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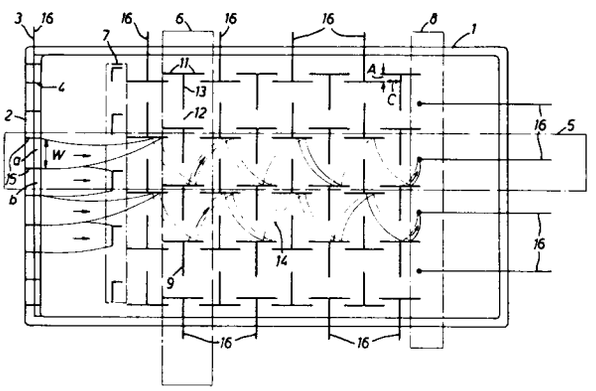
(54) A multichannel electron multiplier arrangement.

(57) An electron multiplier (Figure 1) has many channels (5), defined by plates 6, common to all the channels, which are spaced apart along the channels and extend across the channels. The plates have portions 11 bent out of them to define dynode surfaces, leaving apertures 12 for the passage of electrons through the plates. Each portion serves as a dynode for one channel only so dimensional errors in that portion affect only one channel. In each plate the same surface of the plate serves as a dynode surface for all the channels, so there is no variation in emissivity between the channels at that plate.



EP 0 001 483 A1

"A MULTICHANNEL ELECTRON MULTIPLIER ARRANGEMENT"

This invention relates to a multichannel electron multiplier arrangement.

British Patent No.1470162 discloses a multichannel electron multiplier in the form of a photomultiplier having a plurality of electron multiplying stages each comprising a plate slit to form parallel elements bent out of the plane of the plate. These elements are the dynodes of the stages. At each stage adjacent channels use opposite surfaces of a dynode as dynode surfaces. Dimensional errors in the plates cause small variations in gain and because opposite surfaces of a single dynode are used by adjacent channels, a positive error in one channel causes an equal negative error in the other channel. The plates may be made by a repetitive manufacturing process which introduces the same errors into all the plates. Thus there is a possibility of substantial differences in gain between adjacent channels. Furthermore, the electron emitting properties of different surfaces of a single plate can differ providing the possibility of differences in gain between adjacent channels.

It is an object of the present invention to provide a multichannel electron multiplier in which the effect of dimensional errors in, and the effect of differing electron emitting properties of different surfaces in, each multiplying stage are reduced.

According to one aspect of the invention, there is provided an electron multiplying arrangement comprising a plurality of channels for the electrons, each channel comprising a plurality of electron multiplier stages, wherein corresponding dynode surfaces of the

channels at each stage include respective portions of the same surface of a member disposed transversely of the channels, the member defining passages, for said electrons, through the member.

For better understanding of the present invention, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a schematic view, of a cross-section of a multi-channel photomultiplier tube embodying the invention, and

Figure 2 is a perspective view of a plate of an electron multiplier stage of the tube of Figure 1.

The tube of Figure 1 comprises an evacuated envelope 1 having a window 2 on the inside of which is a substantially transparent electrode 3 and a photocathode 4 which emits electrons in response to light. The tube has four substantially identical channels as exemplified by reference numeral 5 and eight stages of electron multiplication as exemplified by reference numeral 6. A focus electrode arrangement 7 is provided to focus electrons only from distinct "active" areas a of the photocathode into the respective channels and to stop electrons from inactive areas b from entering the channels, which electrons are directed on to the focus electrode itself. The electrode arrangement 7 is shown only schematically in Figure 1; an example of such an arrangement is disclosed in co-pending British patent application 33852/75 (Serial No.). An array 8 of electron collector rods is provided at the ends of the channels to collect the electrons produced by them.

The channels and the electron multiplier stages are defined by eight similar members such as 9 which are spaced apart along the channels and extend across the channels. Each member 9 is formed of two plates 10 each as shown in Figure 2. Referring to Figure 2, the plate 10 is of secondary electron emissive material such as beryllium-copper (Be-Cu) or silver-magnesium (Ag-Mg) alloy which may have been oxidised in known manner. The plate has a plurality of portions 11, one for each channel, integral therewith but bent out of the plane of the plate, all in the same direction, leaving apertures 12 in the plate. In order to form a member 9, two plates 10 are fixed together by spot-welding for example, back-to-back so that the portions 11 and apertures 12 are aligned, the portions on

one plate extending in the opposite direction to those on the other plate.

The members 9 are supported in the tube by electrically insulative pillars (not shown) in the conventional manner. The members 9 are arranged so that the portions 11 extend along the channels defining the dynode surfaces which receive and emit electrons and the portions 13 of the members not bent out of the plane of the plates define barrier surfaces which extend across the channels so that the electrons follow a zig-zag path 14 from dynode surface to dynode surface along each channel. As can be seen from Figures 1 and 2, at each stage 6 all the dynode surfaces of one plate 10 are defined by the same surface of that plate and each portion 11 serves only one channel. Thus, any error in the position of that portion affects only the channel it serves, and any difference in electron emissivity between the surfaces of the plate does not affect the gains of the channels at that stage.

The portions 11 of each stage interdigitate with the portions of the or each adjacent stage so that there are no direct or straight paths across the channels, and the barrier surfaces B are arranged so that there are no direct or straight paths along the channels. These measures reduce the risk of electrons in any channel escaping from that channel and thus reduce cross-talk, and also reduce feed-back of light and/or particles to the photocathode 4.

Light may be guided to the window 2 in channels and to further reduce cross-talk, a light guide arrangement 15 (indicated highly schematically in Figure 1) such as is described in British Patent Specification No.1490695 may be provided at window 2 to further define the active and inactive areas a and b of the photocathode 4.

In operation of the tube, various D.C. potentials are applied to the electrode 3, to the stages 6 and to the array of collector rods 8 via pins 16. (In practice the pins would be located at one end of the tube). Typical potentials which might be applied are 0V to the electrode 3, 5V to 15V to the electrode 7 and 100V, 200V, 300V etc. to the stages 6, the voltages applied to the stages increasing with distance from the photocathode. A potential of +100V relative to the last dynode would be applied to each of the collector rods. The

geometric arrangement of the focus electrode 7 and the stages 6, and the collector rods together with the potentials applied to them set up electrostatic fields between the stages which direct and focus the electrons along the zig-zag paths in the channels to the array 8 of rods where the electrons are collected.

Typical dimensions for the plates 10 may be as follows, referring to Figure 2:-

The plate is of Be-Cu sheet 5 thousandths of an inch thick;

the width B of each portion 11 is 1.5 mm (this is also the width of each aperture 12); and the distance E between apertures 12, i.e. the length of a barrier surface 13, is 2.5 mm.

The stages 6 are typically spaced one from another as follows, referring to Figure 1:-

The vertical spacing A between interdigitated portions 11 is 1 mm; and

the horizontal spacing C between one end of a portion 11 and an adjacent barrier surface is 0.75 mm.

The width W of each active area a and each inactive area b of the photocathode 4 is 2 mm.

It is to be appreciated that these dimensions may be scaled up or down without affecting the operation of the device.

The plates 10 are made by taking a sheet of Be-Cu or Ag-Mg alloy of the desired thickness and stamping or punching out the portions 11 in the same direction. The sheet is then cut into pieces of desired size for the plates. Pairs of the pieces are then spot-welded together back-to-back to form a member 9. In this way the whole of a dynode surface comprising two portions 11 is defined by the same surface of the original sheet of alloy and thus has a uniform electron emissivity.

The above described examplary embodiment could be modified in various ways, for instance as follows:-

The members 9 could be made by photoetching. Instead of the barrier surfaces being defined by the plates 10 they could be separate therefrom. Instead of a plurality of collector rods there could be a plurality fo collectors of other known form. Also, instead of a plurality of collectors there could be a single collector

common to all the channels. The electrode 3 and photocathode 4 may not be present and the tube used for multiplying electrons generated by source other than photo-emitters.

Claims:

1. An electron multiplying arrangement comprising a plurality of channels for the electrons, each channel comprising a plurality of electron multiplier stages, wherein corresponding dynode surfaces of the channels at each stage include respective portions of the same surface of a member disposed transversely of the channels, the member defining passages, for said electrons, through the member

2. An arrangement according to Claim 1, wherein the passages in adjacent members are offset to block straight paths along the channels.

3. An arrangement according to Claim 1 or 2, wherein the dynode surfaces of adjacent stages interdigitate to block straight paths across the channels.

4. An arrangement according to Claim 1, 2 or 3 further comprising a photocathode and a focus electrode for focussing electrons from some areas of the photocathode into the channels, and to stop electrons from other areas entering the channels.

5. An arrangement according to Claim 4, further comprising a light guide arrangement defining the said some and other areas of the photocathode.

6. An arrangement according to any preceding claim, wherein the said member of each stage comprises two plates, each deformed so that respective portions of the same surface of the plate provide corresponding dynode surfaces of the channels and to provide the passages, the plates being fixed together with the passages and the said portions aligned, the said portions extending in opposite directions.

7. An arrangement according to Claim 6, wherein the two plates of each stage are derived from a common sheet, and the dynode surfaces of both plates are defined by the same surface of the common sheet.

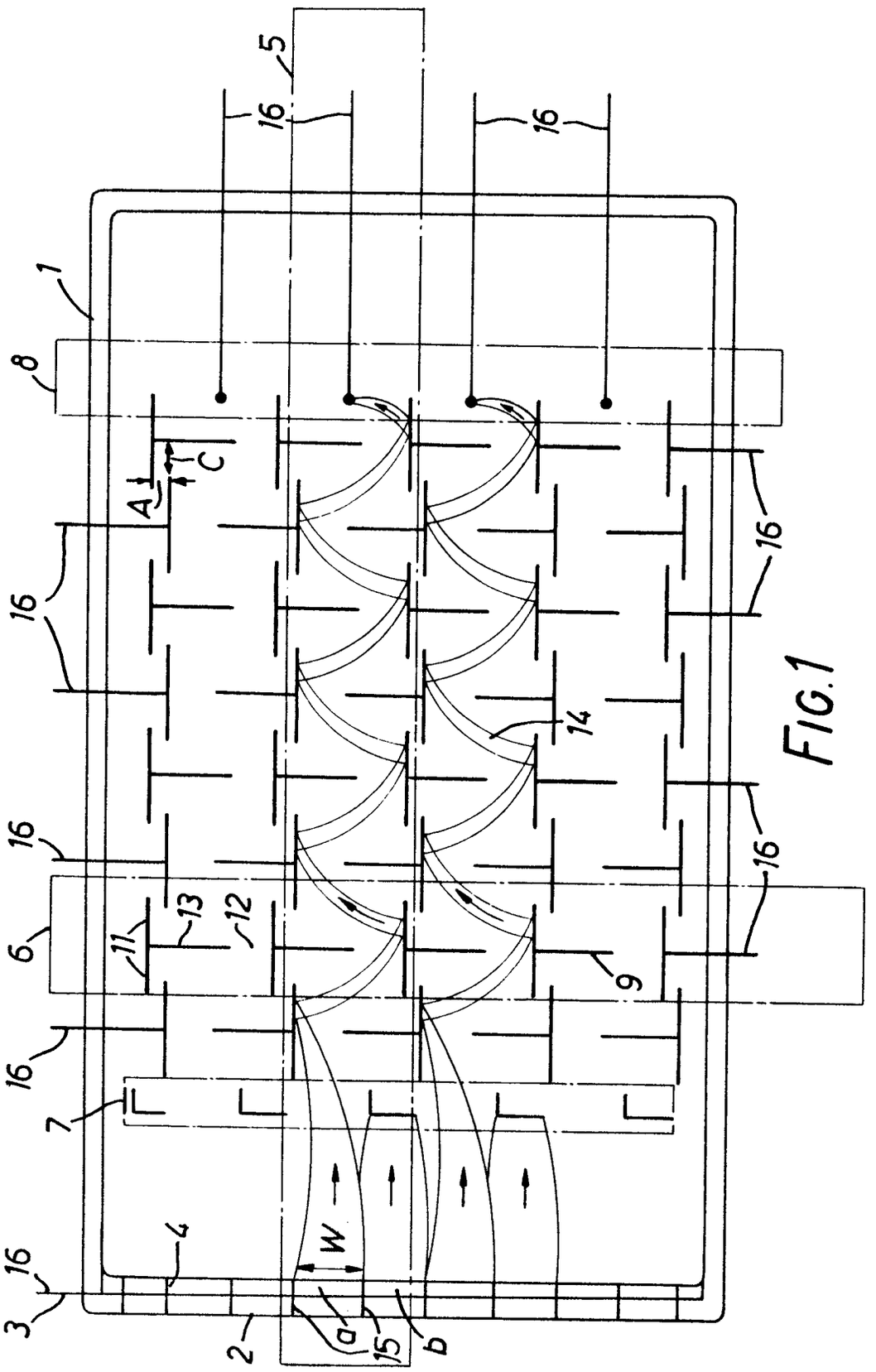


FIG.1

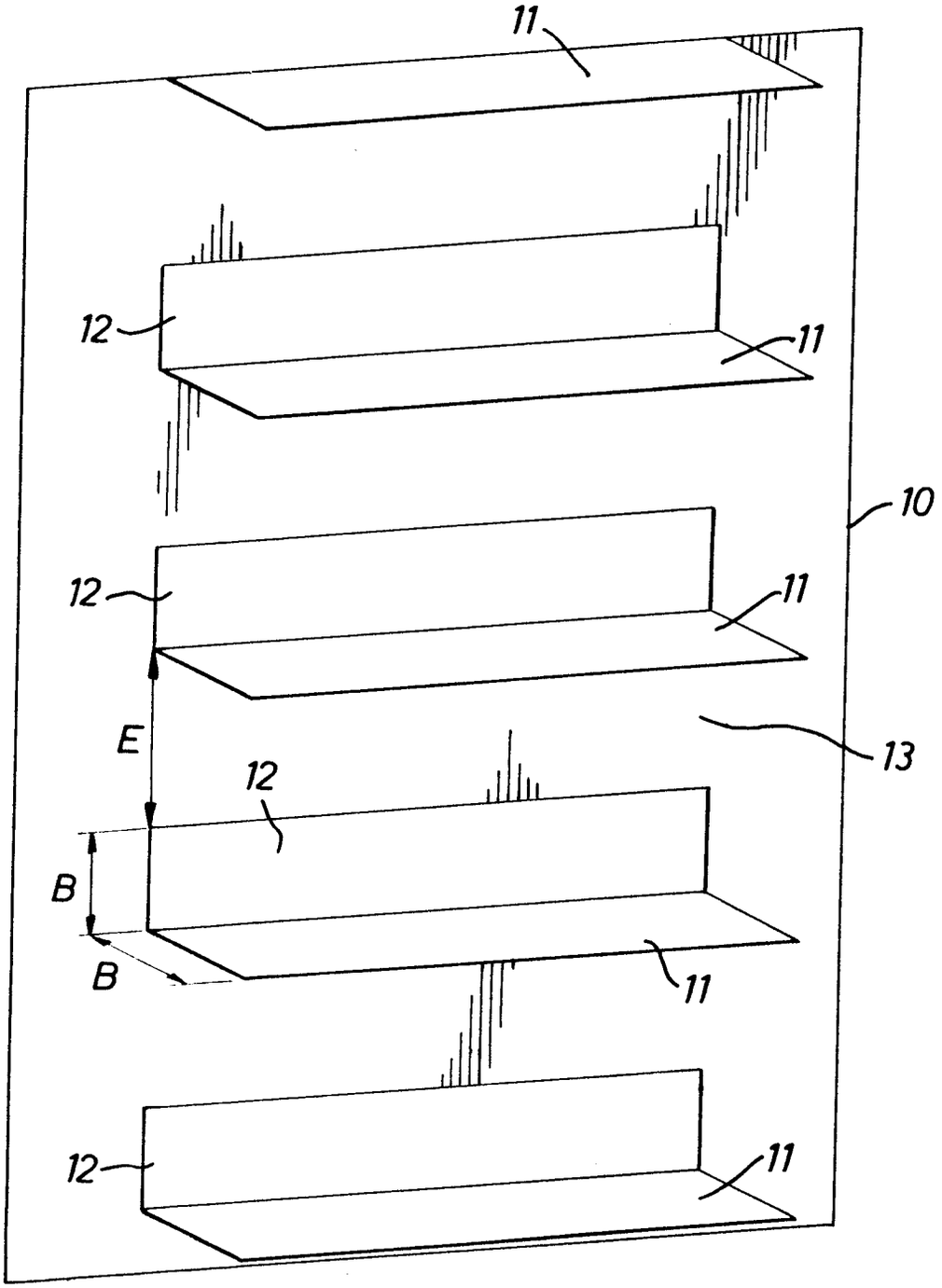


FIG. 2

European Patent Office

EUROPEAN SEARCH REPORT

0001483
Application number
EP 78 30 0392

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	US - A - 3 204 923 (J.W. SCHWARTS) * Column 8, line 66 till column 9, line 51; figures 6 and 7 *	1,6,7
D	GB - A - 1 470 162 (E.M.I.) * Page 1, lines 28 to 37 and 52 till page 2, line 89; figures 1,2 and 3 * & US - A - 3 872 337	1-5
A	GB - A - 1 008 514 (E.M.I.) * Page 1, lines 19 to 38 and 46 to page 2, line 31 and figure *	1
A	INTERNATIONALE ELEKTRONISCHE RUNDSCHAU, vol. 27, no. 9, september 1973. Berlin J.KRIESER "Aufbau Wirkungsweise und Ausführungsformen von Bildverstärkern", pages 196-198. * Page 196, right-hand column, paragraph 9.1; figure 27 *	

CLASSIFICATION OF THE APPLICATION (Int. Cl.²)

H 01 J 43/00
39/16

TECHNICAL FIELDS SEARCHED (Int.Cl.²)

H 01 J 43/00
39/14

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15-12-1978	MAUGAIN

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