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SOLID STATE LIGHT AMPLIFYING DEVICE WITH SINTERED
PHOTOCONDUCTOR AND ELECTROLUMINESCENT INPUT PANEL
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Fig. 1

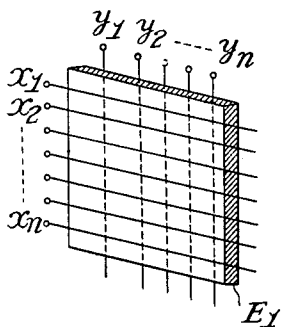


Fig. 2

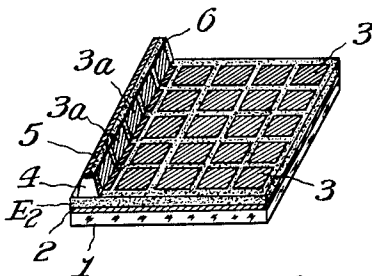
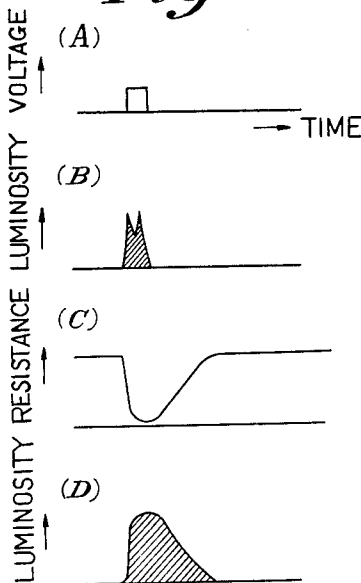
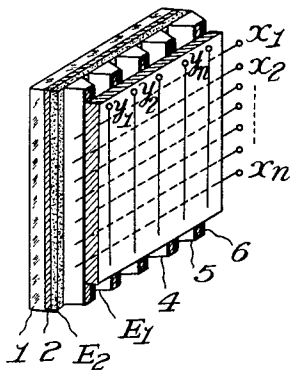


Fig. 4

Fig. 3



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SOLID STATE LIGHT AMPLIFYING DEVICE WITH
SINTERED PHOTOCONDUCTOR AND ELECTRO-
LUMINESCENT INPUT PANEL

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4 Claims. (Cl. 250—213)

This invention relates to a new and improved electro-
luminescent indicating apparatus whereby excellent pic-
tures can be obtained.

The nature, objects, and details of the invention will be-
come clearly apparent by reference to the following de-
tailed description when taken in connection with the ac-
companying drawing in which the same and equivalent
parts are designated by the same reference numerals or
letters, and in which:

FIGURE 1 is a diagrammatic, perspective view showing
the construction of an ordinary electroluminescent (here-
inafter referred to by the abbreviation "EL") indicating
apparatus of known kind;

FIGURE 2 is a perspective view showing a portion of
the construction of an output EL apparatus for observa-
tion to be used in the present invention;

FIGURE 3 is a diagrammatic perspective view showing
an example embodiment of the EL indicating apparatus
of the present invention; and

FIGURE 4 is a graphical representation for description
of the operation of the embodiment shown in FIG. 3.

EL indicating apparatuses of the type wherein mutual
intersecting electrodes are arranged on opposite surfaces
of an electroluminescent layer, and a scanning voltage is
impressed across the two electrodes to cause an intersect-
ing point at any position to luminesce and thereby indicate
position have been proposed. One example construction
thereof is shown in FIG. 1, wherein an EL layer E_1 has
on one surface thereof a group of electrodes $x_1, x_2, \dots$
 x_m and on the opposite surface thereof another group of
electrodes $y_1, y_2, \dots y_n$, the electrodes of the two said
groups extending in substantially perpendicular directions
to form intersections.

An indicating apparatus of the above-mentioned kind
has a disadvantage in that, since the EL layer E_1 used can
luminesce only during the impressing of voltage, and there
is almost no afterglow effect, the output optical image of
the intersections cannot be recognized sufficiently when
the voltage signal scanning is rapid.

While, in an endeavour to reduce this disadvantage, im-
provement of the characteristics of the EL substance itself
has been considered and studied, a satisfactory solution of
the problem has not yet been proposed.

It is an essential object of the present invention to pro-
vide a new and improved EL indicating apparatus capable
of producing excellent pictures.

Said object, other objects, and advantages of the in-
vention have been attained by combining, additionally, an
output EL indicating apparatus for observation with the
above-described EL indicating apparatus.

The output EL indicating apparatus for observation
necessary for the present invention is according to the
following description. This output EL indicating ap-
paratus for observation receives an instantaneous lumi-
nescence at any position of the input EL apparatus, causes
a delayed luminescence to be generated in the EL layer
at a position corresponding to the position of the afore-
said instantaneous luminescence, and accomplishes indi-
cation by means of the luminescing position of the said
delayed luminescence. The principal structure of this

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apparatus comprises a photoconductive layer, which has
delayed resistance drop characteristic due to illumination,
and an EL layer, and is the same as the so-called solid-
light amplifying plate. It differs from such a plate used
merely as a light amplifying plate in that, in the present
case, together with its light amplifying effect, the delayed
resistance drop characteristic of the photoconductive ma-
terial is utilized. Moreover, since the said apparatus is
to amplify EL, it is necessary that it be of high sensitivity.

One example of a practical embodiment of such an out-
put EL apparatus for observation to be used for the EL
indicating apparatus of the present invention is illustrated
in FIG. 2. As shown, the principal structure comprises
a transparent electrode 2 of flat plate form sandwiched
between a glass plate 1 and an EL layer E_2 . On the EL
layer, split electrodes 3 are attached in rows. Heat-re-
sistant, insulating posts 4 are attached adhesively along
each row of the said electrodes 3. A wire electrode 5 and
a photoconductive layer 6 are formed on the upper sur-
faces of the said posts 4 in the axial direction (direction
of the row). On the side faces of the said posts 4, auxil-
iary split electrodes 3a are formed so as to be aligned
with the aforesaid split electrodes 3 and, at the same time,
to clamp the photoconductive layer 6 between themselves
and the wire electrode 5.

The heat-resistant, insulating posts are made of such a
material as a ceramic bar. The cross section of these
posts may be of any shape, such as a rectangle or a semi-
circle, to suit the requirements. When the photocon-
ductive layer 6 is to be formed on a surface of these posts
4, this is accomplished by placing a suitable masking body
thereon and applying thereon a coating of a pulverized
photoconductive substance, such as CdS, in paste state,
then sintering the said coating by placing the posts with
coating in a furnace at a temperature of the order of 600
degrees C. Then the wire electrode 5 and the auxiliary
split electrodes 3a are made to adhere on both sides in
the axial direction by such an expedient as spraying with
silver paint, after which the bottom of the assembly is
made to adhere on the row of the split electrodes 3 by
means of such a substance as Araldis resin. Several of
these heat-resistant, insulating posts assembled, in the
above-described manner, with a sintered photoconductive
layer, wire electrode, and auxiliary split electrodes are
made and attached on all rows of split electrodes 3. Final-
ly, electrical contact between the auxiliary split electrodes
3a of the heat-resistant, insulating post surface and their
respectively corresponding split electrodes 3 is estab-
lished by such means as silver paint.

When, with the apparatus thus constructed, an electric
power source is connected between the wire electrode 5
on the heat-resistant, insulating posts 4 and the flat-plate
electrode 2, a voltage is impressed on the EL layer E_2 by
way of the sintered photoconductive layer 6, auxiliary split
electrodes 3a, and the split electrodes 3, and each portion
luminesces in accordance with the magnitude of resistance
(varying with illumination) of the photoconductive
layer 6.

The conventional photoconductive layers known hereto-
fore have been made, in general, by scattering particles of
such substances as CdS in a synthetic resin and forming
the layer in triangular shape by such a method as cutting.
In the case of the EL apparatus of the present invention
as described above, however, the photoconductive layer
6 is formed by sintering; moreover, the luminescing cur-
rent passing through the said layer flows substantially
parallel to the illumination, so that the sensitivity is ex-
tremely high; and the delayed resistance drop character-
istic is also excellent.

When this output EL apparatus is combined, as shown
in FIG. 3, with the input EL apparatus illustrated in FIG.
1, an instantaneous luminescing of the EL layer E_1

between the intersection of voltage-impressed electrodes illuminates one portion of the sintered photoconductive layer 6 of the output EL apparatus, whereby a delayed resistance drop effect is developed at the said portion and causes delayed luminescence in the EL layer E₂. This effect may be illustrated graphically as in FIG. 4, wherein: graph A represents pulse voltage impressed on an intersection point; graph B represents the condition of luminescence of the layer E₁ due to the said pulse voltage; graph C represents the condition of delayed resistance drop of the photoconductive layer 6 due to the said luminescence illumination; and graph D represents the luminescing condition of the EL layer E₂ based on the said resistance drop. Accordingly, the net effect is that the impressing of a pulse voltage as in graph A causes luminescence as in graph D to be observed.

By using the EL indicating apparatus of the present invention as described above, particularly in such applications as radar equipment, it is possible to obtain clear images without flickering, since it is possible to provide the apparatus with suitable afterglow or phosphorescent characteristic. Accordingly, the apparatus of the present invention has high practical worth.

While the foregoing description has related to an embodiment of the EL indicating apparatus of rectangular shape, it will be understood, of course, that other shapes may be used.

Since it is thus obvious that many changes and modifications can be made in the above-described details without departing from the nature and spirit of the invention, it is to be understood that the invention is not to be limited to the details described herein except as set forth in the appended claims.

What is claimed is:

1. An electroluminescent indicating device which comprises in combination: an electroluminescent unit having on one surface of a layer of electroluminescent material a plurality of first parallel electrodes and on the other surface of the layer a plurality of second parallel electrodes disposed orthogonally with the said first parallel electrodes; a solid-state light amplifying apparatus consisting of heat resistant insulating posts each having on its top surface a photoconductive layer sintered in situ thereon, a first electrode on said posts and a second electrode on a side surface of said posts, said photoconductive layer being positioned between and contacting said first and second electrodes, an electroluminescent layer having a third electrode on one surface, said insulating post being adhesively bonded on said one surface of the electroluminescent layer with the second and third electrodes in electrical contact, a transparent electrode positioned on the opposite side of said electroluminescent layer and a first voltage source connected across said first electrode and said transparent electrode, a second voltage source connectable with the first and second parallel electrodes, said first voltage being applied through said photoconductive layer and said second electrode to said electro-

luminescent layer, said electroluminescent unit resting on the posts.

2. An electroluminescent indicating device as claimed in claim 1, wherein said insulating posts are made of ceramic material.

3. An electroluminescent indicating device which comprises in combination: an electroluminescent unit having on one surface of a layer of electroluminescent material a plurality of first parallel electrodes and on the other surface of the layer a plurality of second parallel electrodes disposed orthogonally with the said first parallel electrodes; and a solid-state light amplifying apparatus consisting of a plurality of heat-resistant, insulating posts each of which has formed thereon in situ a sintered photoconductive layer extending lengthwise along a top surface thereof, a line electrode contacting said layer along the said top surface and a plurality of discrete electrodes on the lateral side surfaces of each post contacting a side of said photoconductive layer, an electroluminescent layer having a plurality of discrete electrodes on one surface thereof, said plural heat-resistant insulating posts being mounted on said surface with the discrete electrodes of the post and conductive layer respectively in contact, said electroluminescent unit resting in the posts, a transparent electrode positioned on the opposite surface of said electroluminescent layer, a first voltage source connected across the said line electrodes and said transparent electrode, a second voltage source connectable with the first and second parallel electrodes, said sintered photoconductive layer being thereby electrically connected to said line electrode and said discrete electrodes whereby the voltage is applied to the luminescent layer.

4. An electroluminescent indicating device as claimed in claim 3, wherein said insulating posts are made of ceramic material.

References Cited by the Examiner

UNITED STATES PATENTS

2,839,690	6/58	Kazan	250—213
2,905,830	9/59	Kazan	250—213
2,932,746	4/60	Jay	250—213
2,999,165	9/61	Lieb	250—213
3,059,118	10/62	Koury	250—213
3,059,144	10/62	Bowerman	250—213
3,070,701	12/62	Wasserman	250—213

FOREIGN PATENTS

851,077 10/60 Great Britain.

OTHER REFERENCES

Nicoll: "Light Amplifier Using Sintered Photoconductors," RCA Technical Notes No. 375, June 10, 1960.

55 RALPH G. NILSON, *Primary Examiner*.

JOHN W. HUCKERT, *Examiner*.