April 3, 1945. B. T. SETCHELL 2,372,857

PRIMARY LIGHT SOURCE

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Fig. 1

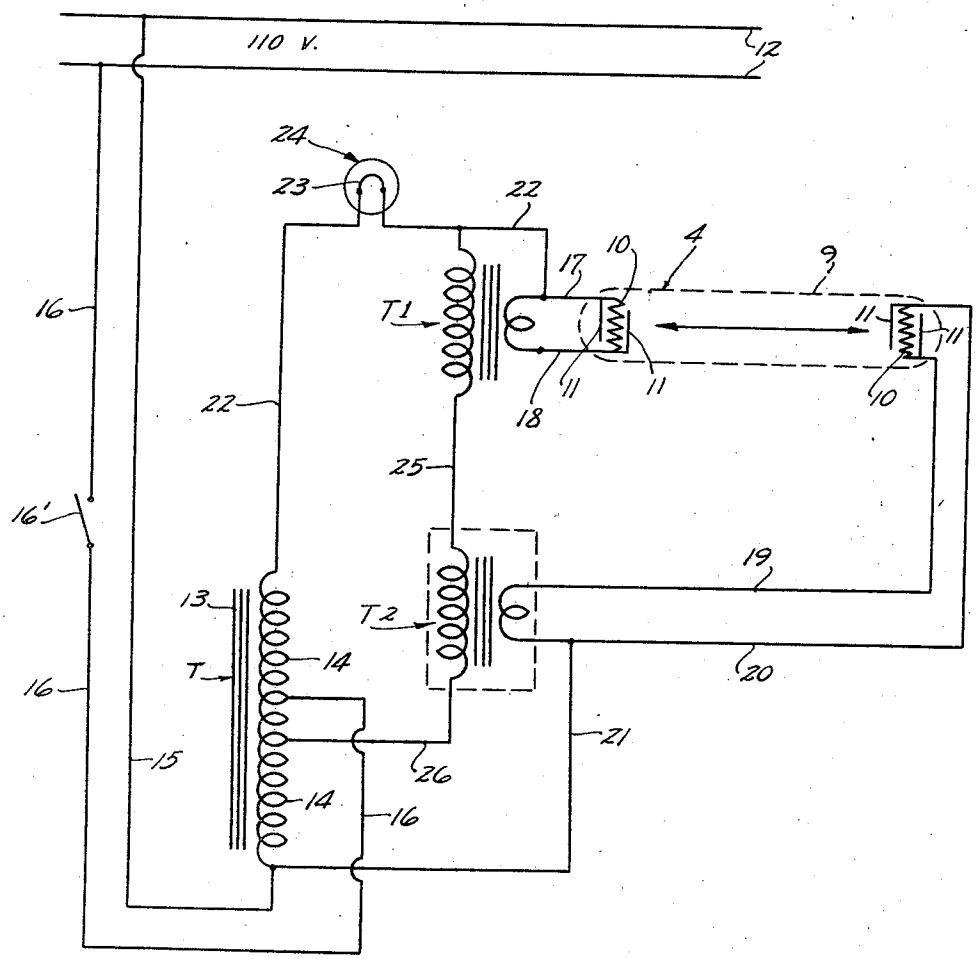
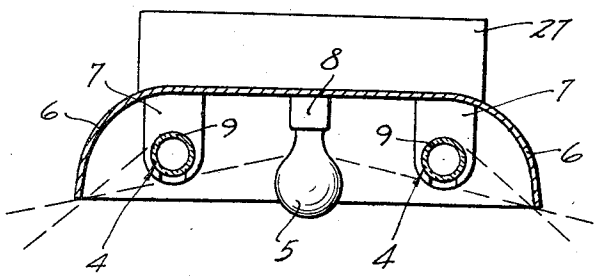


Fig. 2



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PRIMARY LIGHT SOURCE

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2 Claims. (Cl. 315—98)

My present invention relates to improvements in primary light sources and involves the combining of two well known but widely different types of light producing devices in such a manner that the light producing device of one of the types contributes to the satisfactory operation of the light producing device of the other type, and each type of light producing device radiates light energy into a common field of radiation. More specifically stated the present invention involves an electrical hook-up and physical relation of electrically operated light radiating devices of the electrical discharge and incandescent types whereby light output of each is radiated into a common field of radiation and the incandescent type light radiating device is connected in circuit with and serves as a ballast for limiting the amount of current drawn by the discharge type of light radiating device. It will be apparent, therefore, that with my invention the electrical energy consumed in its function as a current limiting medium for the electrical discharge light source is converted into light energy and is additive to the light energy out-put of the electrical discharge lamp or device. This practice greatly simplifies and in some cases eliminates the necessity for auxiliary apparatus commonly used in connection with electrical discharge lamps and, in addition to the advantages before specified, has a further advantage of utilizing the different color characteristics of the light energy radiated from the incandescent light producing device than is radiated from the discharge type light producing device to cover or strengthen a part of the color spectrum wherein the light out-put of the discharge device is weak or void. For example, in fluorescent discharge lamps presently available on the market, the so-called "3,500° white lamp" has a very high light out-put, but the light radiated from these 3,500° white lamps is so cold in appearance, and covers so little of the yellow part of the color spectrum, that it is objected to for many uses. In accordance with my invention, however, I can mix the light out-put of such a 3,500° white fluorescent discharge lamp with the light out-put of an incandescent filament, operating as a current limiting device for the fluorescent discharge lamp, and obtain a light out-put from the primary source of increased intensity and modified color covering a larger part of the color spectrum than either of the devices individually and which has sufficient yellow radiation to give a satisfactory warm effect more nearly representative of true daylight.

Still otherwise said, by combining the different color value out-puts of two light producing devices, one of which is performing an essential function in connection with the actual operation of the other, I am able to obtain, without waste of electrical energy, an increased total light out-put and a modified color value of the total light out-put, while at the same time reducing to a minimum or eliminating the customary auxiliary apparatus customarily employed in discharge tubes.

A still further object of the invention is the provision of an improved electrical hook-up for electrical discharge lamps involving an incandescent lamp filament as a ballast for limiting the amount of current drawn by the discharge lamp.

The above and numerous other important objects and advantages of the invention will be made apparent from the following specification, claims and drawing.

Referring to the drawing:

Fig. 1 is a diagrammatic view illustrating the electrical hook-up of one form of the invention;

Fig. 2 is a transverse sectional view showing a proposed physical relationship of incandescent and electrical discharge types of light producing devices hooked up in accordance with the schematic diagram of Fig. 1 and forming together a primary light source.

In Figs. 1 and 2 a pair of electrical discharge lamps in the nature of fluorescent tubes are indicated as entireties by 4. In Fig. 1 only one of these fluorescent tubes is shown, and it is indicated only by dotted lines. Fig. 2 shows a preferred physical relationship of one or more of these electrical discharge operated fluorescent lamp tubes 4 with one or more incandescent lamp bulbs 5, which bulb or bulbs may be assumed to be connected to operate as ballasts or current limiting device or devices for the discharge lamp or lamps. The tubes 4 may be assumed to be mounted in the reflector 6 in the customary manner through the medium of brackets 7, and the incandescent lamp bulb is shown as mounted on the reflector through the medium of a suitable socket 8. By reference to Fig. 2, however, it will be noted that the incandescent lamp bulb or bulbs is arranged to radiate its light energy into the field of radiation of the discharge lamp or lamps 4.

For the purpose of this case it may be assumed that the discharge lamps 4 are of the standard forty-eight inch forty watt type which operate on approximately 110 volts but which require a

substantially higher potential of approximately 220 volts for the purpose of starting and maintaining the arc or discharge. The fluorescent tube discharge lamps, therefore, comprise an elongated tubular envelope 9 of glass or other transparent material that is suitably sealed from atmosphere at its ends and is provided at opposite ends with thermionic electrodes 10 in the nature of filaments which may be assumed to be coated with a suitable electron emitting substance. Since these tubular discharge lamps are of the fluorescent variety, the tubular envelopes themselves may be assumed to be coated on the inside with a suitable phosphor, the actual variety of phosphor, of course, depending upon the color of the light radiation desired. Since the discharge tubes are of the so-called fluorescent type, the envelopes may be assumed to contain a suitable amount of mercury for the purpose of establishing a mercury vapor arc and to contain also a small amount of argon gas to facilitate starting. Also for the purpose of facilitating starting, the discharge lamp of Figs. 1 and 2 is shown as provided with auxiliary electrodes 11.

The lamp of Fig. 1 may be operated from a suitable high potential source such as the 110 volt A. C. power line shown in Fig. 1 and comprising leads 12. Since higher than line voltage is desired to start the electrical arcing or discharging in the lamp 4, a suitable step-up transformer T is employed and this is illustrated as being of the auto former variety comprising the usual iron core 13 and a winding 14. One end of the winding 14 of transformer T is connected directly to one of the power line leads 12 by a lead 15. The other lead 17 of the power line is connected by a lead 16 to the intermediate portion of the winding 14 of transformer T. In transformers of this type that part of the winding 14 connected between opposite sides of the source of potential, as by leads 15 and 16, serves as a primary and the entire winding serves as the high voltage secondary, so in this case it may be assumed that with 110 volts applied through leads 15 and 16, there will be 220 volts available across the entire winding 14.

For the purpose of heating the thermionic electrodes 10, which as previously stated are in the nature of resistance heating elements or filaments, there are provided step-down transformers T1 and T2. The low voltage secondary of the transformer T1 is connected directly across one of the thermionic electrodes 10 by leads 17 and 18, and the low voltage secondary of the transformer T2 is connected across the other thermionic electrode 10 of the discharge lamp 4 by leads 19 and 20. One extreme end of the winding 14 of transformer T is connected to one end of one of the thermionic electrodes 10 by leads 21 and 20, and the other extreme end of the winding 14 of transformer T is connected to one end of the other of the thermionic electrodes 10 of the discharge lamp by leads 22 and 17, the former of which has interposed serially therein the filament 23 of an incandescent lamp bulb 24. The primaries of the transformers T1 and T2 are serially connected in a circuit comprising that part of lead 22 including the filament 23 of incandescent lamp 24, the primary winding of T1 and lead 25 extending from the other end of the primary of transformer T1 to one end of the primary of transformer T2, and a lead 26 that returns to the winding 14 of transformer T at the intermediate portion thereof but at a point spaced from the point of connection of lead 16 in the direction of the end whereat lead 15 is connected.

From the above it will be evident that the incandescent filament of incandescent lamp 24 is common to both the high voltage arcing circuit and the primary circuit of the filament heating transformers T1 and T2, so that any voltage drop or current flow limitation imposed by the filament 23 will be effective on both circuits.

Now if we assume that the discharge lamp 4 of Fig. 1 is of the fluorescent type, previously described, and if we assume that the incandescent lamp bulb 24 is of the conventional 110 volt, 40 watt type, the operation of the device will be substantially as follows. Upon closing of control switch 16' located in the supply lead 16, current will flow in the primary circuit of transformers T1 and T2 with the result that approximately 10 volts will be applied across the thermionic electrodes 10 and current will flow through said thermionic electrodes, and also approximately 220 volts will be impressed upon the opposite thermionic electrodes 10 through the high voltage circuit comprising lead 22, incandescent filament 23, lead 21 and lead 20. Of course, at the outset no current will flow through the high voltage arcing circuit between the spaced thermionic electrodes 10 so that the voltage drop effected by the incandescent lamp filament 23 will be exceedingly low, being only the result of the small amount of current required to energize the primaries of transformers T1 and T2. However, the thermionic electrodes 10 will heat very rapidly and the arc circuit between the electrodes will be completed almost instantaneously or at least with a very minimum of delay, at which time the current flow in the arcing or discharge circuit will rise to the maximum value permitted by the incandescent lamp filament 23. When the current rises to this normal operating value for the discharge lamp arcing circuit, the incandescent filament of lamp 24 reaches its normal incandescent temperature and provides such impedance to flow of current that the voltage applied between opposite thermionic electrodes 10 of the discharge lamp is dropped from an approximate starting value of 220 volts to an approximate rated operating value of 110 volts, and the voltage applied across the thermionic electrodes 10 is dropped from a starting value of approximately 10 volts to approximately one-fourth (¼) starting voltage.

While it has been customary in practice to open the heating circuits through the thermionic electrodes 10 after starting, I have found by actual tests over a long period of time that discharge lamps of the type described actually last longer with a low voltage applied thereto under operating conditions of the tube than when the circuits thereof are opened completely.

The auxiliary electrodes 10 are employed in commercial discharge lamps of the kind described to facilitate starting of the discharge and function substantially as follows. Under starting conditions before the arc circuit has been completed, arcing is established between the associated auxiliary electrodes 11 which aids the starting of an arc or discharge between opposite thermionic electrodes 10.

By reference to Figs. 1 and 2 it will be seen that the primary light source is made up of a combination of electrical discharge and incandescent types of lamp elements and that the only auxiliary apparatus employed in connection therewith is the transformers T1 and T2 and that

this represents a material reduction in cost of auxiliary apparatus as compared to conventional commercial practice, eliminates waste of energy ordinarily consumed for the purpose of current limitation for the discharge lamp and completely eliminates any and all mechanical devices such as thermal switches and the like.

Another very material advantage of the present system lies in the fact that the power factor of the circuit is very high (usually well above 93%) and, therefore, no costly and troublesome capacitors are necessary for the purpose of correcting or partially correcting a bad power factor condition such as inevitably encountered when reactor type current limiting devices are employed in connection with discharge lamps.

Another very important advantage of the system described is a relatively very great improvement in the stroboscopic effect of the discharge lamp as compared to the stroboscopic effect customarily developed in connection with fluorescent and other types of discharge lamps operated in accordance with customary commercial practice. It will be appreciated that discharge lamps of the kind described require a certain minimum voltage to maintain a discharge between the spaced thermionic electrodes thereof and that under alternating current operation applied voltage falls below the minimum arcing requirement for a period during each cycle so that under sixty cycle operation the arc is established and discontinued 120 times per second, and it is this flicker that is known as the stroboscopic effect. Of course, the degree to which this stroboscopic effect is apparent to the human eye depends to a great extent upon the relation of the length of each arcing cycle to the intervening non-arcing cycle and, in the arrangement described, the excellent voltage regulating characteristics of the incandescent lamp filament **23** results in relatively longer arcing cycles and relatively shorter non-arcing cycles than is the case with discharge lamps of similar or identical character wherein the voltage and current regulation is brought about by other types of regulating or ballast devices. Furthermore, the apparent stroboscopic effect or flicker resulting when alternating operation of the discharge tube is further minimized, insofar as effect upon the human eye is concerned, by virtue of the relatively uninterrupted operation of the incandescent filament which remains hot and incandescent and actually radiates a considerable amount of light into the common field of radiation during non-arcing cycles of the discharge lamp.

In conventional commercial practice this intermittent action or stroboscopic effect is so serious that the use of single discharge lamps is largely discouraged in favor of sources made up of two or more discharge lamps arranged to be operated from an A. C. line in out of phase relation so that one lamp will be arcing while the other is in a non-arcing condition, but this practice has its objections particularly from the standpoint of duplication of auxiliary equipment necessary to bring about this out of phase relationship. However, with the scheme described, two discharge lamps, such as shown in Fig. 2, can be operated in phase without producing any objectionable flicker or stroboscopic effect, so great is the improvement over conventional practice.

In Fig. 2 a housing **27** is mounted on the top of the reflector **6** for the purpose of housing the transformers T, T1 and T2. In connection with the diagrammatic view of Fig. 1 it should be understood, however, that if a discharge tube of the type requiring a starting potential no greater than the available potential at the power line is employed, then the transformer T1 may be dispensed with.

What I claim is:

1. The combination with an electrical discharge lamp having spaced filaments serving as thermionic electron emitters, of step down transformer means involving two secondary windings, independent circuits each comprising one secondary winding and one filament, a transformer primary circuit, a high potential discharge circuit comprising the spaced filaments and the space therebetween, and an incandescent lamp filament connected serially in and common to said high potential circuit and the transformer primary circuit, said incandescent lamp filament being constructed to become incandescent under normal current requirements of the discharge lamp and providing, under such conditions, sufficient impedance to current flow to prevent the current flowing through and between the elements of the discharge lamp from rising to values damaging to the elements of the discharge lamp.

2. The combination with an electrical discharge lamp having spaced filaments serving as thermionic electron emitters, of two step down transformers each involving a primary and a secondary winding, independent circuits each comprising one transformer secondary winding and one of said filaments, a common energizing circuit involving the primary windings of said transformer, a high potential discharge circuit comprising the spaced filaments and the space therebetween, and an incandescent lamp filament connected serially in and common to said high potential discharge circuit and the said transformer primary circuit, said incandescent lamp filament being constructed to become incandescent under normal current requirements of the discharge lamp and providing, under such conditions, sufficient impedance to current flow to prevent the current flowing through and between the elements of the discharge lamp from rising to values damaging to the elements of the discharge lamp.

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