

Aug. 8, 1950

A. H. REEVES
ELECTRIC DISCHARGE DEVICE

2,517,599

Filed April 5, 1948

Fig. 1.

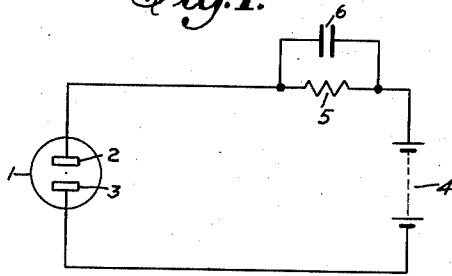


Fig. 2.

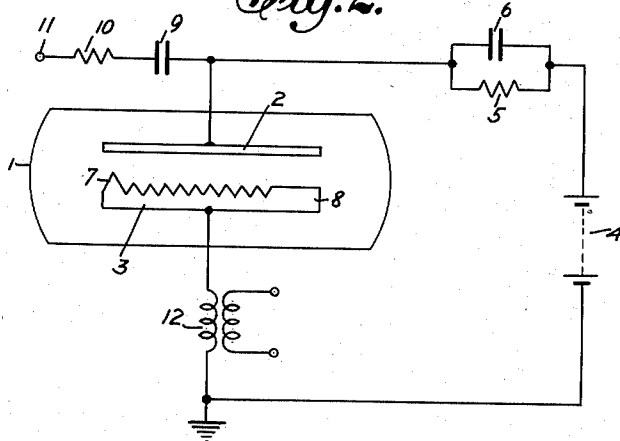
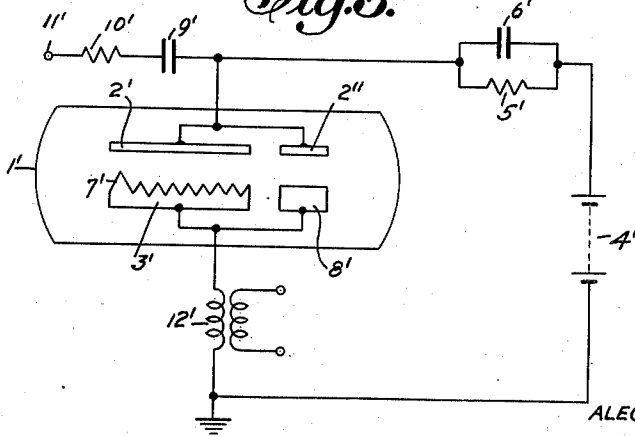


Fig. 3.



INVENTOR
ALEC H. REEVES

BY *Robert Harding Jr.*
ATTORNEY

UNITED STATES PATENT OFFICE

2,517,599

ELECTRIC DISCHARGE DEVICE

Alec Harley Reeves, London, England, assignor to
International Standard Electric Corporation,
New York, N. Y., a corporation of Delaware

Application April 5, 1948, Serial No. 19,083
In Great Britain May 5, 1947

6 Claims. (Cl. 315-261)

1

The present invention relates to cold cathode electric discharge devices of the sequence discharge type, and is particularly concerned with electrode arrangements to facilitate the quenching of an array of discharges. The meaning of the terms "sequence discharge" and "array" will become apparent after consideration of the following discussion.

It is characteristic of cold cathode gas filled discharge tubes that the voltage required to initiate a discharge between two electrodes depends upon the nature and pressure of the gas and its state of ionisation, the shape and material of the discharge electrodes and the distance between them—the gap length. At low interelectrode voltages negligible current will flow if the gas is initially deionised. As the voltage is increased, the molecules of the gas become ionised, until eventually a discharge is set up with a rapid increase in current flow, which may typically rise from microamps to milliamps at a critical voltage which is the "striking," or "firing," voltage for the discharge gap. The discharge is characterised by a glow, which at first appears at the cathode, and may extend to the anode and beyond the immediate neighborhood of the gap, depending upon the degree of ionisation, and is associated with the migration of ions and electrons. When once a discharge has been established, the interelectrode voltage tends to fall and to become to a large extent independent of the discharge current. This approximately constant voltage is called the "maintaining" voltage. Thus, in the familiar neon tubes used as voltage regulators and the like, the striking potential may be of the order of 100 volts or more, but the maintaining voltage tends to be constant in the region of 80 volts.

As mentioned above, ions and electrons tend to migrate from the immediate neighborhood of the discharge. This phenomenon has been extensively used to lower the striking potential of another discharge gap in the same tube envelope. In one known device there is provided a main discharge gap between a main anode and a cathode, and a trigger gap between an auxiliary anode and the said cathode. The auxiliary anode is much closer to the cathode than the main anode, so that the initial striking voltage of the trigger gap is considerably below that of the main gap. The trigger gap is used to lower the striking voltage of, or to "prime," the main gap by ionisation coupling.

It is also well known that whereas, when a striking voltage is applied to a gap, ionisation takes place in a very short time, measured in

2

microseconds; if the voltage across a discharging gap is removed, deionisation is not complete until after a substantial period of time which may often amount to milliseconds.

5 In the specification of my copending application filed July 25, 1947, and bearing Serial Number 763,655 the phenomenon of ionisation coupling is utilised to provide a cold cathode discharge tube having an ordered array of gaps of which a "starting" gap is arranged to have a lower striking voltage than the remainder, so that a recurrent voltage applied to each gap in turn or to all gaps together fires first the starting gap and then the remainder in order. Due to the finite deionisation time, it is not necessary that a priming gap be discharging simultaneously with the application of the recurrent voltage to a neighboring gap. Thus such a "sequence discharge tube" as it may be called, may be operated by a train of pulses applied between a common anode in the form of a plate or wire and an array of cathodes, each mounted independently, or forming the hills of a corrugated plate facing the anode, or, perhaps, taking the form of rods mounted upon a common plate or wire like the teeth of a comb, and having the gap length for a given gap, usually the first, shorter than the remainder. Then the first, or starting gap may be fired by the first pulse, while the second pulse reignites the starting gap and the next adjacent gap simultaneously. The third pulse will fire the first three gaps and so on. On the other hand, if a maintaining battery be connected across the gaps, once fired each gap will remain discharging indefinitely. Thus such a sequence discharge tube may be used, with suitable circuits to extract the information and to restore the initial conditions as to ionisation, as a counter or/and as an information device.

40 Applicant has found with high ionisation coupling that the striking voltage of a gap may be reduced to, or even below, the maintaining voltage for that gap, and that ionisation spread from a discharge proceeds at a definite rate, depending upon the conditions in the discharge tube. These phenomena have been utilized to provide sequence discharge tubes in which, after the discharge has been established at a starting gap, the other gaps of an array may be made to fire automatically at definite time intervals thus providing means for generating pulse trains. Sequence discharge tubes utilising the time aspect of ionisation migration form the subject matter of my copending application filed March 11, 1948, and bearing Serial Number 14184.

In both types of sequence discharge tubes men-

tioned above, after all gaps in an array have been fired arrangements have to be made to extinguish the discharges. The present invention therefore provides a tube designed to be self-extinguishing under suitable conditions. A tube according to the invention comprises one or more discharge gaps each of which is formed by a pair of electrodes, one of which presents a relatively small discharge area to the other electrode, and a further discharge gap formed by a pair of electrodes, one of which presents to the other a discharge surface large compared with the discharge surface corresponding to any other pair of electrodes.

It should be pointed out that this self extinguishing feature is described but not specifically claimed in several co-pending specifications, for example, in the specification of my co-pending application filed October 3, 1947, and bearing Serial Number 777,815.

According to a different aspect, the invention provides a cold cathode gas filled electric discharge tube of the sequence discharge type comprising an array of cathodes and a co-operating anode or anodes, and a further cathode presenting to a co-operating anode a discharge surface large compared with the corresponding surfaces of the other cathodes of said array.

The invention will be described having reference to the associated drawings in which:

Fig. 1 is a circuit diagram used to explain the phenomenon employed;

Fig. 2 is a diagrammatic representation of a device and circuit according to the present invention.

The nature of a squeg or extinguishing action although its use is well known, may perhaps warrant a brief approximate explanation. Consider, then, as shown in Fig. 1 of the accompanying drawings a discharge tube 1, an anode 2 and cathode 3 connected in series with a battery 4 and the parallel combination of a resistance 5 and a condenser 6. Assume, furthermore, that the battery voltage may be raised continuously from some level well below the maintaining potential for the particular tube. Initially, for low voltages, negligible current will flow between the electrodes. What minute current does flow is merely due to free electrons which are normally present. Negligible ionisation takes place. As the voltage is raised, and depending upon the gap length, the pressure and nature of the gas and material of the electrode, the current will still remain minute until the striking potential for this gap is reached. Ionisation then sets in and a discharge takes place. If the resistance 5 is large enough in relation to the potential of the source 4, as soon as the discharge takes place, this resistance will limit the discharge current to a value below that which is sufficient to produce enough ionisation to maintain the discharge, and the tube is extinguished. The condenser 6 delays the rise of the tube current and so lengthens the extinguishing time, and its value is not critical.

In Fig. 2, a device 1 has as an anode a plate or rod 2 and as cathode a serrated plate 3 forming a sequence of discharge gaps and having a shorter starting gap 7 at one end and a smooth prolongation 8 at the other end such that the projected area of this smooth prolongation to the anode is much larger than the projected area of any of the normal gap surfaces. A battery 4 in series with a parallel resistance-capacity network is applied between cathode and anode. The values of resistance 5 and capacity 6 are arranged so that it is possible to maintain all the discharges

except that across the prolongation 8, which we propose to call a "squeg tab," without any squegging taking place, or without reduction of the applied potential below that necessary to maintain the discharges. Means are provided, by blocking condenser 9 and resistance 10, so that a starting pulse from terminal 11 may be applied to the anode. A pulse transformer 12 is inserted in the cathode circuit. Then, in response to the starting pulses, a discharge will be set up across each of the gaps in turn starting at gap 7 in the manner described in the specification of my co-pending application bearing Serial Number 14,184. Finally all the gaps except that formed by 8 and 2 will be discharging. After a further time interval the squeg tab will start discharging. As its area is so much greater than the projected area of the remainder of the discharging surfaces, the current will rise suddenly so that the resistance 5 causes a squeg to take place. Consequently, all discharges are extinguished and the tube remains inactive until such time as the charge on the condenser 6 has leaked away. The train of pulses generated by device 1 is taken to a further circuit from the secondary terminals of transformer 12.

Various possible combinations and uses of a device of this nature will be evident to those skilled in the art. The form of "squeg tab" described above is convenient for many purposes, being made use of, for example, in one of the devices described in the specification of my co-pending application filed April 5, 1948, and bearing Serial Number 19,084. Other forms, in which the squeg tab is structurally separate, may also be used, as, for example, in the device described in my abandoned co-pending application filed April 5, 1948, bearing Serial Number 19,085.

For a clearer understanding of the last described type of construction, I show, in Fig. 3, a structurally separate squeg tab 8', which tab co-operates with anode 2'', creating the discharge gap between tab 8' and anode 2''. The anode 2'' cooperates with electrode 3', which electrode is similar to electrode 3 in Fig. 2, the squeg portion 8', however, being separately constructed, as above stated. It will be seen that the discharge surface defined by the electrodes 2'' is large as compared with the discharge surfaces respectively of the corrugated surfaces of electrode 3'. It will also be noted that both sets of electrodes, to wit 2' and 3', and 2'' and 8' have an ionization coupling therebetween.

I claim:

1. A cold cathode gas filled sequence discharge tube comprising a first pair of electrodes defining a first voltage responsive discharge gap, one of said electrodes presenting a relatively small discharge surface to the other electrode, and a second pair of electrodes one of which constituting said other electrode positioned to define a second discharge gap having an ionization coupling with said first gap, the electrode of said second pair not included in said first pair having the same spacing from said other electrode as the space of said one electrode from said other electrode and presenting to said other electrode a discharge surface large compared with said discharge surface of said one electrode.

2. A cold cathode gas filled electric discharge tube of the sequence discharge type comprising an array of cathodes and cooperating anode means, said cathodes having given discharge surfaces each equally spaced from said anode means and defining with said anode means an array of sequentially firing discharge gaps, and a further

5

cathode equally spaced from said anode means as the cathodes of said array and presenting to said anode means a discharge surface large compared with said given discharge surfaces of the cathodes of said array.

3. A cold cathode gas filled electric discharge tube of the sequence discharge type comprising a first electrode having a discharge surface, a second electrode having a plurality of corrugations the ridges of which are equally spaced from said first electrode, said second electrode terminating at one end in a flat surface spaced from the said first electrode at substantially the same distance as the ridges of the said corrugations.

4. A discharge tube according to claim 3 in which the corrugated electrode has a corrugation at the other end whose ridge is spaced closer to said first electrode than the other ridges are spaced from said first electrode.

5. An electric circuit arrangement comprising a cold cathode gas filled electric discharge tube comprising mutually spaced first and second electrode structures defining a series of discharge gaps all having a relatively small discharge area, and a further electrode positioned with respect to said first and second electrode structures to define a further discharge gap having an ionization coupling with at least one of said first mentioned gaps and having a discharge area large compared with the discharge area of any of the first mentioned discharge gaps, a source of main-

6

taining potential connected between said first and second electrode structures and between said first electrode structure and said further electrode, an impedance in series with said source, and means for initiating a discharge which travels along the sequence of gaps as far as the said further discharge gap, the potential of the source and the value of the resistance being so chosen that when a discharge strikes across the said further discharge gap, a squeg occurs which extinguishes all the discharges.

6. An electric circuit arrangement according to claim 5 in which the said tube comprises a single anode co-operating with a corrugated cathode terminating at one end in a flat plate adapted to form with the said anode the said further discharge gap.

ALEC HARLEY REEVES.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,007,932	Ruben	July 9, 1935
2,443,407	Wales, Jr.	June 15, 1948

FOREIGN PATENTS

Number	Country	Date
644,402	France	Oct. 8, 1928