

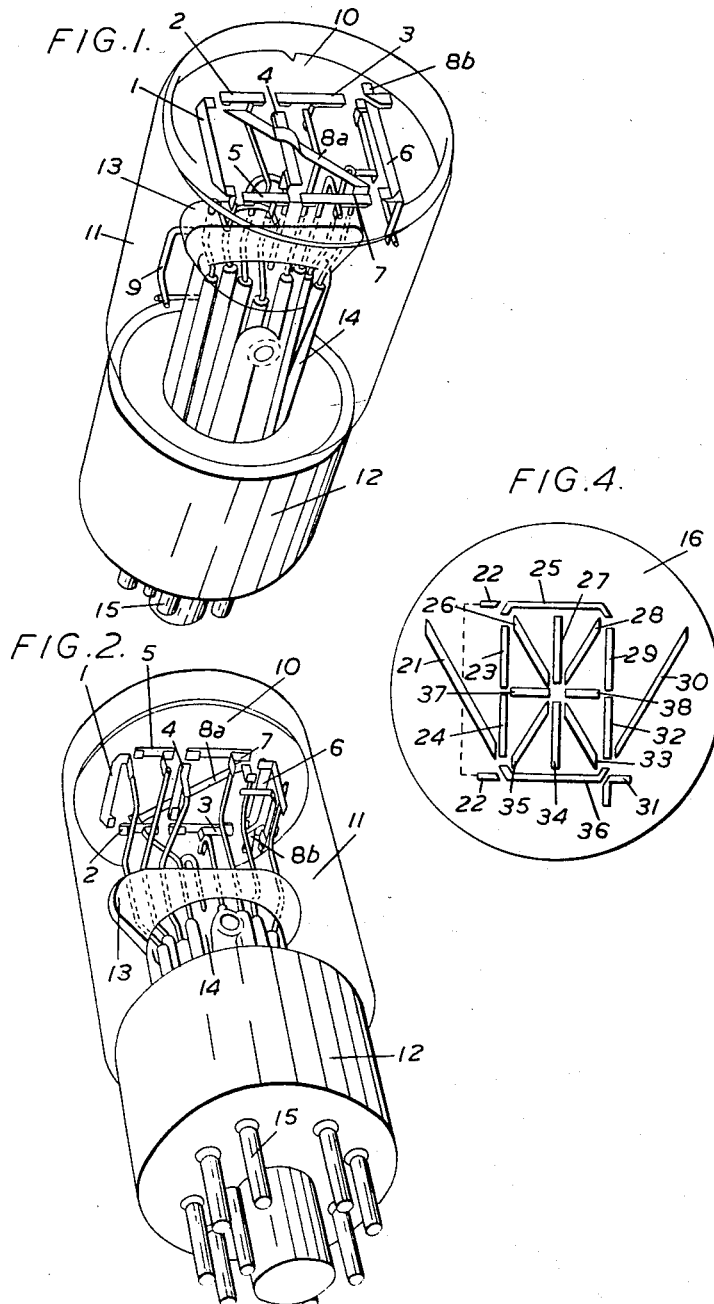
Feb. 26, 1957

D. J. WILLIAMS ET AL  
ELECTRIC DISCHARGE TUBES

2,783,408

Filed April 1, 1953

3 Sheets-Sheet 1



Inventors:  
DAVID JOHN WILLIAMS AND  
RAYMOND CLIFFORD BACON

By  
*W. C. Bacon*

Feb. 26, 1957

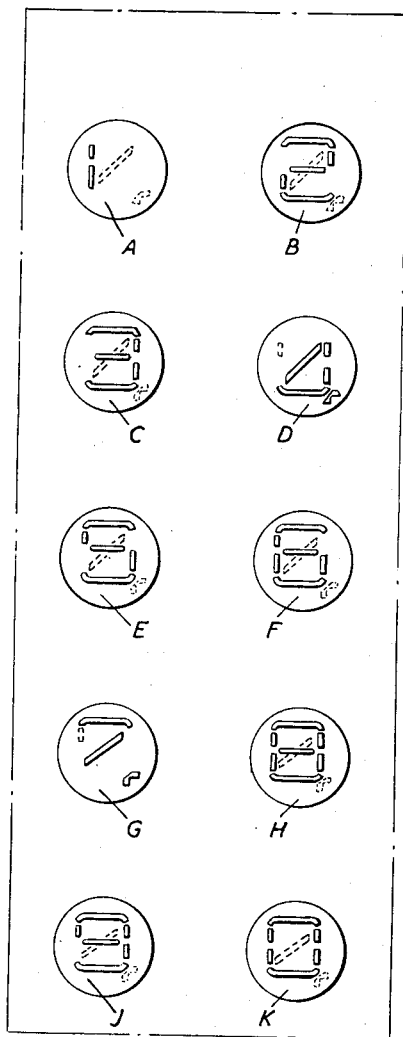
D. J. WILLIAMS ET AL  
ELECTRIC DISCHARGE TUBES

2,783,408

Filed April 1, 1953

3 Sheets-Sheet 2

FIG. 3.



Inventors:  
DAVID JOHN WILLIAMS AND  
RAYMOND CLIFFORD BARON

By  
*Michael S. [Signature]*

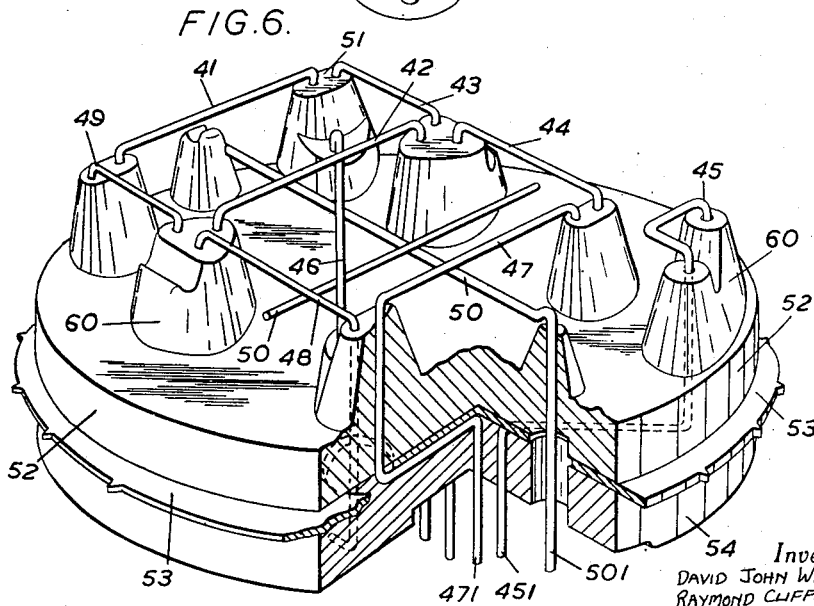
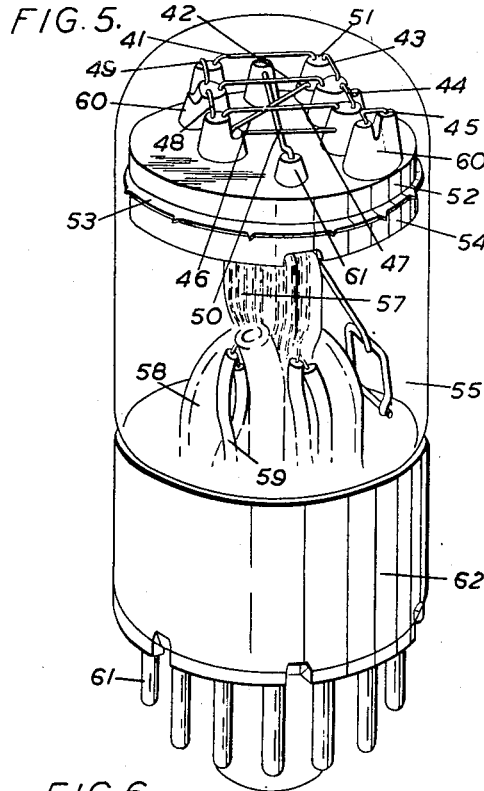
Feb. 26, 1957

D. J. WILLIAMS ET AL  
ELECTRIC DISCHARGE TUBES

2,783,408

Filed April 1, 1953

3 Sheets-Sheet 3



Inventor  
DAVID JOHN WILLIAMS AND  
RAYMOND CLIFFORD BACON

By *Udall*  
94

1  
2,783,408

## ELECTRIC DISCHARGE TUBES

David John Williams, Nottingham, Raymond Clifford Bacon, Wollaton, Nottingham, and John Reginald Acton, Bunny, England, assignors to Ericsson Telephones Limited

Application April 1, 1953, Serial No. 346,078

3 Claims. (Cl. 313—109.5)

Our invention relates to electric discharge tubes and particularly to gaseous discharge tubes used for the purpose of displaying an illuminated character or symbol.

In known forms of discharge tube used for display purposes the electrode invested by the discharge glow is so shaped that the said glow exhibits the characteristics of a particular alphabetical letter, numerical digit, or other symbol. A plurality of such tubes may be arranged in a certain order to display an illuminated message or other signal, and by means of changing the relative position of some or all of the constituent letters and/or digits a variety of such messages may be displayed. The message displayed by any one arrangement of such tubes, however, cannot be changed rapidly to a dissimilar message because of the necessity to rearrange the positions of the constituent tubes each with its individual letter or digit.

It is an object of our invention to provide means whereby each of a plurality of symbols particular to an electric discharge tube is illuminated individually thereby.

According to our invention we provide a gaseous electric discharge tube containing a plurality of electrodes adapted to display any one of a plurality of different illuminated symbols, the shape and/or disposition of the electrodes being such as to cause a discharge glow investing one or more of them to exhibit the form of the desired symbol.

Fig. 1 is a perspective view, from above, of an embodiment of the discharge tube constructed according to the present invention;

Fig. 2 is a perspective view, from below, of the tube of Fig. 1;

Fig. 3 is a diagrammatic view of the different digits available with the tube shown in Figs. 1 and 2;

Fig. 4 is a partial plan view of a modification of the tube shown in Figs. 1 and 2;

Fig. 5 is a perspective view of a second embodiment of the discharge tube according to the present invention; and

Fig. 6 is a perspective view of a portion of the tube shown in Fig. 5, partially in section.

In the discharge tube embodying our invention depicted in Figures 1 and 2 we include within an airtight glass bulb 11, filled with a gaseous mixture of substantially 99.5% neon and 0.5% argon to a pressure equal to some 40 millimetres of mercury, an electrode assembly formed from a plurality of electrodes 1, 2, 3, 4, 5, 6, 7, 8a and 8b each of flat nickel wire 1.07 millimetres wide and attached to a mica disc 10. Each such electrode is fastened to mica disc 10 by clenching both ends thereof which are arranged to pass through holes to the rear of the said disc 10. Electrodes 8a and 8b are connected together within the bulb and provided with a common lead-out wire, each other electrode 1 to 7 inclusive is provided with an individual lead-out wire. All the said lead-out wires pass by way of the flat pinch 13 to the tubular foot 14 of the bulb, through individual insulating

2  
tubes therein to individual connecting pins 15 which project through the bottom of a base 12 of known type. Fused to the flat pinch 13 of foot 14 is a nickel-wire frame 9 to carry the getter. The portion of each electrode at the rear of disc 10, and that portion of each lead-out wire between the electrode and pinch 13 is covered with alumina which is applied when suspended in a suitable painting medium.

When viewed from the front of the discharge tube the position of each electrode 1, 2, 3, 4, 5, 6, 7, 8a and 8b in the electrode assembly is such that when certain of the said electrodes are connected to the negative pole, and one or more of the other electrodes are connected by way of 47,000 ohm resistor to the positive pole of a direct current 200 volts supply a discharge glow will invest the electrodes connected to the negative pole of the supply. The shape of each electrode 1, 2, 3, 4, 5, 6, 7, 8a and 8b is such as to resemble a constituent part of one or more numerical digits, and their disposition is such that the configuration of the discharge glow emanating from the negatively connected electrodes is caused to resemble the particular digit which it is desired to display.

The discharge tube described and illustrated with reference to Figures 1 and 2 is designed to display each of the digits 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0 separately, and the particular combination of illuminated negatively connected cathodes and non-illuminated positively connected anodes for each of the said digits is indicated by symbols A, B, C, D, E, F, G, H, J, and K respectively in Figure 3. In the said symbols A to K inclusive the outline of the illuminated electrodes is shown in full, and that of the non-illuminated electrodes in broken line. Electrodes 8a and 8b form the anode electrodes when a digit 1, 2, 3, 5, 6, 8, 9, or 0 is displayed, and electrode 5 forms the anode when a digit 4 or 7 is displayed. The reference numbers of the individual electrodes in symbols A to K inclusive of Figure 3 have not been included but will be readily understood by reference to Figure 1.

Figure 4 indicates the electrode assembly of a similar type of discharge tube as described with reference to Figures 1 and 2, and as seen from the front of the tube. The electrode assembly shown in Figure 4 is designed to display individually any of a plurality of symbols each indicative of a particular numerical figure or alphabetical character. The design of the discharge tube of which Figure 4 forms a part closely resembles the discharge tube described with reference to Figures 1 and 2, in which a plurality of electrodes of nickel wire or tape are fastened by clenching or other suitable means to the face of an insulating disc of mica or other suitable material, and electrode connections are extended from the rear of the disc on which they are mounted, by way of lead-out wires passing through the pinch and foot of the tube, to connecting pins in the base of the tube, and thence in known manner to external circuiting means. Such an electrode assembly as shown in Figure 4 may be mounted for convenience on a mica disc 16 some 28.5 millimetres in diameter, and enclosed within a glass bulb 65.0 millimetres in length filled with the described gaseous mixture of neon and argon to a pressure equivalent to 40.0 millimetres of mercury.

A discharge tube constructed in the manner described will display by illumination a selected symbol, in the form of an alphabetical character or a numerical figure, when a potential of the order of 200 volts, derived from a suitable direct current source, is applied to a combination of electrodes particular to the selected symbol. A plurality of such different combinations of electrodes each particular to one of the 26 letters of the English alphabet, and/or to one of the ten numerical digits in the range 1 to 9 and 0 inclusive, for use with a discharge tube hav-

ing an electrode assembly as depicted in Figure 4 is given below in tabulated form. In the following table each electrode to be connected to the positive pole of the supply by way of a 47,000 ohm resistor is marked A, each electrode to be connected to the negative pole of the supply is marked C, and each disconnected electrode is marked thus: —.

are formed are suitably spaced from each other and project from flat pinch 57 in a substantially straight row. A small glass tube threaded on the stem wire 501 of electrode 50 is fused to the pinch 57 of the bulb 55, at a point where the said stem 501 emerges from the pinch 57. The surface of each stem wire and electrode 41 to 50 from the discharge surface of the electrode to the pinch

Symbol displayed	Reference number of electrodes shown in Figure 4																	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—
5	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—
8	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—
0	—	—	—	—	—	—	A	—	—	—	—	—	—	—	—	—	—	—
A	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
B	—	C	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
C	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
D	—	C	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
E	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
F	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
G	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
H	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
I	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
J	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
K	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
L	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
M	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
N	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
O	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
P	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
Q	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
R	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
S	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
T	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
U	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
V	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
W	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
X	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
Y	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—
Z	—	—	C	C	—	—	A	—	—	—	—	—	—	—	—	—	—	—

Thus in each of the discharge tubes described with reference to Figures 1, 2, 3, and 4 the shape, disposition, and plurality of the electrodes therein are each arranged to be such that any symbol of a plurality of different keys is displayed individually by a single tube when a suitable negative potential is extended to a selected plurality of electrodes and a suitable positive potential is extended to one or more of the remaining electrodes in the tube. The said positive and negative potentials may be extended to each of the selected plurality of electrodes by known circuiting means, for example, by way of a multi-position rotary switch, manually operated keys, or combinations of relays and/or selector switches of the type employed in telephone exchange equipment.

A preferred form of discharge tube which embodies our invention is shown on Figure 5 of the accompanying drawing, and details of the electrode assembly of such a form of tube are shown on Figure 6. In this type of tube each electrode 41 to 49 inclusive is formed from round nickel wire, and forms an integral part of a stem wire which is sealed within flat pinch 57 of foot 58 of a containing bulb 55. Such a stem wire may be formed from so-called composite-joined wire, and have a nickel wire part within bulb 55, and a borated-copper part which passes through pinch 57 to the interior of foot 58. The part of each stem wire within foot 58 is enclosed by a suitable insulating sleeve 59, and is attached at its lower end to one of a plurality of connecting pins 61 in base 60. Each electrode 41 to 49 forms a cathode electrode whilst electrode 50 forms an anode electrode which is common to all of the said cathodes. Anode electrode 50 which is fastened in foot 58 in a similar way to cathode electrodes 41 and 49, is formed from heavier gauge composite wire than the said cathode electrodes 41 to 49, and has an arm of nickel wire fastened to the main member to form a nickel electrode of cruciform shape.

The stem wires from which the electrodes 41 to 50

57 of foot 58 is insulated by means of a flat plate 54, a mica disc 53, and a studded plate 52. Plates 52 and 54 are formed from a suitable ceramic material, and are suitably perforated and grooved to accommodate the said electrodes 40 to 50 and their stem wires, as shown, for example, by items 471, 451 and 501. The lower surface of plate 54 is provided with a relatively wide channel which is of such a size that it fits upon the upper surface of pinch 57, and the glass tube which surrounds stem wire 501 engages a hole of suitable size in the said plate 54. The engagement of the said glass tube with plate 54 serves to maintain it in its proper position on pinch 57, in this position each stem wire lies opposite an associated hole which passes from side to side through the said plate 54.

When plate 54 is placed in position upon pinch 57 the stem wire of the electrodes 41 to 49 are arranged to project through a straight row of holes in the plate 54, and they are then turned at right angles into such positions that they lay in a plurality of grooves in the face of plate 54 which adjoins mica disc 53. At suitable points in the said grooves the said stem wires are turned upwards at right angles and each passes through an associated hole in mica disc 53 and in the topmost plate 52. The position of the plurality of holes in plate 52 is such that each passes through one of a plurality of studs 60 which project from the upper face of plate 52, and form an integral part thereof. At the point where the electrodes 41 to 49 emerge from plate 52 they are turned at right angles and then pass over the face of plate 52 where they are again turned at right angles to pass downwards through a second associated hole in both plates 52 and 54. The free end of each such electrode 41 to 49, emerges on the grooved under side of plate 54 where it is bent at right angles and fastened by clenching to plate 54. The location of the said holes, and grooves in plates 52 and 54 is such that the exposed surfaces of the wires which form the discharge surfaces of cathode electrodes

5

41 to 49 are caused to assume the shape of a constituent part of one or more numerical digits.

When constructed in the described manner the discharge surface of each of electrodes 41 to 49 lies in substantially the same plane. The stem wire of anode electrode 50 passes through the glass tube, which is fastened to pinch 57 and is located within a hole in plate 54, and thence through mica disc 53 and a hole in plate 52. At the point where anode electrode 50 emerges from plate 52 it is turned at right angles to lie in a plane substantially parallel to and below the plane in which electrodes 41 to 49 are located. The main member of electrode 50 lies parallel to electrodes 43, 44, 48 and 49. The disposition of the described electrode assembly is such that when a suitable negative potential is connected to a selected combination of electrodes 41 to 49, and a suitable positive potential is applied to electrode 50, the configuration of the discharge glow, which emanates from the negatively connected electrodes, resembles a particular selected numerical digit.

The dimensions and operating characteristics of a discharge tube constructed in the manner described with reference to Figures 5 and 6 are given below, such a tube has been manufactured and given satisfactory service. Glass bulb 55 is formed from a domed glass cylindrical tube some 150 millimetres long with an internal diameter of some 32.5 millimetres. Within the open end of such a tube is fused the glass foot 58, in the flat pinch 57 of which is arranged the plurality of electrode stem wires spaced a uniform distance apart. The round ceramic plate 54 which adjoins pinch 57 is substantially 30.0 millimetres in diameter, and some 5.5 millimetres thick. The straight row of holes which abuts on to pinch 57 passes through the centre of plate 54; each such hole is approximately 1.0 millimetre in diameter and is centered some 2.0 millimetres from each adjoining hole. Mica disc 53 is formed from mica sheet substantially 19.0 millimetres thick, and has a minimum diameter of 31.6 millimetres, and a maximum diameter of 33.0 millimetres, measured from the top of the projections on the periphery of the disc. The holes through which the stem wire electrodes 41 to 49 pass may conveniently be formed by a small plurality of cut-outs of suitable circular or ellipsoidal shape or a greater plurality of separate small holes for the passage of an individual electrode may be provided.

The topmost ceramic plate 52 is formed from unglazed ceramic material similar to plate 54 and has a similar diameter. The base of plate 52 is some 3.0 millimetres thick, and studs 60 are raised some 4.0 millimetres above it, whilst stud 61 through which anode electrode 50 passes is raised some 2.5 millimetres above the said base. When the cathode electrodes 41 to 49 are formed from nickel wire some 0.4 millimetre in diameter, and the anode electrode 50 from similar material some 0.8 millimetre thick, the diameter of the holes in plate 52 through which the said anode electrodes pass is of the order of 0.5 millimetre in diameter, the hole through which the anode electrode 50 passes is approximately 1.0 millimetre in diameter.

When such a tube is exhausted in known manner, and filled with a gaseous mixture comprising some 99.5% neon, and some 0.5% argon a discharge glow indicative of a numerical figure is produced when the anode electrode 50 is connected to the negative pole, and at least one cathode electrode is connected by way of a 47,000 ohm resistor to the positive pole of a direct current 200 volts supply.

Although our invention has been described with reference to tubes displaying numerical digits and alphabetical characters we do not confine ourselves to such symbols and in other tubes embodying our invention symbols of other kinds may be employed, for example, conventional arrow symbols indicative of direction. In other forms of tube embodying our invention we may employ electrodes formed in other ways of different ma-

6

terial than the nickel wire and tape used in the described tubes, for example, electrodes of conducting material may be painted or deposited by other known means on a plate or disc of mica or other insulating material.

5 A plurality of discharge tubes embodying our invention may be arranged in rows and/or columns, and adapted to display a plurality of different messages or other signals in rapid succession by employing means whereby a condition is extended to illuminate a selected  
10 electrode indicative of a particular letter or digit in some or all of the plurality of discharge tubes. The order in which the selected electrodes are arranged in the said rows and/or columns is such as to provide an illuminated display indicative of a particular message. Such a mes-  
15 sage can be changed rapidly by switching the illuminating condition to another selected electrode in some or all of the discharge tubes forming a display.

What we claim is:

1. A gaseous electric glow discharge device comprising  
20 a tubular envelope having a light transmitting wall at one end and a pinch at its opposite end, an insulating mounting plate formed with electrode supporting apertures and disposed within the envelope substantially normal to the longitudinal axis thereof in the neighbourhood of its light  
25 transmitting end wall and shaped to conform to and substantially fill the internal cross-section of the envelope, a plurality of electrodes each with its ends bent over and positioned in appropriate apertures in said mounting plate, said electrodes having glow-producing portions all lying in  
30 a common plane adjacent to that face of the mounting plate which is towards said light transmitting end wall and having their ends clenched against the opposite face of the mounting plate, the glow-producing portions of said  
35 electrodes being shaped and disposed to adapt them by selective energisation to display alternatively a plurality of different illuminated symbols, and individual connections extending from ends of said electrodes directly away from the face of the supporting plate and through said  
40 pinch to the exterior of the envelope and serving to position the mounting plate in relating to such pinch.

2. A gaseous electric glow discharge device comprising a tubular envelope having a light transmitting wall at one end and having a pinch from which an electrode assembly can be supported, an insulating mounting plate formed  
45 with electrode supporting apertures and disposed across the interior of the envelope in the neighbourhood of its said end wall and shaped to conform to and substantially fill the internal cross section of the envelopes, a plurality of electrodes each having its ends bent over and extending  
50 through appropriate apertures in said mounting plate and clenched thereagainst, said electrodes having glow-producing portions adjacent to that face of the mounting plate which is towards said end wall and lying in a common plane substantially normal to the longitudinal  
55 axis of the envelope, and being shaped and disposed to form between them the component parts of a plurality of different symbols and individual connections extending from ends of said electrodes away from the plane of the mounting plate towards and through said pinch to the  
60 exterior of the envelope and serving as a sole means of supporting the mounting plate from the pinch.

3. A gaseous electric glow discharge device comprising a tubular envelope having an end wall pervious to light, a pinch for passage of connections at its opposite end, an  
65 insulating mounting plate perforated to form electrode supporting apertures and disposed across the interior of the envelope in the neighbourhood of its first said end and shaped to conform to the internal face of the envelope, a plurality of electrodes each having its end portions offset  
70 and reaching through appropriate ones of the apertures in said mounting plate and clenched against the further face thereof so as to hold intermediate portions of the electrodes exposed to the first said end of the envelope, said intermediate portions of the electrodes lying in a common  
75 plane substantially normal to the longitudinal axis of the

envelope and being shaped and disposed to form component parts of symbols and adapt them by selective energisation to display alternatively a plurality of different illuminated symbols and individual electrical connections extending through said pinch and connected each to an associated electrode and projecting through an aperture in the mounting plate.

5

## References Cited in the file of this patent

## UNITED STATES PATENTS

2,142,106	Boswau	Jan. 3, 1939
2,618,697	Metcalf	Nov. 18, 1952
2,618,760	Hancock	Nov. 18, 1952
2,735,038	Hancock	Feb. 14, 1956