

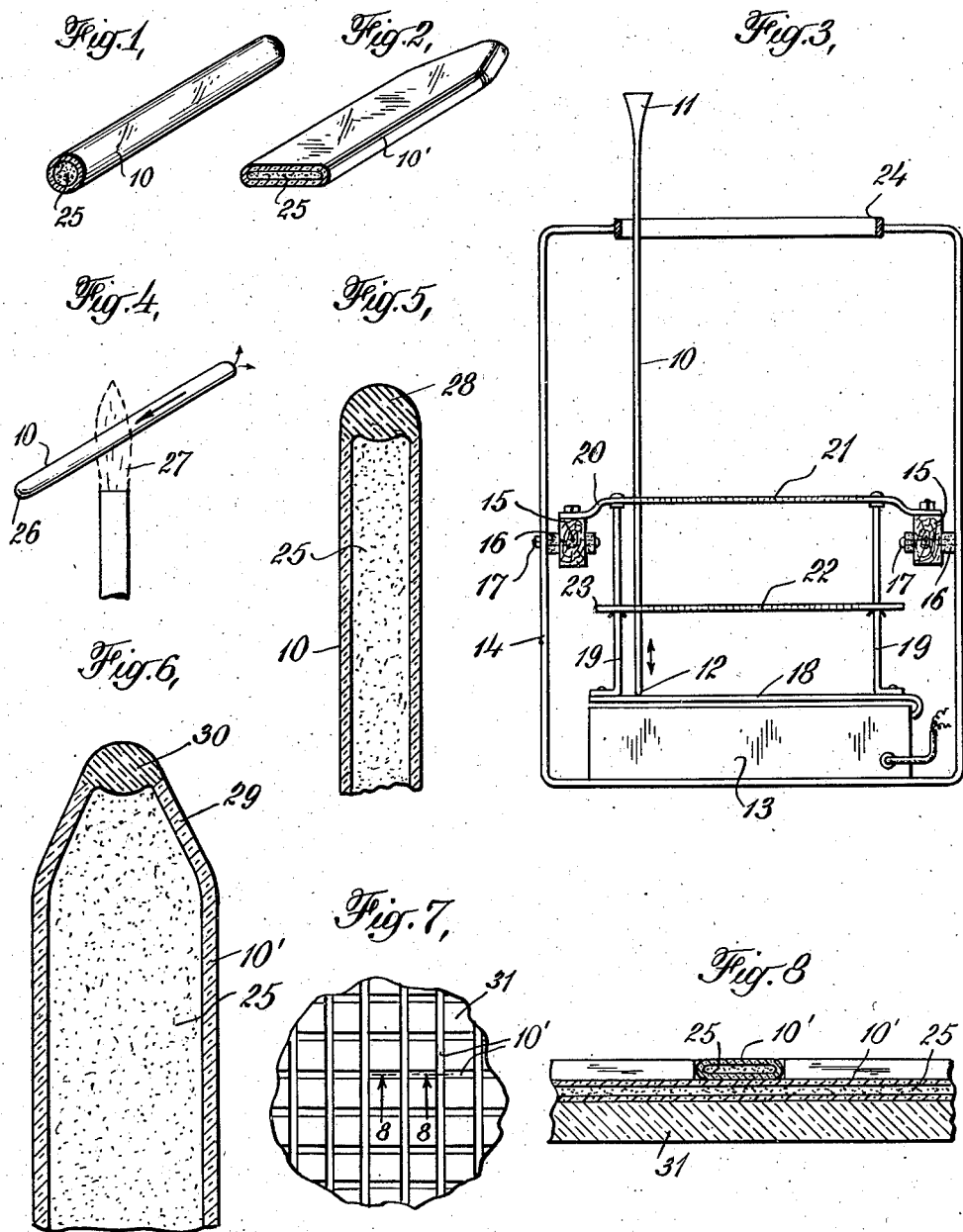
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METHOD OF MAKING SELF LUMINOUS ELEMENT

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METHOD OF MAKING SELF-LUMINOUS
ELEMENT

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This invention relates to self-luminous elements and has particular reference to elements which contain radium compounds so as to be visible in the dark.

It has been the practice heretofore to illuminate indices, pointers, hands, dials, scales, and other parts of instruments, or the like, with radium paint composed of small particles of radioactive material dispersed in a suitable adhesive which readily adheres to the surfaces to which it is applied. The adhesives used, such as lacquer derivatives mixed with oil, and the like, eventually become discolored, either as the result of frequent exposure to sunlight, or the deteriorating action of the radium compounds dispersed therein, or to external causes such as gas fumes and the like. The luminous paint accordingly gradually becomes dull with a commensurate reduction of its luminosity of from 50 to 70%, depending upon circumstances. Furthermore, it is frequently impossible to secure uniformity of application of the luminous paint, so that index lines and the like have different widths and densities, with consequent non-uniformity of illumination. Attempts have been made to overcome the aforementioned objections to luminous paint by enclosing the luminous material in glass tubes and mounting these tubes on the parts to be illuminated, but because the luminous material loosens and shifts after a time, the luminosity of such tubes becomes non-uniform and their utility accordingly impaired. Impregnating the material in the tube with an adhesive, as is disclosed in Patent No. 1,364,368, corrects this objection but introduces a deteriorant in the form of the adhesive, so that that expedient does not solve the problem. Also, the presence of air in the tubes when their open ends are sealed by fusion results in the formation of an enlarged ball at that end of the tube, which is objectionable.

In accordance with the present invention, a self-luminous element in the form of a hermetically sealed capillary tube or capsule containing solidly compacted luminous material in the substantial absence of air is provided, this tube being either circular or flat in cross section, depending upon requirements. The flat tube is especially advantageous for forming index markers and the like, because it is more readily applied than circular section tubes and gives a maximum luminosity for a minimum amount of luminous material, it having been found that luminous material in excess of from twelve- to fifteen-thousandths of an inch in thickness does not increase the luminosity of the element in proportion to

the additional amount of luminous material required, so that a tube of circular cross section providing a luminous line of the desired width may contain a relatively uneconomical excess of the luminous material. Accordingly, flat capillary tubes of from twelve- to fifteen-thousandths of an inch inside thickness and as wide as is required and filled with luminous material, may be provided in accordance with this invention to distinct advantage.

In forming the self-luminous element according to the novel process of this invention, a capillary tube of circular or flat cross section is drawn, preferably to considerable length, with a bell at one end to serve as a filling funnel, the other end of the tube being sealed off by fusion and the tube filled with dry, finely-divided, radioactive material. The tube so filled is rapidly vibrated mechanically longitudinally, so that the luminous material therein is compacted by impact into a hard, solid, homogeneous column, having a density exceeding that obtainable by any vibration to which it may be subsequently subjected in use, and accordingly it will not thereafter compact and shift or slip to vary its original luminous characteristics. It has been found that it is impossible to sufficiently compact the material in the tube by tapping it by hand, but rather a mechanical impact device, vibrating rapidly, such as at a speed of approximately 3600 vibrations per minute, is essential to secure the proper degree of hardness of the fine, impalpable powder comprising the luminous material.

The tube so filled is then severed into the proper lengths, a small amount of the luminous material removed from one end of each length so that it may be sealed by fusion, and a small amount of the material removed from the other end for the same purpose, except that before sealing of the remaining open end, the tube is exhausted to remove air and any other gases which remain in the tube between the particles of luminous material, and is then sealed by fusion, the molten glass being drawn into the tube by the vacuum therein to form a rounded end as compared to the objectionable, enlarged ball end which is formed when the tube is not exhausted.

It will be seen that this invention, which is an improvement on my earlier application filed September 17, 1932, Serial No. 633,583, not only eliminates the laborious painting of luminous paints on instruments of the like, but also provides a practical substitute therefor as compared to the attempts made heretofore to provide self-lumi-

nous tubes which have not proven satisfactory because of substantial diminution of their luminosity due to shifting of the luminous material therein or deterioration due to the presence of adhesives mixed with the luminous material in the tubes.

For a better understanding of the invention reference may be had to the accompanying drawing, in which

Figure 1 is an enlarged perspective view of the round form of the self-luminous element of this invention;

Figure 2 is a similar view of the flat form of the self-luminous element of this invention;

Figure 3 illustrates the compacting machine for compacting the self-luminous material in the elements by impact;

Figure 4 illustrates the method of expelling the air from the elements before sealing them hermetically;

Figure 5 is an enlarged section of the sealed end of the round element;

Figure 6 is an enlarged section of the sealed end of the flat element;

Figure 7 shows a fragment of a grid or grill having its lines formed of the self-luminous elements of this invention; and

Figure 8 is an enlarged cross section of a portion of the grid or grill as seen along the line 8-8 of Figure 7.

In the drawing, numeral 10 designates a capillary glass tube of circular cross section, which is drawn in long lengths, such as three to four feet. In drawing the capillary tube 10, one end thereof is preferably provided with a bell 11 which serves as a filling funnel. The other end 12 of the tube 10 is sealed by fusion in a flame, or the like.

Finely-divided, dry, radio-active material is then introduced into the bell 11 while the tube is held in vertical position, so that it is filled from end to end. The tube is then rapidly vibrated axially or longitudinally by impact. It has been found that tapping the tube by hand is not sufficient to compact the material therein, for, when the finished element is placed on an instrument to illuminate its pointers, dial inscriptions, and the like, and this instrument is mounted on an airplane, vessel or other support subject to a vibration whose rate is in excess of that originally employed to compact the material in the tube, the material soon becomes compacted to a greater degree, so that it loosens and shifts and accordingly diminishes the effective luminosity of the element containing it. Accordingly, tube 10 is vibrated at a rate exceeding that to which the finished element will subsequently be subjected in use, so that the material cannot be further compacted during use and accordingly will not shift or slip and lose its original luminosity. I have found that for all practical purposes, a vibration of approximately 3600 vibrations per minute is sufficient to secure a compactness in excess of that obtainable during subsequent use of the element.

A machine which is suitable for securing the required compactness of the luminous material in the tube is illustrated in Figure 3, and consists of a suitable high-speed electric vibrator 13, supported by bars 14 on a firm frame 15 of suitable construction. Rubber gaskets 16 are preferably interposed between bars 14 and the bolts or other fastening means 17 which secure the bars 14 to the frame 15. The vibrator 13 is provided with a platform 18, from which extend upwardly a

series of rigid bolts or uprights 19 carrying at their upper ends a cross member 20 secured at opposite sides to the frame 15. The cross member 20 preferably comprises a plate having a plurality of perforations 21 which align with similar perforations 22 in an intermediate plate 23, also supported by the bolts or uprights 19. The bars 14 are extended upwardly above the frame 15 and are provided with a ring 24 for assisting in supporting the elongated tubes 10 when they rest on the platform 18 in the upright position illustrated in Figure 3, after insertion through aligned holes 21 and 22 in cross member 20 and plate 23, respectively.

The free vibration of vibrator 13 is restrained or partially suppressed by the rigid connection of cross member 20 with frame 15, so that as the vibrator vibrates tubes 10 are projected upwardly and fall back on the platform 18 to continuously bounce thereon with great rapidity. The resulting impact on the tube 10 solidly compacts the finely-divided, luminous material 25 therein, as much more of the loose luminous material being introduced into the bell 11 as is necessary to completely fill the tube to the desired height. The tube 10 containing the self-luminous material 25 accordingly becomes in effect a unitary element, the self-luminous material being so firmly compacted therein.

The filled tube 10 is then severed or broken into appropriate lengths, depending upon requirements, and a small amount of the self-luminous material is removed from each end of each length so that these ends may be sealed by fusion. One end of the tube is then sealed at 26 in this way. In order to expel the air in these filled lengths of tube, they are passed relatively slowly through a flame 27 in a direction leading from the sealed end 26 toward the unsealed end, as is illustrated in Figure 4, so that the air contained in the tube is substantially entirely expelled therefrom by the heat, which should not be sufficient to injure the material 25. When the tube 10 has been passed entirely through the flame 27, but before its open end is withdrawn out of the flame, this open end is sealed by fusion in the flame, so that no air can enter the tube after it has been exhausted in the manner described. The partial vacuum thus formed in the tube causes the molten glass at the end being sealed to be drawn into the end of the tube to form a smooth rounded end 28, illustrated in Figure 5, engaging the corresponding end of the column of radio-active material 25 in the tube 10. In this way, the objectionable enlarged ball, which is formed in sealing the remaining open end of an unexhausted tube, is avoided. This is an important consideration, because such tubes are frequently mounted in slots or grooves which will not admit any oversized portions of the tube. Other methods of exhausting the tube 10 prior to sealing its remaining open end lie within the scope of this invention.

In a modified form of the invention, flat, ribbon-like, glass capillary tubes are drawn with an inside thickness not substantially exceeding fifteen-thousandths of an inch and a considerably greater inside width, depending upon requirements. I have found that self-luminous material in excess of from twelve- to fifteen-thousandths of an inch in thickness does not increase the luminosity of the finished element in proportion to the additional amount of luminous material required, so that a tube of circular cross section providing a luminous line of the desired width

may contain a relatively uneconomical excess of the luminous material. Also, the flat tube is easier to handle and more adaptable to application on various thin objects without materially increasing the over-all thickness of the assembly, which is not the case with circular cross section tubes providing an equivalent degree of luminosity. These flat tubes 10' are filled in the same way as the circular round tubes 10, but in sealing the ends of the tube a different procedure is necessary to avoid the formation of a ball across the narrow portion of the tube end. This procedure involves first reducing the end of the tube to a point as at 29 in Figure 6, and then it is sealed by fusion at 30, the tube being exhausted before the remaining open end is sealed. The fused end 30 accordingly is no thicker than the minimum thickness of the finished flat tube 10'.

The flat tube 10' is admirably adapted for forming luminous grids and grills, because when it is applied to the surface to be illuminated, it provides a maximum width of luminous line for a minimum increase in thickness of the assembly. Furthermore, instead of mounting the flat tube 10' on the surface of the glass plate 31 forming the base of the grid or grill, parallel grooves may be ground or otherwise formed in one surface of the plate 31 and the flat elements 10' set flush with its surface. Crossing lines may be formed by grinding or otherwise forming grooves twice as deep in a crossing direction in the surface of the plate 31 and setting crossing elements 10' in these deeper grooves, as is illustrated in Figure 8. It will be observed that even with these two levels of overlapping elements 10' the thickness of the plate 31 need not be materially increased. Alternatively, the crossing elements may be set in the opposite surface of the plate 31 in slots ground or otherwise formed in the reverse face of the plate 30.

Instead of forming self-luminous grids or grills in the manner described, the tubes 10 or 10' may be placed in closely-spaced, parallel positions on transparent, translucent, or opaque surfaces to render such surface luminous in the dark for the purpose of providing markers of circular or other shapes for various uses. Also, the elements of this invention have many other uses.

It will be seen that the new self-luminous element made in accordance with the novel method of this invention is devoid of the objectionable features of luminous paint heretofore employed and of capillary tubes heretofore proposed containing loose self-luminous material.

While certain preferred embodiments of the invention have been illustrated and described, it is to be understood that the invention is not lim-

ited thereby, but is susceptible of various changes in form and detail within its scope.

I claim:

1. The method of making self-luminous elements, which comprises filling an elongated glass tube with self-luminous material, said tube being closed at one end, expelling surplus air from the tube by passing the tube through a flame from the closed end to the open end, and sealing the open end by fusion in the flame without withdrawing the tube from the flame after the air-expelling operation.

2. The method of making self-luminous elements which comprises filling an elongated glass tube with dry powdered self-luminous material, said tube being closed at one end, tightly compacting the material by vibrating the tube endwise at a rate exceeding that to which the finished element is subsequently subjected in use, expelling surplus air from the tube by passing the tube through a flame from the closed end to the open end, and sealing the open end by fusion in the flame without withdrawing the tube from the flame after the air-expelling operation, whereby the molten glass at the sealed tube end is drawn inwardly and an enlargement at the sealed tube end is avoided.

3. The method of making self-luminous elements which comprises filling an elongated glass tube with dry powdered self-luminous material, said tube being closed at one end, tightly compacting the material by subjecting the tube to endwise impacts at a frequency exceeding that of any vibration to which the finished element is subsequently subjected in use, expelling surplus air from the tube by passing the tube through a flame from the closed end to the open end thereof and sealing the open end of the tube by fusion in the flame without withdrawing the tube from the flame after the air-expelling operation.

4. The method of making self-luminous elements which comprises filling an elongated glass tube with dry powdered self-luminous material, said tube being closed at one end, tightly compacting the material by vibrating the tube endwise at a rate exceeding that to which the finished element is subsequently subjected in use, severing at least one short filled section from said tube, removing a small amount of the compacted self-luminous material from each end of said tube section, sealing one end of said tube section by fusion, expelling surplus air from said tube section by passing said tube section through a flame from the closed end to the open end and sealing the open end by fusion in the flame without withdrawing the tube from the flame after the air-expelling operation.

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