PCT WORLD INTELLECTUAL PROP International B

INTERNATIONAL APPLICATION PUBLISHED UNDEI WO 9606371A1

(51) International Patent Classification 6 : G02B 5/08, 17/00, 27/14, 27/22	A1	(11) International Publication Number: WO 96/06371
		(43) International Publication Date: 29 February 1996 (29.02.96)

(21) International Application Number: PCT/US95/11188

(22) International Filing Date: 17 August 1995 (17.08.95)

(30) Priority Data:
08/292,007 18 August 1994 (18.08.94) US

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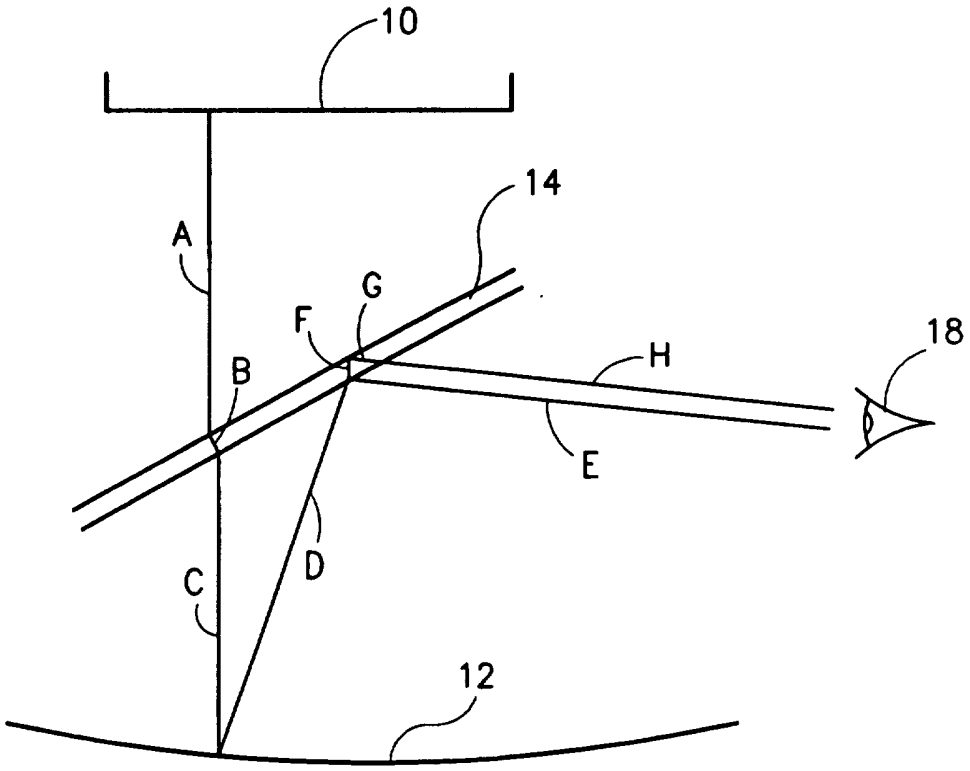
(81) Designated States: CA, JP, TJ, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: THREE-DIMENSIONAL DISPLAY

(57) Abstract

A system for enhancing a viewer's depth perception of two-dimensional images on a display (10), which includes a sector of a concave spherical mirror (12) which is located below a downward facing display with its concave surface toward the display (10), and a transparent plate (14) located midway between the display and the concave spherical mirror at a 45 degree angle to a line connecting the centers of the display and the spherical mirror. In operation, at least a portion of the light coming from the display (10) goes down through the transparent plate (14), is reflected up by the spherical mirror (12) and is reflected horizontally from the transparent plate (14) to the eyes (18) of the viewer.



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Title: THREE-DIMENSIONAL DISPLAY

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to systems for use in viewing two-dimensional images with a perceived three-dimensional effect and, more particularly, to systems which can be used to allow the user to perceive a two-dimensional video image as a three-dimensional image.

Three-dimensional images, or depth, can be perceived in two basic ways. One is a stereoscopic depth perception which requires the use of both eyes while the other is psychological depth perception which is effective even when only one eye is used.

Stereoscopic depth perception relies on the slight displacement of the two eyes, which occurs naturally when viewing real scenes. The effect can also be utilized when viewing two-dimensional images, for example, by photograph the scene from two slightly different locations and superimposing the two images on the same flat display while providing means for the viewer to see each image with a different eye. For example, the two images may be of somewhat different colors and the viewer is provided with glasses which have different colored lenses so that the right eye sees predominantly one of the images while the left eyes sees predominantly the other image.

Psychological depth perception relies on various depth perception clues which are present in the scene or image being viewed. For example, with increased distance, the color of objects generally changes and the shape softens. The light distribution on an object also gives clues about its shape and relative distance of various points on the object. The overlapping of object contours gives an indication of the relative nearness of the objects, as when, for example, one object partially hides another. Various geometrical perspectives give an indication of distance, such as the convergence of parallel sidewalks in the distance. Finally, the size of objects gives an idea of their nearness with larger object perceived to be nearer than distant objects.

The various depth perception clues are widely utilized by the producers of video and computer games and in various other computer applications. The results are two-dimensional images projected on a computer monitor or the like which appear, with various degrees of success, to be three-dimensional.

A shortcoming of presently available techniques is that the three-dimensional perception is incomplete, putting a burden on the user to actively use his or her imagination to perceive the image as being three-dimensional.

Various systems have been devised to augment the various depth perception clues, and hence to reinforce and render more real the depth

perception of the user when viewing two-dimensional images. Typically, such systems involve cumbersome and expensive image display equipment and/or the time-consuming preprocessing or recreating of the images.

There is thus a widely recognized need for, and it would be highly advantageous to have, an inexpensive system for allowing conventional two-dimensional images, particularly those displayed on a computer monitor or similar display devices, to be readily and easily perceived by the viewer as three-dimensional images without having to pre-process or recreate the images prior to viewing and without having to modify the conventional monitor or similar display device.

SUMMARY OF THE INVENTION

According to the present invention there is provided a system for enhancing a viewer's depth perception of two-dimensional images on a display, comprising: (a) a sector of a concave spherical mirror located opposite the display, the concave surface of the spherical mirror being directed toward the display; and (b) a transparent plate located between the display and the concave spherical mirror at substantially a 45 degree angle to a line connecting the centers of the display and the sector of the spherical mirror, so that at least a portion of the light coming from the display goes through the transparent plate, is then reflected by the spherical

mirror and is then reflected from the transparent plate to the eyes of the viewer.

According to further features in preferred embodiments of the invention described below, the system includes means for absorbing stray light, such as walls which surround the system components.

According to still further features in the described preferred embodiments the display is mounted on some suitable mounting means so as to face vertically downward and the sector of concave spherical mirror is mounted so as that its concave surface is directed upwards.

The present invention successfully addresses the shortcomings of the presently known configurations by providing a system for a simple, inexpensive and readily deployable system for giving the user the perception of viewing three-dimensional images when in reality the images being viewed are conventional images displayed on a conventional two-dimensional display, such as a computer monitor.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic depiction of a system according to the present invention;

FIG. 2 shows one example of a collapsible system in the folded condition;

FIG. 3 shows the system of Figure 2 without the display monitor;

FIG. 4 shows the system of Figures 2 and 3 when fully deployed;

FIG. 5 shows another example of a collapsible system according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is of a system which is useful in giving the user the perception of depth when viewing two-dimensional displays, such as a conventional computer monitor.

The principles and operation of a system according to the present invention may be better understood with reference to the drawings and the accompanying description.

Referring now to the drawings, Figure 1 illustrates the basic components of a system according to the present invention. The system, which is designed to enhance the viewer's depth perception of two-dimensional images on a display **10**, is made up of two basic components - a sector of a concave spherical mirror **12** and a transparent plate **14**.

The system may be oriented in any convenient fashion, such as vertically or horizontally. Preferably, the system is oriented vertically such that display **10**, which is typically a conventional computer monitor, is

positioned as shown in Figure 1 with the display directed vertically downward. This orientation is preferred as it allows the user to view the images horizontally, as in viewing a conventional computer monitor. For ease of presentation, the description which follows is of vertically oriented systems, it being understood that any other orientation, for example horizontal, may also be used. In each case the user's viewing direction is approximately perpendicular to the direction of light emitted from display **10**. It is to be mentioned parenthetically that the latter may be advantageous in reducing the amount of radiation emitted by display **10** which directly reaches the eyes of the user.

Sector of concave spherical mirror **12** is located opposite display **10**, such as directly below it, with the concave surface of spherical mirror **12** being directed toward display **10**.

Transparent plate **14**, which may be a suitable plate of glass of suitable transmissivity, is located between display **10** and spherical mirror **12**, preferably substantially midway between the two. Without in any way limiting the scope of the present invention, it is believed that the distance between display **10** and sector of concave spherical mirror **12** is preferably from about 39 cm to about 47 cm.

Transparent plate **14** forms an angle of substantially 45° with an imaginary line connecting the center of display **10** and the center of sector of spherical mirror **12**. Without limiting the scope of the present invention,

it is believed that transparent plate **14** preferably has a thickness of from about 1 mm to about 5 mm and that the radius of curvature of sector of concave spherical mirror **12** is from about 180 cm to about 300 cm.

The system components are dimensioned, oriented and located so that at least a portion of the light coming from display **10** goes through transparent plate **14**, is then reflected by spherical mirror **12** and is subsequently reflected from transparent plate **14** to the eyes **16** of the viewer, as described in more detail below.

Without in any way limiting the scope of the present invention, it is believed that a system according to the present invention operates more specifically as follows.

Some of the light emitted from display **10** impinges on transparent plate **14** (shown as ray illustrative ray A in Figure 1). Some of the light is reflected to the left (not shown) and is lost to the system, as by absorption into light absorbing walls **30** (Figures 4 and 5) which preferably surround the space housing spherical mirror **12** and transparent plate **14**. The un-reflected light is refracted through transparent plate **14** (denoted B). Part of the refracted light (not shown) is reflected from the bottom surface of plate **14** while the rest (denoted C) exits plate **14** and impinges on mirror **12**. The light is reflected from spherical mirror **12** (denoted D) then impinges the lower surface of transparent plate **14**. Part of this light is then reflected toward the user's eyes (denoted E) while the rest of the light

(denoted F) is refracted through plate **14** and reaches the upper surface of plate **14**. Here, some of the light (not shown) exits plate **14** and is lost while the rest (denoted G) is reflected back through plate **14**, some of the light exiting plate **14** (denoted H) then heads for the user's eyes in parallel with light E but slightly displaced from it, the displacement being a function of the system geometry, including the thickness of plate **14**.

It is believed that the two slightly offset images viewed by the eyes of the user, perhaps coupled with the absence of well defined image borders or boundaries, provide a strong depth perception clues to the user's brain.

A system according to the present invention preferably includes suitable means for mounting display **10** in proper position. Various such means may be envisioned.

Preferably, the display mounting means is collapsible so that the display can alternately be used in the conventional way so as to face horizontally and, when desired, could be adjusted to face downward for use in a system according to the present invention.

Two illustrative mounting means are shown in Figure 2-4 and 5, respectively. Shown in Figures 2 and 3 is a system according to the present invention in a collapsed position with display **10** oriented horizontally for conventional viewing. Display **10** is held firmly by a brace **40** which is capable of sliding within a slot **42** and over a track **44** into one

of two positions. In a first position, shown in Figure 2, display **10** sits upright on the collapsed system and is directed horizontally for conventional use. In a second position, shown in Figure 4, display **10** has been rotated 90° downward so as to direct the image through an opening **46** (Figure 3) down toward spherical mirror **12**. It is in the latter position that the system can be used to view three-dimensional images. To make the system operational, the user must expand the accordion-like walls **30** which serve to absorb stray light.

In another embodiment, a frame **60** is provided about a computer unit **62** which pivotally supports back and side walls **30**. Display **10** is mounted in rotatable fashion, similar to that described above with respect to the configuration of Figures 2-4.

While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications and other applications of the invention may be made.

WHAT IS CLAIMED IS:

1. A system for enhancing a viewer's depth perception of two-dimensional images on a display, comprising:

(a) a sector of a concave spherical mirror located opposite the display, the concave surface of said spherical mirror being directed toward the display; and

(b) a transparent plate located between the display and said concave spherical mirror at substantially a 45 degree angle to a line connecting the centers of the display and said sector of said spherical mirror, so that at least a portion of the light coming from the display goes through said transparent plate, is then reflected by said spherical mirror and is then reflected from said transparent plate to the eyes of the viewer.

2. A system as in claim 1, wherein the display is a computer monitor.

3. A system as in claim 1, further comprising means for absorbing stray.

4. A system as in claim 3, wherein said means includes walls which substantially surround said transparent plate and said spherical mirror.

5. A system as in claim 1, wherein said transparent plate is located substantially midway between the display and said sector of said spherical mirror.

6. A system as in claim 1, wherein the thickness of said transparent plate is from about 1 to about 5 mm.

7. A system as in claim 1, wherein the radius of curvature of said sector of said concave spherical mirror is from about 180 cm to about 300 cm.

8. A system as in claim 7, wherein the distance between the display and said sector of said concave spherical mirror is from about 39 cm to about 47 cm.

9. A system as in claim 1, wherein the display is mounted so as to face vertically downward and wherein said sector of said concave spherical mirror is mounted so as that its concave surface is directed upwards.

10. A system as in claim 9, further comprising display mounting means for mounting the display.

11. A system as in claim 10, wherein said display mounting means is collapsible so that the display can alternately be used so as to face horizontally.

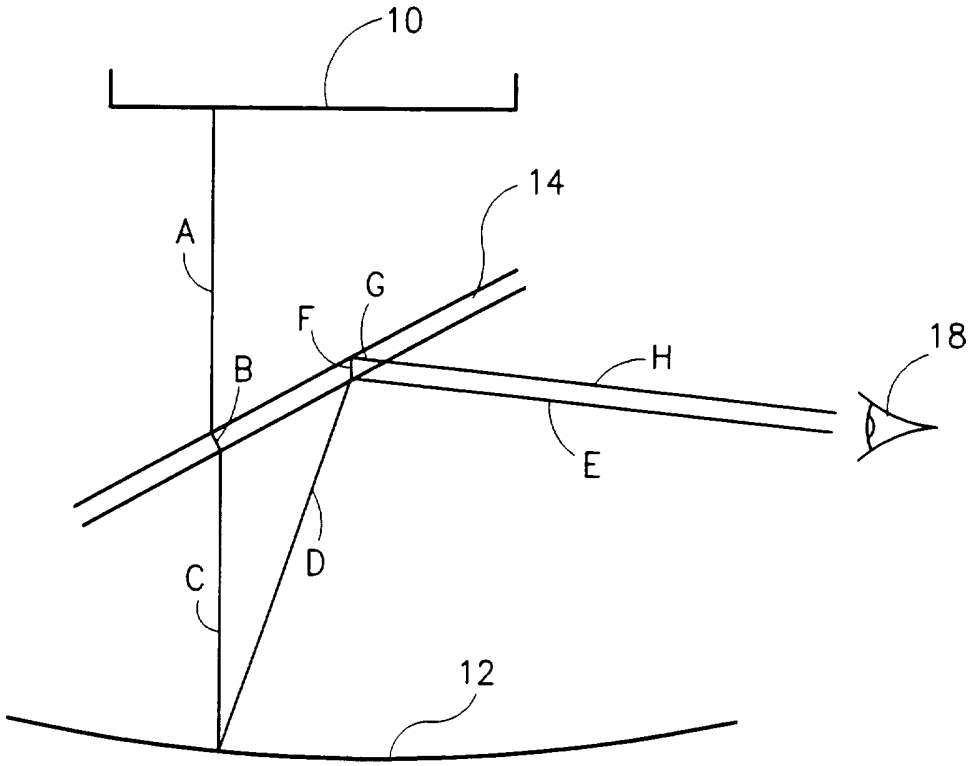

FIG. 1

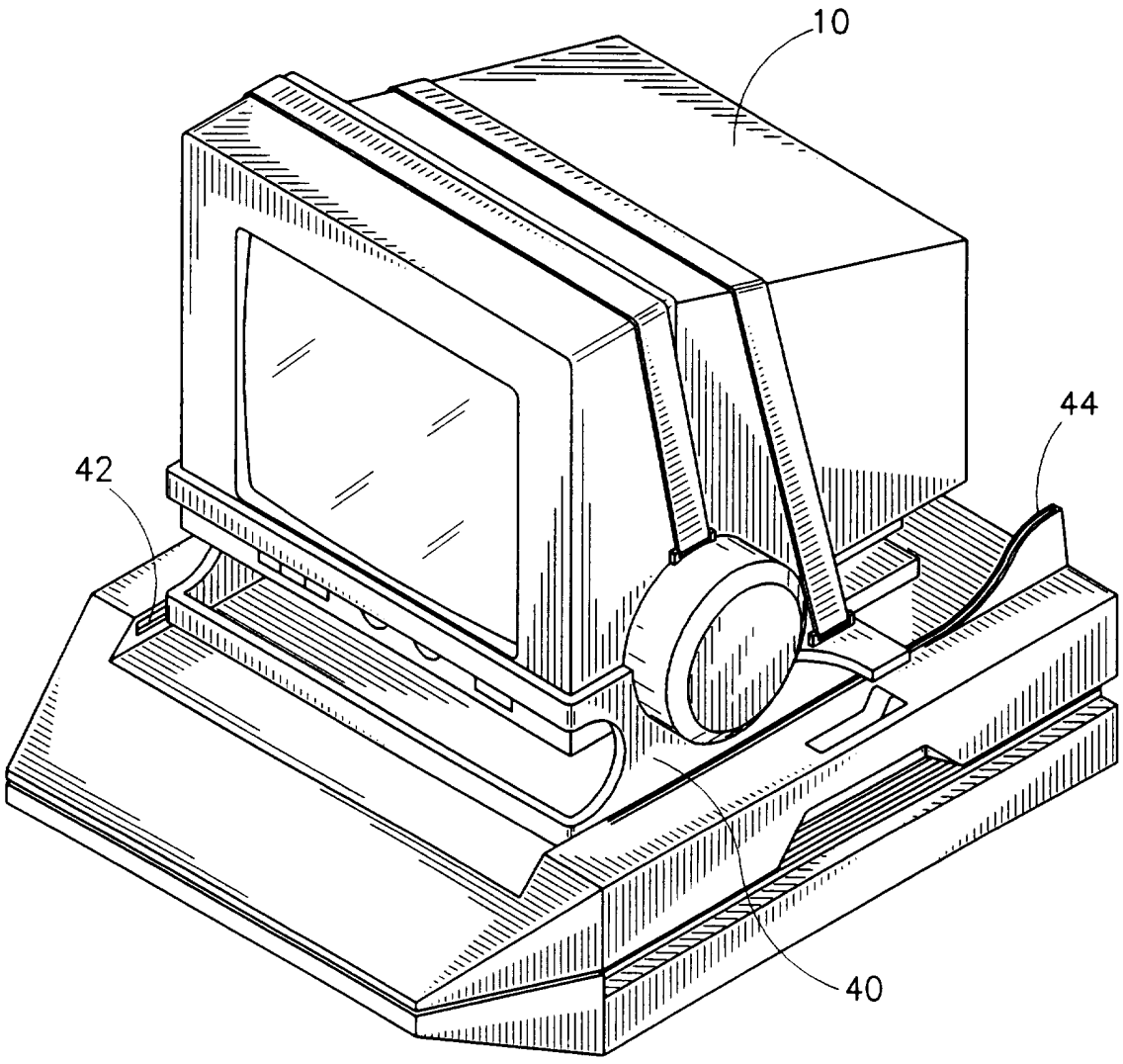

FIG.2

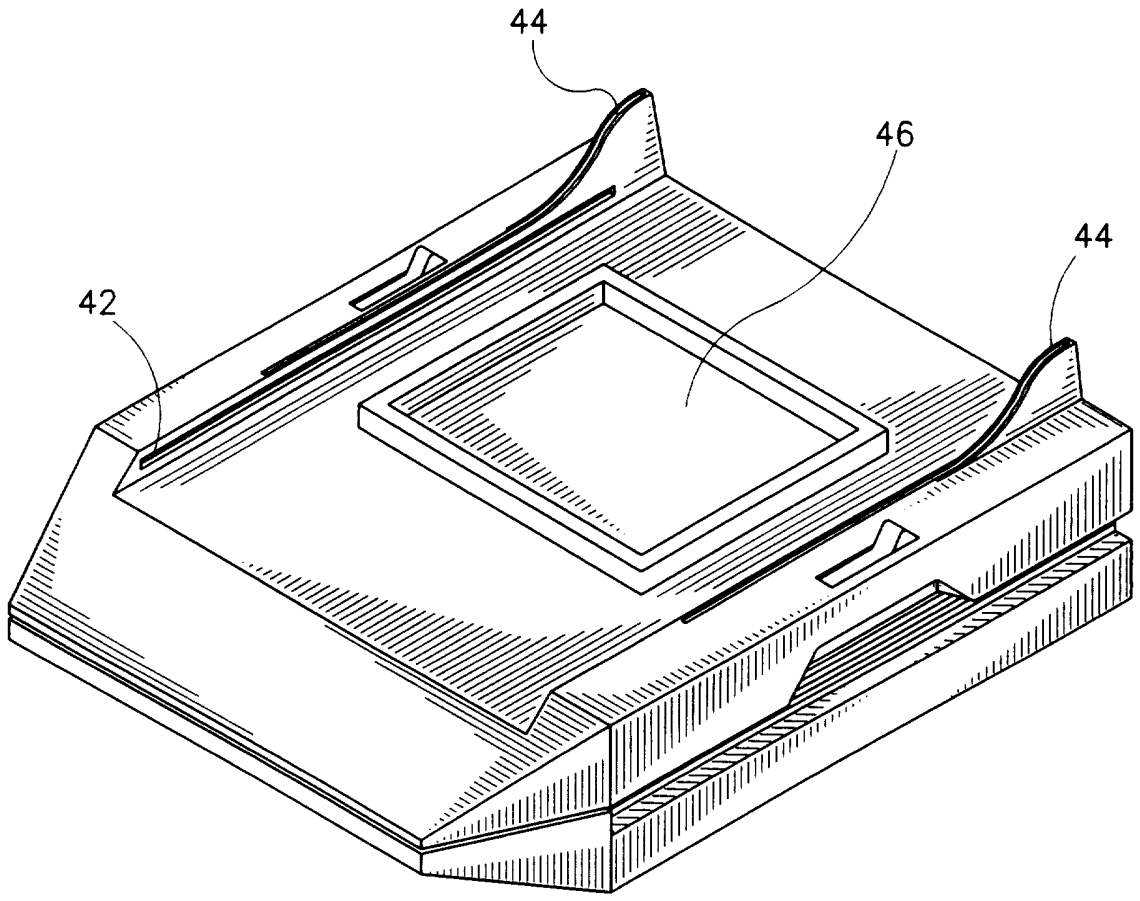

FIG.3

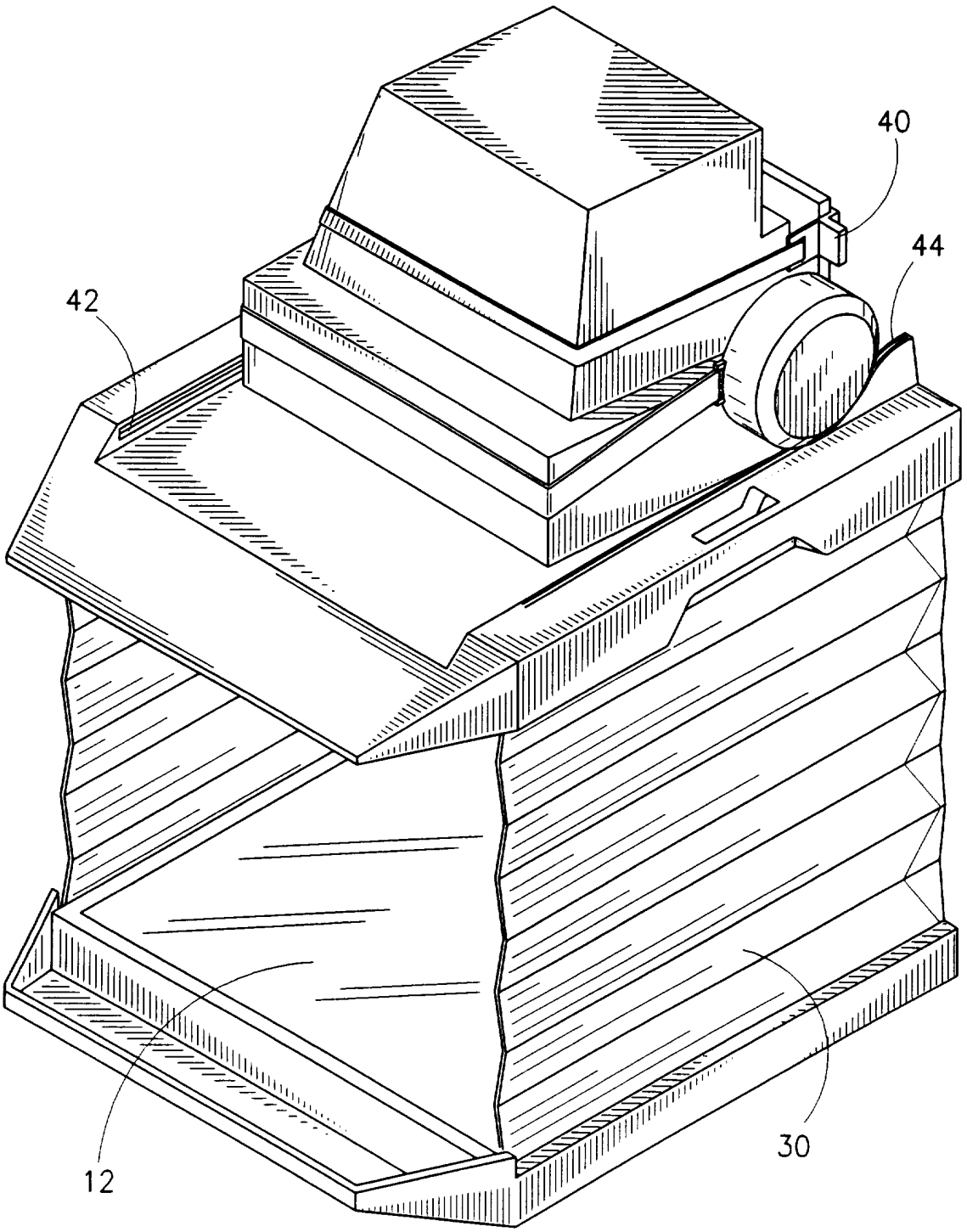

FIG.4

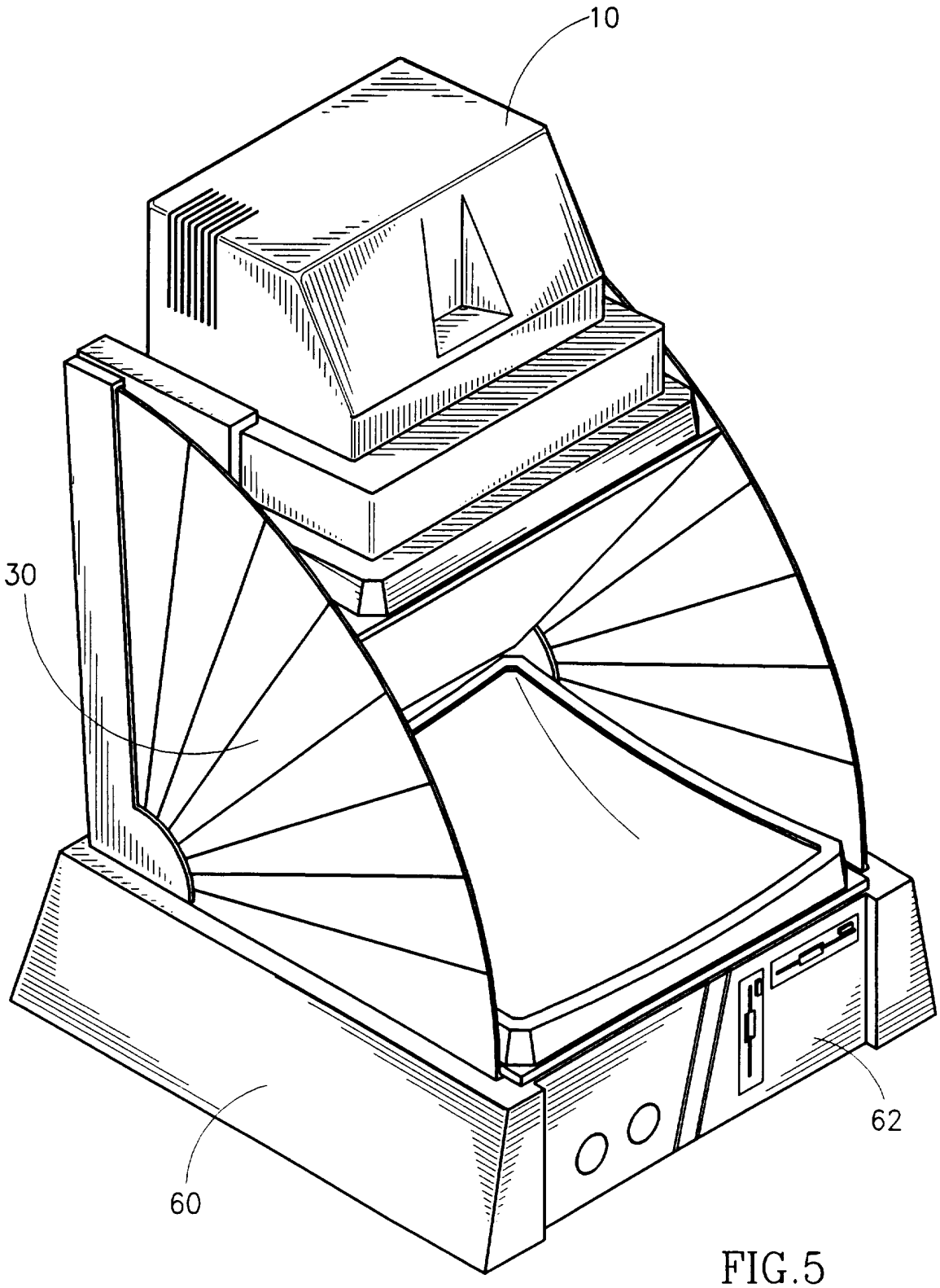

FIG.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/11188

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G02B 5/08, 17/00, 27/14, 27/22.
US CL :359/364, 365, 366, 462, 464, 601, 608, 627, 629, 630.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 359/364, 365, 366, 462, 464, 601, 608, 627, 629, 630.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DEPTH(4A)PERCEPTION, DISPLAY?, MIRROR, TRANSPAREN?, STRAY(3A)LIGHT, (COLLAPSIBLE OR FOLDABLE).

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR, A, 44403 (GERMAIX) 31 MARCH 1944, PAGES 1-3 AND FIG. 1.	1 AND 5.
Y	US, A, 4,840,455 (KEMPF) 20 JUNE 1989, COLUMN 3 (LINES 5-13) AND FIG. 2.	1-11.
Y	US, A, 3,447,854 (MINTER) 03 JUNE 1969, COLUMNS 2 (LINES 70 -72) AND FIGS. 1 AND 3.	1-11.

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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