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GASEOUS DISCHARGE DEVICES

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FIG. 1

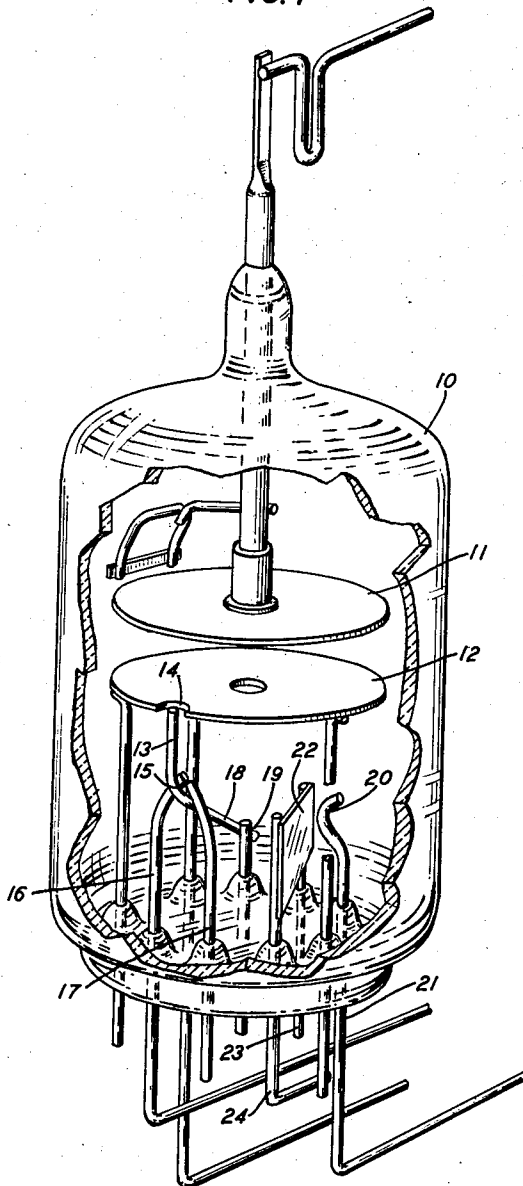
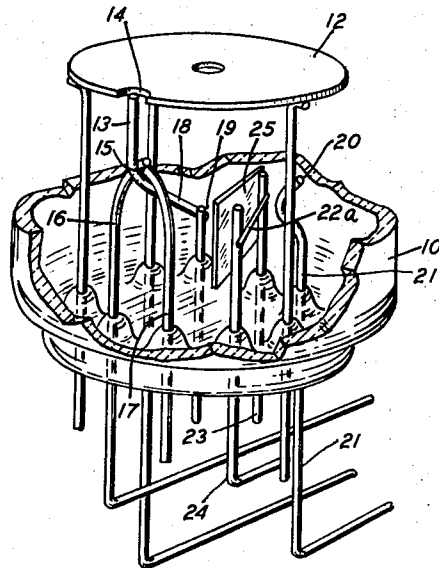


FIG. 2



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GASEOUS DISCHARGE DEVICES

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This invention relates to gaseous discharge devices and more particularly to such devices which include starter and keep-alive electrodes for controlling the initiation of the discharge.

In electronic switching systems employing high potentials it is desirable to utilize gaseous discharge devices of comparatively simple, yet rugged, construction and which possess quite fast firing times to accomplish the various switching operations. A device of this sort is desirable in switching systems because, among other things, it is less expensive than other devices for performing the same operations, and, because of the great number of the devices required in such complicated systems, it is highly desirable to minimize unit costs. Additionally, the device is easier to manufacture, is less liable to breakage, may be more reduced in size, and may be used in faster and more complicated systems than discharge devices which do not include the aforementioned characteristics of simplicity, ruggedness, and speed of operation. However, one encounters certain problems which have heretofore necessitated sacrificing one or more of the foregoing advantages when endeavoring to construct a device with these desirable characteristics.

In the manufacture of gaseous discharge devices with glass envelopes, a problem is encountered in sealing the envelope to the base of the device. The main envelope structure, a glass cup, is sealed, by heating, to a glass base in which the lead-in conductors have been previously positioned. Certain of these lead-in conductors support the whole of the internal structure of the device. The heat generated in the sealing operation tends to diffuse throughout the base and along the lead-in conductors; and these lead-in conductors and the internal dimensions controlled by them may easily be distorted by thermal expansion and contraction. The dimensions of both the starter discharge gap and the main discharge gap are quite important to the operation of such a device because they help determine the necessary starting and maintaining potentials; a small amount of distortion in the dimensions of either of these gaps will cause the device to fire at quite a different input potential than desired, so the exact control of and prevention of distortion to these dimensions is most important. The thermal expansion and contraction mentioned previously will seriously affect these critical dimensions, and it is, therefore, most important that the internal elements of the device be securely positioned so that they will not be affected during the sealing process. Furthermore, it is naturally desirable that any sort of electronic device be as strong as possible so that it may withstand the shocks encountered in normal use. Consequently, there have been suggested various means of securely positioning the internal structure of the device so that it will not be affected by thermal expansion or the shocks of use. These means consist of various complicated and relatively expensive structures including a ceramic disc or wafer construction which holds the main internal elements and is supported by the lead-in conductors within the device. It is readily apparent that

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such internal complication of the structure, whether to protect from distortion or breakage, not only increases the cost of such a device, but also places restrictions on the device as to physical dimensions.

Various means have been suggested to obtain the fast firing times which are desirable in gaseous discharge devices. The firing time, or ionization delay time as it is known, may be divided into two parts, the statistical delay time and the formative delay time. As the latter may be effected only by adjustment of the device's main characteristics, any work in speeding the firing time on a device having determined characteristics must be directed toward cutting the statistical delay time. This time is that necessary for an electron or ion to appear in the main discharge gap after application of the breakdown potential; it is entirely random for any given device. It has been found that this delay time may be lessened by maintaining a preionized area in some portion of the device, thereby assuring the presence of an electron or ion between the discharge electrodes with little or no delay. Some of the means suggested for forming this preionized area include radium spotting of the inner surface of the envelope wall of the device; bombarding the device with X-rays, radio-frequency energy, or ultraviolet light; and maintaining a discharge constantly within the device. It has been found, however, that radium spotting requires quite complicated and bulky shielding to prevent harming those working in the immediate area where a large number of the devices are to be used and various others of the suggested solutions necessitate unduly complicated and expensive structures. It has been determined that the shortest statistical delay times are obtained when the last method, called keep-alive discharge, is used. As the firing times of the various component devices, in the final analysis, control the message-handling capacity of any electronic switching system, the method of discharge initiation which gives the shortest firing time is considered the desirable one. However, since a keep-alive discharge normally requires the addition of one or more electrodes to the device and various shielding means are necessary to protect against discharge to these electrodes. When high potentials are to be maintained, complicated structures have been the result whenever a gaseous discharge device with a fast firing time has been required.

It is, therefore, an object of this invention to provide a simplified internal structure for a gaseous discharge device with a fast firing time.

It is a further object of this invention to provide in a gaseous discharge device a simplified internal structure which will have the inherent strength to maintain the close tolerances necessary throughout its manufacture and operation and to withstand the shocks of use.

It is a still further object of this invention to provide a simplified internal structure for a gaseous discharge device to which high potentials may be applied without undesirable breakdown.

The foregoing and other objects of this invention are accomplished in accordance with features of this invention by a novel mounting structure for a starter-gap anode and a new type of keep-alive discharge gap including a shielded cathode.

In accordance with one feature of this invention in a first illustrative embodiment thereof, a starter anode is mounted at the peak of a tripod arrangement of three widely distributed lead-in conductors. These three widely distributed legs of the tripod give the maximum possible stability for mounting the starter anode both during the manufacturing process and through the life of the device. This mount, formed of lead-in conductors for wires attached to lead-in conductors at the base of the device, does away with the more complicated and expen-

sive ceramic and metallic internal mountings which are common to the art, with no sacrifice in rigidity, but with great savings in cost of manufacture.

In accordance with another feature of this invention in the same illustrative embodiment, a keep-alive discharge gap is defined by a lead-in conductor anode and a metal plate which is positioned between and connected to two lead-in conductors. The plate functions on the side adjacent the keep-alive anode as a keep-alive cathode and on the side remote from the keep-alive anode as a shield to prevent discharge to any of the other lead-in conductors. The shielding function is accomplished by coating the side of the plate remote from the keep-alive anode with a material of high work function, such as nickel. The keep-alive discharge gap is positioned in the base of the device and with the starter mounting defines a simple and reliable structure for accomplishing the aforementioned objects.

In accordance with another feature of this invention, in a second illustrative embodiment thereof, a keep-alive gap is defined by an anode which is formed from a lead-in conductor, a cathode which comprises a wire positioned between and connected to two other lead-in conductors, and a shield also connected to one of these last two lead-in conductors and positioned between the keep-alive cathode and the lead-in conductors which support the starter anode.

A complete understanding of this invention and these and other features thereof may be gained from consideration of the following detailed description and the accompanying drawing, in which:

Fig. 1 is a perspective view of a gaseous discharge device illustrative of one specific embodiment of the invention; and

Fig. 2 is a perspective view of the lower part only of a gaseous discharge device illustrative of another specific embodiment of the invention.

Referring to Fig. 1, there is depicted a gas discharge device having an envelope 10, main discharge gap defining anode 11 and cathode 12, and a starter anode 13 positioned adjacent the cathode 12 in a cut-out portion 14 thereof and supported at the apex 15 of a tripod formed by two lead-in conductors 16 and 17 and a wire 18 connected to another lead-in conductor 19 at the base of the device. The three conductors 16, 17 and 18 are connected, as by welding or brazing, at apex 15; and wire 18 is bent up at apex 15 to form the starter anode 13. Other forms of starter anodes may be used and are positioned, as by welding, at apex 15; also lead-in conductor 19 may be bent at the point where it would normally join wire 18 and take that wire's place as the third leg of the tripod. The three lead-in conductors 16, 17, and 19, which form the base of the tripod are positioned as far from each other as is practical so that a firm support is formed for mounting of the starter anode 13. This simplified structure maintains the close tolerances necessary at the starter gap throughout the glass sealing process, and affords firm support for the starter anode.

The discharge device depicted in Fig. 1 also includes a keep-alive discharge gap comprising lead-in conductor 21 which defines, at its upper extremity which is bent into close proximity with plate 22, a keep-alive anode 20. Plate 22 is connected between lead-in conductors 23 and 24 and is preferably formed of a material such as molybdenum which has a low work function. Plate 22 is coated on the side remote from keep-alive anode 20 with a material of high work function such as nickel, and thereby functions as a keep-alive cathode on the side adjacent anode 20 and as a shield for the keep-alive electrodes on the side remote from the anode 20.

Referring now to Fig. 2 which shows the lower portion only of a gaseous discharge device containing a second illustrative embodiment of the keep-alive structure, there is depicted a keep-alive discharge gap in-

cluding a keep-alive anode 20 formed from lead-in conductor 21 by bending the upper portion near to wire 22a which is connected between lead-in conductors 23 and 24 and defines a keep-alive cathode. Included in the keep-alive structure is plate 25 connected to lead-in conductor 23 and between keep-alive cathode 22a and lead-in conductors 17 and 19. Plate 25 functions as a shield preventing discharge between keep-alive cathode 22a and lead-in conductors 17 and 19 and is advantageously formed of a material of high work function such as nickel while the keep-alive cathode 22a is formed of a material of low work function, such as molybdenum.

The operation of each of the embodiments of the device is approximately the same. A direct-current voltage is maintained across the keep-alive discharge gap. The electrons and ions freed by the discharge tend to diffuse throughout the device; and their presence around, near by, and in the starter gap shortens quite appreciably the time necessary to begin the discharge, in some cases completely eliminating the statistical delay time. The keep-alive cathode 22 or 22a and the shield 25, when present, are maintained at the same potential, normally that of the main cathode 12; the shield 25 or the side of plate 22 which functions as a shield disturbs the field that would normally be created between the keep-alive cathode 22 or 22a and any of the lead-in conductors carrying high potentials and prevents discharge therebetween at the potentials normally applied to these elements. More particularly, the shield prevents discharge between the keep-alive cathode and the starter anode leads which are in proximity to the keep-alive cathode.

The shield protecting the keep-alive discharge gap from undesirable breakdown to certain of the lead-in conductors is depicted in the drawing as a flat plate; this is not to preclude the use of various other shapes of shields such as curved, cupped, or circular, however. It is also to be noted that various coatings may be used for the shielding surface rather than the nickel advantageously employed in this embodiment and that the plate itself need not be of metal; glass, mica, aluminum oxide, and carbon are some other materials and coatings which may be employed. The same is true of the material used for the cathode structure; though molybdenum is suggested, various other materials having the same emissive qualities may be used.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of this invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A gaseous discharge device comprising an envelope, a plurality of lead-in conductors; a plurality of electrodes in said envelope defining a main gap, means defining a starter gap including a starter anode, a tripod mounting arrangement formed by three lead-in conductors for supporting said starter anode, and means defining a keep-alive discharge gap.

2. A gaseous discharge device comprising an envelope; a plurality of lead-in conductors; a plurality of electrodes in said envelope defining a main gap, a starter gap including a starter anode, and a keep-alive gap; and a tripod mounting arrangement for supporting said starter anode, said mounting arrangement comprising three lead-in conductors extending through the base of said envelope.

3. A gaseous discharge device as in claim 2 wherein said keep-alive discharge gap is formed by a lead-in conductor defining a keep-alive anode, a wire connected between two other lead-in conductors defining a keep-alive cathode, and further comprising a shield for said keep-alive gap connected to one of said lead-in conductors to which said keep-alive cathode is connected, said shield extending between said tripod mounting arrangement and said keep-alive gap.

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4. A gaseous discharge device as in claim 3 wherein said shield is a flat plate of nickel.

5. A gaseous discharge device as in claim 2 wherein said keep-alive discharge gap is formed by a wire lead-in conductor defining a keep-alive anode and a metal plate having a low work function connected between two other of said lead-in conductors, said plate being between said keep-alive anode and said lead-in conductors forming said tripod mounting arrangement and being coated on the side remote from said keep-alive anode with a material of high work function, the coated side defining a shield for the keep-alive gap and the other side defining a keep-alive cathode.

6. A gaseous discharge device comprising an envelope, a plurality of lead-in conductors, a pair of main-gap defining electrodes in said envelope, a lead-in conductor defining a keep-alive anode, a wire connected between two other lead-in conductors defining a keep-alive cathode, and a plate connected to one of said lead-in conductors supporting said keep-alive cathode, said plate being remote from said keep-alive anode and between said keep-alive cathode and others of said lead-in conductors.

7. A gaseous discharge device as in claim 6 wherein said plate is of nickel.

8. A gaseous discharge device comprising an envelope, a plurality of lead-in conductors extending through the base of said envelope, a pair of main gap defining electrodes in said envelope, a metal plate connected to at least one of said lead-in conductors and opposite another of said lead-in conductors, said another lead-in conductor defining a keep-alive anode and said plate having a low work function surface adjacent said keep-alive anode lead-in conductor and defining therewith a keep-alive gap and having a high work function surface remote from said keep-alive anode lead-in conductor and shielding said keep-alive gap from the remainder of said lead-in conductors.

9. A gaseous discharge device as in claim 8 wherein said plate is of molybdenum and coated on said surface remote from said anode with nickel.

10. An electron discharge device comprising an envelope; a plurality of lead-in conductors; a main anode and a main cathode in said envelope for defining a main discharge gap therein; a starter anode positioned in a cut-out portion of said main cathode and defining with said main cathode a starter discharge gap; means securely mounting said starter anode to the base of said envelope, said means including three wires which are widely dispersed at said base and meet at an apex to which is connected said starter anode, two of said wires being two of said lead-in conductors and the third of said lead-in conductors; a keep-alive anode positioned in said base, said keep-alive anode being another of said lead-in conductors; and a metal plate of low work function connected between two other of said lead-in conductors, the upper extremity of said keep-alive anode bent into close proximity to said plate, said plate being positioned between said keep-alive anode and said lead-in conductors which mount said starter anode, said plate being coated on the side remote from said keep-alive anode with a material of high work function.

11. An electron discharge device comprising an envelope; a plurality of lead-in conductors; a main anode and a main cathode in said envelope defining a main discharge gap therein; a starter anode positioned in a cut-out portion of said main cathode and defining with said main cathode a starter discharge gap; means securely mounting said starter anode to the base of said envelope, said means including three wires which are widely dispersed at said base and meet at an apex to which is connected said starter anode, two of said wires being two

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of said lead-in conductors and the third of said wires being attached at said base to a third one of said lead-in conductors; a keep-alive anode, said keep-alive anode being another of said lead-in conductors bent at its upper extremity; a keep-alive cathode defined by a metal wire of low work function connected between two others of said lead-in conductors in close proximity with said bent portion of said keep-alive anode and defining therewith a keep-alive gap; and a plate of a material having a high work function positioned between the keep-alive discharge gap and said lead-in conductors which mount said starter anode, said plate being supported by one of said lead-in conductors to which said keep-alive cathode is connected.

12. A gaseous discharge device comprising an envelope, a flat cathode and parallel flat anode positioned in said envelope and defining a main discharge gap, a starter anode adjacent one edge of said cathode and defining therewith a starter gap, a plurality of lead-in conductors extending through the base of said envelope, tripod support means including three of said lead-in conductors for positioning said starter anode adjacent said cathode edge, and a metal plate connected to at least one other of said lead-in conductors, said plate being positioned between said three lead-in conductors and still another of said lead-in conductors and defining with said last mentioned lead-in conductor a keep-alive gap.

13. A gaseous discharge device in accordance with claim 12 wherein said metal plate has a low work function on the side adjacent said keep-alive anode lead-in conductor and a high work function on the side adjacent said three lead-in conductors.

14. A gaseous discharge device comprising an envelope, a pair of electrodes in said envelope defining a main discharge gap, a starter anode adjacent one of said main gap electrodes, a plurality of lead-in conductors extending through the base of said envelope, said starter anode being positioned by three of said lead-in conductors, means including another of said lead-in conductors defining a keep-alive gap in said envelope, and means shielding said keep-alive gap from said starter anode lead-in conductors.

15. A gaseous discharge device in accordance with claim 14 wherein said starter anode is a wire secured at one end to one of said lead-in conductors and at an intermediate point along its length to two other of said lead-in conductors, said three lead-in conductors accordingly defining a tripod support for said starter anode.

16. A gaseous discharge device in accordance with claim 15 further comprising a metal plate secured between two other of said lead-in conductors adjacent said envelope base, said keep-alive gap defining means including a low work function surface on said plate adjacent said keep-alive anode lead-in conductor and said shielding means including a high work function surface on said plate adjacent said starter anode lead-in conductors.

17. A gaseous discharge device comprising an envelope, a pair of electrodes within said envelope defining a main discharge gap, a plurality of lead-in conductors extending through the base of said envelope, and a wire extending between two of said conductors and connected directly thereto, said wire defining a keep-alive cathode and one of said lead-in conductors extending adjacent said wire defining a keep-alive anode.

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