MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)
COMMONWEALTH of AUSTRALIA
Patents Act 1952
APPLICATION FOR A STANDARD PATENT

I/We
Krone Aktiengesellschaft
of
Beeskowdamm 3–11, D–1000 Berlin 37, Federal Republic of Germany

hereby apply for the grant of a Standard Patent for an invention entitled:

Electro–optical flat–design display device, in particular LCD area

which is described in the accompanying complete specification.

Details of basic application(s):

<table>
<thead>
<tr>
<th>Number</th>
<th>Convention Country</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 38 42 900.4</td>
<td>Federal Republic of Germany</td>
<td>16 December 1988</td>
</tr>
</tbody>
</table>

The address for service is care of DAVIES & COLLISON, Patent Attorneys, of 1 Little Collins Street, Melbourne, in the State of Victoria, Commonwealth of Australia.

DATED this TWENTY FOURTH day of NOVEMBER 1989

To: THE COMMISSIONER OF PATENTS

\[Signature\]

\[Name\]

Davies & Collison, Melbourne
COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952
DECLARATION IN SUPPORT OF CONVENTION OR NON-CONVENTION APPLICATION FOR A PATENT

In support of the Application made for a patent for an invention entitled: "ELECTRO-OPTICAL FLAT-DESIGN DISPLAY DEVICE, IN PARTICULAR LCD AREA"

I, Keith Leslie
of No. 1 Little Collins Street
Melbourne 3000
Victoria
Australia.

do solemnly and sincerely declare as follows:-

1. (a) or (b) I am authorized by Krone Aktiengesellschaft
the applicant for the patent to make this declaration on its behalf.

2. (a) or (b) 1. Herbert SPERL
of Zieselweg 8A, 1000 Berlin 28
2. Frank MOEBNER
of Welterpfad 56, 1000 Berlin 48
3. Hartmut SIEFKER
of Egdsorfer Weg 12A, 1000 Berlin 49
All of Federal Republic of Germany

are the actual inventors of the invention and the facts upon which the applicant is entitled to make the application are as follows:--

The applicant would, if a patent were granted on an application made by the said actual inventors, be entitled to have the patent assigned to it.

3. The basic application as defined by Section 141 of the Act was made in Federal Republic of Germany in on the 16 December 1988 by Krone Aktiengesellschaft

4. The basic application referred to in paragraph 3 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

Declared at Melbourne this 24th day of November 1989.

DAVIDS & COLLISON, MELBOURNE and CANBERRA.
Claim

1. An electro-optical flat-design display device, in particular an LCD area, comprising a flat-design housing having at least one line of display elements forming the front of the housing and comprising a backlighting device disposed inside the housing and assigned to the line of display elements, characterised by that the backlighting device includes a light-guide tube (12, 17) disposed inside the housing (1) and a light source (18) disposed at a light entrance opening of the light-guide tube (12, 17), that the light-guide tube (12) is made from transparent material and surrounded by a reflector material (14), and that the reflector material (14) comprises cutouts (15) assigned to the individual display elements (10) and serving as light-exit openings.
COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952
COMPLETE SPECIFICATION

NAME & ADDRESS
OF APPLICANT:

Krone Aktiengesellschaft
Beeskowdamm 3-11
D-1000 Berlin 37
Federal Republic of Germany

NAME(S) OF INVENTOR(S):

Herbert SPERL
Frank MÖSSNER
Hartmuth SIEFKER

ADDRESS FOR SERVICE:

DAVIES & COLLISON
Patent Attorneys
1 Little Collins Street, Melbourne, 3000.

COMPLETE SPECIFICATION FOR THE INVENTION ENTITLED:

Electro-optical flat-design display device, in particular LCD area

The following statement is a full description of this invention, including the best method of performing it known to me/us:
The invention relates to an electro-optical flat-design display device, such as an LCD area according to the preamble of claim 1.

An electro-optical flat-design display device formed as LCD area of the mentioned species is known in the art from EP 0.146.285. Herein, five horizontal lines having several side-by-side display elements each are provided, each of said display elements being built-up by a 5x3 matrix. The five lines of LCD display elements form the front of the housing. In the housing, two light sources extending in longitudinal direction of the lines are installed as backlighting devices.

It is disadvantageous, herein, to have a considerable generation of heat by the light sources within the flat-design housing, such that for conducting the heat away, regularly blowers have to be mounted on the housing. It is disadvantageous, further, that the two light sources have to be replaced after a certain operating time. For this purpose, the individual lines of LCD display elements are arranged in hinged manner on the front side of the housing, in order that the light sources provided with a reflector on the rear side of the housing can be replaced from the front of the housing.

It is disadvantageous, further, that the LCD display elements are continuously exposed to u.v. and heat irradiation. This will lead to disintegration and de-
struction of the dye pigments inside the LCD display elements, such that these have to be replaced after a certain operating time. Further, there is a disadvantage in that electrical installation equipment has to be assigned to the light sources inside the housing or on its rear side, said equipment also generating heat and having a heavy weight. Finally, another disadvantage resides in that by the hinged arrangement of the LCD display element being necessary, dust is capable to enter through a plurality of housing openings, said dust depositing, on one hand, on the light sources and, on the other hand, on the inner sides of the LCD display element and causing, thus, a premature damping of light.

The invention is based, therefore, on the object to improve an electro-optical flat-design display, in which the provision of a backlighting device is significantly simplified. Embodiments of the present invention can provide a more compact flat-design display device, the display elements of which are affected neither by u.v. nor by heat irradiation nor by dust ingress, and which is particularly maintenance-friendly. The invention finds particular application where the display comprises an LCD area display.

According to embodiments of the invention, backlighting of display elements supported on a housing, in particular of LCD display elements, is effected by a light-guide tube disposed inside the housing, the light source of which is disposed at one end of the light-guide tube, in particular outside the housing. The light-guide tube is made from transparent material and is surrounded by a reflector, such that the total light irradiation generated by the light source is continuously reflected inside the light-guide tube and can emerge only through the cutouts of the reflector.
diately in the area of the individual display elements. Hereby, on one hand, complete usage is made of the light radiation of the light source. On the other hand, there is no u.v. or heat irradiation load of the display elements, in particular LCD display elements, further replacing the components disposed inside the housing in the area of the display elements is not necessary anymore, such that the individual display elements can be fixed to the front side of the housing. The housing can, thus, be encapsulated in dust-tight manner. Further, there is no need for electrical equipment inside the housing. Even a blower equipment is not required anymore.

In another embodiment of the invention, the light source is disposed at the end of the light-guide tube disposed outside the housing, and there are mounted heat and colour filters in front of the light source. This arrangement improves, on one hand, the maintenance friendliness of the flat-design display device, and reduces, on the other hand, the heat irradiation on the display elements in the housing.

Further, for an arrangement of several lines of LCD display elements having assigned each a light-guide tube, there can be disposed electronic components in the free spaces formed therebetween for controlling the LCD display elements.

Light-guide tubes are per se known in the art from DE 34 30 191. They serve, however, exclusively as lighting bodies for room lighting purposes, whereas, according to the invention, the usage of such light-guide tubes is claimed for electro-optical flat-design display devices, in particular for LCD areas.
In the following, the invention is described in more detail based on an embodiment shown in the drawing of an electro-optical flat-design display device, in particular an LCD area. There are shown in:

Fig. 1 a perspective representation of the LCD area, and in

Fig. 2 a perspective cross-section of the LCD display.

The LCD area consists of a flat-design housing 1 with rear wall 2, top wall 3, bottom wall 4, side walls 5 and with intermediate walls 6 extending between the side walls 5 in parallel to the top wall 3 and to the bottom wall 4 and forming individual chambers 7. The front side 8 of the housing is substantially formed by lines 9 of LCD display elements 10, which, in the embodiment shown, are formed as known-in-the-art 7-segment display elements. Instead of the 7-segment elements, 3x5 matrix elements or the like can also be employed. The construction of such LCD elements is described in more detail in EP 0.146.285. The LCD elements 10 are received by profiled sections 11 extending on the front side 8, said profiled sections 11 being fixed to the top wall 3 and to the bottom wall 4 as well as to the intermediate walls 6. The electronic components 23 assigned to the individual LCD elements 10 are mounted on the intermediate walls 6. On the inner side, diffuser disks 24 are assigned to the LCD elements 10. The total housing 1 is encapsulated in dust-tight manner.

Within the individual chambers 7 of the housing 1, light-guide tubes 12 are disposed, which, in the embodiment shown, are U-shaped, the open side of the U-shape being formed by a strip-type wall 13. The light-guide tubes 12 and the U-shaped walls 13 are sur-
rounded by reflector material 14 comprising in the area of the LCD elements 10 only cutouts 15 serving as light-exit openings and corresponding in their area dimensions accurately to those of the LCD elements 10 to be lighted and being assigned thereto. Within the light-guide tubes 12, in the curved rear section of the U-shape, concentrators 16 are supported, which direct the light permanently totally reflected in the light-guide tubes 12 on the opposed cutouts 15 of the reflector material 14.

Each light-guide tube 12 is connected to a light-guide tube 17 arranged outside the housing 1, said light-guide tube 17 comprising at its one end a light source 18 directing its total light radiation by means of a suitable reflector 25 into the light-guide tube 17. At the bendings of the light-guide tube 17 and at the entrance locations of the light-guide tubes 12, deflector mirrors 19, 20 are disposed, the deflector mirror 19 deflecting the total light radiation and the deflector mirrors 20 deflecting each part only of the radiation into the respective light-guide tubes 17 or 12, resp. Finally, a heat filter 21 formed as glass disk and a colour filter 22 are mounted in front of the light source 18, said colour filter being formed as electrically controllable, doubly refracting colour filter in liquid-crystal technology (ECB-LC filter).

The light radiation emerging from the light source 18 is, after passing through colour filter 22 and through heat filter 21, guided over the light-guide tube 17 and the deflector mirrors 19, 20 totally into the individual light-guide tubes 12. Here, continuous total reflection of the entering light radiation is effected at the walls of the light-guide tubes 12, included the flat walls 13 assigned to the latter. At the end opposite to the light source 18, additional mirrors are ar-
ranged in non-shown manner for substantially loss-free reflection of the light radiation. The light radiation being, thus, continuously reflected inside the light-guide tubes 12 can only exit through the light exit openings 15 assigned to the respective LCD elements 10. By means of the concentrators 16, the intensity of the light radiation emerging here is further increased.

As material for the light-guide tube 12 and for the wall 13 limiting the latter, a per se known reflector foil is employed. In particularly advantageous manner, a reflector foil is employed, which is described in more detail in DE 34 30 191 A1 following the example of a lighting body having prismatic light guiding for room illumination. Herein, a special shape of the outside contour of the light-guide foil serves for total reflection of the light radiation inside the light-guide tube 12, an exit of the radiation being only possible within the cutouts 15.

The reference numerals in the following claims do not in any way limit the scope of the respective claims.
LIST OF REFERENCES

1 housing
2 rear wall
3 top wall
4 bottom wall
5 side wall
6 intermediate wall
7 chamber
8 front side
9 line
10 LCD element
11 profiled strip
12 light-guide tube
13 wall
14 reflector material
15 cutout
16 concentrator
17 light-guide tube
18 light source
19,20 deflector mirrors
19 heat filter
22 colour filter
23 electronic components
24 diffuser disk
25 reflector
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An electro-optical flat-design display device, in particular an LCD area, comprising a flat-design housing having at least one line of display elements forming the front of the housing and comprising a backlighting device disposed inside the housing and assigned to the line of display elements, characterised by that the backlighting device includes a light-guide tube (12, 17) disposed inside the housing (1) and a light source (18) disposed at a light entrance opening of the light-guide tube (12, 17), that the light-guide tube (12) is made from transparent material and surrounded by a reflector material (14), and that the reflector material (14) comprises cutouts (15) assigned to the individual display elements (10) and serving as light-exit openings.

2. An electro-optical flat-design display device according to claim 1, characterised by that the light source (18) is disposed at the end of the light-guide tube (12, 17) disposed outside the housing (1).

3. An electro-optical flat-design display device according to claim 1 or 2, characterised by that a heat filter (21) and a colour (22) are assigned to the light source (18).
4. An electro-optical flat-design display device according to claim 3, characterised by that the heat filter (21) is composed of a glass disk.

5. An electro-optical flat-design display device according to claim 3, characterised by that the heat filter (22) is composed of an electrically controllable, doubly refracting colour filter in liquid crystal technology (ECB-LC filter).

6. An electro-optical flat-design display device according to claims 1 to 5, characterised by that the display elements (10) are formed as liquid crystal display elements.

7. An electro-optical flat-design display device according to claim 6, characterised by that several lines of LCD display elements (10) having assigned each a light-guide tube (12) are disposed inside the housing, and that the electronic components (B) assigned to the LCD display elements (10) are disposed between the light-guide tubes (12).
8. An electro-optical display device comprising a display panel provided with electro-optical display elements, said panel being supported by a housing, wherein said display elements are provided with backlighting means comprising light guide means extending at least partially inside said housing, and a light source disposed at a position remote from said display elements.

9. A display device according to claim 8 wherein said light guide means comprises optically transparent material, said backlighting means further comprising a layer of reflective material in said housing for directing light emitted from the light guide means within said housing towards the display elements.

10. A display device according to claim 9, wherein said layer of reflective material substantially surrounds said light guide means in said housing, the layer being provided with apertures corresponding to respective display elements such that light from the light guide means can exit the housing to the respective display elements.
11. An electro-optical flat-design display device substantially as hereinbefore described with reference to the drawings.

12. The steps, features, compositions and compounds disclosed herein or referred to or indicated in the specification and/or claims of this application, individually or collectively, and any and all combinations of any two or more of said steps or features.

DATED this TWENTY FOURTH day of NOVEMBER 1989

Krone Aktiengesellschaft

by DAVIES & COLLISON
Patent Attorneys for the applicant(s)
DRAWINGS