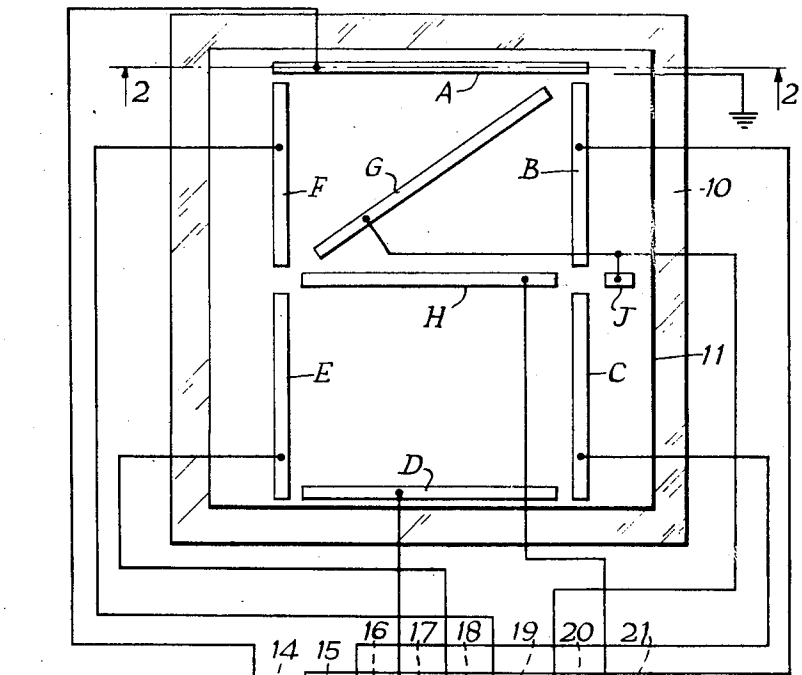
Dec. 11, 1962 D. H. MASH 3,068,440

SWITCHING DEVICES

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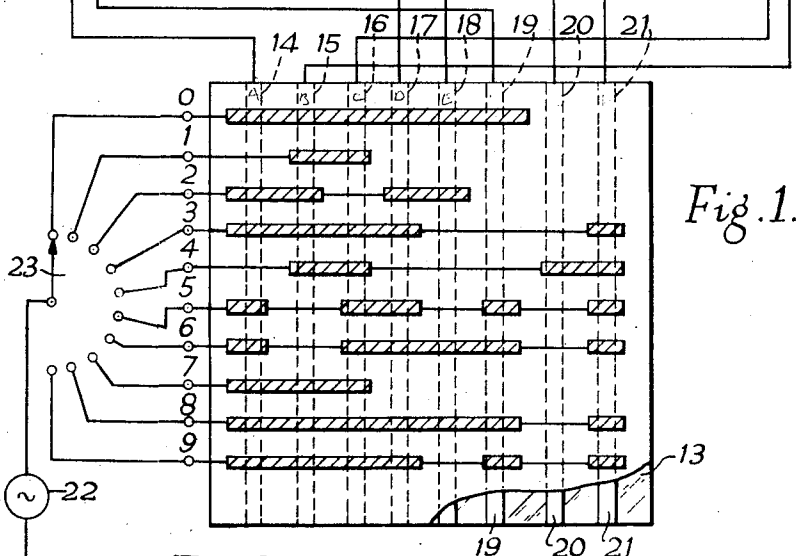
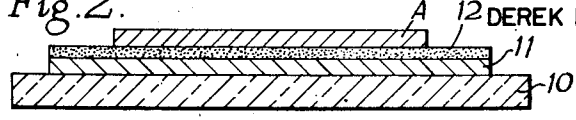




Fig. 1.

Fig. 2.




DEREK HUBERT MASH

INVENTOR

BY Lawrence Brun

ATTORNEY

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Fig. 3.

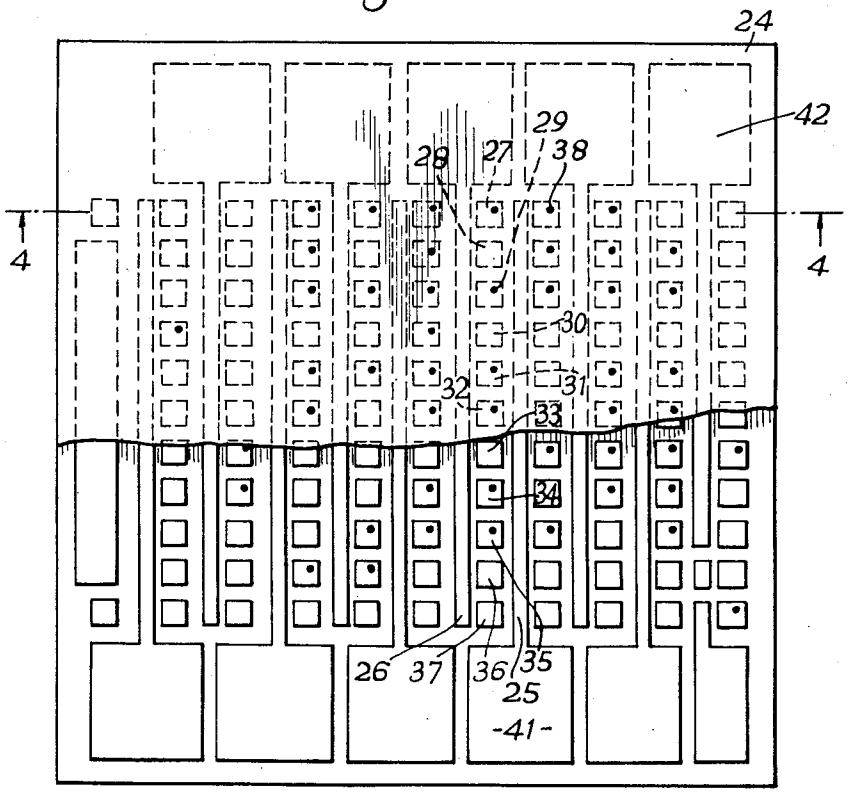
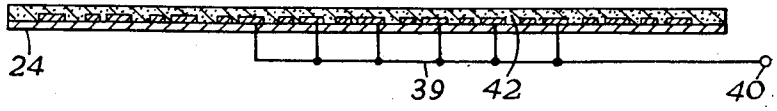



Fig. 4.




DEREK HUBERT MASH
INVENTOR

BY Lawrence Bu

ATTORNEY

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3,068,440

# SWITCHING DEVICES

Derek Hubert Mash, 105–109 Judd St., London W.C.1, England

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1 Claim. (Cl. 338—308)

The present application is a continuation-in-part of my co-pending application Serial No. 835,932, filed August 25, 1959, now Patent No. 2,966,616, and is concerned with switching devices suitable for enabling different combinations of lamps to be selected for illumination.

In providing an indicator for displaying characters such as numbers it has been proposed to use an electro-luminescent device comprising a transparent, conductive front electrode, a layer of electroluminescent material and a back electrode in the form of say the ten digits 0 and 1 to 9 superimposed on one another but electrically insulated from one another. Any desired one of the digits can be illuminated by selecting the appropriate back electrode and applying operating voltage between selected back electrode and the front electrode.

Thus a simple ten-position selector switch is adequate for operating the indicator.

Two disadvantages of such an arrangement are, however, that the number of crossovers in the back electrode is inconveniently large for a satisfactory display, and manufacture is made difficult by the large number of crossovers to be provided.

It has further been proposed to overcome these disadvantages by providing an electroluminescent device in which the back electrode is in the form of a number of strips separated from one another.

The strips are arranged in such a manner that by selecting different combinations of strips and applying operating voltage between the selected strips and the front electrode, different characters can be displayed.

This arrangement has the disadvantage that the selector switch has to be relatively complex if conventional switching apparatus is used.

It is an object of the present invention to provide an improved switching device suitable for operating the last said proposed electroluminescent device.

According to the present invention a switching device comprises an insulating support, a plurality of spaced electrically-conducting strips carried by said support, a plurality of of sets of electrically-conducting input electrodes each set having portions thereof co-operatively adjacent corresponding portions of a combination of the strips individual to that set and a layer of dielectric or resistance material in contact with the strips and sets of electrodes at least at the said adjacent portions thereof, whereby the electrical impedance with respect to a predetermined operating signal between any selected set of input electrodes and the strips of the combination individual to that set of electrodes is substantially smaller than the impedance between the selected set of electrodes and the strips not in the combination individual to that set.

The invention will now be described by way of example with reference to the accompanying drawings, in which

FIG. 1 is a schematic diagram of a unit including a plurality of electroluminescent lamps connected to a switching device,

FIG. 2 is a cross-section taken along the line 2—2 of FIG. 1,



FIG. 3 is a schematic drawing of a further switching device, and

FIG. 4 is a cross-section taken along the line 4—4 of FIG. 3.

In FIGS. 1 and 2 an assembly of nine electroluminescent lamps includes a base plate **10** of glass one surface of which is substantially completely covered with an electrically-conducting layer, this layer being transparent and conveniently in the form of stannic chloride deposited on the glass plate **10** from the vapour state.

Superimposed over the layer **11** is a layer **12** of electroluminescent material and nine conducting strips A, B, C, D, E, F, G, H and J respectively are arranged over the electroluminescent layer and in contact therewith.

By illuminating different combinations of the nine electroluminescent lamps so formed different ones of the digits 0, and 1 to 9 can be displayed. The following table shows the selections of lamps to be made in displaying the different digits:

*Table I*

| | |
|---|---|
| 0— | A B C D E F |
| 1— | B C |
| 2— | A B H E D |
| 3— | A B H C D |
| 4— | B G H J C |
| 5— | A F H C D |
| 6— | A F E D C H |
| 7— | A B C |
| 8— | A B C D E F H |
| 9— | A B H F C D |

A switching device suitable for use in selecting these different combinations of lamps comprises a rectangular glass plate **13** with eight strips **14** to **21**, of conducting material lying on and affixed to the glass plate **13** parallel to one another.

Over these conducting strips is formed a layer (not shown) of resistance material having a superlinear characteristic, that is the characteristic of a rapid fall in resistance with increase of voltage across the material. A suitable material is silicon carbide used in the present embodiment.

Lying over and in contact with the silicon carbide layer are 10 sets of electrodes in the form of further conducting strips connected to terminals **0** and **1** to **9** respectively. The conductors shown inter-connecting the electrodes of each set are arranged to be out of direct contact with the silicon carbide lying beneath them.

Different sets of the electrodes cross different combinations of the conducting strips **14** to **21** in accordance with the following table:

*Table II*

| Set No.: | Conducting strips crossed |
|---|---|
| **0** | **14, 15, 16, 17, 18, 19.** |
| **1** | **15, 16.** |
| **2** | **14, 15, 17, 18, 21.** |
| **3** | **14, 15, 16, 17, 21.** |
| **4** | **15, 16, 20, 21.** |
| **5** | **14, 16, 17, 19, 21.** |
| **6** | **14, 16, 17, 18, 19, 21.** |
| **7** | **14, 15, 16.** |
| **8** | **14, 15, 16, 17, 18, 19, 21.** |
| **9** | **14, 15, 16, 17, 19, 21.** |

The portions of the sets of electrodes and of the conducting strips at the crossings are closely adjacent one another.

The electroluminescent lamps are connected to the terminals 14 to 21 as follows:

*Table III*

A—14
B—15
C—16
D—17
E—18
F—19
G and J—20
H—21

A source 22 of alternating current at a suitable voltage and frequency for operating the electroluminescent lamps A to J has one terminal earthed and the other connected to the wiper of a 10-position selector switch 23. The conducting layer 11 of the electroluminescent lamp assembly is also earthed.

In operation the selector switch 23 is adjusted to select the set of electrodes corresponding to the digit to be displayed. For example if the digit 5 is to be displayed the selector switch 23 is set to apply A.C. from the source 22 to the terminal 5. From the drawing and Table II it will be seen that set No. 5 of electrodes crosses the conducting strips 14, 16, 17, 19 and 21.

From Table III and the drawing it will be seen that these conducting strips are connected to the lamps A, C, D, F and H respectively which will be seen from Table I to be the lamps for displaying the digit 5.

Although all the conducting strips 14 to 21 are interconnected by the layer of silicon carbide the resistances of the paths between the electrodes of a selected set and the conducting strips crossed by them is always considerably smaller than the resistances of the paths between the selected electrodes and the other conducting strips. It can readily be arranged that the voltage drops in the paths to the unselected lamps is such that the unselected lamps do not luminesce.

Although a switching device utilising a layer of resistance material has been described it will be understood that as the frequency required for exciting some electroluminescent materials is high—say 20 mc./s.—dielectric material can sometimes be used in place of the resistance material.

It is preferred however to use a layer of material such as silicon carbide having a superlinear characteristic relating voltage and resistance since design is facilitated. This is so because the resistance between the electrodes of the selected set and the conducting strips crossed by them is reduced on application of a potential to the selected strip to a greater extent than is the resistance of the longer paths to the other strips.

It will also be understood that although the embodiment shown in FIG. 1 is used in connection with a digital indicator it may be used with an assembly of lamps for selectively displaying other characters and symbols.

Referring now to FIGS. 3 and 4 these show a further embodiment of a switching device according to the invention.

In this embodiment an insulating plate 24 is provided with a plurality of spaced copper strips such as 25 and 26 the strips being parallel to one another. In the gap between each adjacent pair of the copper strips there is provided a plurality of separate input electrodes such as the eleven electrodes 27 to 37 lying between the adjacent pair of strips 25 and 26. The strips and the input electrodes may be provided in any convenient way such as



by bonding a copper foil to the insulating plate 24 and etching away unwanted copper.

Regarding the strips such as 25 and 26 as vertical it will be seen that the input electrodes are arranged in horizontal rows.

Some of the input electrodes in each row are provided with a dot such as the dot 38. Each dot represents an aperture formed through the electrode and the insulating plate beneath it, and all such electrodes in a horizontal row are connected together by a wire such as the wire 39 of FIG. 4 shown connected to an input terminal 40.

The combinations of electrodes connected to one another are different in the different rows and form different sets the electrodes in each set being individual to the set.

Each of the strips is provided with an enlarged terminal area such as the terminal area 41 of the strip 25 these enlarged terminal areas facilitating connections to the strips.

Over the strips and the input electrodes and in the gaps between them there is provided a layer 42 of silicon carbide.

It will be seen in FIG. 3 that the input electrodes between each adjacent pair of strips is nearer the left-hand strip (in the drawing) than the right-hand strip.

In use the enlarged terminal areas of the strips are connected to the lamps of a display panel which may be of a construction following the lines of that shown in FIG. 1. The terminals of a selector switch are connected to the different sets respectively of interconnected input electrodes and operating voltage is applied to any set selected by means of the selector switch.

The path of lowest resistance from each input electrode to a strip is the path between the electrode and the nearest strip on its left. All other paths to other strips are of higher resistance and hence as in the arrangement of FIGS. 1 and 2 illumination of electroluminescent lamp on the display panel can readily be limited to the lamps connected to the strips which have selected and energised input electrodes immediately on their righthand side in the drawing.

An advantage of the second embodiment is that the thickness of the layer of silicon carbide is not critical provided it exceeds a predetermined minimum value.

I claim:

A switching device, comprising an insulating support carrying a plurality of spaced, electrically-conducting strips, a row of separate electrically-conducting input electrodes spaced along the gap between each adjacent pair of strips, the input electrodes being nearer one of the strips of the pair than the other, a layer of resistance material covering both the strips and the input electrodes, and filling the gaps between them and means connecting different combinations of the input electrodes from different rows to one another to form sets, the electrodes of each set being individual thereto.

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