E = [V_3^2 + V_4^2 + 2\phi V_3 V_4 \cos \theta]^{1/2}$$

V_3 = output of t_4

V_4 = maximum output of t_3 for EL winding

It can be seen that V_b is a linear function of ϕ while V_E is a nonlinear function of ϕ . By suitable choice of V_1 , V_2 , V_3 , V_4 and θ , nearly equal brightness for all values of ϕ can be obtained.

It will be noted that the interaction between the apparent potentials applied to the two types of lights in which a continuous variation in light is obtained for a continuous movement of the dimmer dial and all lights, regardless of their characteristics are dimmed in the same proportionate manner.

While certain specific embodiments have been described, it is obvious that numerous changes may be made without departing from the general principle and scope of the invention.

I claim:

1. An illumination system employing lights of the

bulb and electroluminescent types having different percent brightness plotted against percent applied voltage characteristics, a transformer having a primary coil connected to a source of alternating current, said transformer having a pair of secondary coils, one of which is connected to the lights of the bulb type and the other secondary coil is connected to the lights of the electroluminescent type furnishing part of the energy thereto, a second transformer, the primary of which is connected to said source of alternating current and having a secondary coil, connections from said secondary to said other said secondary and also to the electroluminescent lights for furnishing the remainder of the energy thereto, and means for shifting the phase relation between the voltage and current of the energy furnished by the secondary coil of said second transformer to the electroluminescent lights in order to bring the percent brightness plotted against percent applied voltage characteristics of the bulb lights and the electroluminescent lights into coincidence with one another over the operating range, and means connected in circuit with the first-mentioned transformer for dimming the luminosity of both types of lights in the same proportional amount.

2. An illumination system employing lights of the bulb and electroluminescent types according to claim 1 and in which the second phase shifter is connected in the primary circuit of said second transformer.

3. An illumination system employing lights of the bulb and electroluminescent types according to claim 1 and in which the dimming means is constituted of an adjustable inductance device connected across the primary of the first-mentioned transformer.

4. An illumination system employing lights of the bulb and electroluminescent types having different percent brightness plotted against percent applied voltage characteristics, means whereby upon changing the voltage applied to the lights on a proportional basis, the luminosity of both types of lights will be changed on an equal proportional basis as to each type, said means including a transformer having a primary connected to the line voltage and a secondary connected to the bulb type lights for supplying a part of the energizing voltage, a second transformer connected to line voltage and a secondary having two portions, one of which is connected to the bulb type lights to furnish the remaining part of the energizing voltage, and the other portion being connected to the electroluminescent type lights to supply a part of the energizing voltage thereto, a third transformer connected to line voltage and having a secondary which is connected to the electroluminescent type lights to supply the remaining part of the energizing voltage thereto, means for changing the phase of the voltage to said third transformer whereby the percent brightness plotted against the percent applied voltage characteristic of the electroluminescent type light is modified to bring the same into coincidence with the characteristic of the bulb type, means for reducing the voltage applied to each of the bulb and electroluminescent type lights to obtain a dimming effect of the light aggregation, said means being constituted of an adjustable auto-transformer connected across the primary of said second transformer.

5. An illumination system employing lights of the bulb and electroluminescent types connected to a main source voltage, said types having a percent brightness characteristic plotted against percent voltage which are different from one another and of a curvilinear character, means including a single control element for reducing the voltages applied to each of the two types of lights in order to dim the respective intensities of the radiated light, means for causing said characteristics to conform to one another as a linear function whereby when the voltage applied to the bulb type lights is reduced to dim the luminescence, the light radiated by the electroluminescent lights is reduced in the same relative proportion, said last-mentioned means comprising a first

transformer energized from said main source of voltage, means for reducing the voltage applied to said transformer, said transformer having a plurality of secondary windings, one of which supplies part of the voltage required by the bulb type lights and another secondary winding which supplies part of the voltage required by the electroluminescent type of lights, a second transformer energized from said main voltage source through a phase-shifting device, and having a secondary winding which supplies the remaining part of the voltage required by the electroluminescent type lights, a third transformer connected to the main voltage source and having a secondary winding which supplies the remaining part of the voltage required by the bulb type lights, whereby as the voltage on the said first transformer is reduced, the overall voltages on each of the bulb type and electroluminescent type lights will be reduced and the difference in phase between the voltages applied to the first and second transformers will cause the percent brightness versus percent voltage characteristics of said light types to coincide with one another on a linear basis to provide the same degree of dimming in each of the light types.

6. An illumination system employing lights of the bulb and electroluminescent types connected to a main source voltage, said types having a percent brightness characteristic plotted against percent voltage which are different from one another and of a curvilinear character, means including a single control element for reducing the voltages applied to each of the two types of lights in order to dim the respective intensities of the radiated light, means for causing said characteristics to conform to one another as a linear function whereby when the voltage applied to the bulb type lights is reduced to dim the luminescence, the light radiated by the electroluminescent lights is reduced in the same relative proportion, said last-mentioned means comprising a first transformer energized from said main source of voltage, means for

reducing the voltage applied to said transformer, said transformer having a plurality of secondary windings, one of which supplies part of the voltage required by a group of bulb type lights, another secondary winding supplying the voltage required by a second group of bulb type lights of different wattage, a third secondary winding for supplying part of the voltage required by a group of electroluminescent type lights, a second transformer energized from said main voltage source but having voltage-phase relation different from the voltage-phase relation of the main source of voltage, said second transformer having a secondary winding which supplies the remaining part of the voltage required by the electroluminescent lights, and a third transformer connected to the main voltage source and having a plurality of secondary windings which supply the remaining part of the voltage required by each group of the bulb type lights whereby when the voltage across said first transformer is reduced on a percent basis to dim the lights, the phase difference between the line voltage and the voltage applied to the second transformer being such as to cause the percent brightness of the bulb type lights and the electroluminescent type lights to correspond in percentage according to the voltage charge applied to the respective lights.

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