Dec. 28, 1965 R. S. CHRISTY 3,226,590

FLUORESCENT PANEL LAMP

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Fig. 1.

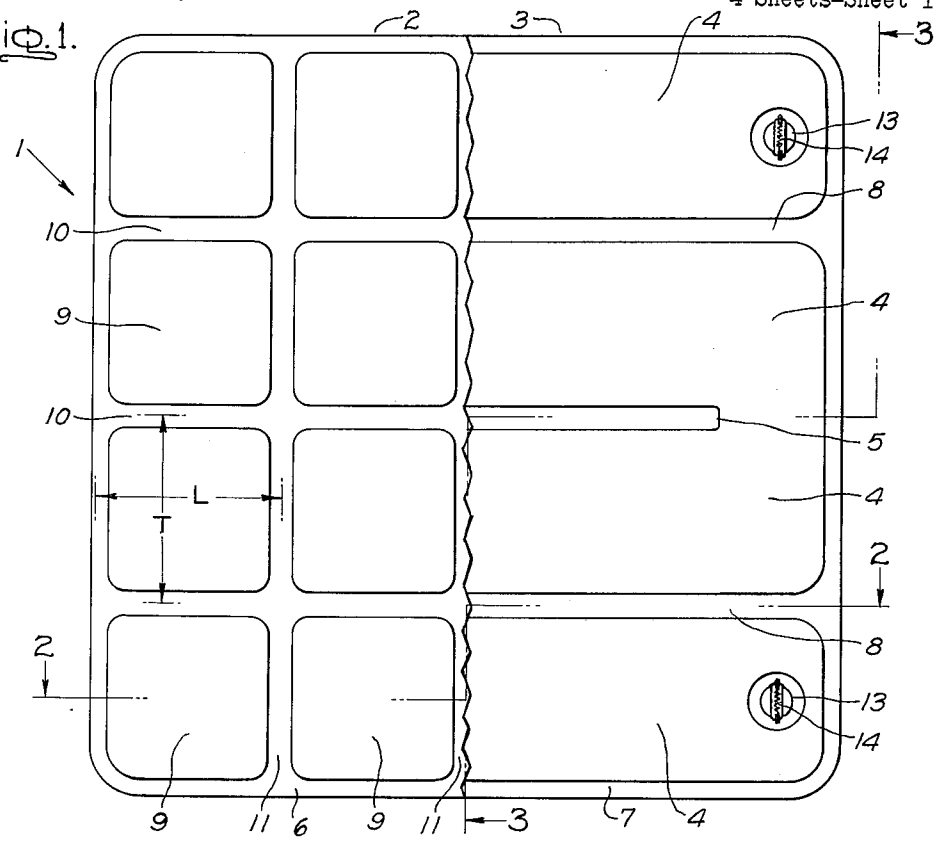


Fig. 2.

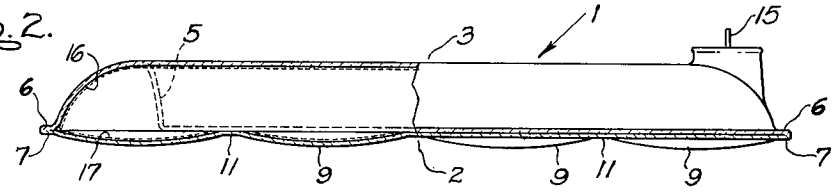
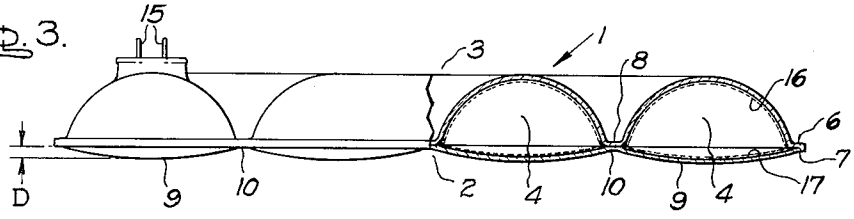


Fig. 3.



Inventor:
Richard S. Christy
by Ernest W. Kuyper
His Attorney

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Fig. 4.

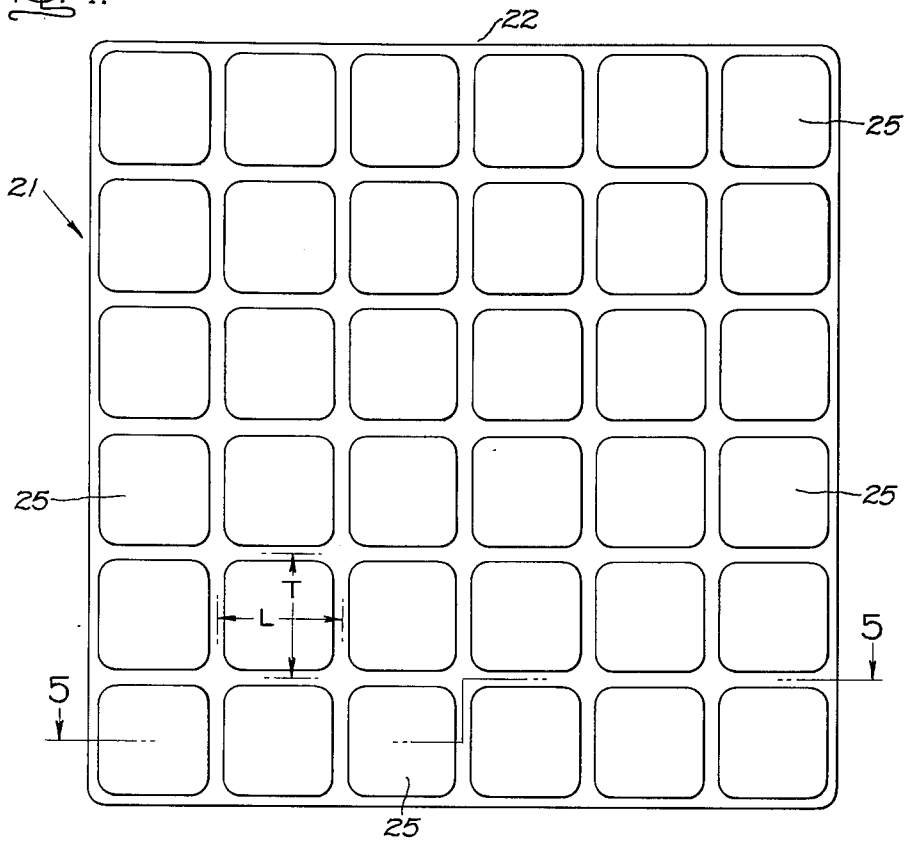
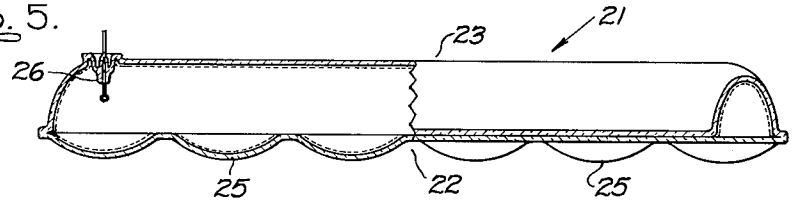


Fig. 5.



Inventor:
Richard S. Christy
by Ernest W. Legner
His Attorney

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Fig. 6.

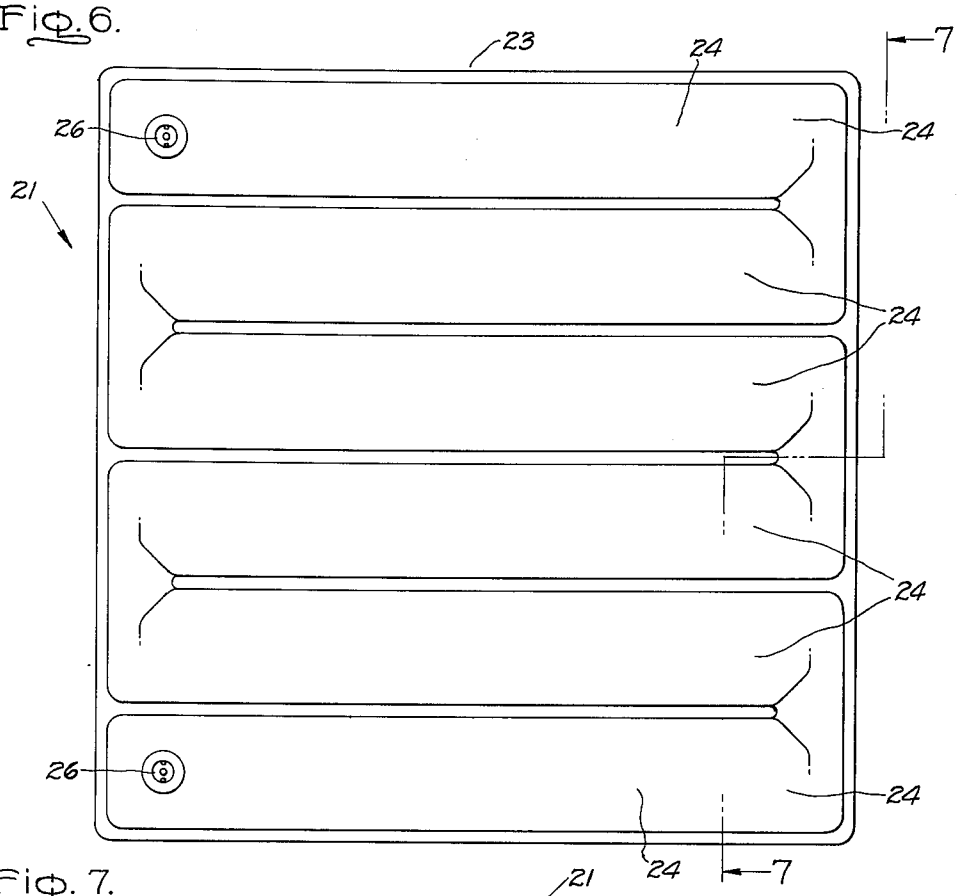
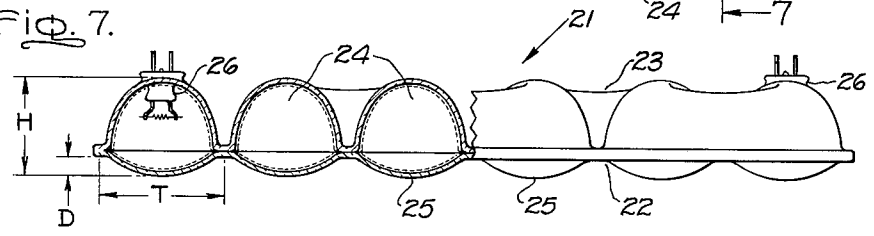


Fig. 7.



Inventor:
Richard S. Christy
by Ernest W. Legner
His Attorney

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Fig. 8.

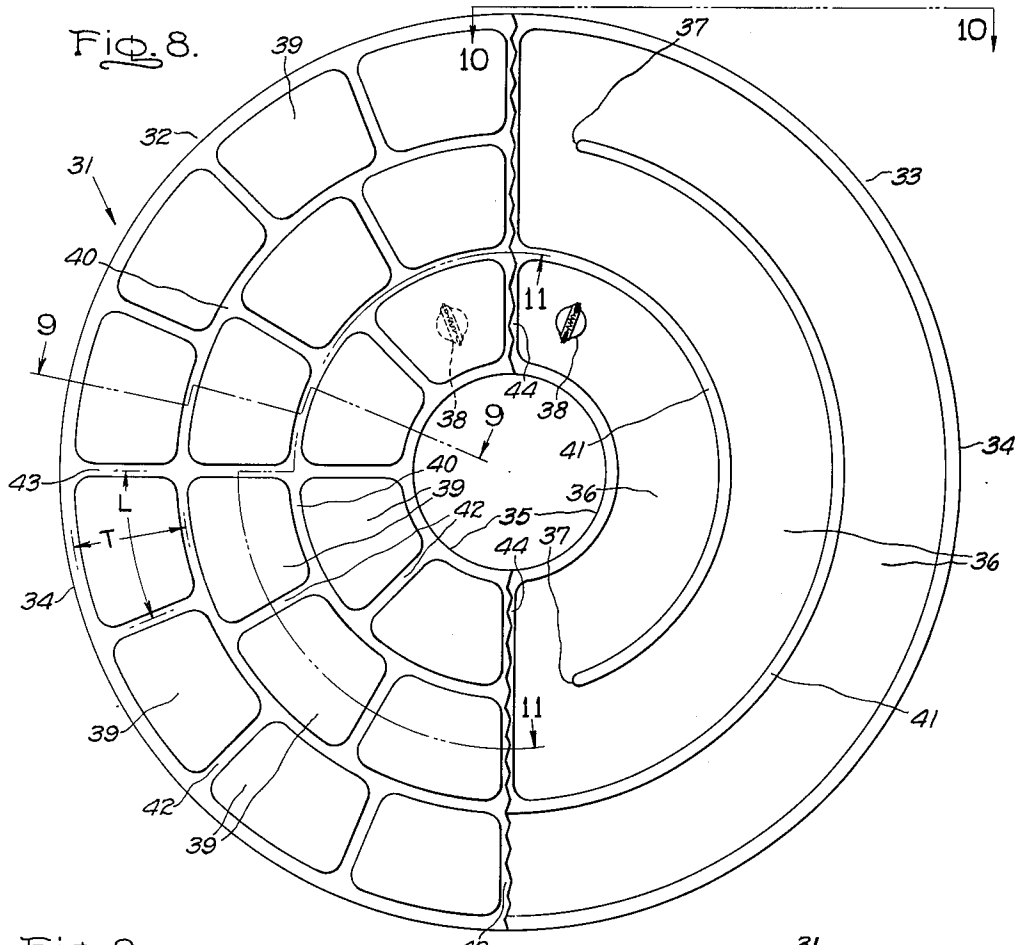


Fig. 9.

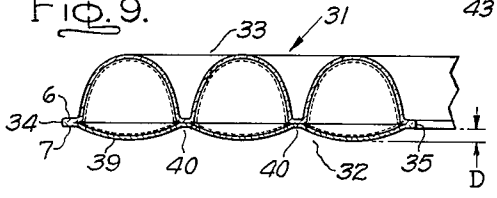


Fig. 10.

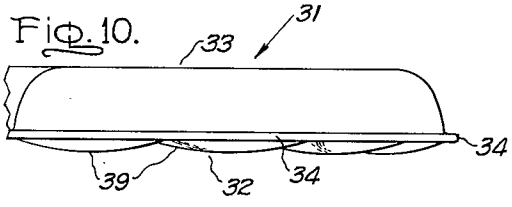
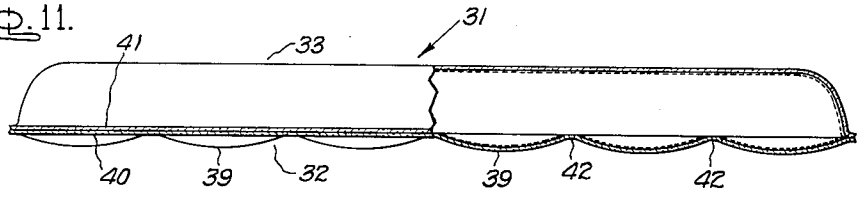


Fig. 11.



Inventor:
Richard S. Christy
by Ernest W. Pegues
His Attorney

United States Patent Office 3,226,590
Patented Dec. 28, 1965

3,226,590

FLUORESCENT PANEL LAMP

Richard S. Christy, Willoughby, Ohio, assignor to General Electric Company, a corporation of New York

Filed Nov. 15, 1960, Ser. No. 69,314
3 Claims. (Cl. 313—109)

This invention relates to fluorescent panel lamps utilizing a labyrinthine discharge path between electrodes, for instance a grid-like or spiral or sinuous path.

In lamps of this type, the discharge path is generally a channel formed between two vitreous components sealed together. The length of the discharge channel or path is one of the principal factors determining light output and luminous efficiency of a lamp. Panel-shaped fluorescent lamps provide a long channel in a relatively small area and offer substantial advantages where compactness of source and ease of handling are desired. Furthermore, they have the advantage of offering a so-called area light source as against a line source which is the case with the usual elongated tubular fluorescent lamp. Area light sources permit the use of smaller and more compact fixtures with concomitant cost savings. For this reason they are of particular interest in connection with the lighting of smaller spaces and enclosures, as in domestic lighting.

In most of the applications presently visualized for a panel fluorescent lamp, it is intended that at least one face of the lamp be exposed to view. For instance, it is contemplated that panel lamps be made in modular sizes corresponding to the dimensions of standard ceiling tiles. Alternatively, it is contemplated that panel lamps be used in shallow fixtures. In either case, the lower plate, which may be referred to as the faceplate of the lamp, is exposed to view and a pleasing appearance is desired for it.

It has been proposed to make a panel lamp with a flat faceplate and to groove or channel the backplate only. This has the advantage of providing a smooth, level face which is easily cleaned off. However, in practice a flat faceplate has several serious disadvantages. Firstly, when flat glass is used, a thicker gauge of glass is needed to withstand the atmospheric pressure pressing against the evacuated lamp. Secondly, and perhaps more importantly, even though the interior of the panel lamp is entirely coated with phosphor, the bright tortuous path of the plasma or discharge channel is readily discernible through the faceplate and the result is definitely unattractive. The mere use of figured or pebbled or frosted glass does not produce a satisfactory camouflage.

The general object of the invention is to provide a fluorescent panel lamp which is lightweight with good implosion resistance, practical to manufacture, and attractive in appearance.

Another object is to provide a panel fluorescent lamp having a faceplate which appears substantially uniformly lit throughout the area of the lamp.

In accordance with the invention, I provide a panel fluorescent lamp having a faceplate characterized by a regular pattern of shallow embossments forming outwardly convex geometrical figures which are repeated throughout the area of the faceplate. The embossments match the discharge channel in that their transverse dimension is selected to correspond to the width of the discharge channel formed by the grooves molded in the backplate, and they are disposed to overlie the grooves. The other dimension of the embossments, which may be referred to as the longitudinal dimension, is selected to achieve an orderly pattern providing a pleasing appearance, for instance one repeating regularly.

In the case of a square panel lamp, the transverse and

the longitudinal dimensions of the embossments may be chosen equal and a quilt-like or checkerboard pattern is obtained. In other panel lamps, for instance in a rectangular panel lamp which is not square, the longitudinal dimension may be chosen different from the transverse dimension in keeping with the ratio of length to breadth of the lamp. In a round panel lamp wherein the plasma channel is in the form of a plurality of interconnected segments of concentric rings, the transverse or radial dimension of the embossments will be equal to the width of the channel; the circumferential or lengthwise dimension may be made roughly equal to the radial dimension, if desired, to provide a plurality of keystone-shaped embossments. I have found that by dividing the surface of the faceplate into a multitude of such shallow embossments which correspond to the width of the plasma channel so that the valleys or unraised portions of the faceplate between them overlie what would otherwise be the dark areas in the illuminated surface, a pleasing appearance is obtained which gives the illusion of uniform illumination throughout and which substantially obliterates or at least greatly camouflages the bright sinuous pattern of the discharge. At the same time, the embossments which constitute in effect a multitude of convex surfaces in the faceplate provide increased strength and resistant to implosion permitting the use of a thinner gauge of glass. This results in a lamp which is relatively lightweight and economical to manufacture.

For other features and for further objects and advantages of the invention, attention is now directed to the following description of specific embodiments and to the accompanying drawings. The features of the invention believed to be novel will be more particularly pointed out in the appended claims.

In the drawings:

FIG. 1 is a plan view of the faceplate of a square four-channel fluorescent panel lamp partly cut away to reveal the inside of the backplate; FIG. 2 is an inverted side sectional view along one dimension; and FIG. 3 is an inverted side view, partly sectioned, along the other dimension.

FIG. 4 is a plan view of the faceplate of a square six-channel fluorescent panel lamp embodying the invention; FIG. 5 is an inverted side sectional view of the assembled lamp along one dimension; FIG. 6 is a plan view of the outside surface of the backplate; and FIG. 7 is an inverted side view, partly sectioned, along the other dimension.

FIG. 8 is a plan view of a round fluorescent panel lamp embodying the invention showing the faceplate partly cut away to reveal the inside surface of the backplate; FIG. 9 is an inverted radial section along the line **9—9**; FIG. 10 is an inverted part side view along the line **10—10**; and FIG. 11 is an inverted circular section along the line **11—11**.

Referring to FIGS. 1 to 3 of the drawings, the envelope of the lamp **1** is in the form of a generally flat square panel made up of a pair of complementary molded glass components **2**, **3**. The lower component **2** forms the underside or faceplate of the lamp which is exposed to view when the lamp is mounted in its fixture or incorporated into a ceiling. The upper component **3** which may be referred to as the backplate is molded or blown to define, in cooperation with the faceplate, a labyrinthine discharge channel or passage by means of four parallel grooved sections **4** extending side by side and joined together at alternate ends, as at **5** where the partition wall ends, thereby forming a continuous grid-like channel. Both plates may be formed from sheets of window glass by any suitable means, for instance by vacuum molding. In this procedure, a flat sheet of glass is placed over a

mold having a cavity corresponding in shape to the surface of the desired plate; the glass sheet and mold are heated to the softening point of the glass; vacuum is then applied to the mold so as to suck the glass down into the cavity and cause it to conform to the configuration of the mold. While still plastic, the glass plates may be trimmed to size leaving the outside sealing edges **6**, **7**, then annealed and cooled. With care in the molding operation and in subsequent annealing, the inner surface of the sealing edge **6** of the backplate may be made sufficiently flat to permit sealing directly to the corresponding edge **7** of the faceplate. Alterntaively, the sealing edge **6** may be ground flat to facilitate subsequent sealing, as also the upper surfaces of the ridges **8** which form partitions between the grooved sections.

In accordance with the invention, the faceplate **2** is provided with a plurality of shallow embossments **9** which give it somewhat the appearance of a quilt or checkerboard. The transverse dimension or width of the embossment, indicated by T in FIG. 1, is made about equal to the width of the grooved sections **4** in the backplate. By so doing, the shallow valleys **10** extending along one dimension of the faceplate between the embossments **9**, which appear as shallow ridges on the inside surface, mate with the ridges **8** in the backplate, as best seen in FIG. 3. In the illustrated embodiment, the longitudinal dimension L of the embossments has been selected equal to the transverse dimension T so that a square embossment results. The shallow valleys **11** running along the other dimension of the faceplate between the embossments **9** do not abut against any corresponding portion of the backplate. However they are desirable for the sake of symmetry and are an integral part of the pattern of shallow embossments. If the outer sealing edges **12** of the faceplate and also the shallow ridges on the inside surface corresponding to the valleys **10**, **11** are not perfectly flat after the vacuum molding operation, they may be ground flat. Grinding of the shallow ridges may also be desired in order to enhance the quilted appearance of the faceplate by affording a definite contrast in the appearance of the glass as between the shallow embossments and the valleys inbetween.

The faceplate and backplate are fusion sealed together at least along the outer sealing edges **6** and **7**, either directly by fusion of the glass, or through the use of a lower melting point soldering glass. Along the junctures of the ridges **8** in the backplate and the shallow ridges corresponding to the valleys **10** in the faceplate where the glass components abut together to make partitions defining the labyrinthine discharge channel, the vitreous components may be sealed together if desired but it is not essential that this be done. Provided the vitreous components fit closely together along the junctures, the discharge will not leak through at the partitions but will follow the labyrinthine path from end to end. When the envelope is evacuated, atmospheric pressure serves to press the vitreous components together so that the assembly is rigidified despite lack of sealing along the intermediate junctures; atmospheric pressure, by pressing the components together, is also helpful to prevent leakage of the discharge at the junctures.

The lamp is provided with a pair of discharge supporting electrodes **13**, **13**. In the illustrated embodiments, the electrodes are sealed through the backplate **3** about at the ends of the labyrinthine channel. The emitting portion proper of each electrode may consist of a coiled coil filament **14** of tungsten wire provided with an overwind and coated with alkaline earth electron emitting oxide. The filament is supported across a pair of inleads sealed through a mount and connected to external base pins or terminals **15**. If desired, the electrodes may be of the low resistance, low thermal capacity rapid-start type disclosed and claimed in U.S. Patent 2,774,918, Lemmers, Electric Discharge Device. Other types of electrodes and other sealing techniques or structures may of course be used.

The lamp contains an ionizable atmosphere including a starting gas or mixture of one or more of the inert rare gases of Group O of the Periodic Table at a low pressure, for instance argon at a pressure of 0.5 to 5 millimeters of mercury, along with mercury vapor. The quantity of mercury or mercury vapor added exceeds in amount the quantity vaporized during normal operation of the lamp wherein the mercury vapor exerts a partial pressure generally in the range of 5 to 8 microns for optimum generation of 2537 A. radiation. This radiation energizes the phosphor coating indicated at **16** on the backplate and at **17** on the faceplate, the phosphor in turn producing visible light. If desired, in order to cause the lamp to emit a greater proportion of its light downwardly through the faceplate than through the backplate, the phosphor coating may be applied relatively thickly on the backplate and more sparingly on the faceplate. Alternatively a reflecting coating, internal or external, may be applied to the backplate.

In a square panel lamp of nominal 12-inch size actually constructed as illustrated in FIGS. 1 to 3, transverse dimension T is approximately 3″ and dimension D corresponding to the projection of the embossments below the flat portions or valleys is approximately 0.13″. The ratio of depth to width of the embossments, that is D/T, is approximately 1:23. The pattern of embossments in the faceplate was observed to reduce substantially the prominence of the bright sinuous path of the discharge. At the same time the embossments increase the strength or implosion resistance of the faceplate so that the envelope, for same margin of safety, may be constructed of a thinner gauge of glass than required with a flat faceplate.

Referring to FIGS. 4 to 7 of the drawings, there is illustrated another embodiment of the invention in the form of a square six-channel lamp **21** comprising faceplate **22** and backplate **23** sealed together along their margins. The backplate is formed with six channels or grooves **24** joined together at alternate ends to form a continuous back and forth or grid-like channel. The faceplate is provided with a plurality of pronounced embossments **25** of square outline. In accordance with the invention, the transverse dimension T of the embossments in the faceplate is equal to the width of the grooved channels in the backplate. In this square design, the longitudinal dimension L of the embossments is equal to the transverse dimension T. In a square lamp of nominal 12-inch size, the nominal dimensions T and L of the embossments **25** are 2 inches.

As best seen in FIGS. 5 and 7, the discharge channel cross section in lamp **21** is more nearly circular than that of lamp **1** illustrated at FIGS. 1 to 3. This has been found desirable in order to achieve maximum strength and resistance to implosion from atmospheric pressure with least weight in a lamp of a given size. Also the greater depth and more pronounced convexity of the embossments **25** in faceplate **22** results in more effective camouflage of the actual path of the discharge as it winds its ways through the labyrinthine channel between electrodes **26** at the ends. By way of illustrative example, in 12″ square lamps constructed according to the illustrations of FIGS. 4 to 7, dimension H corresponding to the external height of the discharge channel is approximately 1½″; dimension D corresponding to the projection of the embossments in the faceplate below the surface of the flat portions or valleys between embossments is approximately $\frac{9}{32}$″; the transverse dimension T and the longitudinal dimension L of the embossments are approximately $1\frac{15}{16}$″. It will be observed that the ratio of depth to width of the embossments, that is D/T, is approximately 1:7 in this example. In general, a ratio or proportion of depth to width D/T is not less than 1:25 is necessary in accordance with the invention. For a high strength faceplate with a pronounced embossed or three-dimensional effect and for

better camouflage of the light path, a ratio of depth to width lying between 1:4 to 1:10 is preferred. With dimensions within this preferred range, there is achieved a faceplate which has an attractive appearance at all times, that is, whether lit or not, which gives the effect of substantially uniform illumination throughout when the lamp is turned on, and which is practical to manufacture.

FIGS. 8 to 10 illustrate another embodiment of the invention in the form of a round panel lamp apertured at the center. The lamp 31 is formed by a pair of circular or disc-like complementary molded glass components consisting of the faceplate 32 and backplate 33 which are fusion-sealed together at their outer and inner peripheries 34, 35. A tortuous discharge channel is defined by means of the three concentric grooves 36 in the backplate which revert at 37 to form a continuous channel extending between electrodes 38, 38 located at the ends near the inner periphery.

In accordance with the invention, the faceplate 32 is provided with a plurality of relatively shallow embossments 39 throughout its entire area. The transverse dimension T of the embossments corresponds to the width of the concentric channels or grooves 36 in the backplate. Thus the flat rings 40 forming the valleys between embossments and which appear as ridges on the inside surface of the faceplate seat on the ridges 41 between the grooves in the backplate. The longitudinal or circumferential dimension L between radial flats 42 is comparable to the transverse dimension T in the three rows of embossments; this results in generally keystone-shaped embossments of about the same area throughout the surface of the faceplate. However, the longitudinal dimension L is varied slightly as between the innermost row of embossments and the outermost row in order to permit symmetry in the four quadrants. Thus there are two embossments in the innermost row, three in the middle row, and four in the outermost row. This arrangement allows the provision of flat radial lines 43 at 90° intervals in the faceplate and one pair of these radial flats mates with the radial ridges 44 in the backplate which serve as partitions between the reverting portions of the discharge channel.

By way of illustrative example, in a lamp constructed according to the illustration of FIGS. 8 to 10 and having a nominal diameter of 14", the arc length is approximately 72". Dimension T corresponding to the radial or transverse dimension of the embossments is 1¾"; longitudinal or circumferential dimension L, measured along the center line of the embossment in each case, is 2⅜" in the outermost row, 2$\frac{3}{16}$" in the middle row, and 1$\frac{15}{16}$" in the innermost row. Dimension D corresponding to the projection of the embossments in the faceplate below the surface of the flat portions of the radial and circumferential valleys between embossments is ¼". Thus the ratio of depth to width in the embossments, that is D/T, is approximately 1:7. The faceplate gives a pleasing patterned appearance; when lit, the embossments substantially camouflage the bright sinuous path of the discharge corresponding to the reverting concentric grooves in the backplate and obtain the effect of substantially uniform illumination.

The specific embossments of the invention which have been illustrated and described in detail are intended by way of example only. Obviously many modifications are possible within the spirit of the invention following the general principles which have been outlined and will readily occur to competent designers. The scope of the invention is accordingly to be determined by the appended claims which are intended to cover such modifications.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A fluorescent panel lamp comprising a vitreous envelope formed by a backplate and a faceplate sealed together along their margins, said backplate being formed with a labryrinthine groove of substantially constant width extending continuously throughout its area to provide a discharge channel, electrodes sealed into said lamp at the ends of said channel and an ionizable medium therein, a phosphor coating on said faceplate, said faceplate having relatively shallow outwardly convex embossments formed therein throughout its area, said embossments being of substantially the same width as the discharge channel formed by said groove and being disposed to overlie the discharge channel, said embossments having a ratio of depth of projection to width in the range of 1:4 to 1:10 and being of a length providing an orderly arrangement whereby to achieve a faceplate of improved strength and attractive appearance effectively camouflaging the bright path of the discharge in said channel.

2. A fluorescent panel lamp comprising a vitreous envelope formed by a square backplate and a cooperating faceplate sealed together along their periphery, said backplate being formed with a sinuous groove of substantially constant width extending grid-like throughout its area to provide a continuous discharge channel, electrodes sealed into said lamp at the ends of said channel and an ionizable medium therein, a phosphor coating on said faceplate, said faceplate having relatively shallow outwardly convex embossments formed therein throughout its area, said embossments being approximately square and of substantially the same width as the discharge channel formed by said groove and disposed to overlie the discharge channel and having a ratio of depth of projection to width in the range of 1:4 to 1:10 whereby to achieve a faceplate of improved strength and attractive quilted appearance effectively camouflaging the bright sinuous path of the discharge.

3. A fluorescent round panel lamp comprising a vitreous envelope formed by a disc-like backplate and a cooperating faceplate sealed together along their margins, said backplate being formed with concentric grooves of substantially constant width reverting and joined together to provide a tortuous discharge channel extending continuously throughout its area, electrodes sealed into said lamp at the ends of said channel and an ionizable medium therein, a phosphor coating on said faceplate, said faceplate having relatively shallow outwardly convex keystone-shaped embossments formed therein throughout its area, said embossments being of substantially the same radial width as the discharge channel formed by said grooves and being disposed to overlie the discharge channel and having a ratio of depth of projection to width in the range of 1:4 to 1:10, said embossments being of a length permitting a symmetrical arrangement throughout said faceplate whereby to achieve improved strength and an attractive appearance effectively camouflaging the bright tortuous path of the discharge.

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GEORGE N. WESTBY, *Primary Examiner.*

RALPH G. NILSON, *Examiner.*