March 21, 1967 R. W. SHEPPARD 3,310,670

SEALED ILLUMINATOR

Filed March 26, 1962

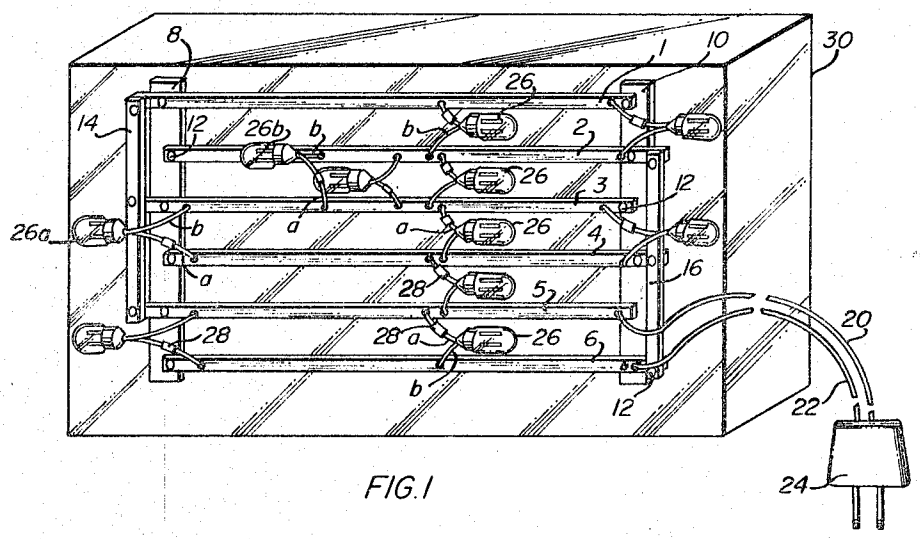

FIG. 1

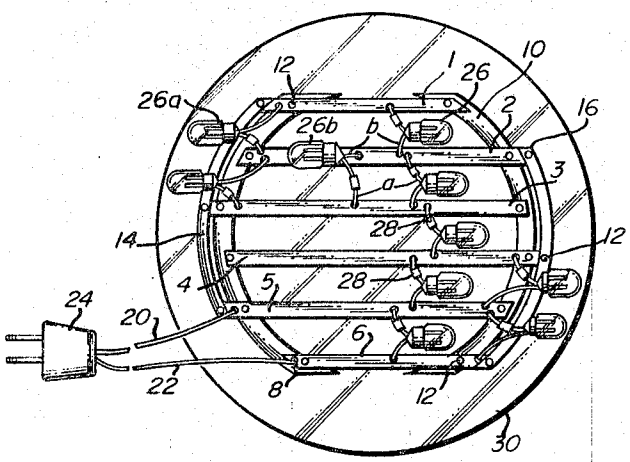

FIG. 3

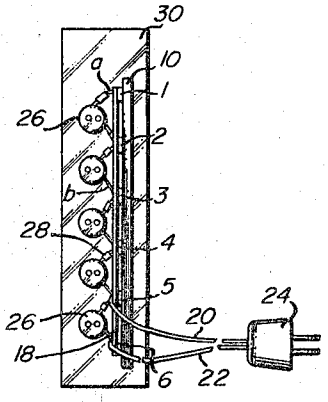

FIG. 2

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SEALED ILLUMINATOR

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5 Claims. (Cl. 240—11.2)

This application is a continuation-in-part of my prior copending application Ser. No. 181,132, filed Mar. 20, 1962, now abandoned.

This invention relates to a new illuminator suitable for providing a practical, compact, efficient, economical, hermetically sealed, completely protected, fully insulated, dielectric, encapsulated light source for use in connection with all kinds, types, sizes and shapes of stationary and/or portable signs used for identification, direction, location and advertising purposes; for bulletin boards and marquees; for night lights; for road and street signs; for darkrooms; for use aboard ships; for all sizes of individual letters and/or figures (which are interchangeable in use) for installations which require a long-life light source, without heat, with very low current consumption; for installations requiring an illuminator that can be locked in a sealed enclosure for reasons of safety or control, and for many other commercial and industrial practical applications and uses.

It is the object of the present invention to provide a new, practical and entirely different illuminating unit having one or more of the following characteristics: (1) which is entirely enclosed in a clear, transparent, or pigmented, enclosure which is fire retardant and self-extinguishing from fire; (2) which is hermetically sealed; (3) which is waterproof, rustproof and weatherproof; (4) which is unified into one piece and is entirely insulative and dielectric; (5) which is not affected by severe shock or vibration; (6) which requires no housing because all components are completely covered, hermetically sealed and protected; (7) which can, however, if desired, be placed in housings as thin as three-fourths of an inch made of glass, plastic, wood, or metal; (8) which will operate without producing heat; (9) which requires no maintenance; (10) which requires no change of bulbs or tubes; (11) which has an extremely low operating cost; (12) which has an extremely long operating life; (13) which is operatable on regular or high voltages, on either alternating or direct current, or on dry or wet batteries; (14) which provides, automatically, double-faced illumination from a single unit; (15) which can be mass produced to any desired specification, in any size, shape, contour, conformation, or periphery, at low cost; and, (16) which has an extremely wide field of applications and uses.

These and other objects are particularly achieved in accordance with one feature of this invention by the provision of a novel grid circuit comprising a first plurality and a second plurality of narrow, electrical conductors in fixed relationship to advantageously provide electrical connections to a multiplicity of lamps which are selectively positioned. In the illustrative embodiments of this invention, the first and second plurality of electrical conductors lie in substantially the same plane. According, each of the electrical conductors is juxtaposed between adjacent ones of the other plurality of electrical conductors and in substantially parallel arrangement therewith. To provide for a convenient bidirectional illuminating unit, the total area of the electrical conductors is small with respect to the area of the novel grid circuit structure. Each of the multiplicity of illuminating lamps and associated grid leak resistors is electrically connected in series relationship with the first plurality and second plurality of the conductors to which operating voltages are connected. More particularly, the illuminating lamps

so connected are positioned with respect to the interstices of the grid circuit structure in accordance with another feature of this invention whereby a minimum of interference is presented by the narrow electrical conductors strips to bidirectional illumination.

Upon a sufficient multiplicity of illuminating lamps having been connected to the grid circuit structure to satisfy particular illuminating requirements, the unit thus formed is completely enclosed in either a transparent or a pigmented polyester resin, in accordance with yet another feature of this invention to effect a rigid-support of the individual illuminating lamps with the grid structure. In this instance, such illuminating lamps and, also, the novel grid structure are effectively insulated from all external influences and suitably contained in a single integrated unit.

These and other objects and features of this invention will become obvious to one skilled in the art from a consideration of the description hereinafter set forth when taken in conjunction with the accompanying figures wherein: FIG. 1 is a front view of an illustrative embodiment of an illuminator in accordance with the invention; FIG. 2 is a side view of the illuminator unit of the type shown in FIG. 1; and, FIGURE 3 is a front view of another embodiment of the invention. In each of FIGS. 1, 2, and 3, an encapsulation medium providing a circuit and lamp support is shown which is either transparent or pigmented, and in which the novel grid circuit and illuminating lamps are supported and contained to form the integrated illuminator units.

Referring now to FIGS. 1 and 2, the novel grid circuit structure is illustrated as comprising six narrow, electrically conductive strips 1 to 6. Illustratively these strips are of copper, or brass. Strips 1 to 6 are attached at their extremities by copper eyelets 12 to electrically nonconductive support structures 8 and 10, respectively to form a rigid grid structure. Such support structures may advantageously comprise fibre board, plastic, or other electrically nonconductive material. To assist in the light providing properties of the illuminating unit, such support structures may be white to assist by reflection.

The electrically conductive strips and the support structures 8 and 10 may be of any length or number to provide an illuminating unit of any size, shape or contour, for example, substantially triangular, trapezoidal or circular (see FIG. 3), and of any desired dimensions.

As illustrated in FIG. 1, the extremities of groups of alternate ones of the conductive strips, i.e., 1, 3, and 5 and 2, 4, and 6, extend oppositely beyond the support structures 8 and 10. These extensions of these groups of conductive strips are connected to copper bus bars 14 and 16 so as to provide electrically multipled circuits. The connection of these strips to buses 14 and 16 may be by welding but is by means of the eyelets 12, as illustrated. The electrically conductive strips 1, 3, and 5 are multipled by the bus 14 and the electrically conductive strips 2, 4, and 6 are multipled by the bus 16 in conjunction with the supports 8 and 10 to form a rigid structure.

Electrical lead lines 20 and 22 are connected respectively to the groups of electrically conductive strips 1, 3, and 5 and 2, 4, and 6, and extend from a plug 24. For example, the lead lines 20 and 22 are welded to the adjacent electrically conductive strips 5 and 6. Accordingly, each of the lead lines 20 and 22 is electrically integral with its group of electrically conductive strips 1, 3, 5 and 2, 4, 6, respectively.

Illuminating lamps 26 are electrically connected in parallel across the first and second groups of electrically conductive strips, i.e., the conductors *a* and *b* of each of the lamps 26 is connected by butt-welds respectively

to the two adjacent strips in series with a resistor 28. Resistors 28 limit the current applied to the electrodes of the illuminating lamps 26. When the illuminator unit is to be operated on a standard 115–120 volt line, the ohmic values of the resistors 28 is between 27,000 and 36,000, and at higher voltages, the ohmic values are greater. Thus, each illuminating lamp 26 is connected in an electrical circuit in series with its resistor 28 between adjacent electrically conductive strips of the grid circuit structure and the lead lines 20 and 22. A welding of each of the conductors *a* and *b* to adjacent ones of the electrically conductive strips, respectively, provides positive assurance of dependable electric contacts therebetween.

By varying the spacing between the strips 1 through 6 on eyeletting them to the supporting supports 8 and 10, spaces or interstices therebetween are determined such that illuminating lamps 26 in any number and densities may be supported thereon to produce any desired illumination. Further, by providing that the total area of the electrically conductive strips 1 through 6 is small with respect to the area of the grid structure, the multiplicity of illuminating lamps are advantageously positioned between adjacent electrically conductive strips and, accordingly, at such interstices so that a same amount of illumination emanates from each face of the illuminating unit. It is to be noted that illumination from the individual lamps 26 pass through the interstices of the grid circuit structure to provide a convenient double-faced illuminator. Referring again to FIG. 1, the illuminating lamps 26 are positioned between and outside of the electrically conductive strips 1 through 6 and the supporting structures 8 and 10. Further, it is also evident that the illuminating lamps 26 may be positioned at either of the planar surfaces of the grid circuit structure.

If maximum illumination is desired from the illuminating unit, i.e., a maximum density of illuminating lamps 26, such lamps may be positioned not only between the electrically conductive strips 1 through 6 and supporting structures 8 and 10 but thereover and, also, extending beyond the grid circuit structure, as illustrated. For example, the illuminating lamp 26*a* is welded to the grid circuit structure, e.g., to the electrically conductive strips 3 and 4 to complete an electrical connection therefor from the lead lines 20 and 22. The illuminating lamp 26*a* is illustrated as positioned beyond the limits or periphery of the grid structure. In such case, a more efficient utilization of the particular grid circuit structure is effected as a maximum number of illuminating lamps are supported thereby. In addition, the illuminating lamp 26*b* is welded to the grid circuit structure, e.g., to the electrically conductive strips 2 and 3, and positioned over one of the electrically conductive strips, e.g., electrically conductive strip 2. In the latter instance, while the illumination provided by the illuminating lamp 26*b* directed through the grid circuit structure is somewhat reduced, a balancing of the bidirectional illuminating qualities of such unit may be effected by correspondingly positioning an additional illuminating lamp, not shown, on the opposite planar surface of the grid circuit structure. However, it is evident that a reduction in the width of the electrically conductive strips 1 through 6, and correspondingly a reduction in the total area thereof, minimizes such interference thereby to bidirectional illumination.

To insure an extremely long life to the illuminating unit in accordance with the principles of this invention, gaseous discharge lamps may advantageously be employed as the illuminating lamps 26. Such gaseous discharge lamps have greater illuminating properties than do conventional neon-glow indicating lamps and also an extremely long life in comparison therewith—in the nature of twenty years.

After the illuminating lamps 26 have been welded to the grid circuit structure, the resultant structure is

thoroughly cleaned of dirt and grease, and flattened so that the illuminating lamps 26 are selectively positioned with respect to the interstices therein, the assembly is ready for encapsulation as hereinafter detailed. It is to be noted that the illuminating lamps 26, although electrically continuous along the respective conductors *a* and *b* are not rigidly supported with respect to the grid circuit structure. However, the encapsulation to be provided not only effects such support but, also, renders this resultant structure virtually insensitive to all forms of external influence.

The forming molds employed for encapsulation purposes may be of any size and shape to produce the final and desired form of the illuminating unit. While forming molds of many different materials may be employed, materials of a nonporous type are best suited for encapsulating this illuminating unit, for example, such forming molds made of chrome plated metal, glass and polished aluminum.

While there are many materials which may be used as an encapsulation medium, I have determined that the method hereinafter detailed may be advantageously employed for use in producing this illuminating unit. The hereinafter detailed method is particularly suitable for avoiding any requirement or necessity for extraneous heat, treatment, control, or baking, to cure and make rigid the encapsulation medium of the illuminating unit to be produced. The unit so produced also gives very outstanding performance from the standpoint of illumination. The illumination is uniform, even though the lamps are spaced relatively far apart. The encapsulating of the lamps by the molding operation gives improved light transmission and dispersion or diffusion, and the dispersion and diffusion are controlled by varying the added pigmentation or other constituents and quantities in the encapsulating material.

I have determined that lecithin thinned with ethyl anhydrous denatured alcohol may advantageously be employed as a parting agent for use in separating the encapsulation medium of an illuminating unit from the forming mold. Thinned lecithin solution is wiped on all contact surfaces of the forming mold; thereafter, all contact surfaces of the forming mold are wiped off very thoroughly with a clean, dry cloth to remove all droplets and/or moisture remaining on the contact surfaces. All contact surfaces of the forming mold are, therefore, evenly coated with a very thin film of the lecithin solution. Applied, and wiped off, as detailed hereinabove, this very thin film of lecithin solution will part six, or more, encapsulated illuminating units, in succession, from the same forming mold before the mold requires another application of the lecithin solution.

I have also determined that Hetron 31, supplied by Durez Plastics Division of The Hooker Chemical Company, North Tonawanda, N. Y., may advantageously be employed as an encapsulation medium for illuminating units in accordance with this invention. Hetron 31 is a clear, fire retardant, polyester resin which, when integrated with specific quantities of a suitable promoter and catalyst, cures to a rigid state at room temperature without extraneous heat, baking, or treatment. This is an important factor in producing the illuminating unit economically. To produce a rigid encapsulation of this illuminating unit, the following formulation is used.

1.5 milliliters of cobalt naphthenate, a promoter, is carefully and thoroughly mixed with 350 milliliters of the Hetron 31 resin. Thereupon, 3.5 milliliters of methyl ethyl ketone peroxide, a catalyst, is added and carefully and thoroughly mixed with the combined resin and promoter. Caution must be exercised at all times to be certain that cobalt naphthenate and the methyl ethyl ketone peroxide are never mixed together directly to avoid the likelihood of an explosion.

A predetermined amount of the above mixture of resin, promoter, and catalyst, is now deposited in the forming

mold. Thereafter, the resultant grid circuit structure including the multiplicity of illuminating lamps **26**, which has been flattened and thoroughly cleaned of dirt and grease is eased and slid into the encapsulating material, hereinabove defined. In the event that the multiplicity of illuminating lamps **26** are positioned at one planar surface of the grid circuit structure, such surface is advantageously inserted to face the bottom of the forming mold. This procedural continuity is desirable as (a) it allows the insulative encapsulating material to completely cover all the components of the grid circuit structure which carry electric current as well as the individual illuminating lamps **26** and (b) it avoids the formulation of an excessive number of air pockets which are formed if the grid circuit is deposited in the forming mold before the encapsulating material.

By using the formulation and procedure detailed above, the curing time required to obtain a rigid encapsulation of the illuminating unit without extraneous heat, or baking, is approximately three hours at room temperature. Thereupon, the encapsulated illuminating unit can be removed from the forming mold and the process repeated. It is to be noted that the resultant illuminating unit is a unitary, integrated structure insensitive to external influences and wherein each of the illuminating lamps **26** including the conductors *a* and *b* thereof are rigidly supported with respect to the grid circuit structure. Accordingly, not only is the grid circuit structure unshortable, but also, the fragile conductors *a* and *b* are protected against breakage and moisture.

In addition, I have determined that sufficient diffusion of illumination can be effected for most purposes by adding to the formulation of the Hetron 31 polyester resin, the cobalt naphthenate promoter, and the methyl ethyl ketone peroxide catalyst, in the quantities detailed hereinabove, one gram of titanium dioxide powder of a specific gravity approximating 4.1. The titanium dioxide must NOT be added to the cobalt naphthenate but may be added to the Hetron 31 resin either before or after the cobalt naphthenate is added thereto. The titanium dioxide must be very thoroughly mixed with the Hetron 31 resin and the cobalt naphthenate promotor. Thereafter, the methyl ethyl ketone peroxide catalyst is added and thoroughly mixed. A translucent skim milk white encapsulation with maximum diffusion qualities surrounding each special miniature gaseous discharge lamp in the encapsulation medium results to provide greater uniformity of illumination over the entire surface area of the illuminating unit.

The illuminator resulting from this invention has the following novel, practical, economical and desirable features and advantages:

(1) Being entirely encapsulated in clear, or pigmented, rigid resin, it is hermetically sealed and protected.
(2) It is waterproof, rustproof, and weatherproof.
(3) It is fire retardant and self-extinguishing.
(4) It is completely insulative and dielectric.
(5) It is not affected by severe shock or vibration.
(6) It requires no maintenance.
(7) It requires no change of bulbs or tubes.
(8) It operates without heat—at ambient temperatures.
(9) Its operating cost is extremely low.
(10) It has an extremely long operating life.
(11) It is operatable on regular or high voltages, on either alternating or direct current, or on dry or wet batteries, without any change in the physical construction of the illuminating unit.
(12) A single unit provides double-faced illumination.
(13) It requires no housing because all components are completely covered and can be hermetically sealed, and protected by the enclosure.
(14) It is very compact.
(15) It can be unified into one piece, regardless of the desired size of the illuminating unit.
(16) It can be mass produced to specification in any size or shape at low cost.
(17) When used instead of incandescent lamps and/or fluorescent tubes, this illuminating unit effects tremendous savings in maintenance and operating costs.
(18) It can be mounted how, where, and when desired without using insulators or insulation because the resin used in the encapsulation is dielectric and insulative.
(19) It has an extremely wide field of thoroughly practical applications and uses.

To widen further the field of practical uses for this new, novel illuminator, this invention contemplates a utilization of special miniature gaseous discharge illuminating lamps of all and various sizes, some being filled with different suitable gases and/or combinations of gases required to obtain different colors and intensities of illumination.

As many possible embodiments may be made of the mechanical features of the above invention, and as the art herein described might be varied in various parts of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. An illuminator comprising a translucent supporting base, an assembly of lamps and two groups including electrical conductors carried by said base, each of said groups having a common bus bar to which one end portion of each conductor of such group is electrically connected, said bus bars of the respective groups of conductors being spaced apart in one direction, the conductors of each group being substantially equi-spaced from each other and from adjacent conductors of the other group in a direction substantially normal to the spacing directions between said bus bars, all of said conductors being arranged with their longitudinal axes substantially parallel to each other and in substantially the same plane, and each lamp being electrically connected between a conductor of one group and an adjacent conductor of the other group and being mounted in a position relative to other elements of said assembly to transmit light unobstructed laterally in opposite directions through portions of said base.

2. An illuminator according to claim **1**, and wherein said assembly includes two electrically non-conductive transversely arranged and longitudinally spaced tie members to which each conductor is secured at its opposite end portions to effectively retain said conductors and said lamps in operative relation as an assembly unit independently of said base.

3. An illuminator according to claim **2** and wherein said conductors are elongated flat strips each secured at one end to one of said tie members and at the other end to the other of said tie members, and each said bus bar is an elongated flat strip secured to and electrically connected with an end portion of each conductor of one of said groups of conductors, said bus bars being arranged in substantially the same plane, said tie members being arranged in substantially the same plane, and said conductors being arranged in a plane between said bus bar and said tie member defined planes.

4. An illuminator comprising a supporting housing having a translucent face portion, an assembly of lamps and two groups including electrical conductors carried by said housing, each of said groups having a common elongated terminal to which one end portion of each conductor of such group is electrically connected, said elongated terminals of the respective groups of conductors being spaced apart in one direction, the conductors of each group being substantially equi-spaced from each other and from adjacent conductors of the other group in a direction substantially normal to the spacing direction between said elongated terminals, all of said conduc-

tors being arranged with their longitudinal axes substantially parallel to each other and in substantially the same plane, and each lamp being electrically connected between a conductor of one group and an adjacent conductor of the other group and being mounted in a position relative to other elements of said assembly to transmit light unobstructed laterally in at least one direction through said translucent face portion of said housing.

5. An illuminator comprising a supporting housing having a translucent face portion, an assembly of lamps and two groups including electrical conductors carried by said housing, each of said groups having a common elongated terminal to which a portion of each conductor of such group is electrically connected, said elongated terminals of the respective groups of conductors being spaced apart in one direction, the conductors of each group being substantially equispaced from each other and from adjacent conductors of the other group in a direction substantially normal to the spacing direction between said elongated terminals, all of said conductors being arranged with their longitudinal axes substantially parallel to each other and in substantially the same plane, and each lamp being electrically connected between a conductor of one group and an adjacent conductor of the other group and being mounted in a position relative to other elements of said assembly to transmit light unobstructed laterally in at least one direction through said translucent face portion of said housing.

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