June 12, 1962 J. G. MacHUTCHIN ET AL 3,038,271

SELF-LUMINOUS SIGNS

Filed July 22, 1959

FIG. 1

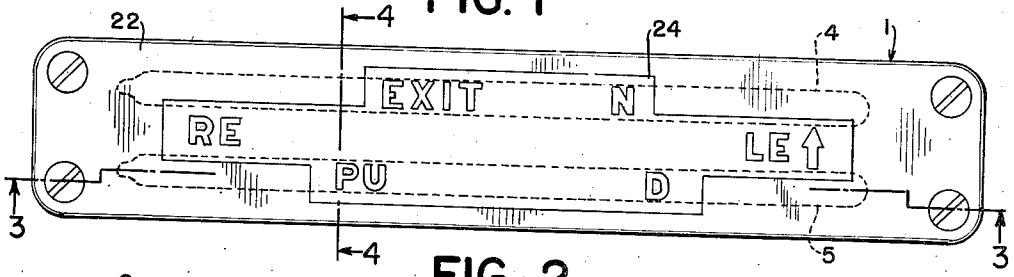


FIG. 2

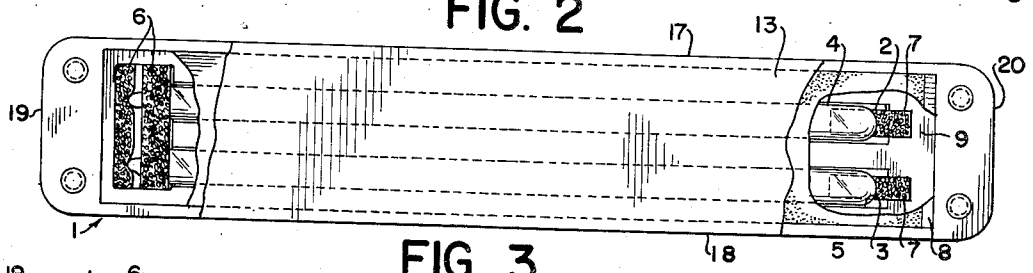


FIG. 3

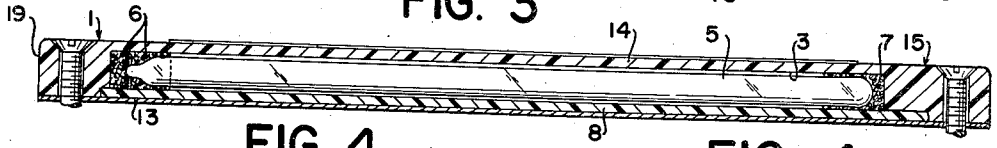


FIG. 4

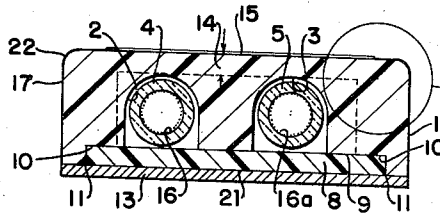


FIG. 4a

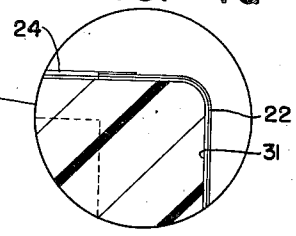


FIG. 5

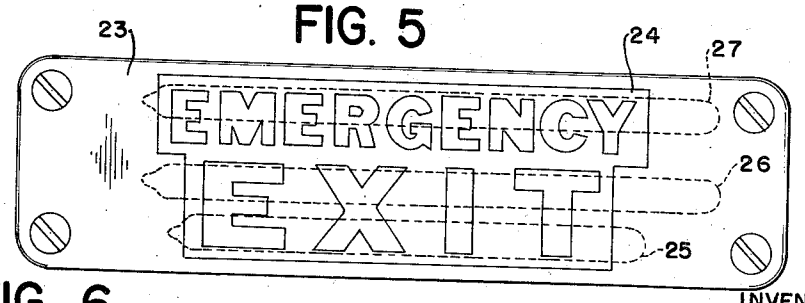
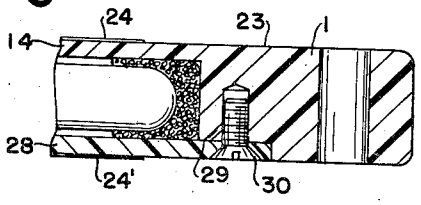


FIG. 6



INVENTORS
JOHN G. MacHUTCHIN
WALTER F. BUCK
JOHN C. FLYNN

BY Pennie, Edmonds, Morton, Barrows & Taylor
ATTORNEYS

United States Patent Office 3,038,271 Patented June 12, 1962

3,038,271

SELF-LUMINOUS SIGNS

John G. MacHutchin, Berwick, Walter F. Buck, Bloomsburg, and John C. Flynn, Espy, Pa., assignors to United States Radium Corporation, Morristown, N.J., a corporation of Delaware

Filed July 22, 1959, Ser. No. 828,798
4 Claims. (Cl. 40—130)

This invention relates to self-luminous signs, and is especially useful in vehicles and other locations where the signs should be legible under widely different lighting conditions.

Signs which carry instructions or other legends giving directions in case of emergencies, are of particular importance in vehicles, buildings and other public places. Such signs should be legible under the unusual circumstances which are likely to occur during emergencies, although many of them fall far short of this requirement.

The problems involved, especially in connection with aircraft, are well-known, but have been overcome only to a limited extent. It is therefore the object of the present invention to provide a sign structure of which the legend is uniformly legible at a useful distance under a wide range of incident light intensity as well as in the dark, is entirely self-contained and independent of other structures and electric circuits, etc., requires no maintenance, has a long useful luminous life, is resistant to damage, introduces no appreciable radiation hazard to personnel either in normal use or if damaged, and which, if desired, can be compact and of light weight. The novel sign structure in accordance with the present invention includes a light source comprising a phosphor excited by a radioactive material. This structure provides all of the above mentioned advantages, as will be understood from the following description considered in connection with the accompanying drawing, in which

FIG. 1 is a front view of a sign in accordance with the invention in which the legend includes three rows of lettering;

FIG. 2 is a rear view, partly cut away, of the sign of FIG. 1;

FIG. 3 is a cross-sectional view in elevation taken along the line 3—3 of FIG. 1;

FIG. 4 is a cross-sectional view in elevation taken along the line 4—4 of FIG. 1;

FIG. 4*a* is an enlarged detail of a corner of the structure represented in FIG. 4;

FIG. 5 is a front view of a modified form of sign according to the invention in which the self-luminous light sources are arranged differently than in the first embodiment; and

FIG. 6 illustrates a further modification in which legends are provided on both sides of the sign.

The embodiment illustrated in FIGS. 1–4*a*, inclusive, was designed especially for aircraft. The body 1 of the sign is formed of a suitable plastic material which is translucent as distinguished from transparent. Synthetic resins including acrylic resin such as polymethylmethacrylate are especially effective. Other materials having suitable properties can be employed. For the reasons below described, these properties should include sufficient absorption of radio-active emanations as well as the required optical properties. Under some circumstances milk glass can be substituted for the synthetic resins, although it would not be as suitable for aircraft as plastic materials.

Since it is usually desirable to minimize the overall dimensions of such a sign consistent with legibility, it is important that the body material have as good light transmittance as possible, consistent with sufficient light

dispersion and diffuse reflective properties to provide uniform illumination of the legend, regardless of its extent. The structure according to the invention provides these qualities, even though the light travels but a very short distance through the material of the body from the light source to the legend which, most efficiently, is directly over the light source. It has been found that "Plexiglas" V–647–60 and V–647–70 translucent-white molding powders produce a product having the described characteristics. They provide a luminous transmittance of over 50%, for a thickness of 1/16 inch; a reflectance of less than 40%, namely as low as 26%, for the same thickness; and a refractive index 1.49 (under A.S.T.M. D–542–42 test conditions). If it be desired that the body of the sign be constructed of laminations instead of by moulding, translucent white "Plexiglas" of type W–2447, II, which is obtainable in thin sheets, is satisfactory. This type of construction, however, requires cementing of the laminations, and subsequent machining in order to form an essentially homogeneous body as described and illustrated herein.

As shown, the body is moulded or otherwise formed, with one or more grooves 2, 3 in the back of the body, leaving the partition portion 32 between them, suitably spaced with respect to the lettering or other sign legend, to provide uniform illumination. In each groove a self-luminous tube 4, 5 is disposed and preferably resiliently supported so as to be free of contact with the material of the body. This is especially important if the tube is constructed of glass. Such a tube is described in more detail below.

As seen in the drawing, the self-luminous tubes 4, 5 are suspended by being imbedded at each end in sponge or foam material, also advantageously of a plastic which is unaffected by radioactive emanations. As shown in the figures, the plastic foam 6 is disposed above and below the tube, and also across the end. The tubes are secured and sealed in place by means of a backing plate 8 which is advantageously in sheet form, and may be transparent if coated, as below described. "Plexiglas" type II UVA, which has very high transmittance, is satisfactory. The thickness of the backing plate is here substantially the same as the thickness of the front of the body at 14, which is the dimension between the front face 15 of the body and the curved bottoms of the grooves 2, 3. In the particular embodiment herein illustrated this thickness was approximately 1/16 inch, whereas the remainder of the body was, as shown, five times as thick. This backing plate is preferably ground or lapped to a snap fit in the body 1 and sealed by a suitable cement against the back 9 of the body. To improve the gas seal such cement may be applied all around the backing plate as represented at 10, 10*a* and also around the outside chamfered joint 11 (FIG. 4). FIGS. 1, 2 and 3 are drawn approximately to scale.

Covering the entire bottom of the sign body is a cover-plate 13, advantageously of metal such as aluminum which also provides radio-emanation shielding and still further insurance against possible gas leakage in the event that any of the self-luminous tubes become broken. The exposed surface of this cover-plate provides a convenient area for use as name plate.

The tubes 2, 3 which comprise the self-luminous light sources employed in the sign structure of this invention have many features and characteristics in common with those described in co-pending application for U.S. Letters Patent, Serial No. 650,247, filed April 2, 1957, now abandoned, and its continuing application Serial No. 778,202, filed December 4, 1958, now patent No. 3,005,102, granted Oct. 17, 1961. Each tube is of glass or other suitable transparent material, closed on one end and seal-

able on the other. Penberthy DB–115 non-browning glass is suitable for the tubes. Although in the drawing they are represented as being straight, the tubes may be curved to conform to any unusual sign requirements. The entire tube may be filled with particles of luminescent phosphor, but it is more efficient to apply a thin uniform coating of phosphor on the inside wall. To do this, a layer of suitable adhesive is first applied, the phosphor powder is poured in, and the excess then shaken out. If the process is carefully executed, a very thin coating of phosphor will remain. It is preferable in this case to employ a coating (**16**, **16***a*) only a few particles thick, the average particle size generally being of the order of 10 to 20 microns. By weight, such a coating will be not more than of the order of 50 milligrams of phosphor per square centimeter of surface. Alternatively, the bottom half of the phosphor coating may be considerably thicker than the top half. The thicker coating will thereby produce more light; and the thin layer on top will itself produce more light than it will absorb from the thicker coating below it. But the light in the rearward direction will be less than if the coatings were uniform.

In accordance with the invention, the phosphor is preferably excited to luminescence by a colorless radioactive gas which is injected into the tube after the tube is evacuated. Gases presently preferred for this purpose are tritium and krypton 85, both of which emit beta radiations which excite the phosphor to luminescence. A brightness well in excess of 1,000 micro-lamberts may readily be achieved by pumping in a suitable quantity of the gas, althought the efficiency of the present structure is so great that less brightness than this has proved to be sufficient in most cases. The required quantity can conveniently be determined by measuring the light intensity as the gas is being injected, and stopping the injetcion when the desired brightness has been reached. Brightness of the order of 1000 micro-lamberts or more will usually require a gas pressure within the tube in excess of one atmosphere. Such pressure, especially at high altitudes, requires extreme precautions against gas leakage. In addition to precautions against gas leakage, it is also evident that for most applications, precautions against dangerous radioactive emanations are also required. The structure here described provides complete shielding agianst beta radiation and adequate shielding against the gamma radiation from krypton 85.

The light output from an area of luminescent phosphor is inherently diffused. Nevertheless, if the distances between the luminescent surfaces and the overlying sign legend on the front face **15** of the sign body are short as in the present example, the illumination of the legend would be unacceptably non-uniform in the absence of additional features of the invention now to be described.

The material of the body, being homogeneous, is uniformly translucent throughout, and it presents a dull gray surface because of its low reflectivity. This is desirable as a factor in achieving light duffusion, and also in achieving clear legibility of the sign in daylight or when otherwise illuminated by incident light, as discussed below. However, this does not provide either maximum illumination efficiency from the self-luminous sources or sufficient light diffusion. Therefore, according to the invention, the sides **17**, **18**, **19** and **20** of the body, as well as the front face **15** and the rear face **21**, are coated with a white gloss or semi-gloss paint or enamel layer **31** which diffusingly reflects the light back into the body. As a result, the sign legend is illuminated much more uniformly and to a higher brightness level than is obtainable without this reflective coating. If such a coating be sufficiently opaque and if a white finish for the sign proper be desirable, further coatings on the sign body need not be added. However, in most cases it is desirable that the sign proper be of a darker color. For example, emergency exit signs or signs giving emergency instructions, are frequently finished in red; and other signs are colored to harmonize with their surroundings. At greater expense, a coating of suitable metal such as aluminum or silver may be applied, as by evaporation, as a substitute for the white paint. Hence, the references in the appended claims to light-reflecting or white layers include useful equivalents.

The sign legend, whether it be formed of words, letters, numbers, symbols or combinations thereof, comprises bare or uncoated areas of the front face **15** of the sign body. In other words, the sign legend is produced by applying an opaque coating to all of the front face of the body except for the areas which constitute the legend. There are several methods by which such selective coating can be applied, including photographic, masking, screening and lithographic processes and combinations thereof. As a result of such coating process it may be assumed, for example, that the exterior layer **22** of the sign of FIG. 1 is French gray, and the exterior layer **23** of the sign of FIG. 5 is red. Usually the coating adheres better if the body surface is first given a frosted finish by sandblasting or the equivalent. This also tends to decrease the reflectivity of the legend surface areas, which is desirable, because it makes the surface still darker and thereby increases legibility under incident light.

In FIG. 1 and FIG. 4, it is seen that the first and third lines of the sign legend lie directly over the illumination tubes **4** and **5**, and are separated therefrom by only a fraction of an inch of body material **14**, whereas the second legend line lies over the much thicker partition portion **32** of the body material. It might therefore be expected that the illumination of the second line would be much less than that of the other two. This, however, is not the case, because the various constructional features above mentioned, cooperate to produce extremely uniform illumination of all portions of the legend in spite of the fact that, in the particular embodiment described, the overall thickness of the entire sign is only approximately one-half inch.

From the foregoing it will be noted that the sign legend is formed of substantially non-reflecting areas which, in the dark, or in feeble incident light, are legible because they are illuminated by the self-luminous source within the body. On the other hand, in brighter incident light they would be illegible, or substantially so, because the difference in reflectivity of the legend areas and of the dark painted areas adjacent them would be insufficient. Therefore, according to the invention, if the sign body is finished in a color substantially darker than white, a background coating of a white or substantially white paint or enamel, or the equivalent as previously mentioned, is applied as a frame adjacent to and surrounding the legend areas. As a result, the incident light which falls on the front of the sign will be diffusingly reflected back to the observer by the white framing coat **24** (FIGS. 1, 4*a*, 5), and substantially no light will be reflected back from the legend areas, thus making the dark legend legible by contrast. Alternatively, the white framing areas can be formed by masking the color coat **22**, thus exposing the opaque white undercoat **31**. In the rare case when the brightness of the incident light from an external source is substantially equal to the brightness of the self-illumination of the legend areas, the legend will be legible if the two sources of illumination have different color characteristics. This can best be provided for by using a phosphor which produces light having color characteristics different from those of any likely source of light which could fall on the sign. For example, the phosphor mixture which was employed in the self-luminous tubes of the sign illustrated in FIGS. 1–4, was such as to produce a golden yellow light; and there was no such source of light in the airplanes for which these signs were designed.

Referring now to the alternative embodiment illustrated in FIG. 5, it will be seen that the "Emergency Exit" sign

is self-illuminated by three self-luminous tubes which may be constructed as previously described. However, in order to distribute the light therefrom so as to uniformly illuminate the letters forming the legend, the tubes are not symmetrically spaced. Here the areas of the letters in the word "Exit" are larger than those in the word "Emergency," and it was discovered that to provide the same apparent brightness for the two words it was necessary to locate the tubes **25** and **26** closer together than the tubes **26** and **27**. Except for the number of self-luminous tubes and the relative spacing thereof, the construction of the sign shown in FIG. 5 is substantially the same as that of the embodiment first described.

The self-luminous sign illustrated in FIG. 6 may be understood to be constructed in general in the manner described in connection with the embodiment of FIG. 5. In the present instance, however, the sign embodies two legend areas, viz., one on each side of the body. As seen in the drawing, the body and the front face thereof are constructed after the manner of the sign of FIGS. 1–4, as well as that of FIG. 5. In the double-sided embodiment of FIG. 6 the legend plate **28**, which corresponds to the backing plate **8** of FIGS. 3 and 4, is formed of translucent material having the same optical characteristics as those of the body of the sign, or at least of the legend portion **14** (FIG. 3). Likewise, legend plate **28** may carry coatings which duplicate in nature and function those described in connection with the former embodiments. For the reasons explained in the first case, it is also advisable to secure legend plate **28** to the back **29** of the body with a suitable gas sealing cement. In the present embodiment the seal is re-enforced by suitably located screws **30**. If the self-luminous tubes which are imbedded in the body of the sign of FIG. 6 are constructed so as to emit light of uniform brightness toward both of the legend areas, and if the self-luminous tubes are constructed to provide sufficient brightness, a sign of this nature will have many valuable uses. For example, it can be secured to the ceiling of a vehicle or of a building passageway to indicate the location of an emergency exit to the side.

The foregoing descriptions of three embodiments of this invention are given by way of example to provide a clear and complete understanding of the invention; but no limitation is intended thereby, because the scope of the invention is limited only by the appended claims.

We claim:

1. In a low-intensity luminous sign, a body of solid homogeneous translucent milky material, at least one lighting element substantially entirely imbedded in said body, an opaque coating covering the exterior surface of said body except for an uncoated area on the front surface of the body which is of configuration to comprise a legend, said coating being diffusingly light-reflecting on its interior surface, parts of said legend area overlying said element and the remaining part of said area extending laterally beyond said lighting element, the material of the portion of said body which carries at least some of said overlying parts of the legend area being much thinner than the remaining portion of said body, and both of said portions providing uninterrupted paths through the material of said body for light from said lighting element to the legend area, whereby said legend area is substantially uniformly illuminated.

2. A luminous sign according to claim 1 wherein said lighting element is of the type comprising a phosphor excited by beta-ray emitting gas, said translucent milky body is of beta-ray absorbing material, and hermetic means sealing said lighting element within said body against escape of gas.

3. In a low-intensity luminous sign, at least one elongated tubular lighting element, a unitary body formed with a groove on its back side within which said lighting element is mounted, resilient shock-absorbing means supporting said lighting element in said groove, an opaque rear plate covering the back of said body and enclosing said lighting element, said body being of homogeneous translucent milky material, an opaque coating covering the exterior surface of said body except for uncoated legend areas on the front surface of said body, said coating and said plate being diffusingly light-reflective on their interior surfaces, said shock-absorbing means being disposed beneath coated areas, parts of said legend areas overlying said lighting element and other parts of said areas extending laterally beyond the enclosed lighting element, the material of the portion of said body which carries at least some of said overlying parts of the legend areas being much thinner than the remainder of said body, and the material forming the front of said body providing uninterrupted paths through the material of said body for light emitted by said lighting element to all parts of said legend areas, whereby all parts of said legend area are uniformly illuminated.

4. A luminous sign according to claim 3 wherein said lighting element is of the type comprising a phosphor excited by beta-ray emitting gas, said plate and translucent milky body are of beta-ray absorbing acrylic material, and hermetic means is included between said plate and said body to seal said lighting element within said body against the escape of gas.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 18,679	Hotchner	Dec. 6, 1932
1,816,220	Hotchner	July 28, 1931
1,914,932	Wamser	June 20, 1933
1,937,957	Hotchner	Dec. 5, 1933
1,994,519	James	Mar. 19, 1935
2,155,449	Seaman	Apr. 25, 1939
2,604,711	Porter	July 29, 1952
2,651,863	Howenstine	Sept. 15, 1953
2,712,188	Neugass	July 5, 1955
2,740,957	Davies	Apr. 3, 1956
2,880,536	Sullivan	Apr. 7, 1959
2,883,770	Lieb	Apr. 28, 1959

OTHER REFERENCES

United Natl. Publication Peaceful Uses of Atomic Energy, New York, 1956, vol. 15, pages 307–309, Div. 54.

Publication, Nucleonics, September 1957, p. 192, Div. 54, 250–106.