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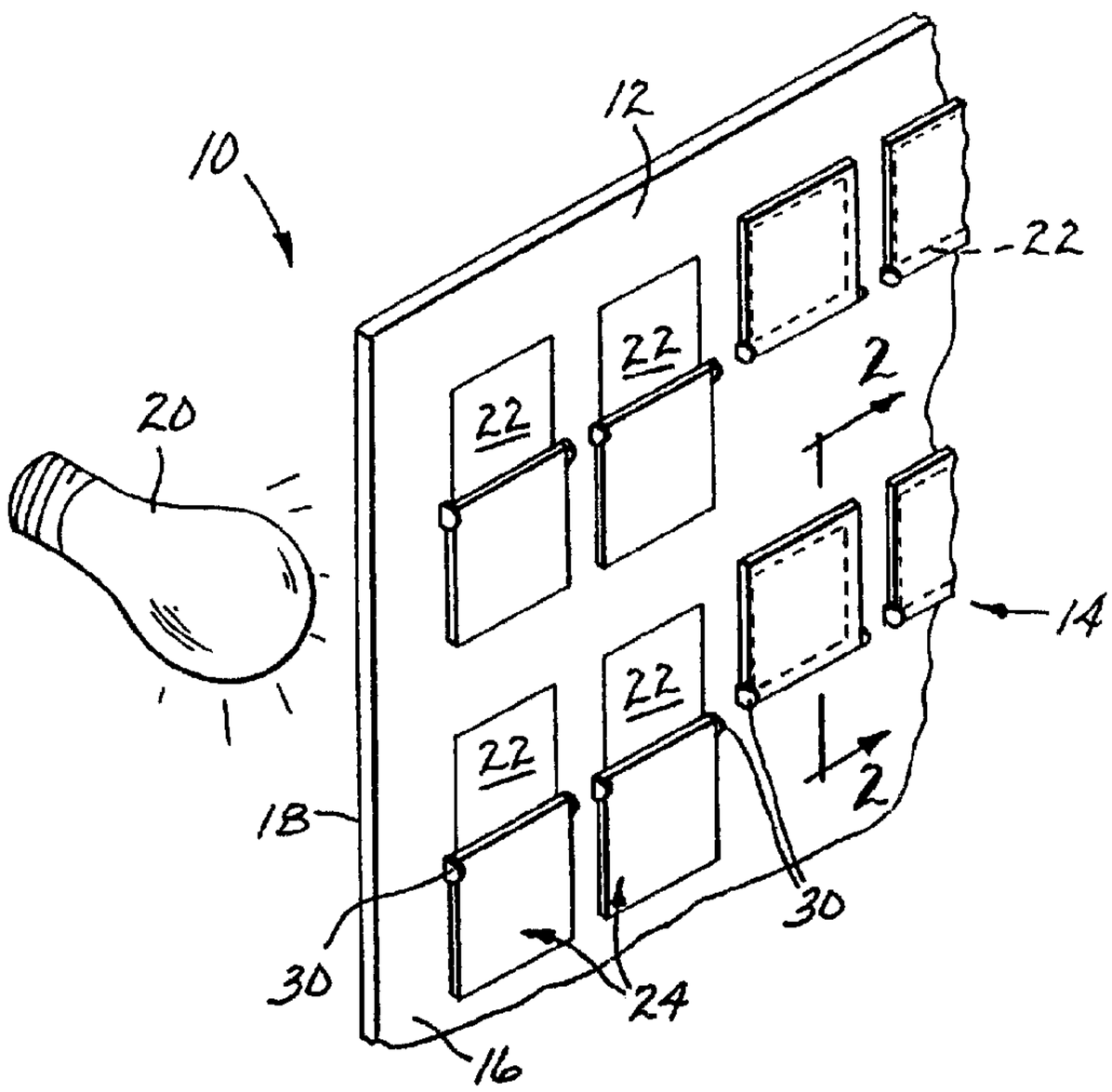

(57) Abrégé/Abstract:
Information display device comprising a legend face (12) with a two-dimensional array of individually operated pixels (14). The legend face comprises an opaque sheet having a front side (16) to be presented to an observer and a back side (18). Each pixel comprises an aperture (22) in the opaque sheet and an associated shutter (24), the aperture being partially-light-transmissive and preferably retroreflective, the shutter being opaque and having first and second faces which are of visually distinctive appearance with the second face being retroreflective. Each shutter is selectively settable to a first state in which it occludes its associated aperture such that the first face (26) of the shutter is presented so as to be visible to an observer, and a second state in which it exposes its associated aperture such that the shutter's second face (28) and associated aperture are presented so as to be visible to an observer. The device further comprises means (30) for selectively positioning the shutters in the two states and at least one light source (20) disposed on the rear side of the opaque sheet.

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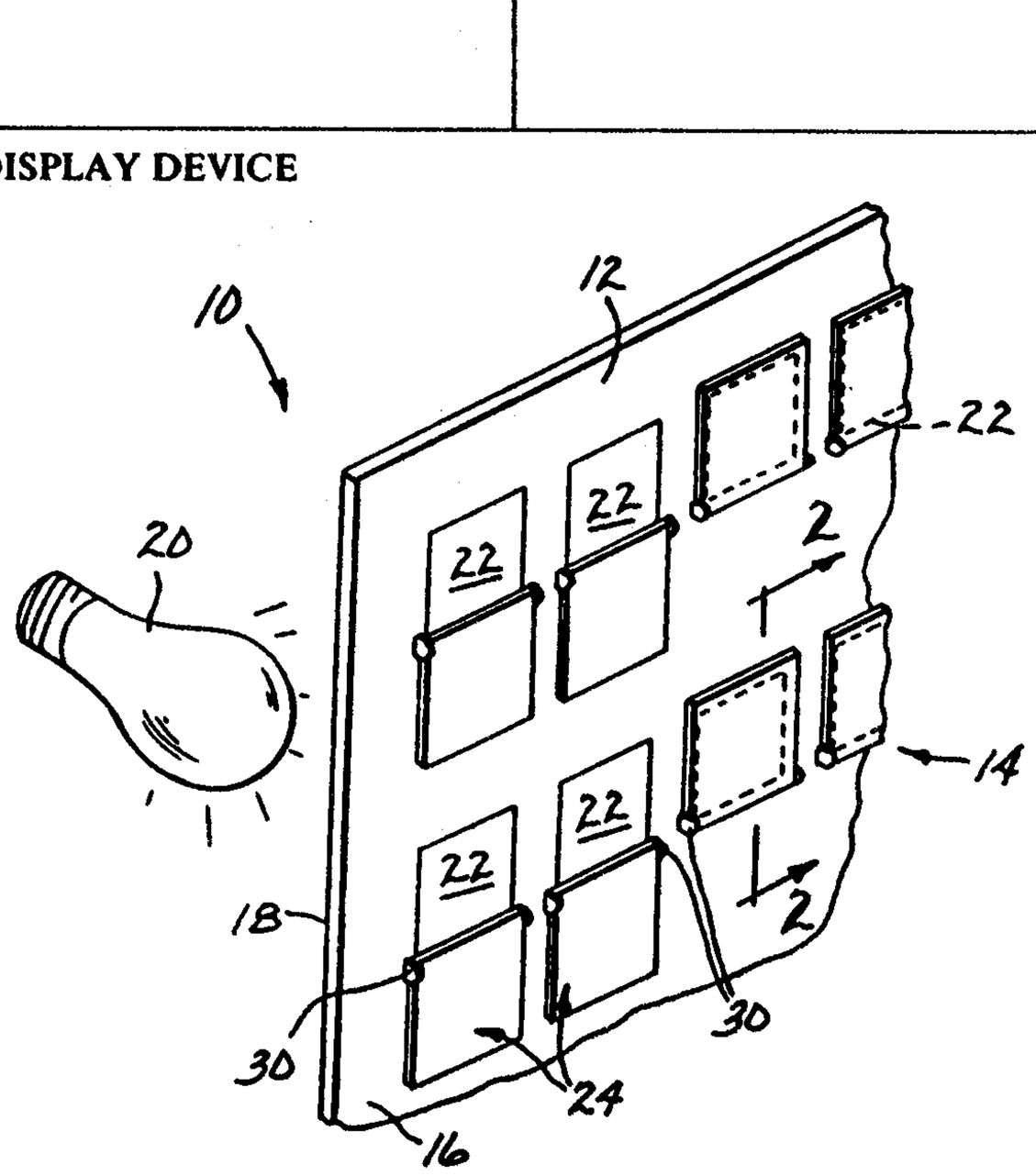


(57) Abstract

Information display device comprising a legend face (12) with a two-dimensional array of individually operated pixels (14). The legend face comprises an opaque sheet having a front side (16) to be presented to an observer and a back side (18). Each pixel comprises an aperture (22) in the opaque sheet and an associated shutter (24), the aperture being partially-light-transmissive and preferably retroreflective, the shutter being opaque and having first and second faces which are of visually distinctive appearance with the second face being retroreflective. Each shutter is selectively settable to a first state in which it occludes its associated aperture such that the first face (26) of the shutter is presented so as to be visible to an observer, and a second state in which it exposes its associated aperture such that the shutter's second face (28) and associated aperture are presented so as to be visible to an observer. The device further comprises means (30) for selectively positioning the shutters in the two states and at least one light source (20) disposed on the rear side of the opaque sheet.

INFORMATION DISPLAY DEVICE

Field of Invention

The present invention relates to matrix or array information display devices such as are used as variable message signs.

Background

Information display devices from which the displayed information can be varied, sometimes referred to as changeable copy or variable message signs, have been in use for some time. They have been used for such applications as advertising media, traffic signs, information displays in or on sports stadiums, mass transit stations and vehicles, etc.

The information-displaying face of such signs is usually made up of an array or matrix of individually activated pixels. The pixels are typically capable of being set in one of two different states of distinctive appearance, i.e., "activated" and "deactivated" states. By selectively activating and deactivating pixels, the information displayed can be changed. The sign may simply switch to another legend (e.g., switch from a time indication to a temperature indication) or portions of the existing legend may be moved across the face of the sign.

Many different pixel types have been used in variable message signs. In one type, each pixel is an individually controlled light bulb and bulbs within the array are selectively energized or de-energized to generate the desired legend. Another type of variable message signs are electromechanical devices with pixels comprising elements whose position or orientation is changed to alter their appearance. For example, U.S. Patent No. 4,318,098 (McGreevy) discloses variable message signs wherein pixels comprise members that selectively rotate about an axis, presenting at least two different visual appearances as desired to generate the desired legend. In one embodiment disclosed in that

patent, the pixels comprise members which are fluorescent and reflective in one state and have a different appearance, e.g., black, in another state. Variable message devices having certain similarities are disclosed in U.S. Patent Nos. 3,140,553 (Taylor), 3,295,238 (Winrow), 3,518,664 (Taylor), and 4,779,082 (Salam).

In another electromechanical sign disclosed in U.S. Patent No. 4,163,332 (Salam), the pixels comprise light transmissive areas in a backlit opaque sheet and movable opaque vanes that selectively occlude or expose the light transmissive areas. The reference teaches that the vanes are reflective, i.e., specularly reflective, such that when the light transmissive portion of the pixel is exposed the vane will reflect light from a second source to an observer.

A problem with previously known variable message signs is that they did not provide sufficient legibility and conspicuity under a variety of conditions, e.g., at twilight, under nighttime darkness, during power failures, etc.

Summary of Invention

The present invention provides matrix or array information display devices that provide improved legibility and conspicuity throughout a variety of conditions. Display devices of the invention provide high conspicuity and legibility during daylight conditions, at twilight, under nighttime darkness, during power failures, etc.

In brief summary, the invention provides an information display device comprising: (a) a legend face comprising an opaque sheet with a two-dimensional planar array of pixels thereon, said sheet having a front side to be presented to an observer and a back side, each pixel

comprising an aperture in said opaque sheet and an associated shutter, said aperture being retroreflective and partially-light-transmissive, said shutter being opaque and having first and second faces, said second face being retroreflective, each shutter being selectively settable to a first state in which it occludes its associated aperture such that the first face of said shutter is presented to an observer, and a second state in which it exposes said associated aperture such that the second face of said shutter and said associated aperture are presented to an observer; (b) means for selectively positioning said shutters in said first and second states; and (c) at least one light source disposed on said back side of said opaque sheet.

In important distinctions from previously known matrix or array information display devices, the second faces of the shutters are retroreflective, preferably also fluorescent, and preferably the apertures are also retroreflective and more preferably retroreflective and fluorescent. As a result, devices of the invention, and especially the preferred embodiments thereof, provide previously unattained uniformity of appearance during daytime and nighttime hours as well as previously unattained brightness of appearance under a variety of viewing conditions.

Brief Description of Drawing

The invention will be further explained with reference to the drawing, wherein:

Figure 1 is a perspective view of a portion of an illustrative embodiment of an information device of the invention;

Figure 2 is a cross-sectional view of one pixel of the device shown in Figure 1 in which the shutter has been positioned in a first state such that it occludes its associated aperture; and

Figure 3 is a cross-sectional view of a portion of the pixel shown in Figure 2 in which the shutter has been positioned in a second state such that its associated aperture and the second face of the shutter are presented so as to be visible to an observer.

These figures, which are idealized, are not to scale and are intended to be merely illustrative and non-limiting.

Detailed Description of Illustrative Embodiments

As shown in Figure 1, in a typical embodiment, information display device 10 of the invention comprises opaque sheet 12 comprising a two-dimensional planar array of pixels 14 arranged in horizontal and vertical rows, sheet 12 having front side 16 and back side 18, front side 16 being presented so as to be visible to an observer. As shown schematically, at least one light source 20 is disposed on back side 18 of opaque sheet 12. Opaque sheet 12 and array of pixels 14 is referred to herein as a legend face of device 10. By selectively setting each pixel in one of two visually distinguishable states, the array of pixels generates a legend. A device of the invention may have one or more legend faces.

Each pixel 14 comprises aperture 22 in opaque sheet 12 and associated shutter 24. As used herein, a shutter which, in its first state, occludes an aperture is said to be that aperture's "associated shutter". Similarly, an aperture which is occluded by a shutter in the shutter's first state is said to be that shutter's "associated aperture". Aperture 22 is partially-light-transmissive such that it will transmit light when backlit by light source 20. Aperture 22 is preferably retroreflective on its front side and more preferably is also fluorescent. Illustrative examples of commercially available materials that may be used for aperture 22 include SCOTCHLITE Brand Reflective Sheeting Diamond Grade Series 3923 G and 3924 G, which are yellow and orange, respectively, retroreflective sheetings sold commercially by the Minnesota Mining and Manufacturing Company ("3M"). Such sheetings are sometimes called cube-corner or prismatic reflectors. Preferred embodiments of devices of the invention wherein apertures 22 are retroreflective, and particularly where they are also fluorescent, provide exceptional and unexpected levels of visibility and legibility.

Shutter 24 is opaque and has first face 26 and second face 28. First face 26 has an appearance that is

visually distinguishable from second face 28, e.g., has a different color, and is preferably of low reflectance. For example, it may have a matte black finish. It is typically preferred that first face 26 of shutters 24 and the portions of front side 16 of sheet 12 between apertures 22 have similar appearances. If first faces 26 and front side 16 are similar in appearance and of low reflectance, e.g., matte black, better contrast with activated pixels is provided and non-activated pixels appear indistinguishable from the background. The resultant device can generate a more readily visible, "crisper" looking legend.

Each shutter 24 is selectively settable to or positionable in a first state and a second state, e.g., by operation of means for positioning 30. As shown in Figure 2, in the first state, shutter 24 occludes its associated aperture 22 with first face 26 of shutter 24 being presented so as to be visible to an observer (not shown). As shown in Figure 3, in the second state, shutter 24 exposes associated aperture 22 such that second face 28 of shutter 24 and associated aperture 22 are both visible to an observer (not shown).

Second face 28 is made of a retroreflective material. Illustrative examples of materials which may be used for second face 28 include such sheetings as 3M SCOTCHLITE Brand Reflective Sheeting Diamond Grade Series and High Intensity Series sold commercially by the 3M. If desired, second face 28 can be made of the same material as aperture 22 if another layer within shutter 24 is opaque. Preferably, aperture 22 and second face 28 are of substantially similar color and retroreflective performance such that under retroreflective viewing conditions the pixel has a uniform appearance. At relatively longer viewing distances, nonuniformities within individual pixels become less apparent.

The present invention provides great utility and unexpected performance because second faces 28 of

shutters 24 are retroreflective, and preferably fluorescent, and apertures 22 are partially-light-transmissive, and preferably retroreflective. As a result, devices of the invention provide exceptional visibility under a variety of conditions, including during bright daylight illumination at twilight, and at dark nighttime. Signs of the invention also provide high visibility in the event of internal light source 20 failure as well.

Shutter 24 is moved from its first state shown in Figure 2 to its second state shown in Figure 3 by operation of means for positioning 30. Various suitable means for selectively moving shutters 24 will be apparent to those skilled in the art. Shutters 24 may be switched between their first and second states by hand or by operation of individual motors, mechanical drive systems, etc. In a simple embodiment, means for positioning 30 is simply a pivot or axle about which shutter 24 is moved between its first and second states by hand. Preferably, means for positioning 30 is a mechanism that positions shutter 24 as desired without manual labor. U.S. Patent No. 4,819,357 (Salam) discloses a display device having an array of vanes (i.e., shutters) that are rotated between closed and opened positions (i.e., first and second states) by selectively actuated electromagnets. Each pixel may be operated under individual manual control or the entire array may be operated by a computer programmed to selectively position individual pixels as appropriate for the desired legend which the device is to display. Such systems may be used to great advantage in the present invention.

Typically, a device of the invention is fully enclosed, with provision for ventilation if desired,

encasing the light source(s) and certain components of the means for positioning the pixels, etc. As mentioned above, a device of the invention may comprise more than one legend face. The pixel arrays of different legend

faces may be operated independently or in concert as desired.

As shown in Figure 1, in some embodiments, each pixel 14, whether in its first state or second state, is separated from adjacent pixels by a portion of front side 16, referred to herein as a buffer zone. Typically, it is preferred that front side 16 have a similar appearance to first face 26 of shutter 24 so as to maximize the contrast between pixels in their second state from those in their first state and from front side 16. If desired, the pixels may be arranged on the opaque sheet 12 in very close proximity so that adjacent pixels are separated by only a small buffer zone or even abut directly together.

Pixels 14 shown in Figure 1 have substantially square apertures 22 and shutters 24. It will be understood, however, that the apertures and associated shutters may be made in other shapes (not shown) as desired, e.g., other polygons (such as rectangles or octagons), circles, semicircles, etc. A shutter is preferably large enough and positioned properly so as to be capable of occluding the entirety of its associated aperture. Accordingly, apertures will typically be of similar shape and of similar or slightly smaller size than their associated shutters. It is not required, however, that apertures and their associated shutters be of similar shape or similar size. It is also not necessary for pixels within an array to be of similar size.

The number of pixels in an array and their size will depend upon the resolution performance desired of the device which in turn will depend in part upon its intended location with respect to intended viewers. Information display devices which are intended to be seen from relatively great distances will usually be made with relatively larger pixels and greater spacing between pixels than are those which are intended to be seen from shorter distances. In typical embodiments, the array is likely to be between about 2 feet by about

2 feet (about 120 centimeters by about 120 centimeters) and about 20 feet by about 40 feet (about 12 meters by about 24 meters) in dimension. Arrays having dimensions outside these ranges may be used if desired.

As shown in Figure 1, device 10 may comprise an array of pixels arranged in horizontal and vertical rows. It will be understood, however, that the pixels of devices of the invention may be arranged in an array of any desired configuration. For instance, U.S. Patent No. 755,272 (Burnham et al.) discloses a changeable sign wherein pixels are arranged in an array designed to permit display of an alpha-numeric character. The legend face of a device of the present invention might be made up of pixels as described herein arranged in one or more, typically several, such arrays with individual pixels being of different sizes and shapes. Thus, the pixels in an array may be of at least two different sizes and/or of at least two different shapes.

Light source 20 will typically emit visible light. A portion of the light emitted by source 20 will be transmitted through partially-light-transmissive aperture 22, so as to be, in the case of pixels 14 which are in their second states (Figure 3), visible to one viewing the device. If desired, light source 20 can be tuned to also emit radiation of a wavelength that causes aperture 22 to fluoresce more brightly, thereby enhancing the visibility of the non-occluded pixels. In such embodiments, selection of the material used in aperture 22 and of light source 20 will thus be interdependent.

Figures 1 and 3 show schematically a single light source 20, e.g., an incandescent or neon light bulb. Devices of the invention may have a single light source, a plurality of light sources each of which is intended to

provide light to a number of apertures 22, or even a single light source for each aperture 22. For reasons of cost and complexity, it is typically preferred to construct a device having fewer light sources. It is typically preferred that the pixels be substantially uniform when activated (i.e., when their shutters are in their second states leaving their associated apertures unoccluded). Thus, a diffuser will often be used to make the brightness of each pixel in the array more uniform. In a preferred embodiment, light may be introduced into the device so as to illuminate the back side of the pixels using so called "optical light pipes" or "light guides" such as are disclosed in U.S. Patent Nos. 3,641,332 (Reick et al.), 4,260,220 (Whitehead), 4,422,719 (Orcutt), 4,466,697 (Daniel), and 4,805,984 (Cobb). U.S. Patent No. 4,952,023 (Bradshaw et al.) discloses an internally illuminated sign that employs light pipe and remote light sources in some embodiments, see, e.g., Figure 4. Such light introduction techniques may be used in devices of the invention. An illustrative example of a commercially available light pipe which may be used herein is SCOTCH Brand Optical Lighting Film from 3M.

Many retroreflective sheetings, such as 3M's SCOTCHLITE Brand Reflective Sheeting Diamond Grade Series cube-corner sheetings, are encapsulated-lens sheetings with cover films, sometimes called seal films, sealed over the cube-corners to protect same and maintain the desired air interface necessary to maintain high retroreflective brightness. U.S. Patent No. 4,025,159 (McGrath) discloses one type of such sheeting. When used as an aperture in devices of the present invention, if the apertures are made with a sheeting having such a seal film, the seal film may be clear or translucent. Translucent seal films may provide a diffusing effect and may be preferred where a separate

diffuser is not being used. Typically, nonuniformity of the intensity of light incident to the back side of, and transmitted by, the apertures tends to be more apparent when the legend being displayed is made up of a large proportion of the pixels in their second state than in

the case of legends made up of more varied patterns of pixels in their first and second states.

Devices of the invention require power to operate light source 20 and, unless the shutters are switched manually, to selectively switch shutters between their first and second states. In some instances, e.g., when the means for positioning the shutters employs electromagnets, external power to maintain shutters in a particular state may be required. Devices are typically powered by outside electrical sources, e.g., conventional AC electrical service. Other power sources such as batteries and solar cells may be used to provide greater utility. For instance, battery power may be used as a backup, ensuring continued operation in case of disruptions in commercial electrical service. Batteries and solar power may be used to permit location of a device of the invention in remote and/or temporary locations where commercial electrical service or mobile generators are unavailable or considered too expensive.

One of the advantages of devices of the present invention is the high visibility provided because the second faces of the shutters are retroreflective, preferably fluorescent, and the apertures are preferably retroreflective and more preferably fluorescent in addition to being partially-light-transmissive. As a result, the device can still generate a highly visible legend even if light source 20 is deactivated or left without power backup in times of disruption of power supply from the primary power source while backup power is conserved for operation of the means for positioning the shutters.

If desired, devices of the invention may be built such that in the case of an interruption of power supply, the pixels (1) remain in their last selected settings, such that the device continues to display the last legend, or (2) switch to another selected group of settings, such that the device switches to another legend. For instance, a sign which displays speed limit and other traffic-related information during routine

operation may, upon failure of power, switch to a group of shutter settings that generates a preselected message, e.g., a warning that traffic signals are inoperative.

Various modifications and alterations of this invention will become apparent to those skilled in the art without departing from the scope and spirit of this invention.

CLAIMS:

1. An information display device comprising:

(a) a legend face comprising an opaque sheet with a two-dimensional planar array of pixels thereon, said sheet having a front side to be presented to an observer and a back side,

each pixel comprising an aperture in said opaque sheet and an associated shutter, said aperture being retroreflective and partially-light-transmissive, said shutter being opaque and having first and second faces, said second face being retroreflective,

each shutter being selectively settable to a first state in which it occludes its associated aperture such that the first face of said shutter is presented to an observer, and a second state in which it exposes said associated aperture such that the second face of said shutter and said associated aperture are presented to an observer;

(b) means for selectively positioning said shutters in said first and second states; and

(c) at least one light source disposed on said back side of said opaque sheet.

2. The device of claim 1 wherein adjacent pixels are separated by a buffer zone.

3. The device of claim 1 wherein said front side of said opaque sheet and said first faces of said shutters are of low reflectance.

4. The device of claim 1 wherein said second faces of said shutters are fluorescent.

5. The device of claim 1 wherein said apertures are fluorescent.

6. The device of claim 1 wherein said apertures comprise a prismatic retroreflective sheeting.

7. The device of claim 1 wherein said aperture and said second faces of said shutters have similar retroreflective performance and color appearance.

8. The device of claim 1 wherein said pixels are of substantially uniform size and shape.

9. The device of claim 1 wherein said light source emits visible light.

SMART & BIGGAR

PATENT AGENTS

OTTAWA, CANADA

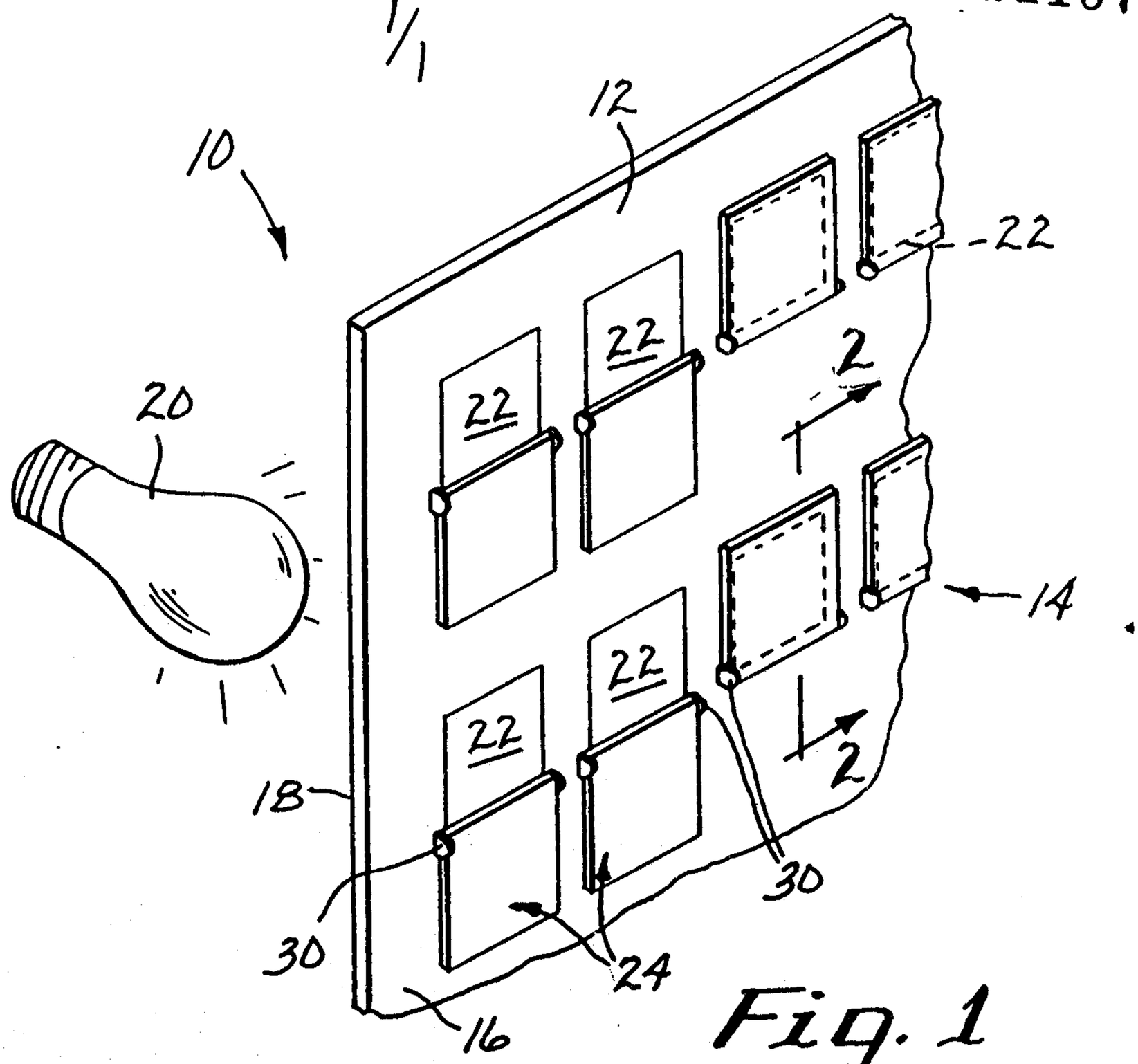
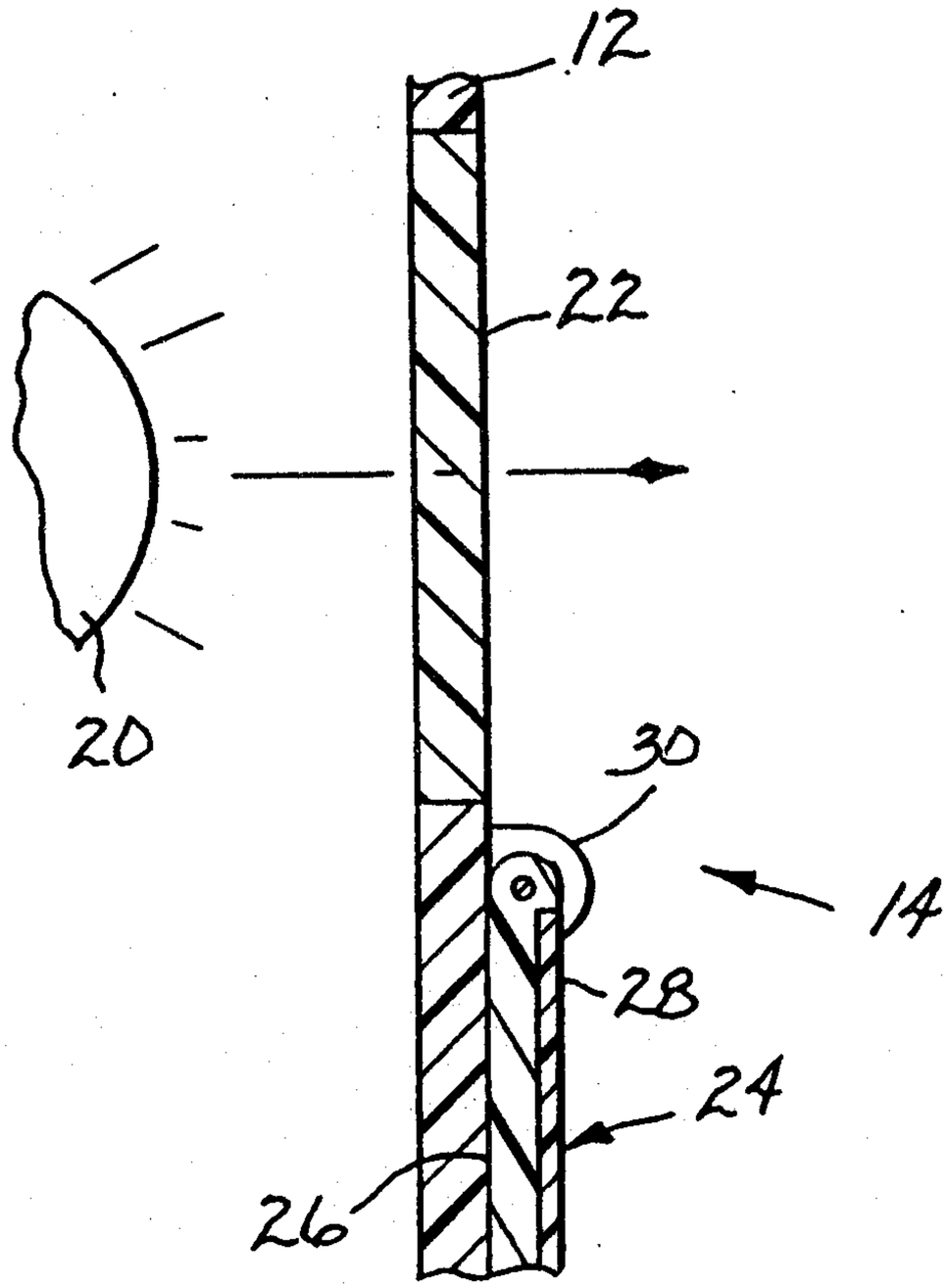


Fig. 1

Fig. 3



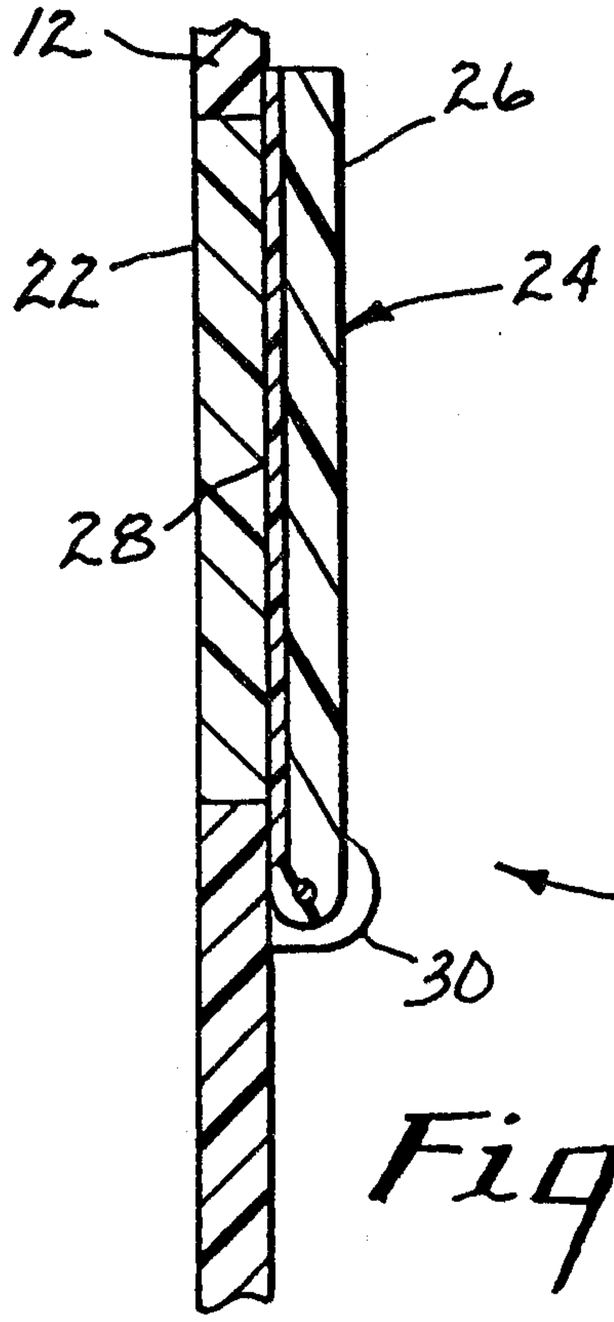
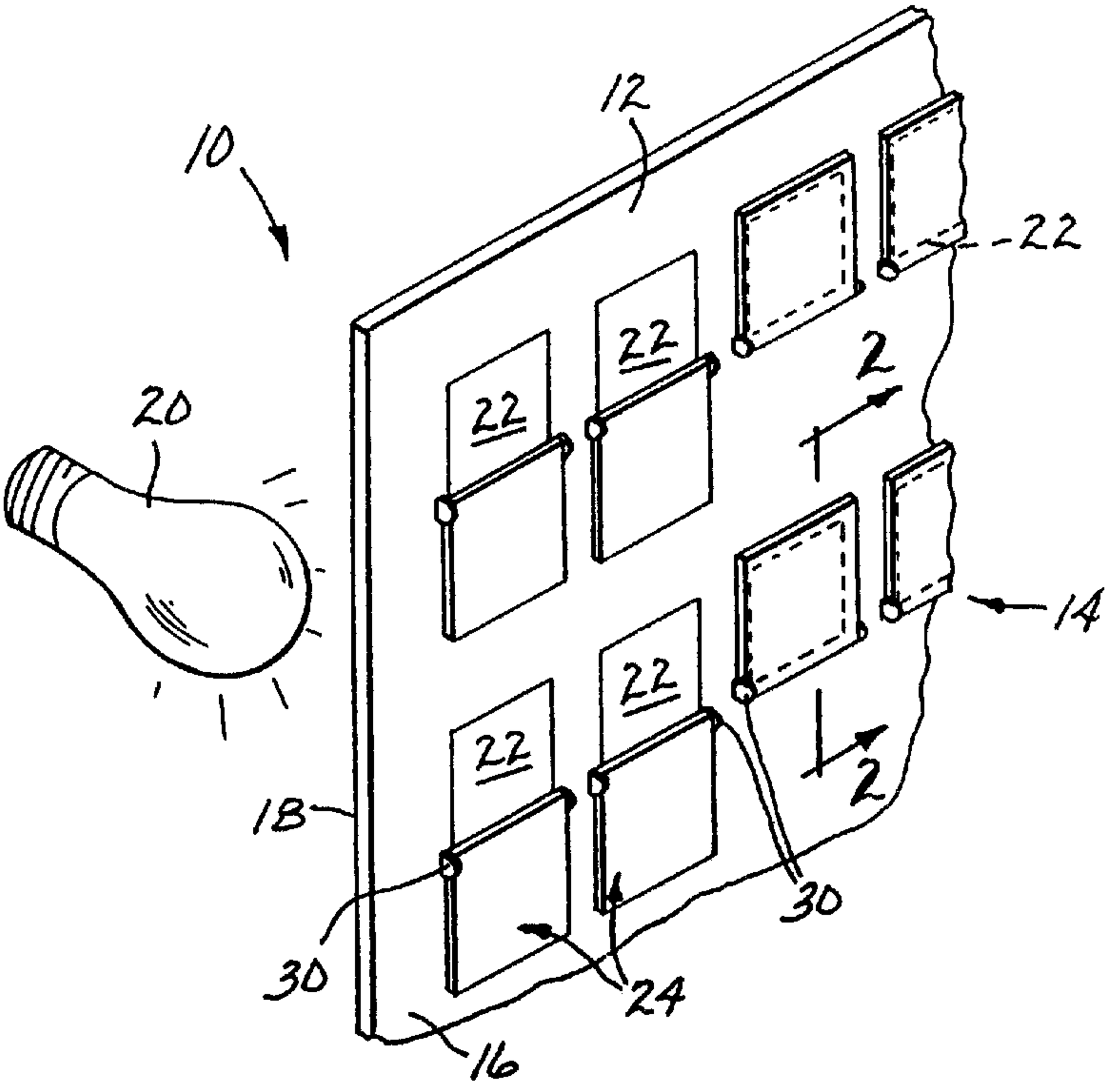


Fig. 2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