April 22, 1952 C. H. FOULKES 2,593,429

GAS FILLED ELECTRIC DISCHARGE DEVICE

Filed Aug. 7, 1947

Fig. 1.

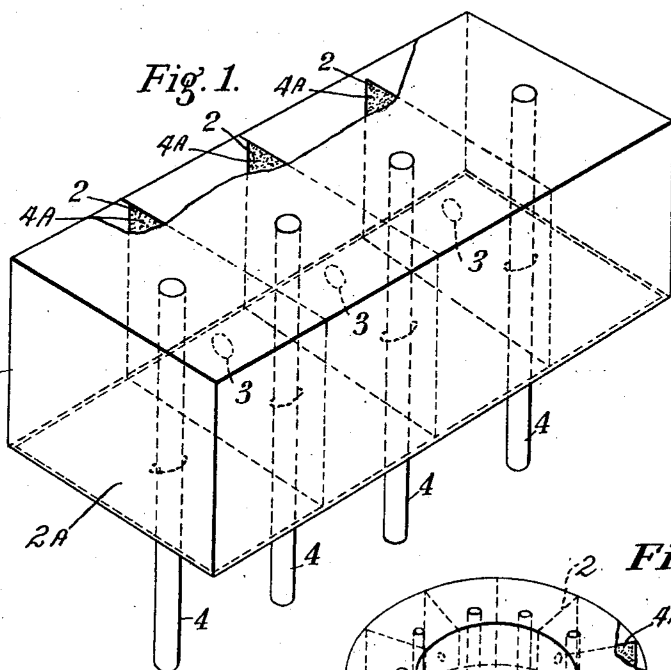


Fig. 2.

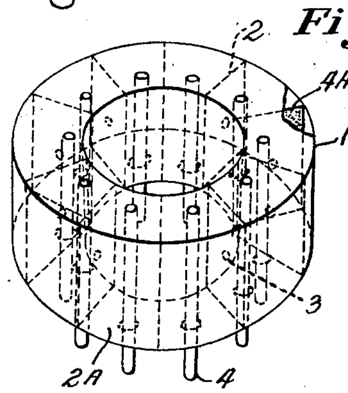


Fig. 3.

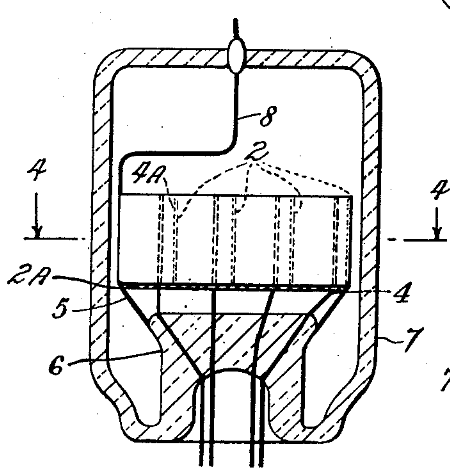
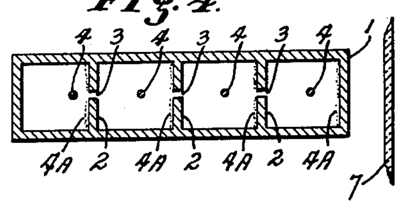


Fig. 4.



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GAS FILLED ELECTRIC DISCHARGE DEVICE

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10 Claims. (Cl. 313—188)

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The present invention relates to gas filled electric discharge devices having a plurality of electrodes to form discharge gaps, the discharge across one of said gaps being arranged to reduce the striking voltage across another of said gaps.

It is well known that in order to initiate a discharge between electrodes in a gaseous atmosphere a minimum voltage must be set up between the electrodes. This striking voltage is dependent on the dimensions of the gap between the electrodes, the nature and pressure of the gaseous atmosphere and the number of charges particles-ions or electrons—present in the vicinity of the discharge gap. When once the discharge has been struck, a much lower interelectrode voltage is required to maintain it. Furthermore, if there be another gap in the vicinity, so that charged particles from the discharge irradiate this other gap, the striking voltage therefor will be reduced. Thus in a tube wherein a discharge is caused to take place between the cathode and a triggering electrode such that when a small current of the order of a few microamperes is caused to flow between them the main gap striking voltage, i. e., between anode and cathode, may be caused to be reduced by as much as 50 v. or more depending upon the magnitude of the current between the triggering electrode and the cathode.

It has been proposed to connect a number of tubes comprising an anode, cathode and triggering electrode, such as the above, by external circuit elements such that when the first tube is made conducting, a voltage derived from its external circuit is applied to the trigger electrode of the next tube so as to prime it. If now a voltage pulse is applied to the system of sufficient magnitude to exceed the striking voltage of a primed tube, but insufficient to strike an unprimed tube, then this primed tube is made conducting. This in turn primes the next tube; so that with the application of successive voltage pulses, the tubes are caused to strike one after the other. One use for such a series of operations, as described, is that of a counter for counting voltage pulses.

To save space, a number of suitably designed units may be assembled into one envelope, the limit being set by the number of connecting leads which may be conveniently sealed into the press of the tube. It would therefore be advantageous if priming of successive units could be done by some means other than by special triggering electrodes, thereby reducing the number of connecting leads and simplifying the external circuit. A further economy of connecting leads would be achieved if a common cathode were used for all the units, or alternatively a common anode.

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The present invention therefore, consists in a gas filled electric discharge device having a plurality of electrodes arranged to form discharge gaps, the discharge across one of said gaps being arranged to reduce the striking voltage across another of said gaps, in which one of said electrodes is constructed as a plurality of compartments each containing a further electrode to form with the first mentioned said electrode a discharge gap within said compartments, and passages for ions and/or electrons in the dividing walls between said compartments.

Particular embodiments of the present invention will now be described with reference to the accompanying drawings in which:

Fig. 1 shows diagrammatically an electrode arrangement according to the invention.

Fig. 2 shows an alternative form of electrode arrangement,

Fig. 3 shows a device according to the construction of Fig. 1, and

Fig. 4 is a section through the discharge device taken along the line **4—4** in Fig. 3.

The electrode assembly of one embodiment as shown in Fig. 1 comprises a metal box **1** enclosed on all sides except the bottom and has partitions **2** dividing it off into separate compartments. Each partition has a small hole **3** in it, and facing each hole and situated in close proximity thereto is an anode **4** in the form of a vertical rod or wire. The open side of the box is mounted on a mica insulator **2A** upon which are also mounted the anode wires. This whole assembly is mounted on a press and enclosed in a glass envelope, in any convenient known manner.

The box may act as the cathode of the device, and the distance between the anode **4** and the partition **2** of the first unit is made smaller than that between the anodes and partitions of the other units. This is in order that the unit with the smallest distance will be the first one to strike, since this distance does in a certain measure determine the striking voltage.

The anodes are polarised to a suitable voltage and have in series with each of them a current limiting resistance (not shown). If now a voltage pulse of the correct amplitude is applied to all the anodes, it may be caused to initiate a discharge between the first anode and its associated partition, because of its lower striking voltage. A proportion of the ions travelling from the anode towards the cathode may then shoot through the aperture **3** into the anode/cathode region of the next unit. As already described, the presence of these ions will have the effect of reducing the striking voltage of this next unit such that when another voltage pulse is applied to the system this next unit will strike. The process will continue with the application of successive pulses so as to strike successive units. This may be made use of either by visually counting the number of lighted boxes in a counting system or the information may be transferred from the load resistances and made to operate relays or other recording devices.

With a filling of neon 99%, argon 1%, at a pressure of 10 mm. of mercury, the striking voltage on an experimental tube having only three units (similar to the four unit tube portrayed in Figs. 1 and 3 with the exception that it lacks the fourth unit) was found to be as laid out in the following Table No. 1. These figures were obtained without the adjacent units being struck and are given to illustrate, in conjunction with Table No. 2, the difference in striking voltage when an adjacent unit is struck.

Table No. 1

Unit number	Striking Voltage	Maintaining voltage for the currents shown below.					
		0.5 ma.	1.0 ma.	1.5 ma.	2.0 ma.	2.5 ma.	3.0 ma.
1	101	67	69	71	72	74	75
2	103	67	71	72	73.5	75	75.5
3	102	64	66	67	68	70	71

Table No. 2

Unit number		Striking voltage when adjacent unit is struck and conducting the currents shown below.					
		0.5 ma.	1.0 ma.	1.5 ma.	2.0 ma.	2.5 ma.	3.0 ma.
1 2	Struck Striking voltage	89	84	83	81	76	74
2 3	Struck Striking voltage	85	80	77	75	73	71
2 1	Struck Striking voltage	94	92	90	88	86	84.5
3 2	Struck Striking voltage	91	88	87	86	84	83

Referring to Table No. 2, it can be seen that when the first unit is struck or conducting, the striking voltage of the second unit is reduced with increasing current in the first unit. Similarly, when the second unit is struck, the striking voltage of the third unit is reduced with increasing current in the second unit and so on. It should be pointed out that previous units which are conducting other than the unit immediately before it do not affect the primed unit. Corresponding reductions in striking voltage will be realized in a tube having more than three units such as in Figs. 1, 2 and 3 herein

It will be noticed that the reduction in striking voltage is greater in going from unit **1** to unit **2** to unit **3**, etc., than it is going in the reverse direction, i. e. from unit **3** to unit **2** to unit **1**. This is arranged by making the distance from an anode to its adjacent cathode surface less than the distance between this same anode and the previous partition. It thereby ensures that the units will become operative in one direction only with the application of successive voltage pulses.

It is easier to operate the tube, so far as the external circuit is concerned, if the difference between the striking voltage in the unprimed condition and maintaining voltage of the units is made as large as possible. This may be achieved by covering the surface of the partition adjacent to its operating anode with alkaline earth metals or their oxides **4A** such as barium or strontium, or a mixture of these. Furthermore, gases or gas mixtures other than these mentioned may be used for the same purpose of increasing the difference in voltages, or combinations of gases or gas mixtures, together with clean or coated surfaces, may be used to get the desired operating conditions.

Another factor affecting the sensitivity of the device is the size of the holes in the connecting partitions. The larger the hole, the greater the sensitivity for a given current in the priming unit.

The invention is not limited to four units, furthermore, they need not be in a straight line but may be made in the form of an annulus, as shown in Fig. 2, thereby making better use of the space in the envelope. Again, although in the above description the common electrode is arranged as a cathode, it is obviously possible to make the common electrode the anode and to coat, as necessary the further electrodes, which would then serve as cathodes, with electron emmissive material.

The electrode arrangement of Fig. 1 may be mounted by means of its supporting wires **5** on a glass press **6** (Fig. 3) in a conventional tube envelope **7**, the cathode lead **8** being brought out at the top of the envelope. The annular arrangement of Fig. 2 is well adapted for use with an envelope having a base capable of being inserted into a tube socket.

I claim:

1. Cold cathode gas filled electron discharge device having a plurality of electrodes mounted separately from each other to form discharge gaps, in which one of said electrodes is constructed with partitions forming a plurality of compartments each containing a further electrode to form with the first mentioned said electrode a discharge gap within said compartment, said partitions having passages for either ions or electrons between said compartments.

2. Cold cathode gas filled electron discharge device having a plurality of electrodes mounted separately from each other to form discharge gaps, in which one of said electrodes comprises a rectangular metallic box with partitions forming a plurality of compartments, said box having apertures on one side, and a plurality of further electrodes each extending through one of said apertures into one of said compartments, said partitions having passages for either ions or electrons between said compartments.

3. Cold cathode gas filled electron discharge device having a plurality of electrodes mounted separately from each other to form discharge gaps, in which one of said electrodes comprises a hollow annular metallic cylinder with radial conducting partitions forming a plurality of compartments, said cylinder having apertures on one side, and a plurality of further electrodes each extendng through one of said apertures into one of said compartments, said partitions having passages for either ions or electrons between said compartments.

4. Electric discharge device according to claim 1 in which said further electrodes comprise rods of conducting material inserted into the open ends of the respective said compartments.

5. Electric discharge device according to claim 2 in which said metallic box is mounted upon an insulator member closing the apertures on said one side of the first mentioned electrode.

6. Electric discharge device according to claim 1 in which said further electrodes are mounted upon a glass press at one end of the envolpes of said device and the lead out connection for said first mentioned electrodes is taken out at the other end of said envelope.

7. Electric discharge device according to claim 1 in which the gap-defining distance between a given dividing partition and one of said further electrodes is less than the distance of each remaining further electrode from a corresponding partition.

8. Electric discharge device according to claim 1 in which said first mentioned electrode forms a cathode and said further electrodes form anodes.

9. Electric discharge device according to claim 1 in which said first mentioned electrodes forms an anode and said further electrodes form cathodes.

10. Electric discharge device according to claim 3 in which said annular cylinder is mounted upon an insulator member closing the other end of said cylinder.

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