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ELECTRIC DISCHARGE DEVICE

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FIG. 1

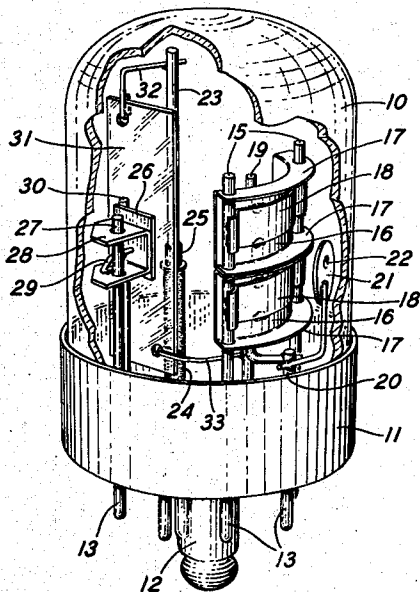


FIG. 2

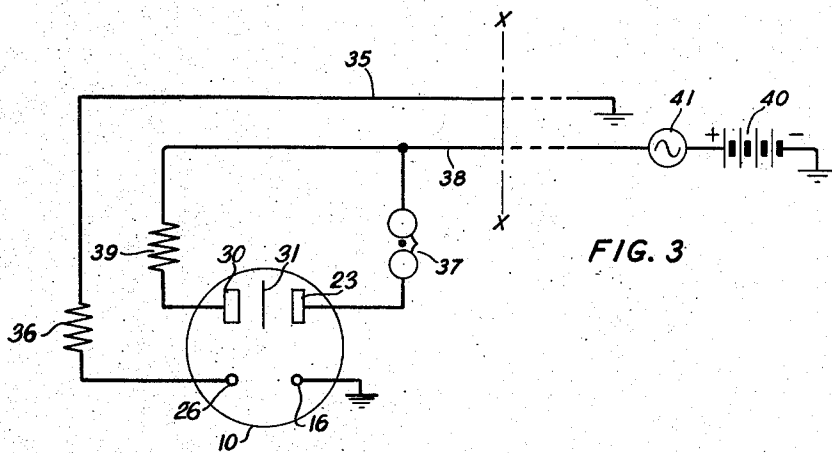
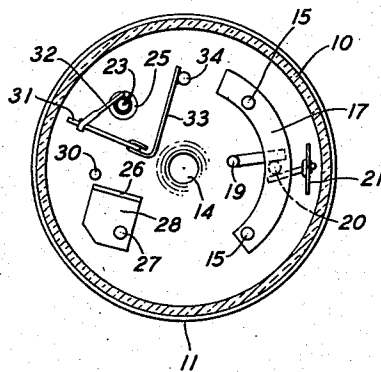


FIG. 3

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ELECTRIC DISCHARGE DEVICE

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9 Claims. (Cl. 250—27.5)

1

This invention relates to electric discharge devices and more particularly to such devices of the cold cathode type and especially suitable for use as ringing control elements for multi-party selective telephone systems.

Discharge devices of the type to which this invention pertains comprise in general a main cathode, a main or work anode, an auxiliary cathode, and an auxiliary or control anode all within a vessel having a filling of a suitable gas. In the operation of the device, a discharge is initiated between the auxiliary cathode and control anode. Then the discharge is caused to transfer to the gap between the auxiliary cathode and the main anode. This is known as the anode transfer. Finally, the discharge is caused to transfer to the gap between the main cathode and the main anode. This is known as the cathode transfer.

In order to prevent false operation, it is desirable that the breakdown voltage between the main anode and the other electrodes and between the main cathode and the other electrodes be relatively high. On the other hand, it is also desirable that the potential difference between the main and auxiliary cathodes requisite to effect transfer of the discharge from the auxiliary cathode-main anode gap to the main cathode-main anode gap be relatively low. These two desiderata are in a sense in opposition in so far as electrode construction and spacing are involved.

It is desirable also, in order to expedite manufacture of devices of the type and general construction above-noted and to reduce the cost thereof, that the two cathodes be processed simultaneously. The processing involves high frequency heating of these electrodes and because of their different sizes, the auxiliary cathode being much smaller than the main cathode, there is danger of damage to the main cathode by overheating or deleterious effects upon the auxiliary cathode by underheating.

One object of this invention is to improve the transfer characteristics of multigap gaseous discharge devices.

More specifically, one object of this invention is to realize transfer of the discharge to the main anode-main cathode path at a relatively low potential difference between the main and auxiliary cathodes, concomitantly with the attainment of a high breakdown voltage between each of the main anode and main cathode and the other electrodes.

Another object of this invention is to enable

2

simultaneous high frequency processing of both the main and auxiliary cathodes.

In accordance with one feature of this invention, in a discharge device of the type and construction above-described, means are provided for causing the auxiliary cathode to main anode discharge to follow a path, portions of which are relatively close to the main cathode, whereby transfer of the discharge to the main cathode-main anode gap occurs for a relatively low potential difference between the main and auxiliary cathodes.

More specifically, in accordance with one feature of this invention, an insulating baffle or barrier is provided between the auxiliary cathode and main anode and is positioned so that the discharge between these two electrodes passes around a side edge of the barrier toward the main cathode.

In accordance with another feature of this invention, the main and auxiliary cathodes are constructed and arranged so that both may be heated simultaneously by high frequency induction to the temperature requisite to effect proper processing thereof, without deleterious heating of the main cathode.

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a perspective view of an electric discharge device illustrative of one embodiment of this invention, a portion of the enclosing vessel being broken away to show the internal structure more clearly;

Fig. 2 is a plan view of the device, with a portion of the vessel removed; and

Fig. 3 is a circuit diagram illustrating one manner in which the discharge device shown in Figs. 1 and 2 may be utilized.

Referring now to the drawing, the discharge device illustrated in Figs. 1 and 2 comprises a vitreous enclosing vessel 10 secured to a base 11 and having therein a filling of a gas such as a 10 per cent argon, 90 per cent neon mixture at a pressure of 55 millimeters of mercury or a single gas such as argon at a pressure of 15 millimeters of mercury. The vessel has an exhaust tubulature 14, shown in Fig. 2, which is enclosed by a cap 12 on the base, and has sealed in its base wall a plurality of parallel metallic rods having terminal portions 13 through which electrical connection to the electrodes of the device may be established.

Two of the rods 15 mount the main cathode which comprises a pair of arcuate, sheet metal, e. g. nickel, members 16 having metallic projections or flanges 17 through which the rods 15 project, the two juxtaposed flanges being secured together, as by welding, and the cathode being affixed to the rods by metal strips 18 welded to the cathode members 16 and to the rods. The concave faces of the cathode members 16 have thereon a coating of electron emissive material; the convex faces and flanges may be calorized to prevent conduction therefrom.

Disposed opposite the concave cathode surface and uniformly spaced therefrom is a rod electrode 19 which is supported from the rod 20 and is utilized as an activating anode, in known manner, in the activation treatment of the electron emissive coating during the manufacture of the device. Also supported from the rod 20 is a disc 21 which carries a quantity of getter material 22 on the outwardly facing surface thereof.

Another of the rods 23 is opposite and relatively widely spaced from the emissive face of the main cathode and constitutes the main anode of the device. The lower portion of this rod is encompassed by an insulating, e. g. glass or ceramic, sleeve 24 which is held in place by a retaining band or collar 25 affixed, as by welding, to the rod 23.

Facing the main anode 23 is the auxiliary cathode which is in the form of a metal plate 26 the face of which toward the anode 23 is coated with electron emissive material. The auxiliary cathode is supported from the rod 27 by a U-shaped sheet metal projection, bracket or flange 28 which is fixed in place upon the rod by a U-shaped wire 29 welded to the bracket and the rod. The bracket 28 and rear face of the auxiliary cathode 26 are calorized to prevent conduction therefrom.

The auxiliary or control anode is constituted by the rod 30 and, as shown most clearly in Fig. 2, is positioned opposite the emissive face of the auxiliary cathode 26 and in juxtaposition to one of the side edges thereof.

An insulating, e. g. mica, sheet baffle or barrier 31 extends across the gap between the main anode 23 and the auxiliary cathode 26. One side of the barrier is in proximity to the side wall of the vessel 10, as shown in Fig. 2, and the barrier extends a substantial distance above and below the auxiliary cathode, as shown in Fig. 1. Consequently, the discharge between the auxiliary cathode and main anode is directed into a path around the side or edge of the barrier facing toward the main cathode. The barrier is supported by a pair of hooked wires 32 and 33 affixed to the anode 23 and rod 34 respectively.

The operating characteristics of the device are dependent largely upon the electrode spacings. The spacing between the main anode 23 and main cathode 16 is made such as to provide the desired breakdown voltage for the gap therebetween. Similarly, the control elements, that is the auxiliary cathode 26 and control anode 30, are spaced relative to the main cathode 16 to provide the desired breakdown voltage requirements therebetween. Also, the main anode to auxiliary cathode spacing is fixed to meet the breakdown voltage requirements, this spacing being less than it would be if the barrier or baffle 31 were absent. The control anode is placed in immediate proximity to the auxiliary cathode, e. g. spaced of the order of 0.010 inch therefrom, to produce a low breakdown voltage in the con-

trol gap. The position of the control anode relative to the control cathode is such that it does not mask the emissive face of the control cathode and also causes the conducting area and associated ionized gas to be exposed to the field of the main anode and main cathode, thereby effecting low transfer conditions for both the anode transfer and the cathode transfer.

In general, in the operation of the device, the main or work anode is biased positively with respect to the other electrodes. Upon the application of a prescribed potential between the control anode and auxiliary cathode, the gap between these elements breaks down and the discharge is transferred to the gap between the auxiliary cathode and the main anode. This discharge, as has been pointed out heretofore, is directed along a path, around the edge of the barrier or baffle 31 toward the main cathode 16. It has been found that as a result of this effect, transfer of the discharge from the auxiliary cathode-main anode gap to the main cathode-main anode gap can occur at a much lower difference in potential between the two cathodes than would be necessary if the baffle or barrier were not present. In a typical case a reduction of the order of 30 volts, i. e. from about 60 volts to 30 volts, in this potential difference has been realized.

One application of the discharge device, specifically as a ringing control in 4-party line telephone systems, is illustrated in Fig. 3. The main cathode 16 is grounded, as shown, and the auxiliary cathode 26 is connected to the telephone line conductor 35 through a resistor 36. The main anode 23 is connected, in series with the ringer 37, to the other line conductor 38 and the control anode 30 is connected to this conductor through a resistor 39. The line conductors lead to terminals at a central office, indicated to the right of the line X-X in Fig. 3, one of the terminals being grounded directly and the other terminal leading to a biasing battery 40 and ringing current source 41. For the positive party on ring, the conductor 35 is connected to the grounded terminal and the conductor 38 is connected to the terminal leading to the source 41. The voltage due to the source 40 is insufficient to effect breakdown of the control anode-auxiliary cathode gap. However, when the voltage due to source 41, which may be of sine wave form, together with that due to the source 40 reaches a prescribed value, conduction in the control anode-auxiliary cathode gap is initiated and as the voltage increases, in the positive half of the cycle of source 41, the current in this gap increases. The potential of the main anode 23, when no ringer current is flowing, follows that of the line 38 and the potential difference between the control cathode and main anode is equal to that of line 38 minus the drop in the auxiliary cathode resistor 36. As the control gap current increases, a condition is reached, early in the cycle, when transfer of the discharge to the auxiliary cathode-main anode gap occurs.

The impedance of the ringer 37 is much smaller than that of the control anode resistor 39. Hence, when the aforementioned transfer occurs, the current in the auxiliary cathode-main anode gap is greater than that which flowed in the control gap and the drop in the cathode resistor 36 increases rapidly as the line voltage increases. Consequently, the potential of the auxiliary cathode relative to the main cathode likewise increases

and when this potential reaches a certain value, transfer of the discharge to the main cathode-main anode gap occurs. Ringing current continues to flow as long as the line voltage remains above the sustaining voltage of the main cathode-main anode gap.

In the manufacture of the device, it is necessary to outgas the several electrodes. As to the two cathodes, this may be accomplished most conveniently by radio frequency induction heating through the agency of a coil positioned about the vessel 10 for producing a radio frequency field parallel to the axis of the vessel. It will be appreciated that both cathodes should be heated to the same temperature to effect the desired outgassing thereof. Most of the heating current induced in the main cathode 16 results from interception of the radio frequency field by the flanges 17; similarly much of the heating current induced in the auxiliary cathode 26 results from interception of the radio frequency field by the bracket 28. The combination of the bracket support 28 and the flanged cathode members enables correlation of the effective heating areas of the two cathodes so that despite the large difference in the sizes of the two cathodes the two can be heated simultaneously to the same temperature and thus concurrently denuded of occluded gases.

Although a specific embodiment of the invention has been shown and described, it will be understood that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electric discharge device comprising an enclosing vessel having an ionizable atmosphere therein and housing a main anode, a main cathode opposite said anode, an auxiliary cathode opposite said anode, a control electrode adjacent said auxiliary cathode, and baffle means mounted between said anode and said auxiliary cathode for directing the discharge between said auxiliary cathode and anode into a path passing into proximity to the gap between said main cathode and said anode.

2. An electric discharge device comprising an enclosing vessel having an ionizable atmosphere therein and housing a main anode, a sheet auxiliary cathode opposite said anode, a main cathode opposite one side edge of said auxiliary cathode, a control electrode in proximity to the face of said auxiliary cathode toward said anode, and an insulating barrier means mounted between said anode and said auxiliary cathode for directing the discharge therebetween into a path toward said main cathode.

3. An electric discharge device comprising an enclosing vessel having an ionizable atmosphere therein and housing a main cathode, an insulating barrier plate spaced from and having one side edge toward said cathode, an anode opposite one face of said barrier plate, and an auxiliary cathode opposite the other face of said barrier plate.

4. An electric discharge device in accordance with claim 3 wherein said auxiliary cathode is of sheet form and has one side edge toward said

main cathode, the device comprising also a control electrode in juxtaposition to the opposite side edge of said auxiliary cathode.

5. An electric discharge device comprising an enclosing vessel having an ionizable atmosphere therein and housing a main cathode having an arcuate concave emissive face, an insulating sheet spaced from and having one side edge toward said face, a rod anode opposite one face of said sheet, and an auxiliary cathode opposite the other face of said sheet and having an emissive surface facing said other face.

6. An electric discharge device in accordance with claim 5 wherein said auxiliary cathode is of plate form and has one side edge toward said concave face, the device comprising also a rod control electrode in juxtaposition to the other side edge of said auxiliary cathode.

7. An electric discharge device comprising an enclosing vessel, a pair of electrodes within said vessel, said electrodes being of unequal sizes, flange means extending from the larger of said electrodes substantially normal to the major surfaces thereof, other flange means extending from the smaller of said electrodes substantially normal to the major surfaces thereof, said flange means being of unequal sizes effecting inductive heating of said electrodes by a high frequency field substantially parallel to said major surfaces simultaneously to substantially the same temperatures, and means cooperating with said flange means to support said electrodes in said vessel.

8. An electric discharge device comprising an enclosing vessel, a pair of sheet metal cathodes within said vessel and extending parallel to an axis thereof, one of said cathodes being substantially larger than the other, and means for effecting simultaneous heating to substantially the same temperature of both said cathodes by a high frequency field parallel to said axis, said means comprising metallic projections on both said cathodes extending in directions at angles to said axis, said projections being of different sizes, whereby the effective heating areas of the two electrodes are correlated.

9. An electric discharge device comprising an enclosing vessel, a pair of sheet metal cathodes within said vessel and extending parallel to an axis thereof, one of said cathodes being substantially larger than the other, an anode opposite one face of each of said cathodes, and metallic projections extending substantially normal from the opposite face of each of said cathodes, said projections being of different sizes, whereby the effective heating areas of the two electrodes are correlated to effect simultaneous heating of the two cathodes to substantially the same temperature by a high frequency field parallel to said axis.

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

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