Aug. 13, 1968 J. F. MOTSON 3,397,334

ELECTROLUMINESCENT LAMP WITH ALTERNATIVELY DEFINED AND UNDEFINED INDICIA

Filed Jan. 6, 1967

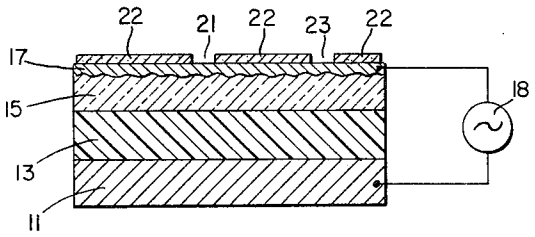

Fig. 1

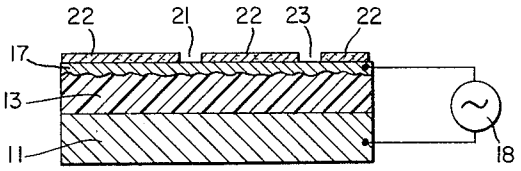

Fig. 2

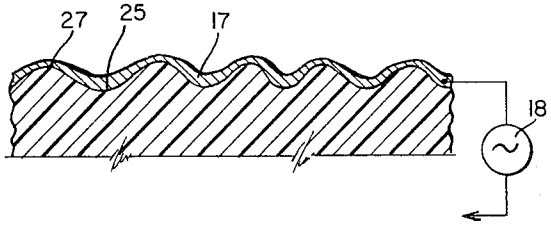

Fig. 3

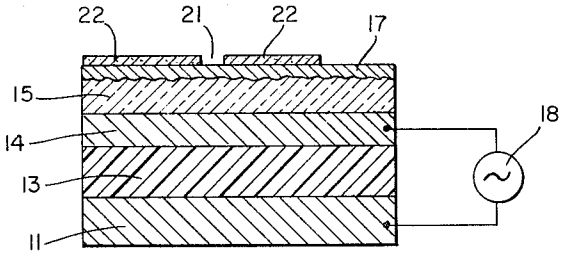

Fig. 4

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ELECTROLUMINESCENT LAMP WITH ALTERNATIVELY DEFINED AND UNDEFINED INDICIA

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ABSTRACT OF THE DISCLOSURE

The present invention provides a "transparent" electrode means which enables indicia to be defined when the lamp is lighted, or energized, and undefined when the lamp is de-energized.

This invention relates to electroluminescent lamps and more particularly to an electroluminescent lamp which has indicia selectively defined on its face.

Electroluminescent lamps find great utility with instruments and signs which can be illuminated such as the dashboard instruments of automobiles, the control panel of an airplane or nautical ship, the "no-smoking" or "fasten your safety belts" signs in an aircraft fuselage, etc. Heretofore, the electroluminescent lamps have been masked to define the indicia when the lamp is lighted, but masked in such a manner that a person observing the instrument or sign could read the indicia without having the lamp energized. For many applications, this arrangement has been satisfactory. However, for other applications, this arrangement has not been satisfactory.

In certain of the aircraft panels it has become desirable to provide instruments whose indicia cannot be read until the lamp is energized. The requirement has come into being because under some conditions of high ambient light, it is difficult to determine whether or not the lamp or panel is lighted. Such an arrangement is very disconcerting to a pilot who must continually scan his instrument panel. Accordingly, it is necessary that the pilot know without question whether or not the panel is lighted.

The present invention provides a "transparent" electrode which is not fully transparent since it defines the required indicia, but which has its transparent portion so designed and fabricated that to ordinary daytime light, such as room light, the indicia cannot be distinguished from the non-transparent background.

Summary

The present invention provides a "transparent" electrode of a thin film of anti-static metal such as Inconel, tin, cadmium and the like, which is deposited by evaporation deposition on a rough surface of either glass or epoxy resin. In the preferred embodiment, the metal Inconel is employed as the thin film metal. In addition, indicia are placed on the outer surface of the Inconel electrodes by means of a photographic process or a silk screening process. Inconel is an alloy which is made up of approximately 80% nickel, 14% chromium and 6% iron.

The indicia are formed by keeping the areas of the Inconel electrode, which define the indicia, clear or free of the background ink or colored material. The background material, when Inconel is used as the transparent electrode, is black so that the hue or color resulting from the Inconel being placed on a rough surface (which hue is black), blends with the black color of the background material. Accordingly, the viewer sees a black instrument face when the lamp is de-energized, and alternatively lighted and defined indicia on said instrument face, when the lamp is energized.

The advantages of the present invention will be ap-

parent and will be suggested to those skilled in the ar from a reading of the following specification and clain in which:

FIGURE 1 is a schematic side view of an electr luminescent lamp employing the present invention;

FIGURE 2 is a schematic side view of a second en bodiment of an electroluminescent lamp employing th present invention, and

FIGURE 3 is a partial view of the rough surface the lamp upon which the transparent electrode is d posited;

FIG. 4 is another embodiment of an electrolumine cent lamp employing the present invention.

As was stated earlier the present invention provides means whereby an electroluminescent lamp can provid lighted indicia when turned on, but which does not enabl the viewer to see the indicia when it is turned off.

Such an arrangement has been found to be advar tageous in aircraft control panels because the ment pressures of flying modern aircraft do not leave room fc any disconcerning factors to be present in the cockpi It has been found that the pilot is less distracted as h views his instrument panel if he sees solid panel face unless he is supposed to see a lighted instrument pane

The manner in which the present invention effects th phenomenon is by roughing that portion of the electr luminescent lamp to which the transparent electrode bonded. It has been found that if the surface of the lam is "roughed" and a thin film electrode is applied, the thi film (which when applied against a smooth surface virtually colorless and transparent) appears to have significant color characteristic. In the preferred embod ment, I have used Inconel as the transparent electrod

When Inconel is applied to a rough surface, it has hue or color of black and hence if a black ink or pair or colored material is used as background material (i.e to define the indicia which are to be lighted) the entir face of the lamp appears black. In ordinary room ligh the indicia cannot be detected. The lamp must be ene gized in order for the indicia to be recognized.

Inconel as the transparent electrode has a number c advantages. It gives the black hue as indicated above an in addition is a strong material with which to work Inconel is not normally employed as an electrode becaus of its high impedance, but I have found its high impec ance to be advantageous since high voltages are ofte employed with instrument panel lights. In addition, In conel has a good affinity for glass and plastics (such a epoxy resin) which usually form that part of the lam to which the transparent electrode is bonded.

Consider FIGURE 1 which shows a side view of a electroluminescent lamp employing the present invention In FIGURE 1, there is depicted an electroluminescen lamp with a back electrode **11** to which there is secure a layer of electroluminescent phosphors held in vehicl of epoxy resin. This last mentioned layer will be referre to as the electroluminescent layer **13**.

The phosphors in layer **13**, in the preferred embodi ment, are arranged according to the process set forth i my Patent Number 3,037,138, which in effect is a on crystal thick layer of phosphors. Accordingly, this ar rangement provides for maximum light output. It shoul be understood that other phosphor arrangements can b used.

In the embodiment of FIGURE 1, there is shown layer of glass **15** bonded to the electroluminescent laye **13**. The upper portion of the glass layer **15** is "roughed' as shown. On the upper surface of the glass layer **15** there is deposited a thin layer of Inconel **17**. The Incone **17** serves as the "transparent" electrode. While the laye of Inconel is shown having a smooth upper surface, i

act its upper surface is better depicted in FIGURE 3. Connected to the back electrode **11** and the Inconel **17** ; an A.C. source **18** of electrical power which provides ıe electrostatic field across the electroluminscent layer **3** to generate light. The generation of light from elec-·oluminescent phosphors by applying an A.C. field is ·ell known and will not be described herein.

To the upper surface of the Inconel layer **17**, there ; applied a pattern of ink **22** or paint. In the preferred mbodiment, the pattern of indicia is silk screen printed n the Inconel surface using Naz-Dar enamel manufac-ıred by Naz-Dar Company. Other forms of ink can be mployed such as Grip-Flex and other indicia forming ;chniques can be employed such as a photoresist tech-ique.

In the preferred embodiment, the Naz-Dar ink pro-ides a black hue to the viewer in room light and does ot allow any light to pass therethrough in response to ıe electroluminescent lamp being energized. At the same me, the Inconel provides a black hue (of virtually the ame depth as the ink), to the viewer in room light (i.e., rdinary daylight but does permit 50% to 70% of the ght to pass therethrough from the illuminated electro-ıminescent lamp.

Accordingly, when the face **19** of the lamp is viewed ı daylight, the indicia **21** and **23** cannot be detected. The ntire face looks black.

The reason for the foregoing phenomenon seems to ccur because of the behavior of the Inconel when it is eposited in the valleys of the rough surface. As can be ;en in FIGURE 3, the Inconel becomes thicker in the alleys **25** of the rough surface than at the crests **27** of ıe nodes. This pattern has been determined by virtue f a microscope.

I believe that the Inconel builds up in the fashion hown in FIGURE 3 because of the sputtering that takes lace when it hits the sidewalls of the valleys. In other ·ords, the valleys are located at a farther point from the vaporant than the crests and hence might well receive ;ss evaporant (Inconel) in any given time. However, ince the Inconel appears to be built up in the valleys, I ave concluded that the sputtering, or splashing, from he sidewalls of the valleys creates a change in the crystal-ıne structure arrangement of the Inconel and thus ef-ects the build up.

Because the Inconel is built up in the valleys and faces he light incident thereto from an angular position, I ave concluded that the colors (different light frequen-ies) of the light excepting black are absorbed thereby iving the overall layer a black hue. In other words, if the urface of Inconel is analyzed under a microscope, it does ot appear as a solid black surface but more nearly a potty dark surface. However, when the surface is viewed ·ith the human eye, the dark areas are predominant and ive the whole area a black hue.

On the other hand, the light emanating from the re-·erse side of the Inconel layer is passed therethrough and ence the activation of the electroluminescent lamp re-ults in providing a well illuminated lamp with well de-ined indicia.

FIGURE 2 is a second embodiment of the invention. The Inconel need not be deposited on glass as shown in 'IGURE 1 although the embodiment of FIGURE 1 is ometimes preferable in the high voltage application. In 'IGURE 2, the back electrode **11** has an electrolumines-ent layer **13** bonded thereto and the "away" surface is roughed." Thereafter, a layer of Inconel is deposited ·y evaporation on the "roughed" surface of the elec-roluminescent layer. As depicted in FIGURE 2, the nconel electrode and the back electrode are connected ɔ the A.C. source **18**.

FIGURE 3 depicts a third embodiment wherein there ; a back electrode **11**, a layer of phosphors **13**, a trans-ıarent electrode **14** (which can be gold, tin or Inconel), . glass layer **15** (the glass layer and transparent elec-

trode can be an integral layer commercially sold as Nesa-Glass), a layer of Inconel **17** deposited on the roughed surface of the glass and the non-transparent indicia **22**. The package of FIGURE 3 has the advantage of securing the electrodes away from the outer surface of the pack-age and lending a deep hue to the face of the panel.

It should be understood that the "roughed" surface can be so effected by applying hydrochloric acid on a glass surface, some other suitable etchant or by a physical abrasion process.

The embodiments of the invention in which an exclu-sive property or privilege is claimed are defined as fol-lows:

1. An electroluminescent lamp having selectively de-fined indicia on its face comprising in combination: a back electrode means; a layer of electroluminescent phosphors on said back electrode means, said layer hav-ing a roughed surface; a selectively transparent and con-ductive means comprising a thin layer of an alloy made of approximately 80% nickel, 14% chromium and 6% iron on said roughed surface to provide an electrostatic field across said electroluminescent layer in conjunction with said back electrode; non-transparent means, having substantially the same hue to ambient light as said selec-tively transparent means, formed on said selectively transparent means, to define indicia thereon; and means connected to said selectively transparent means and said back electrode whereby said layer of electroluminescent phosphors may be energized.

2. An electroluminescent lamp according to claim **1** wherein said non-transparent means is a layer of black material such as black ink, black paint, black enamel or the like.

3. An electroluminescent lamp having selectively de-fined indicia on its face comprising in combination: a back electrode means; a layer of electroluminescent phos-phors on said back electrode means; a thin, transparent layer of metal on said layer of electroluminescent phos-phors, said thin, transparent layer and said back elec-trode means enabling an electrostatic field to be provided across said phosphors; a layer of glass material having one surface contacting said thin, transparent layer of metal and an opposite, roughed surface, a thin transpar-ent layer of an alloy of approximately 80% nickel, 14% chormium and 6% iron on said roughed surface; non-transparent means, having substantially the same hue to ambient light as said thin, transparent layer of alloy, formed on said thin transparent layer of alloy to define indicia thereon; and means connected to said thin, trans-parent layer of metal and said back electrode whereby said layer of electroluminescent phosphors may be ener-gized.

4. An electroluminescent lamp having selectively de-fined indicia on its face comprising in combination: a back electrode means; a layer of elcetroluminescent phos-phors on said back electrode means; a layer of glass ma-terial having one surface on said layer of electrolumines-nickel, 14% chromium and 6% iron on said roughed a thin, transparent layer of alloy of approximately 80% nickel, 14% chromium and 6% iron on said roughed surface; non-transparent means, having substantially the same hue to ambient light as said thin, transparent layer thereon; and means connected to said thin, transparent layer of alloy and said back electrode whereby said layer of electroluminescent phosphors may be energized.

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ROBERT SEGAL, *Primary Examiner.*