May 9, 1950

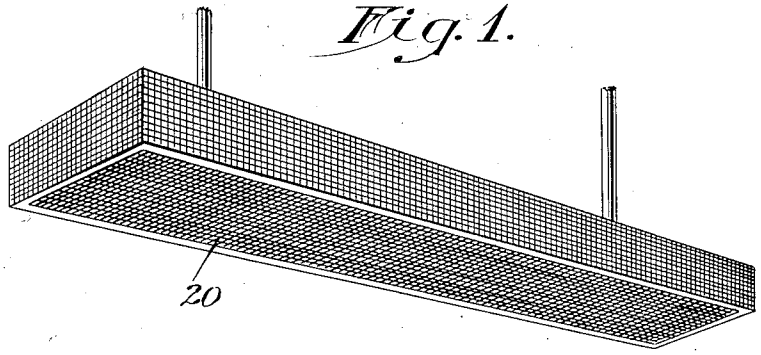
L. C. DOANE
FORAMINOUS SHEET MATERIAL AND
LUMINAIRE MADE THEREFROM

2,506,951

Filed Nov. 5, 1945

2 Sheets-Sheet 1

Fig. 1.



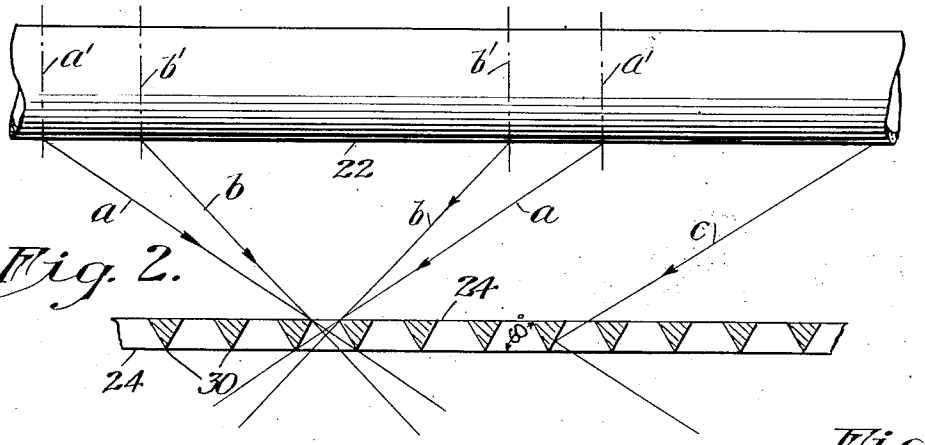
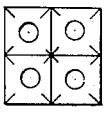


Fig. 2.

Fig. 4.



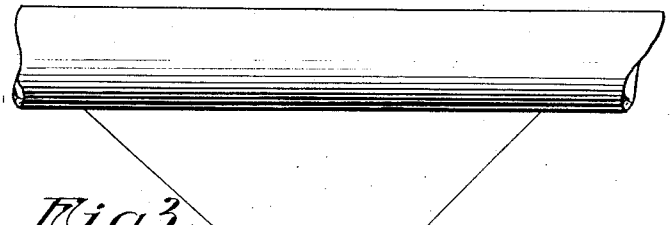


Fig. 3.

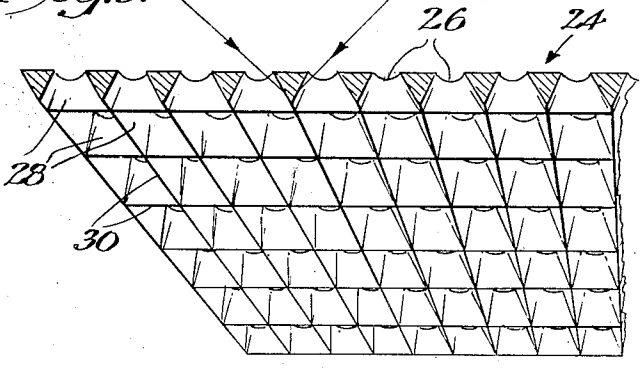


Fig. 5.

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Fig. 6.

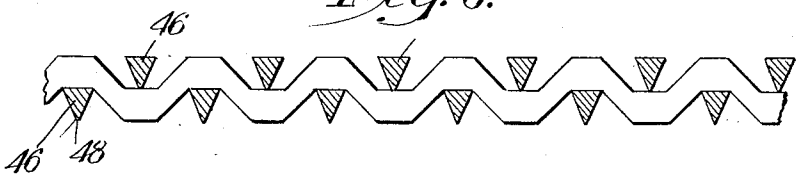


Fig. 7.

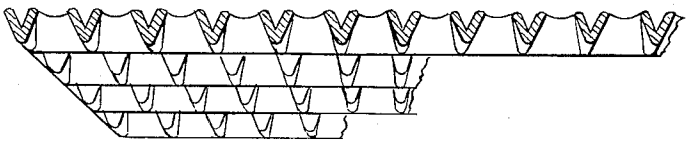


Fig. 8.

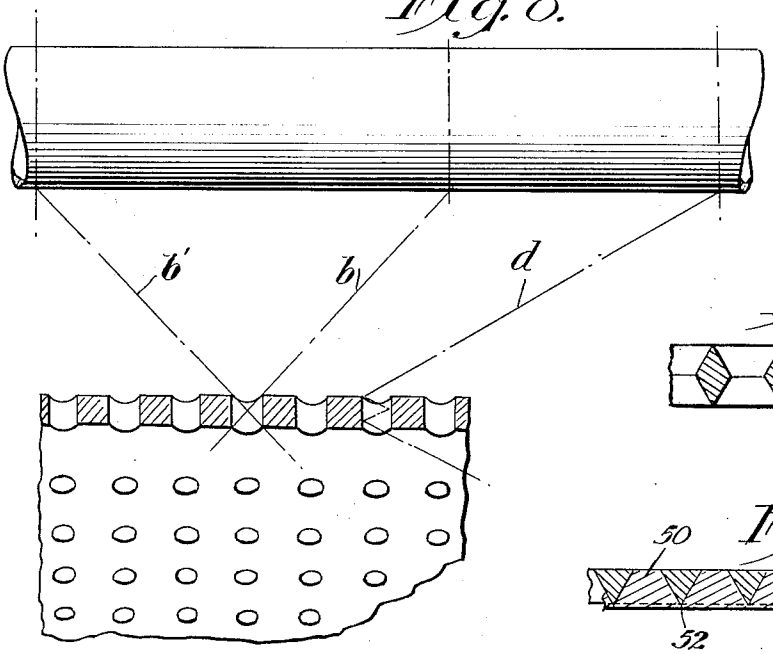


Fig. 12.

Fig. 13.

Fig. 10

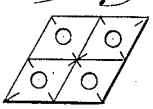


Fig. 11.

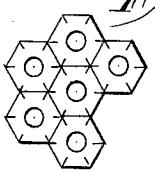
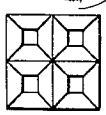


Fig. 9.



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FORAMINOUS SHEET MATERIAL AND LUMINAIRE MADE THEREFROM

Leroy C. Doane, Essex, Conn.

Application November 5, 1945, Serial No. 626,747

11 Claims. (Cl. 240—108)

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This invention relates to foraminous or perforated sheet material which will transmit a substantial amount of light through the same and which is useful for illuminating devices, such as lighting fixtures or luminaries, electric signs, and similar uses. The invention also relates to lighting devices made from the novel material.

It has heretofore been proposed to use perforated sheet metal for making lighting fixtures and signs. While such perforated sheet metal transmits a fair percentage of the light and is capable of producing pleasing effects, much of the light is cut off or is lost by cross reflection in the perforations and the sheets have the disadvantage that the outer surface thereof does not receive direct rays of light and therefore presents a dark appearance, detracting from the desired luminous effect of the entire fixture or sign. This is due to the fact that the side walls of the perforations are parallel and therefore do not effectively reflect the rays out of the fixture. Also, the outer surface of the imperforate part of the sheet which constitutes the greater part of the area, is not directly illuminated and therefore presents a dark appearance. It is the object of the present invention to overcome these defects and this is accomplished by inclining the side walls of the holes or perforations so that they will reflect any rays falling on the walls downwardly or outwardly, the side walls preferably being brought to an edge so that the exposed side of the sheet consists essentially of numerous intersecting edges, there being no substantial flat areas presenting a dark appearance. Preferably the material used is of a reflecting nature, usually sheet metal, which may be brightly finished. In some instances brightly finished plastic might be used, but metal is usually the cheapest and most satisfactory material. The bright inclined surfaces forming the side walls of the perforations thus will reflect the maximum amount of light and the entire exposed face of the sheet will present a continuous bright appearance, without any shadows or dark spots. A very brilliant and pleasing effect is thus produced. The novel material of this invention is particularly useful in connection with illuminating devices presenting a more or less extended area of illumination, such as fluorescent tubes. With such a source of illumination the light is well distributed back of the perforations so that a spotty effect is avoided and a very effective, completely luminous fixture is produced.

The accompanying drawings, which show certain preferred embodiments of the invention, are illustrative of the principles thereof.

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Fig. 1 is a perspective view of a conventional lighting fixture or luminaire made of the improved foraminous material.

Fig. 2 is a diagrammatic view in longitudinal section showing a portion of a fluorescent tube and a sheet of the improved material below the same, illustrating the paths of light rays.

Fig. 3 is a view showing a sheet of the material in perspective as viewed from the underside, and showing a portion of the fluorescent tube.

Fig. 4 is a plan view of the outside of a piece of the material.

Fig. 5 is a transverse sectional view of a sheet showing a modified form of perforation.

Fig. 6 is a transverse sectional view of a woven wire mesh fabric having some of the characteristics of the perforated sheet shown in Figs. 2 and 3.

Fig. 7 is a sectional perspective view, showing the underside of a modified form of perforated sheet.

Fig. 8 is a diagrammatic view similar to Fig. 2, showing the action of the light rays in connection with the conventional perforated sheet of the prior art.

Figs. 9, 10, and 11 are plan views of sheets having modified forms of perforations.

Fig. 12 is a transverse sectional view of a modified form of perforated sheet, and

Fig. 13 is a transverse sectional view of a sheet having a transparent filling in the perforations.

Referring to the drawings in detail, and particularly to Figs. 1, 2, and 3: Fig. 1 shows a conventional form of luminaire containing a source of light such as a plurality of fluorescent tubes (not shown) enclosed in a casing partly or wholly made of the foraminous sheet material of the present invention. As illustrated, bottom, sides and ends of the casing 20 are all made of perforated material.

Fig. 2 shows a portion of a fluorescent tube 22 and a sheet of the material 24 below the same. In the form shown the sheet has holes therethrough which are round at the top or inside as shown at 26, and the side walls 28 of which flare outwardly meeting in edges 30 at the outside of the sheet. These edges intersect so that at the outside of the sheet the openings are rectangular. There are thus no flat surfaces on the outside of the sheet but only on the intersecting edges, as clearly shown in Fig. 3.

The angle of inclination of the side walls 28 depends upon the closeness of spacing of the perforations. A convenient spacing is such that

the side walls when brought to an intersection so as to form the edges 30 have an angle in the neighborhood of 60 degrees more or less to the plane of the sheet. The section between the perforations is thus that of an equilateral triangle. If the holes are spaced a little farther apart the angle would be nearer 45 degrees, and if the spacing is closer the angle would be more than 60 degrees. 60 degrees, however, is a desirable angle. With such an angle it will be seen that light passing through the perforations from an extended source of light such as a fluorescent tube will strike the side walls as indicated by the ray *c* in Fig. 2, and be reflected outwardly. This light will illuminate the inclined surfaces so that they will appear bright from below the sheet. As there are no exposed surfaces in the plane of the sheet but only edges the entire sheet will appear luminous and there will be no shadows or dark spots. The form of perforations shown also permits substantial increase in the emission of light from the luminaire. This is apparent by comparing the path of the rays in Fig. 2 with the path of the rays in the case of an ordinary perforated sheet as shown in Fig. 8. The maximum emission of light in the case of a parallel side perforation is that emitted between the rays *bb* of maximum inclination capable of passing through the perforations, these being emitted from the length of the fluorescent tube between the lines *b'* and *b'*. On the other hand with the inclined wall perforations light is emitted between the limiting rays *aa*, this light coming from the length of the tube included between lines *a'* and *a'* (Fig. 2). Thus it will be seen that there is a substantial increase in the amount of illumination obtained by the use of the improved form of sheet.

With the parallel wall perforations as shown in Fig. 8 there is much light absorbed in cross reflection, as shown by ray *d* in that figure.

Sheets 24 are made of metal although they may be made of other suitable material such as plastic capable of taking bright finish so as to provide a reflecting surface. The perforations may be formed in any suitable manner, as by means of a proper punch or die, or combined punch and die. The sheet may also be formed by die casting or by use of bent, stamped or extruded strips or sheets, as indicated in Fig. 7.

The side walls of the perforations need not be plane surfaces but may be concavely curved, as shown at 40 in Fig. 5. Also, the perforations need not be circular but may be rectangular, as shown in Fig. 9. The edges 30 do not necessarily cross each other at right angles but may be arranged in any suitable manner, as for instance in a diagonal direction, as shown in Fig. 10. Furthermore they might be arranged in a hexagonal pattern, as shown in Fig. 11.

The thickness of the sheet and size and spacing of the perforations may be varied to suit conditions. As a typical example, but without intending any limitation of the scope of the invention, a convenient thickness of sheet is about $\frac{1}{32}$ of an inch, with the holes about $\frac{1}{8}$ of an inch diameter at the inner surface of the sheet.

Another form of sheet or screen embodying some of the characteristics of the present invention is shown in Fig. 6. In this case the light transmitting sheet or screen is formed of wire mesh composed of triangular wires 46 woven in the manner of an ordinary screen and presenting edges 48 on the outside or side away from the source of light. Such a wire mesh will emit a much larger percentage of light and present a brighter appearance than a mesh made of round wires. The angular wire mesh will permit the passage of additional light rays in a manner clear from what has already been said.

Fig. 12 shows a form of perforated sheet in which the walls of the perforations diverge from the center of the sheet to both the upper and lower surfaces thereof. This form of perforation will permit the passage of rays in a manner similar to that indicated in Fig. 2, but permits the sheet to be made twice the thickness so that it will have increased strength.

In Fig. 13 a perforated sheet is shown in which the perforations are filled with transparent material such as plastic or glass. The sheet can conveniently be made by pressing or rolling a sheet of plastic, while in softened condition, against the bottom surface of the sheet so that the plastic will be forced into the perforations. The plastic filling the perforations is indicated at 50. Preferably a thin layer of the plastic is permitted to extend across the under side of the sheet, so as to cover the meeting edges between the perforations, such thin layer of plastic being indicated at 52. By providing a thin layer of plastic over the edges, the lower surface of the sheet can be made perfectly smooth. The transparent plastic permits the rays to pass through as described in connection with Fig. 2, but excludes dust. The outer surface of the plastic may also be given any desired ornamental formation or effect. Also the plastic may, if desired, be colored so that a luminaire made with this sheet will emit a colored or tinted light.

While I have illustrated and described in detail certain preferred forms of my invention, it is to be understood that changes may be made therein and the invention embodied in other structures.

I claim:

1. A luminaire comprising a source of diffused illumination of large area with a light transmitting screen in front of the source of illumination; said screen comprising a sheet having holes therethrough, said holes having wall portions which diverge outwardly towards the side of the screen furthest from the source of illumination, said wall portions of adjacent holes merging to form substantially sharp edges on the side of the screen furthest from the source of illumination, said wall portions being of such angularity with reference to the plane of the sheet as to receive rays from the source of light and reflect them to the outside of the sheet.

2. A light transmitting screen for use with fluorescent tubes and the like, comprising a wire mesh formed of woven wires of triangular cross section, the bases of the triangles facing the inside of the screen and the apices of the triangles facing the outside of the screen.

3. A light transmitting screen for use with fluorescent tubes and the like, comprising a sheet of metal having closely spaced small perforations therein, the walls of the perforations flaring outwardly and merging to form intersecting edges arranged in a regular pattern over the outer surface of the screen, and transparent plastic material filling the perforations and extending in a thin layer over the intersecting edges between the perforations.

4. A light transmitting screen for use with fluorescent tubes and the like, comprising a sheet of metal having closely spaced perforations therein, the walls of the perforations flaring from the center of the sheet towards the inner and outer

surfaces of the sheet, and merging to form intersecting edges arranged in regular patterns over the surfaces of the sheet.

5. A light transmitting screen for use with fluorescent tubes and the like comprising a sheet of metal having closely spaced small perforations therein, the walls of the perforations flaring outwardly and merging to form intersecting edges arranged in a regular pattern over the outer surface of the screen, the inner surface of the screen being substantially smooth throughout.

6. A luminaire adapted to hold a fluorescent tube and having a light transmitting screen in front of the tube position comprising a sheet of opaque material having closely spaced, small perforations therein, the walls of the perforations flaring outwardly and merging to form intersecting edges arranged to form a series of polygons constituting substantially the entire outer surface of the screen, said flaring wall portions having light reflecting surfaces.

7. A luminaire adapted to hold a fluorescent tube and having a light transmitting screen in front of the tube position comprising a sheet of opaque material having closely spaced, small perforations therein, the walls of the perforations flaring outwardly and merging to form intersecting edges arranged to form a series of polygons constituting substantially the entire outer surface of the screen, said flaring wall portions having light reflecting surfaces, the minimum diameter of the perforations being about equal to the thickness of the sheet.

8. A light transmitting screen comprising a sheet of opaque material of uniform thickness having closely spaced, small perforations therein, the perforations being of a minimum diameter approximately equal to the thickness of the sheet and having their centers spaced apart at distances approximately equal to twice the thickness of the sheet, the walls of the perforations flaring outwardly and merging to form intersecting edges, the flaring walls of the perforations having light reflecting surfaces.

9. A light transmitting screen comprising a sheet of opaque material of substantially uniform thickness having a plurality of closely spaced, small perforations therein, the thickness of the sheet being not more than double the minimum diameter of the perforations, said perforations including flaring wall portions merging to form intersecting edges on a side of the sheet, said flaring wall portions having light reflecting surfaces.

10. A light transmitting screen comprising a thin metal sheet of substantially uniform thickness having a plurality of closely spaced small perforations therein, said perforations having wall portions flaring at angles of not more than about 60° from the plane of the sheet, said perforations being spaced close enough together so that the edges of the flared wall pertions of adjacent perforations substantially merge, said flared wall portions having light reflecting surfaces, whereby, when light is transmitted through the screen from the back thereof, the face of the screen presents a substantially continuous series of flaring light reflecting portions producing an effect of a substantially continuous luminous surface.

11. A luminaire adapted to hold a fluorescent tube having a light transmitting screen in front of the tube position formed as set forth in claim 10.

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