Feb. 9, 1960 F. E. CARLSON 2,924,748

LIGHTING UNIT

Filed April 29, 1957

Fig. 1.

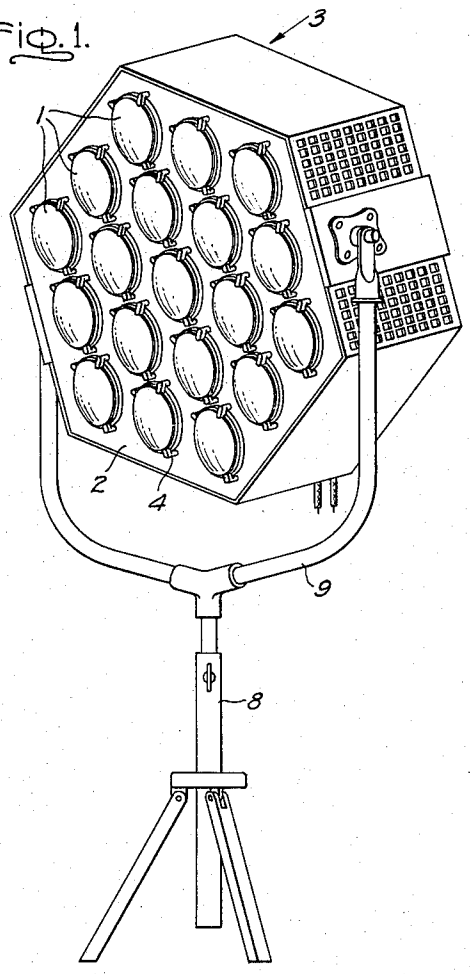


Fig. 2.

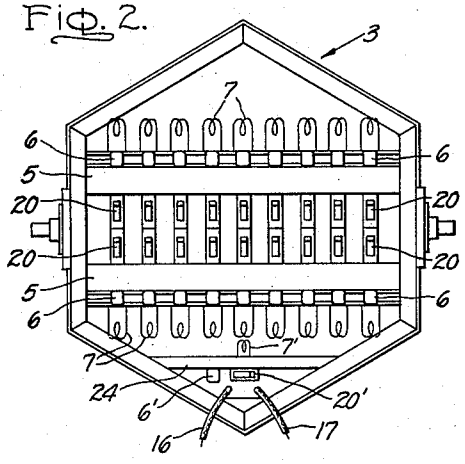


Fig. 3.

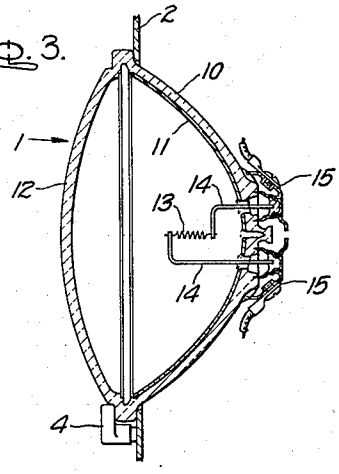


Fig. 4.

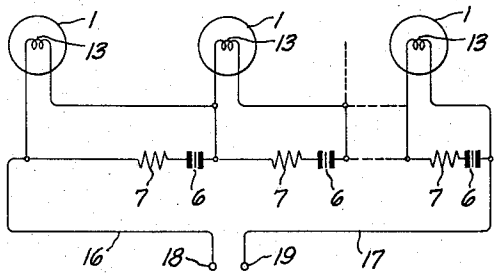


Fig. 5.

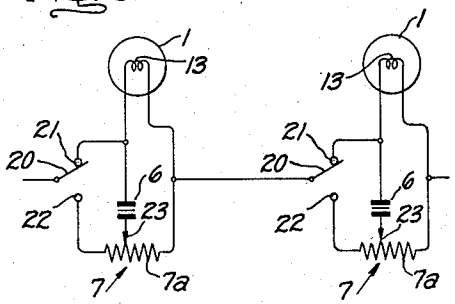
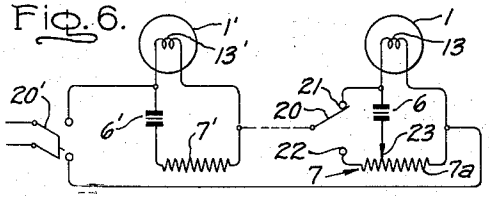


Fig. 6.



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LIGHTING UNIT

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Application April 29, 1957, Serial No. 655,708

5 Claims. (Cl. 315—122)

My invention relates to a light projecting fixture or unit using incandescent tungsten filaments and producing a beam of light of unusually high intensity for the beam dimensions and power consumed from such sources. More particularly, my invention relates to a unit of the type comprising a plurality of lamps each including a tungsten filament light source enclosed in a light concentrating reflector and arranged in a cluster to project a composite beam of light.

It is an object of my invention to provide a fixture or unit which will produce a carefully designed beam of great output for use in such applications, for example, as motion picture and television studios, searchlights, airway beacons, and similar services. It is a further object to provide a unit which will be operable directly from a commercial power source of 120 or 220 volts for example, with high brightness of the tungsten filament light source for a reasonable life. It is a further object to provide a unit capable of producing a light beam of a candlepower substantially exceeding that produced by conventional Fresnel lens spotlights of comparable power consumption for a tungsten filament lamp.

In accordance with my invention, I employ low voltage, high current, lamps connected in a series circuit. An important advantage of series operation at relatively high currents is that it permits achievement of higher brightness of the tungsten filament for a given design life, or longer life for a given color temperature and brightness, by virtue of the fact that the filament is made of thicker wire. The filament for low voltage operation is also of shorter length thereby resulting in a more concentrated light source and better control of the light beam. It thus becomes possible to employ lamps in which the beam axis coincides to less than one degree with the mechanical axis of the lamp so that the beams from several lamps can be added together by superimposing them. While the lamps may be in the form of separate light bulb and reflector units, I prefer to employ lamps of the so-called "sealed beam" type which comprise a bulb having a reflecting surface with a concentrated filament in the bulb accurately located at the focus of the reflector.

A complete darkening of the entire unit upon failure of one of the lamps of the series group is avoided by providing a film cutout connected across the terminals of each lamp whereby to maintain the circuit through the remaining lamps. In accordance with a further aspect of the invention, a resistor is connected in series with each cutout across the individual lamps in order to avoid premature failure of the remaining lamps due to increased voltage and current across the terminals of those remaining lamps. The value of the resistance may be selected so that the voltage and current to each of the remaining lamps will be either substantially the same as before failure or so that the voltage and current across each of the remaining lamps will be increased slightly. In the former case, assuming as an example a series group of about twenty lamps, the beam intensity and total light output will be reduced about 5% by each lamp failure. In the latter case, the voltage and current might be such that the beam intensity and total light remain substantially at the level preceding each of the first few lamp failures; after the first few failures the balance of the lamps would fail at an accelerated rate if the earlier failures were not replaced with other lamps. Alternatively, it would probably be desirable to make a group replacement of all the lamps at that time since they would, in any event, have a relatively short life expectancy at that time.

In accordance with a further aspect of the invention, I provide a novel arrangement for dimming the light beam. A serious problem in producing color motion pictures and color television pictures has been the fact that dimming of studio lights, by lowering the voltage, changes the color temperature of the light. In a unit of the type comprising my invention, the intensity and total light output of the combination may be dimmed in steps, without changing the color temperature, by incorporating therein switches arranged to substitute, for each lamp to be turned off, a resistor of the same electrical rating as the lamp. In the case of a combination employing about twenty lamps, the light output may be dimmed in steps of about 5% of full output.

Further features and advantages of my invention will appear from the following detailed description, and from the drawing wherein:

Fig. 1 is a perspective view of a studio lighting unit comprising one form of my invention, and Fig. 2 is a rear elevation thereof;

Fig. 3 is a sectional elevation of an individual lamp of the sealed beam type in the unit;

Fig. 4 is a diagram of the series circuit of the lamps such as might be used for an airway beacon or searchlight;

Fig. 5 is a diagram showing the switching arrangement for dimming the light from a unit designed for studio lighting and similar purposes; and

Fig. 6 is a modification of the Fig. 5 diagram.

Referring to Fig. 1, the studio fixture or unit illustrated therein comprises a group of nineteen lamps **1** of the "sealed beam" or "PAR" type arranged in a hexagonal group for compactness and with their axes parallel, and mounted in openings in the front or face plate **2** of a housing or frame **3** and secured thereto at their peripheries by suitable clamps **4**. A pair of horizontal members **5** at the rear of the housing carry the cutouts **6** and resistors **7**. The housing **3** is supported from a standard **8** having a yoke portion **9** rotatably mounted in the standard and supporting the housing for rotative adjustment about a horizontal axis.

The lamps **1** are preferably of the type disclosed in Patent 2,148,314, D. K. Wright, and comprising a pressed glass bulb including a parabolic reflector section **10** with an internal reflecting coating **11** of aluminum or silver, for example, and a front cover or lens section **12** which may be of clear glass or suitably configurated with flutes and prisms to provide a desired distribution to the beam. When employing configurated lenses, they are preferably all alike so that the composite beam is of the same shape as that from a single lamp. At the focus of the reflector **11** is a concentrated tungsten filament **13** which is supported by lead wires **14** which are connected to terminals **15**. As herein illustrated, the filament **13** is a helical coil having its axis coincident with the axis of reflector **11**, but other filament shapes and arrangements may be employed. Because of the extreme accuracy with which such lamps can be made, and the relatively small size of the filament **13** required for operation at low voltages, the beam axis can be made to coincide very closely (to less than one degree) with the mechanical axis of the

lamp, so that the beams from the several lamps are added together by superimposing them to form a highly concentrated composite beam or spot of light.

In order to avoid a complete outage of the unit when one lamp fails, a cutout 6 (Fig. 4) is connected across the terminals of each lamp. The cutouts 6 may be of the well-known type employed in series street lighting circuits and which comprise a pair of contacts separated by a material which is normally non-conducting at the voltage available across each lamp but which is broken down and becomes conducting when the associated lamp fails and the full line potential of 120 volts, for example, is impressed across the cutout.

As shown in Fig. 4, a resistor 7 is placed in series with each cutout 6 across the terminals of the associated lamp 1 to avoid premature failure of all the lamps after the first failure since, in the absence of the resistors, each successive failure would result in an increase in voltage across the terminals of the surviving lamps. It will be evident from Fig. 4, therefore, that the lamps 1 are connected in series and are supplied with current by conductors 16, 17 from the terminals 18, 19 of a source of electricity of, for example, 120 volts. The value of the resistances 7 in Fig. 4 is preferably chosen to be somewhat less than the hot resistance of the filaments of the lamps 1 because the cutouts, after breakdown, also have some resistance to current flow. Thus, the sum of the two resistances (resistor 7 and cutout 6) preferably equals the hot resistance of the lamp filament so that, upon failure of a lamp, the voltage and current supplied to each of the surviving lamps remains the same as before the failure, and the beam intensity and total light are reduced by slightly more than 5% by failure of each of the nineteen lamps.

As shown in Fig. 5, I preferably provide means for dimming the intensity and total light output of the unit without changing the beam pattern or the color temperature. This is in contrast to the effect obtained with a conventional studio spotlight wherein the single lamp employed therein is dimmed by decreasing the voltage to the filament and thereby decreasing its temperature. In the present case, dimming is achieved in steps by disconnecting one or more lamps from the circuit and substituting an equivalent resistance therefor, so that the voltage across the other lamps remains the same. Accordingly, I provide a switch 20 in association with any desired number of, or all, the lamps 1, depending upon the degree of dimming desired. The switches 20 may be of the single-pole double-throw type. In the normal position of a switch 20, the circuit is completed to the associated lamp 1 through a contact 21. When it is desired to dim the light from the unit, the switch 20 is actuated to engage a contact 22, thereby substituting for the lamp 1 the resistance 7 substantially equal to the hot resistance of the filament. Thus, in the case of a combination comprising nineteen lamps as illustrated herein, the output can be dimmed in steps of slightly over 5% of full output.

Since the cutout 6 has a significant resistance after breakdown, an intermediate tap 23 may be provided on each of the resistors 7 in Fig. 5 to cancel out the resistance inherent in the cutout 6 after breakdown thereof; in other words, the combined resistance of cutout 6 and of the portion 7*a* of resistor 7 is substantially equal to that of the filament 13. However, when desired, the tap 23 may be moved to the right to make the combined resistance of the cutout 6 and the portion 7*a* of resistor 7 slightly less than the hot resistance of filament 13. In this case, the voltage and current acros the remaining lamps would be raised slightly and the total light output of the unit maintained at about the same value as before failure, thus permitting a scene in a studio to be finished at about the same lighting level before replacing the burned out lamp. It will be obvious that, if desired, the portion 7*a* of resistor 7 may be made a physically separate member from resistor 7.

In the particular physical arrangement shown in Fig. 2, and the corresponding circuit arrangement shown in Fig. 6, eighteen of the cutouts 6, resistors 7 and switches 20 are supported by the cross members 5, and the nineteenth one of each of those elements is supported by a lower cross member 24. This arrangement has the advantage that the nineteenth switch 20′ is placed to one side so that it may serve as a master switch. This switch 20′ also differs from the others in that it is a double-pole single-throw switch. In this particular case, the value of the resistance 7′ associated with the nineteenth lamp 1′ is so chosen that, when added to the resistance (after breakdown) of the associated cutout 6′, the combined resistance is equal to that of the filament 13′. The resistance of each of the other eighteen resistors 7, on the other hand, is itself equal to the resistance of the associated filament 13.

In general, the greater the number of lamps employed, the smaller is the dimming increment. Also, it is desirable to provide for maximum current rating of the lamps for longest life at a given color temperature. The "sealed beam" type of lamp construction permits very high currents for example in the order of 75 amperes or more; however, at present, commercial designs of cutouts place the limitation on current at some 40 amperes. The beam shape is a matter of design of the lens section 12 of the lamp, the reflector section 11, and the shape of the filament 13. With a clear cover glass or lens section 12, the parabolic reflector 11 and concentrated filament 13 mounted coaxially as shown, the beam is a concentrated circular spot of light. By providing a lens 12 with proper flutes and prisms the beam may be spread out as desired. For general lighting of a studio scene, the lens may be designed to provide a beam of, for example 80° horizontal spread and 20° vertical spread.

In a specific case, a total of nineteen lamps were used in the unit, each consuming 20 amperes at 6.32 volts. Each of the lamps had a maximum beam candlepower of about 220,000 and a beam spread of 9 degrees at a color temperature of 3200° K. The combined effect of the unit consuming 2.4 kw. was approximately 2.5 million candlepower. This is more than 2.5 times the maximum candlepower of conventional Fresnel spotlights with 5 kw. tungsten filament lamps, and is approximately equal to that of such spotlights with 10 kw. tungsten filament lamps.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A light projection unit comprising a plurality of similar electric lamps of sealed beam type each including a concentrated tungsten filament light source designed for operation at a low voltage in the order of 6 volts and enclosed in a light-concentrating reflector bulb and means supporting said lamps in a cluster with their axes substantially parallel to project a composite beam of light, means connecting said lamps in a series circuit for operation from a commercial power supply of about 120 to 220 volts, a resistor and a cutout connected in series across the terminals of each lamp, the combined resistance of each said resistor and cutout, after breakdown of the cutout, being approximately the same as, and not essentially exceeding, that of the associated lamp so that, upon failure of a lamp, each of the remaining lamps continues to operate at a voltage and current at least equal to that before the failure.

2. A light projection unit comprising a plurality of similar electric lamps of sealed beam type each including a concentrated tungsten filament light source designed for operation at a low voltage in the order of 6 volts and enclosed in a light-concentrating reflector bulb and means supporting said lamps in a cluster with their axes substantially parallel to project a composite beam

of light, means connecting said lamps in a series circuit for operation from a commercial power supply of about 120 to 220 volts, a resistor and a cutout connected in series across the terminals of each lamp, the combined resistance of each said resistor and cutout, after breakdown of the cutout, being slightly less than that of the associated lamp so that, upon failure of a lamp, the remaining lamps continue to operate at a voltage and current slightly higher than before failure whereby the composite light output of the said remaining lamps closely approximates that of all the original lamps.

3. A light projection unit comprising a plurality of similar electric lamps of sealed beam type each including a concentrated tungsten filament light source designed for operation at a low voltage in the order of 6 volts and enclosed in a light-concentrating reflector bulb and means supporting said lamps in a cluster with their axes substantially parallel to project a composite beam of light, means connecting said lamps in a series circuit for operation from a commercial power supply of about 120 to 220 volts, a resistor and a cutout connected in series across the terminals of each lamp, the combined resistance of each said resistor and cutout, after breakdown of the cutout, being approximately the same as, and not essentially exceeding, that of the associated lamp so that, upon failure of a lamp, each of the remaining lamps continues to operate at a voltage and current at least equal to that before the failure, and dimming means associated with at least some of said lamps and including an equivalent resistance of substantially the same electrical rating as the associated lamp and means to selectively switch either the associated lamp or the said equivalent resistance into the series circuit.

4. A light projection unit comprising a plurality of similar electric lamps of sealed beam type each including a concentrated tungsten filament light source designed for operation at a low voltage in the order of 6 volts and enclosed in a light-concentrating reflector bulb and means supporting said lamps in a cluster with their axes substantially parallel to project a composite beam of light, means connecting said lamps in a series circuit for operation from a commercial power supply of about 120 to 220 volts, a resistor associated with each lamp and having a resistance of substantially the same electrical rating as the lamp, a switch associated with each lamp and arranged to selectively connect either the associated lamp or resistor in the series circuit to provide for dimming of the unit in steps, and a cutout connected in a shunt circuit including, in series with the cutout, a portion of the associated resistor having a resistance which, together with the resistance of the cutout after breakdown thereof, is approximately the same as, but does not exceed, that of the associated lamp.

5. A light projection unit comprising a plurality of similar electric lamps of sealed beam type each including a concentrated tungsten filament light source designed for operation at a low voltage in the order of 6 volts and enclosed in a light-concentrating reflector bulb and means supporting said lamps in a cluster with their axes substantially parallel to project a composite beam of light, means connecting said lamps in a series circuit for operation from a commercial power supply of about 120 to 220 volts, a resistor and a cutout connected in series across the terminals of each lamp and having a combined resistance, after breakdown of the cutout, substantially the same as that of the associated lamp so that, upon failure of a lamp, the remaining lamps continue to operate at substantially the same voltage and current and to emit light of substantially the same color temperature, and dimming means associated with respective lamps and including an equivalent resistance of substantially the same electrical rating as the lamp and switch means arranged to selectively connect either the associated lamp or the said equivalent resistance in the series circuit to provide for dimming of the unit in steps without changing the color temperature of the light.

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