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EMISSION EXCITED LIGHT SOURCE

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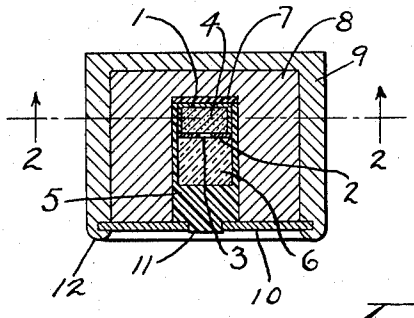


Fig. 1.

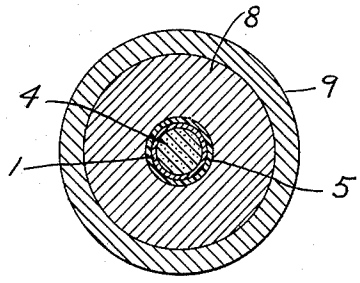


Fig 2.

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EMISSION EXCITED LIGHT SOURCE

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This invention relates to an encapsulated self-luminous light source in which fluorescence is induced in a material through excitation derived from a radioactive substance and it resides more specifically in an encapsulating structure within which beta emission from strontium 90 acts to excite a fluorescing material, such as, zinc sulfide, the elements of the encapsulating structure not only being effective to shield emission of substantially all but visible radiation but also to provide mechanical encasement to prevent or discourage escape of the strontium 90 through accident or tampering.

Heretofore, standardized light sources have been difficult to provide and primary comparison standards for calibration purposes have been difficult to obtain. For this reason, a convenient standardized source, based upon fluorescence, excited by radioactive emission, has been sought as a more economical and convenient photometric standard source. Difficulties, however, have been encountered in providing a source excited by radioactivity since the intensity of light obtainable in this manner, without hazard, has been undesirably low.

It is an object of the present invention to provide a light source having a sufficient intensity of illumination to be effective when a standardized source is desired, the light being derived from fluorescence excited through radioactivity but shielded to preclude harmful emission or radiation.

Another object of this invention is to provide a light source excited by radioactive emission from strontium 90 in which the radioactive material is so encapsulated that the hazard of its escape, harmfully, is markedly reduced.

Another object of this invention is to provide a light source of the type described wherein the rate of deterioration is low, predictable and readily calibrated in terms of familiar photometric standards.

Another object of this invention is to provide a light source of the type described dependent upon radioactive excitation which may be readily assembled by simple steps without danger of traces of the radioactive material remaining on the exterior surfaces of the shielding.

The foregoing and other objects and advantages of this invention will appear from the description following, which is set forth by way of illustration and not of limitation, reference being had to the drawing hereto attached and forming a part hereof.

In the drawing:

Fig. 1 is a side sectional view of the light source constructed in accordance with this invention, and

Fig. 2 is a plan view in section, viewed through the plane 2—2 indicated in Fig. 1.

Referring now to the drawing, the shielded light source excited by radioactivity in the form set forth in the drawing includes an internal light cell made up of a cylindrical thin walled aluminum cup 1 covered by a thin aluminum mask 2 with a central aperture 3. The mask 2 is preferably anodized and dyed black or otherwise blackened. The cell 1 is filled with a mass 4 made up of a carefully prepared, thoroughly blended mixture of small particles

of insoluble strontium 90 carbonate with carefully purified particles of zinc sulfide.

The dimensions and proportions of the mass 4 of fluorescent mixture contribute to its effectiveness and it is preferred that the body of the mixture be approximately one-fourth of an inch in diameter with a thickness of about one-tenth of an inch or slightly more if the aperture 3 in the black emission mask 2 is to be approximately one-sixteenth of an inch in diameter. By reason of the translucence of the constituents of the fluorescent mixture, visible light reaches the aperture 3 in considerable amount from points well within the body of the fluorescent mixture. At the same time, the dimensions and proportions of the body are such as to bring about interception by fluorescent molecules of a considerable proportion of the emitted electrons.

The average path of emergence of internally excited light, when the dimensions of mass 4 are increased, governs the useful yield and this yield is not materially increased by further increase of the mass unless aperture 3 is increased proportionately. For each size of aperture 3 there are, consequently, certain optimum dimensions for the mass 4.

The cup 1 is carefully filled with the mass 4 and the external surfaces freed as nearly as possible from extraneous particles of strontium 90 carbonate. The cup 1 is then placed within a transparent enclosure made up of a main case 5 composed of a transparent plastic, for example, methyl methacrylate. Prior to inserting the cup 1 with its aperture 3 facing inwardly, there is first placed in a central cylindrical well, in the case 5, a shield 6 consisting of a body of cerium glass which will slow and absorb the major part of the beta radiation without chromophoric degradation before such radiation can reach the plastic case 5 in quantities sufficient to discolorize the same.

The plastic substance forming the case 5 is, in itself, a thoroughly effective intercepter of emission from the strontium 90 carbonate and between the shield 6 and the material of the case 5 the beta radiation from the strontium 90 carbonate is practically stopped where these two materials, facing the aperture 3, together, present a transmission path upwards of one-fourth of an inch. The case 5 is enclosed by a cap piece 7 also of plastic, cemented in position, as shown, and the entire external surface of the case 5, after being sealed, is again thoroughly inspected and if necessary cleansed of any remaining externally adhering strontium 90 carbonate.

In order to intercept emission proceeding in directions other than in the direction intercepted by the shield 6 and case 5, the case 5 is inserted in a well formed in a light metal screen 8, preferably formed of aluminum and preferably having a minimum wall thickness in the neighborhood of about three-sixteenth inch, which is sufficient to practically stop radiation from strontium 90.

The screen 8 is enclosed in a mechanically strong casing 9 of generally cup shape formed of heavier metal having high mechanical strength and substantial resistance to fire damage. The open end of the enclosure 9 is fitted with a cover 10 having a central opening accommodating a stepped projection 11 formed as an integral part of the casing 5. The cover 10 is formed of a heavy metal selected for its mechanical strength and resistance to fire damage and is permanently held in position by staking, spinning or otherwise working the material at the margin of the enclosing cup 9, as shown at 12, to produce, as nearly as possible, a strong, tamper-proof mechanical joint.

The central opening in the cover 10, which accommodates the projection 11, has a diameter smaller than the minimum dimension of the glass shield 6 and, preferably, is larger than the aperture 3 in the cover 2 of the

cup 1. With the parts thus proportioned, even though the light source unit is exposed to fire and its temperature is raised to the point where the plastic material forming the case 5 is completely destroyed, the glass shield 6, nevertheless, cannot escape nor can the mass 4 be conveniently reached. Dangerous exposure to the substance contained in the mass 4, therefore, is unlikely to occur through carelessness, accident or even curious tampering.

Strontium 90 is the preferred exciting material and the carbonate of the same is the most economical and convenient compound of the same for the purposes intended. Other compounds of this isotope, however, may be employed as may be readily understood. Among the advantages of strontium 90 is the relatively slow rate of radioactive decay. It is generally accepted that the half life of this substance, so far as its radioactive properties are concerned, is approximately twenty-five years. While strontium 90, as an isolated substance, is not available except at extreme expense, mixtures are available dominated by strontium 90 and containing minor amounts of strontium 89 and yttrium 90. In the radioactive decay of strontium 90, it disintegrates into yttrium 90. Yttrium 90 has a half life of only approximately sixty-one hours but its presence and effect in the mixture is of consequence, since it emits a very hard beta ray that contributes substantially to the light emission. It consequently requires adequate shielding, and dimensions of the shielding of the apparatus are largely dictated by the presence of the yttrium 90. Any strontium 89 available in the mixture has a half life of about fifty-three days so that after a period of seasoning, its radioactive effect in the mixture becomes negligible. The nature of the mixture and the amount of seasoning required will depend, to a certain extent, upon the source of the strontium 90, and after seasoning radioactive equilibrium will be established.

The mixtures more readily available, therefore, after seasoning, will exhibit the properties of strontium 90 for most practical purposes and on this basis and using the accepted formula of radioactive decay, the radioactivity after one year would have an output of 97.3% of that at the effective outset. At the end of two years it would be approximately 94.7% and in five years 87.2%. After ten years that output would drop to approximately 76.1% and at the end of approximately twenty-five years, it would be 50%.

There is sufficient certainty in the decline of the light intensity which results that a light source, constructed in accordance with this invention, may be standardized at the time of its construction and the standardization may be applied thereto in terms of its calendar age for any period thereafter with great certainty.

The dependability of the light source of this invention thus lends itself well to photometer applications and particularly for photographic light meters for direct comparison of light intensity after transmission through calibrated screens. Other uses may exist as well where small continuous and dependable light output is required. For example, in photoelectric actuated inspection devices, alarm systems, telemetering systems or signal generators.

We claim:

1. In a self-energized light source capable of standardization the combination comprising a self-luminous mass consisting of intimately mixed beta emitting radioactive material and a metal compound capable of fluorescing when exposed to beta emission; a visible-light mask for said mass having an aperture through which a defined area of said mass is observable; a transparent beta emission absorbing ceramic glass screen positioned adjacent said mass to absorb emission from the side thereof on which the aperture is located and through which said aperture may be sighted; a visible-light transparent organic plastic casing surrounding said mass, said mask and said screen and having a viewing wall opposite said glass screen through which said aperture may be sighted through said glass screen; an emission absorbing light metal shield having an absorbing wall of substantial thickness sufficient to absorb substantially or all of the radiation from said radioactive material, said wall surrounding an open ended well which receives, in closely fitting engagement, the transparent casing with the glass screen enclosed thereby outwardly disposed with respect to the mass and with the viewing wall of the casing at the open end of the well; and a strong, heavy metal shell closely surrounding said light metal shield firmly closed against tampering and having an opening therein adjacent the viewing wall of said transparent casing.

2. In a self-energized light source capable of standardization the combination comprising a self-luminous mass consisting of intimately mixed strontium 90 compound and a metal compound capable of fluorescing when exposed to beta emission, a visible-light mask for said mass having an aperture through which a defined area of said mass is observable, a transparent cerium glass screen capable of absorbing radioactive emission from said strontium 90 compound positioned adjacent said mass to block emission therefrom on the side thereof in which the aperture is located, an emission absorbing light metal shield having an absorbing wall of substantial thickness sufficient to absorb substantially or all of the radiation from said strontium 90 compound, said wall surrounding an open ended well which receives the mass, the mask and glass screen the latter being outwardly disposed with respect to the mass and mask to present a viewing area screened by the glass at the open end of the well; and a strong, heavy metal shell surrounding and encasing said light metal shield firmly closed against tampering and having an opening therein adjacent said viewing area smaller than said glass screen to prevent removal of the latter and access to said mass.

3. In a self-energized light source capable of standardization the combination comprising a self-luminous mass consisting of intimately mixed beta emitting radioactive material and a metal compound capable of fluorescing when exposed to beta emission; a transparent beta emission absorbing glass screen capable of absorbing radioactive emission from said mass positioned adjacent said mass to block emission from one side thereof; and an emmission absorbing metal shield having an absorbing wall of substantial thickness sufficient to absorb substantially or all of the radiation from said mass, said wall surrounding an open ended well in which said mass is situated with the glass screen outwardly disposed with respect thereto to pass visible-light but to absorb beta radiation proceeding toward the open end of said well.

4. In a self-energized light source capable of standardization the combination comprising a self-luminous mass consisting of intimately mixed strontium 90 carbonate and a metal compound capable of fluorescing when exposed to beta emission, a visible-light masking enclosure for said mass having an aperture through which a defined area of said mass is observable, a glass screen capable of absorbing radioactive emission from said strontium 90 carbonate positioned adjacent said mass to block emission therefrom on the side thereof in which the aperture is located, a visible-light transparent organic plastic casing surrounding said mass, said mask and said screen and having a viewing face through which said aperture may be viewed through said glass screen, an emission absorbing light metal shield having an absorbing wall of substantial thickness sufficient to absorb substantially or all of the radiation from said strontium 90 carbonate having a well therein receiving in closely fitting engagement the transparent casing with the glass screen enclosed therein outwardly disposed with respect to the mass and with the viewing area of the casing at the open end of the well, and a strong heavy metal shell surrounding and encasing said light metal shield firmly closed

against tampering and having an opening therein adjacent the viewing area of said transparent casing.

5. In a self-energized light source capable of standardization the combination comprising a self-luminous mass consisting of intimately mixed strontium 90 carbonate and zinc sulfide capable of fluorescing when exposed to beta emission, a visible-light masking enclosure for said mass having an aperture through which a defined area of said mass is observable, a transparent cerium glass screen capable of absorbing radioactive emission from said strontium 90 carbonate positioned adjacent said mass to block emission therefrom on the side thereof in which the aperture is located, a visible-light transparent beta emission absorbing organic plastic casing surrounding said mass, said mask and said screen and having a viewing face through which said aperture may be viewed through said glass screen, an emission absorbing light metal shield having an absorbing wall of substantial thickness sufficient to absorb substantially or all of the radiation from said strontium 90 carbonate having a well therein receiving in closely fitting engagement the transparent casing with the glass screen enclosed therein outwardly disposed with respect to the mass and with the viewing area of the casing at the open end of the well, and a strong heavy metal shell surrounding and encasing said light metal shield firmly closed against tampering and having an opening therein adjacent the viewing area of said transparent casing.

6. In a self-energized light source capable of standardization the combination comprising a self-luminous mass consisting of intimately mixed strontium 90 carbonate and zinc sulfide capable of fluorescing when exposed to beta emission; a visible-light masking enclosure for said mass having an aperture through which a defined area of said mass is observable; a transparent cerium glass screen capable of absorbing radioactive emission from said strontium 90 carbonate positioned adjacent said mass to block emission therefrom on the side thereof in which the aperture is located; a visible-light transparent, beta emission absorbing organic plastic casing surrounding said mass, said mask and said screen and having a viewing face through which said aperture may be viewed through said glass screen; an emission absorbing aluminum shield having an absorbing wall of substantial thickness sufficient to absorb substantially or all of the radiation from said strontium 90 carbonate having a well therein receiving in closely fitting engagement the transparent casing with the glass screen enclosed therein outwardly disposed with respect to the mass and with the viewing area of the casing at the open end of the well; and a strong heavy metal shell surrounding and encasing said light metal shield firmly closed against tampering and having an opening therein adjacent the viewing area of said transparent casing, said opening being small enough to preclude removal therethrough of said glass screen.

References Cited in the file of this patent

UNITED STATES PATENTS

787,170	Glew	Apr. 11, 1905
1,534,937	Foley	Apr. 21, 1925
2,403,316	Wallhausen	July 2, 1946