A clock having an indicating assembly with phosphorescent indicia for emitting visible light when exposed to ultraviolet radiation, and preferably combined with a radio receiver, is provided with a light tube which emits ultraviolet radiation directed against the phosphorescent indicia. Such light tube is preferably disposed between the indicating assembly of the clock and a filter plate which bars the passage of ultraviolet radiation therethrough towards the viewer. The light tube desirably includes a sealed tubular envelope interiorly coated with a phosphor for emitting the ultraviolet radiation when excited by a discharge between main electrodes within the opposite end portions of the envelope, and auxiliary electrodes are disposed adjacent the main electrodes for the generation of ions therebetween by which the main discharge is promoted. The auxiliary electrodes are preferably connected with respective resistors which are disposed adjacent the end portions of the envelope for heating the electrodes therein.

3 Claims, 5 Drawing Figures
RADIO COMBINED WITH A DIGITAL CLOCK

This invention relates generally to the illumination of the time-indicating indicia of a clock, and particularly to a digital clock combined with a radio receiver, so that such indicia can be easily read in the dark for ascertaining the indicated time.

When a neon tube or incandescent bulb is employed for illuminating the indicia on a clock, for example, in a clock-radio combination, the power of such illumination is usually relatively small, and the visible light from such a light source is reflected from the background of the indicia as well as from the indicia themselves, so that it is difficult to distinguish the numerals or indicia, particularly from a distance. If the power of the neon or incandescent lamp is increased to provide greater illumination of the indicia on the clock, the mentioned problem of reflection of light by the background of the indicating assembly and by the clock, and the effective reading of the indicia, and further the increased brightness of illumination is undesirable in a clock-radio positioned near the bedside as it disturbs the sleep of the occupant of the bed.

Accordingly, it is an object of this invention to provide an arrangement by which the indicia of a clock, particularly in a clock-radio combination, are illuminated without illuminating the background of such indicia so that great contrast is provided between the illuminated indicia and the otherwise dark background for facilitating the reading of the indicia.

Another object is to provide an improved light source for effecting illumination of the indicia, as aforesaid, and which affords substantially uniform illumination of the indicia while producing less heat than conventional light sources.

A further object is to provide a light source for illuminating the indicia of a clock, as aforesaid, and in which the operation of the light source is made substantially independent of the ambient temperature.

In accordance with an aspect of this invention, a clock, preferably in the form of a digital clock combined with a radio receiver, is provided with an indicating assembly having phosphorescent or fluorescent indicia for emitting visible light when exposed to ultraviolet radiation, and a light tube is provided which emits ultraviolet radiation directed against such indicia so as to illuminate the latter without the reflection of light from the background of the indicia.

In accordance with another aspect of this invention, a filter plate which permits the passage of visible light and bars the passage of ultraviolet radiation is disposed in front of the indicating assembly of the clock, and the light tube emitting ultraviolet radiation is disposed between the indicating assembly and the filter plate so that the viewer's eyes are not exposed to ultraviolet radiation.

In accordance with a feature of this invention, the light tube for emitting ultraviolet radiation includes a sealed tubular envelope coated at its interior with a phosphor material which emits ultraviolet radiation in response to the occurrence of a discharge between main electrodes disposed in the opposite end portions of the envelope and connected to the opposite sides of an alternating electrical source, and auxiliary electrodes are disposed in the envelope adjacent the respective main electrodes and also connected with the alternating electrical source so that ions are generated as a result of a preliminary discharge between each main electrode and the adjacent auxiliary electrode, and the generated ions promote the main discharge between the main electrodes.

In accordance with still another feature of this invention, auxiliary resistors are connected with the auxiliary electrodes, and such resistors are disposed adjacent the ends of the tubular envelope, so that current flowing through the auxiliary resistors serves to heat the electrodes within the adjacent ends of the tubular envelope for maintaining efficient operation of the light tube irrespective of the ambient temperature.

The above, and other objects, features, and advantages of the invention, will be apparent in the following detailed description of an illustrative embodiment of the invention which is to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a perspective view of a combined radio receiver and digital clock which has its indicating assembly advantageously illuminated in accordance with this invention;

FIG. 2 is an enlarged, vertical sectional view taken along the line 2—2 on FIG. 1 and particularly showing the indicating assembly of the clock-radio in association with the apparatus provided in accordance with this invention for illuminating indicia on such indicating assembly;

FIG. 3 is a perspective view of the light tube included in the illuminating apparatus provided in accordance with this invention;

FIG. 4 is an axial sectional view of the light tube and a schematic diagram of the electrical circuit associated therewith for energizing the light tube in accordance with this invention; and

FIG. 5 is an enlarged detail sectional view of the electrodes provided at one end of the light tube.

Referring now to the drawings in detail, and initially to FIG. 1 thereof, the invention is there illustrated applied to a clock-radio combination 10 having a housing 11 with a transparent cover plate 12 extending across the front of housing 11 to permit the viewing therethrough of the dial assembly 13 of a radio and the time indicating assembly 14 of a digital clock which are exposed at windows 15 and 16, respectively, provided in an opaque mask or front wall of housing 11. The housing 11 is further provided with suitable control knobs, one of which is indicated at 18, for controlling the operations of the radio and the digital clock.

As shown particularly on FIG. 2, the time indicating assembly 14 may be of a construction that is conventional in digital clocks and that includes a cylindrical support 19 rotated about a horizontal axis on a shaft 20 by means of an electric motor (not shown) which operates in synchronism with the frequency of the usual alternating current supply. A number of leaves are pivotally mounted, as at 22, on the surface of cylindrical support 19 so as to be swingable relative to the latter about axes which are parallel to the rotational axis of support 19 and spaced apart around the circumference of the latter. The support 19 is turned in the direction of the arrow A on FIG. 2 so that the leaves 21 at the top of cylindrical support 19 are moved forwardly toward a stop member 23 which depends from the top of housing 11 in a vertical plane that is substantially tangent to cylindrical support 19 at the front of the latter. Thus, the foremost leaf 21a moving forwardly and downwardly at the top of cylindrical support 19 is held
erect by stop member 23 until the top edge portion of 3
the leaf 21a moves below the bottom edge of stop member 23 for release from the latter. As each leaf is released from stop member 23, it swings under the influence of gravity about its respective pivot 22 and attains a vertically depending position, for example, as in the case of the leaf 21b immediately preceding the leaf 21a. The surfaces of adjacent leaves 21 are provided with indicia, as indicated at 24 on FIG. 1, so that such indicia cooperate to indicate the time when the respective leaves occupy the positions indicated at 21a and 21b on FIG. 2.

In accordance with the present invention, the indicia 24 are painted, stenciled, or otherwise formed on leaves 21 with a paint, ink or the like containing phos- phors which are phosphorescent or fluorescent for emitting visible light when exposed to ultraviolet radiation. An example of a suitable phosphor is that available commercially from Dai Nihon Tokyo, Japan, under the trademark “Sinoib Color.”

Further, in accordance with this invention, the clock-radio combination 10 is provided with a “black-light” illuminating apparatus 25 located within housing 11 between face plate or mask 17 and the front of time indicating assembly 14 for emitting ultraviolet radiation which is directed, as by a reflector 26, against the indicia 24 exposed to view at the forwardly facing surfaces of indicator leaves 21a and 21b. The ultraviolet radiation emitted by apparatus 25 preferably has wavelengths in the range from approximately 3,000 to 4,000 Angstroms. With the arrangement according to this invention, the ultraviolet radiation from apparatus 25 causes the indicia 24 to emit visible light, and no light is emitted or reflected from the background portions of the indicator leaves 21a and 21b so that the indicia 24 are highly visible and readily distinguished, even from a distance and in the dark.

In order to protect the eyes of the viewer from ultraviolet radiation, the passage of ultraviolet radiation from apparatus 25 forwardly through the transparent cover plate 12 is prevented either by forming such transparent cover plate 12 of an acrylic resin which is a filter for ultraviolet radiation, or, if the cover plate 12 is formed of glass, by providing an additional filter plate 12A (indicated in broken lines on FIG. 2) extending across the window 16 of mask 17 and being formed of an acrylic resin to bar the passage therethrough of ultraviolet radiation while permitting the passage of visible light.

Referring now to FIG. 4, it will be seen that the “black-light” illuminating apparatus 25 includes a cold cathode discharge tube 27 having an elongated sealed tubular envelope 28 of a material, such as, quartz, which prevents the passage therethrough of visible light while permitting the passage of ultraviolet radiation. The interior of envelope 28 is coated, as at 29, with a phosphor which emits ultra-violet radiation when excited by a discharge within the tube. A suitable phosphor for the coating 29 is, for example, Sylvania No. 2051, which is SrFbO2Eu++. Cylindrical main electrodes 30a and 30b are mounted within tubular envelope 28 adjacent the opposite ends of the latter, and auxiliary electrodes 31a and 31b are provided within the envelope adjacent main electrodes 30a and 30b, respectively. In the illustrated embodiment, the auxiliary electrodes 31a and 31b are rod-shaped and extend coaxially within the respective cylindrical main electrodes. As shown particularly on FIG. 5, one of the main electrodes 30b may be provided with an anular getter 32 containing a getter material 33. The sealed tubular envelope 28 may further contain a small amount of neon, argon, and/or mercury vapor under a low pressure, such as, for example, a pressure of 20 Torr.

An alternating electrical supply source 34 in series with a stabilizing resistor R, is connected across main electrodes 30a and 30b. The auxiliary electrode 31a, in series with an auxiliary resistor R, is connected in parallel with the main electrode 30b and, similarly, the auxiliary electrode 31b, in series with an auxiliary resistor R, is connected in parallel with the main electrode 30a. The value of the stabilizing resistor R, is selected in relation to the voltage of alternating source 34 so that, in the absence of the auxiliary electrodes 31a and 31b, the voltage available across the main electrodes 30a and 30b would not be sufficient to produce a discharge therewithin. On the other hand, the auxiliary electrodes 31a and 31b are selected so that the resulting voltage applied across main electrode 30a and the adjacent auxiliary electrode 31a, or across main electrode 30b and the adjacent auxiliary electrode 31b, will be sufficient to produce an initial discharge therewithin generating sufficient ions to promote the main discharge between main electrodes 30a and 30b.

In a specific example of a “black-light” illuminating apparatus 25 in accordance with this invention, the tubular envelope 28 has a length of 85mm and an inner diameter of 7.3mm, and the distance between main electrodes 30a and 30b is 70mm. The cylindrical main electrodes have an inner diameter of 5.5mm, and the length of the main electrodes and of the auxiliary electrodes 31a and 31b is 6mm, while the auxiliary electrodes have a diameter of 0.6mm. With the alternating electrical source 34 having a voltage of 200 volts, the stabilizing resistor R, is selected to have a value of 15 K ohms so that the current through resistor R, is 3 mA. The auxiliary resistors R, and R, are each selected to have a value of 56 K ohms so that the current through each of the auxiliary resistors is 0.5 mA at the commencement of the initial discharge. The voltage at which the discharge commences between the main electrodes 30a and 30b is approximately 140 volts to 150 volts, and the resulting ultraviolet radiation emitting column has a diameter of 7mm and a length of 60mm.

With the above described arrangement, the discharge commences between the main electrode 30a and the auxiliary electrode 31a, or between the main electrode 30b and the auxiliary electrode 31b to generate ions which promote the discharge between the main electrodes 30a and 30b at a relatively low voltage. Since the auxiliary resistors R, and R, are connected to the alternating electrical source 34 in parallel with the main electrodes 30b and 30a, respectively, the initial discharge voltage, that is, the voltage at which the initial discharge occurs between each main electrode and the adjacent auxiliary electrode, is substantially low.

Further, in accordance with this invention, the auxiliary resistors R, and R, are physically located adjacent the tubular envelope 28, and preferably adjacent the end portions thereof, so that heat resulting from the current flows through the auxiliary resistors is able to heat the main and auxiliary electrodes within the adjacent end portions of envelope 28, thereby to ensure
efficient discharge of the light tube 27 even when the ambient temperature is relatively low. It is further to be noted, that, when the temperature within the envelope 28 is decreased, the discharge voltage between the main electrodes 30a and 30b is correspondingly increased and, accordingly, the current flowing through the auxiliary resistors R₃ and R₄ will increase. Such increased currents flowing through the auxiliary resistors will similarly increase the heat generated thereby, and thus similarly increase the heating of the light tube 27. Thus, a thermal feed-back is provided for maintaining the temperature of the light tube 27 substantially constant, and thereby maintaining the discharge voltage of such light tube at the lowest possible value.

Although an illustrative embodiment of this invention has been described in detail herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to that precise embodiment, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of the invention.

What is claimed is:

1. The combination of a clock having indicating means with phosphorescent indicia for emitting visible light when exposed to ultraviolet radiation, a filter plate disposed in front of said indicating means and which permits the passage therethrough of visible light while blocking the passage of ultraviolet radiation, and a light tube disposed between said indicating means and said filter plate and emitting ultraviolet radiation directed against said indicia, said light tube including a sealed tubular envelope of a material which permits the passage therethrough only of ultraviolet radiation and which has its interior coated with a phosphor material which emits ultraviolet radiation when excited by electrons, first and second main electrodes disposed in the opposite end portions of said envelope and being connected to the opposite sides of an alternating electrical source, first and second auxiliary electrodes respectively connected in parallel with said second and first main electrodes to the respective sides of said alternating source, said first and second auxiliary electrodes being disposed in said envelope adjacent said first and second main electrodes, respectively, so that discharge between said main electrodes is promoted by the generation of ions between each of said main electrodes, alternately, and the adjacent auxiliary electrode, a main resistor connected in series with said main electrodes and said source so that the voltage across said main electrodes is insufficient to cause said discharge therebetween in the absence of said ions generated between each main electrode and the adjacent auxiliary electrode, and first and second auxiliary resistors connected between said first auxiliary electrode and said second main electrode and between said second auxiliary electrode and said first main electrode, respectively, so that said ions generated are sufficient to promote said discharge between the main electrodes, said auxiliary resistors being disposed adjacent the opposite end portions of said tubular envelope for heating the electrodes therein.

2. The combination according to claim 1, further comprising a radio having a dial with phosphorescent indicia on said dial for emitting visible light when exposed to ultraviolet radiation, and in which said ultraviolet radiation from said light tube is also directed against such indicia of the radio dial.

3. The combination according to claim 1, in which said tubular envelope is of quartz.