Jan. 27, 1953 G. H. HOUGH ET AL 2,627,054

ELECTRIC DISCHARGE TUBE

Filed March 23, 1951

FIG. 1.

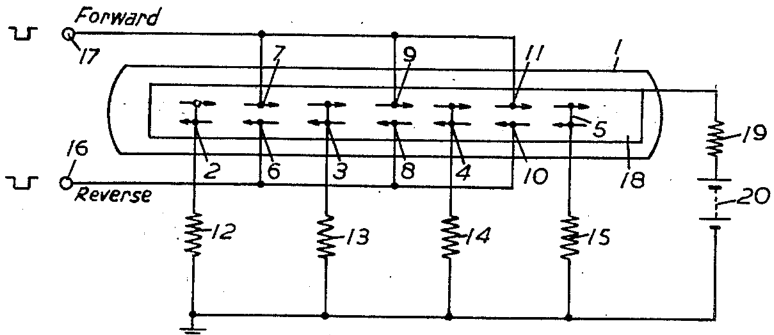
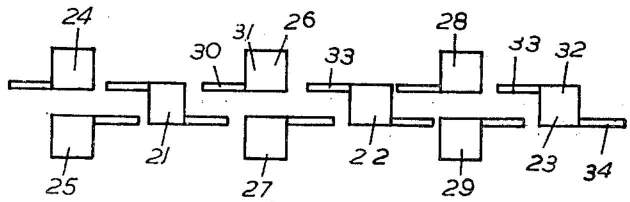


FIG. 2.



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ELECTRIC DISCHARGE TUBE

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2 Claims. (Cl. 315—169)

1

The present invention relates to electric discharge tubes and is particularly concerned with a modification to the arrangements forming the subject matter of my U. S. Patent No. 2,553,585, granted May 22, 1951.

The aforesaid specification is concerned with cold cathode sequence discharge tubes, such are disclosed in the U. S. Application No. 763,665, filed July 25, 1947, of A. H. Reeves for "Gaseous Discharge Tubes," characterised in this, that the successive gaps are shaped so as to concentrate the discharge of each gap in the neighbourhood of the next succeeding gap, whereby ionisation and field coupling to the said next gap is greater than to the preceding gap. Particular embodiments are described in the specification of said U. S. Patent which are characterised in that the electrodes of an ordered array of discharge gaps are so constructed and arranged as to favour the transfer of discharge from gap to gap in succession along the said array in one direction rather than the other. The gaps are differentiated by alternate gaps having cathodes of different shapes, one set of cathodes, known as storage cathodes, comprising two portions, a first portion or tail, adjacent the previously discharging gap, and a second portion or plate remote from it. It is arranged that the discharge between the cathode plate and the common anode has a lower maintaining voltage than that between the tail and anode, while the latter portion goes into abnormal glow discharge at a much smaller current than the plate portion. When, due to ionisation coupling from discharge at the previous gap, discharge at the storage cathode occurs, the cathode glow is first initiated on the tail, and transfers to the plate.

Intermediate the storage cathodes are transfer cathodes, which, in some embodiments, are plate-shaped similarly to the plates of the storage cathodes. The tube is connected through a common anode resistance to a battery of sufficient voltage to maintain glow at one cathode only at a time; the storage cathodes are connected to the negative terminal of the battery through resistance capacity circuits; the transfer cathodes, on the other hand, are biased positively with respect to the storage cathodes and are connected to a terminal at which negative pulses may be applied. Assuming that glow is being maintained on the plate portion of a storage cathode, if a negative pulse is applied to the transfer electrodes, discharge will occur at that transfer cathode closest to the said cathode plate; the common anode resistance, for one of the

2

possible modes of operation, provide a voltage drop such that glow at the storage cathode cannot now be maintained. When the negative pulse applied to the transfer cathode is removed, the latter, being biased more positively than the storage cathode, ceases to discharge; the gap associated with the succeeding storage cathode, however, is now primed by ionisation coupling from the discharge at the transfer cathode, while the charge stored by the condenser of the resistance capacity circuit of the previously discharged storage cathode prevents this from firing again immediately. Hence glow discharge speeds along the cathode tail of the next storage cathode and becomes established on its cathode plate. The net result of the negative pulse applied to all the transfer electrodes in common has been to transfer the cathode glow from one storage cathode to the next; it will be evident that transfer may be made in one direction only along the array.

For many applications it would be of advantage were it possible, in a tube such as described above, to transfer the discharge in either direction along the cathode array. The present invention provides a modified construction of tube such that transfer discharge from storage gap to storage gap may be made in succession along the array of gaps in either direction of sequence according to whether signals are applied to one or the other of a pair of transfer terminals.

According to the present invention there is provided a cold cathode sequence discharge tube comprising first, second and third arrays of cathodes aligned in respective rows, each cathode comprising at least two contiguous portions co-operating with an anode to form corresponding glow discharge gaps differing in maintaining voltage and saturation current, the like portions of all gaps having substantially the same discharge current voltage characteristics, each cathode of the said first array being positioned opposite a corresponding cathode of the said third array, the pair of cathodes so formed being positioned between a pair of adjacent cathodes of the said second array, this array being aligned along the middle said row, the cathodes of the two said pairs being shaped so that when a pulse is applied in common to all the cathodes of the said first array, a glow discharge which is being maintained at a cathode of the second array may be transferred to the next cathode of the said array in one direction therealong, and that when a pulse is similarly applied to the cathodes of the said third array, the said glow discharge is transferred along the said second array in the reverse direction.

The nature of the invention will better be understood from the following description with reference to the accompanying drawings.

Fig. 1 shows schematically a discharge tube and circuit according to the present invention and

Fig. 2 shows diagrammatically the geometry of the cathode array of the tube of Fig. 1.

The tube 1 indicated in Fig. 1 comprises three arrays of cathodes aligned in respective rows, an array of storage cathodes 2, 3, 4 and 5 being aligned along the middle row; to either side of the middle row arrays of transfer cathodes are arranged, the transfer cathodes of one array each being positioned opposite a corresponding transfer cathode of the other array to form pairs, 6 and 7, 8 and 9, 10 and 11 positioned between pairs of adjacent storage cathodes. Arrows on the cathodes indicate that they are shaped to favour transfer of discharge in the direction indicated rather than in the reverse direction. The storage cathodes are bidirectional in the sense that transfer is favoured from cathode 3, for example, to either of transfer cathodes 9 or 6 more than to 8 or 7. The storage cathodes are connected to ground through resistances 12, 13, 14 and 15 respectively; transfer cathodes 6, 8 and 10 are connected together to terminal 16, labelled Reverse, while transfer cathodes 7, 9 and 11 are connected together to terminal 17, labelled Forward; all transfer cathodes are normally biased, by means not shown, above earth potential. A common anode 18 is connected via a resistance 19 to the positive terminal of battery 20, the negative terminal of which is earthed.

Assume now that cathode 3 is discharging; this cathode is shaped so that the ionisation coupling to transfer cathodes 9 and 6 is equal but greater than that to 7 or 8. If a negative pulse is applied to terminal 17, transfer cathode 9 will commence to discharge and it is arranged that the voltage drop through resistance 19 is then sufficient to extinguish the discharge at cathode 3. Provided the negative pulse is of sufficient duration to permit the requisite decay of residual ionisation at cathode 3, storage cathode 4 will be primed to a greater degree than 3 due to it being nearer to the discharge at cathode 9. On removal of the negative pulse, therefore, cathode 4 will fire in preference to 3 and the discharge has effectively been transferred from storage cathode 3 to storage cathode 4. A further pulse applied to terminal 17 will transfer the discharge in the forward direction to storage cathode 5; if, however, a negative pulse be applied instead to terminal 16, the glow being on storage cathode 4, transfer cathode 8 will fire and transfer the discharge back again to storage cathode 3 on the removal of the pulse.

Referring now to Fig. 2 the discharge surfaces of three storage cathodes are indicated diagrammatically at 21, 22 and 23 and three pairs of transfer cathodes are depicted at 24—25, 26—27, 28—29. Each transfer cathode has discharge surfaces similar to those of the storage cathodes described in the aforementioned U. S. Patent No. 2,553,585 and comprise a tail portion 30 and a plate portion 31. Each pair of transfer cathodes are placed opposite one another in the same plane but with their tails oppositely directed, the tails of cathodes 24, 26 and 28 pointing towards the left of the figure and those of 25, 27 and 29 to the right. The storage cathodes 21, 22 and 23 each comprise a rectangular plate portion 32 and, at diagonally opposite corners, tail portions 33 and 34, respectively. The tails 33 are arranged to be in line with and projecting from the same side of the cathode plates as the tails of transfer cathodes 24, 26 and 28, while the tails 34 are similarly in line with the tails of storage cathodes 25, 27 and 29. It will be appreciated that if cathode 22, say, is discharging, provided the plate is substantially completely covered with glow, coupling to the tails of cathodes 27 and 28 is approximately equal and greater than that to cathodes 26 and 29 which are further remote. If, now, a negative pulse be applied to the cathodes 24, 26 and 28, cathode glow will transfer to the tail portion of transfer cathode 28 and then on to its cathode plate; at the end of the pulse the glow will transfer to the tail 33 of cathode 23 and thence on to plate 32. Similarly, if the transfer cathodes 25, 27 and 29 had been activated by the pulse, the transfer would have proceeded in the opposite direction to storage cathode 21.

It will be clear that although a linear array has been shown in Figs. 1 and 2 the principle of the invention can be applied to a circular array. In the practical construction of a tube according to the present invention, field control plates to prevent glow from spreading beyond the desired surfaces should be positioned adjacent them, and, in general, similar principles of design will apply as described with reference to embodiments of the parent invention in our U. S. Patent No. 2,553,585.

While the principles of the invention have been described above in connection with specific embodiments and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What we claim is:

1. A cold cathode sequence discharge tube comprising first, second and third arrays of cathodes aligned in different respective rows, each cathode comprising at least two contiguous portions co-operating with an anode to form corresponding glow discharge gaps differing in maintaining voltage and saturation current, the like portions of all gaps having substantially the same discharge current voltage characteristics, each cathode of the said first array being positioned opposite a corresponding cathode of the said third array, the pair of cathodes so formed being positioned between a pair of adjacent cathodes of the said second array, this array being aligned along the middle said row, the cathodes of the two said pairs being shaped so that when a pulse is applied in common to all the cathodes of the said first array, a glow discharge which is being maintained at a cathode of the second array may be transferred to the next cathode of the said array in one direction therealong, and that when a pulse is similarly applied to the cathodes of the said third array, the said glow discharge is transferred along the said second array in the reverse direction.

2. A sequence discharge tube according to claim 1 in which the discharge surface of each cathode comprising a plate portion and at least one tail portion of narrower width, forming with the co-operating anode a discharge gap of higher maintaining voltage and smaller saturation current than the contiguous gaps formed by the

plate portion, and projecting as a continuation of the cathode discharge surface in line with one side of the said plate portion, the cathodes of the said second array intermediate the ends thereof each comprising two tail portions on opposite sides of the middle said row the tail portions on one side all projecting in one direction along the array, those on the opposite side all projecting in the opposite direction, and in which the cathodes of the said first and third arrays have each one tail portion, aligned with and projecting in the same direction as the tail portions of the second array on the same side of the said middle row, the plate portions of the

cathodes of the said first and third arrays projecting away from the said middle row.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,524,213	Wales	Oct. 3, 1950
2,547,008	Hough	Apr. 3, 1951