July 15, 1947. A. VANG 2,423,858

ELECTRIC DISCHARGE, ULTRA HIGH FREQUENCY GENERATING, AND SWITCHING TUBE

Filed Feb. 24, 1944 3 Sheets-Sheet 1

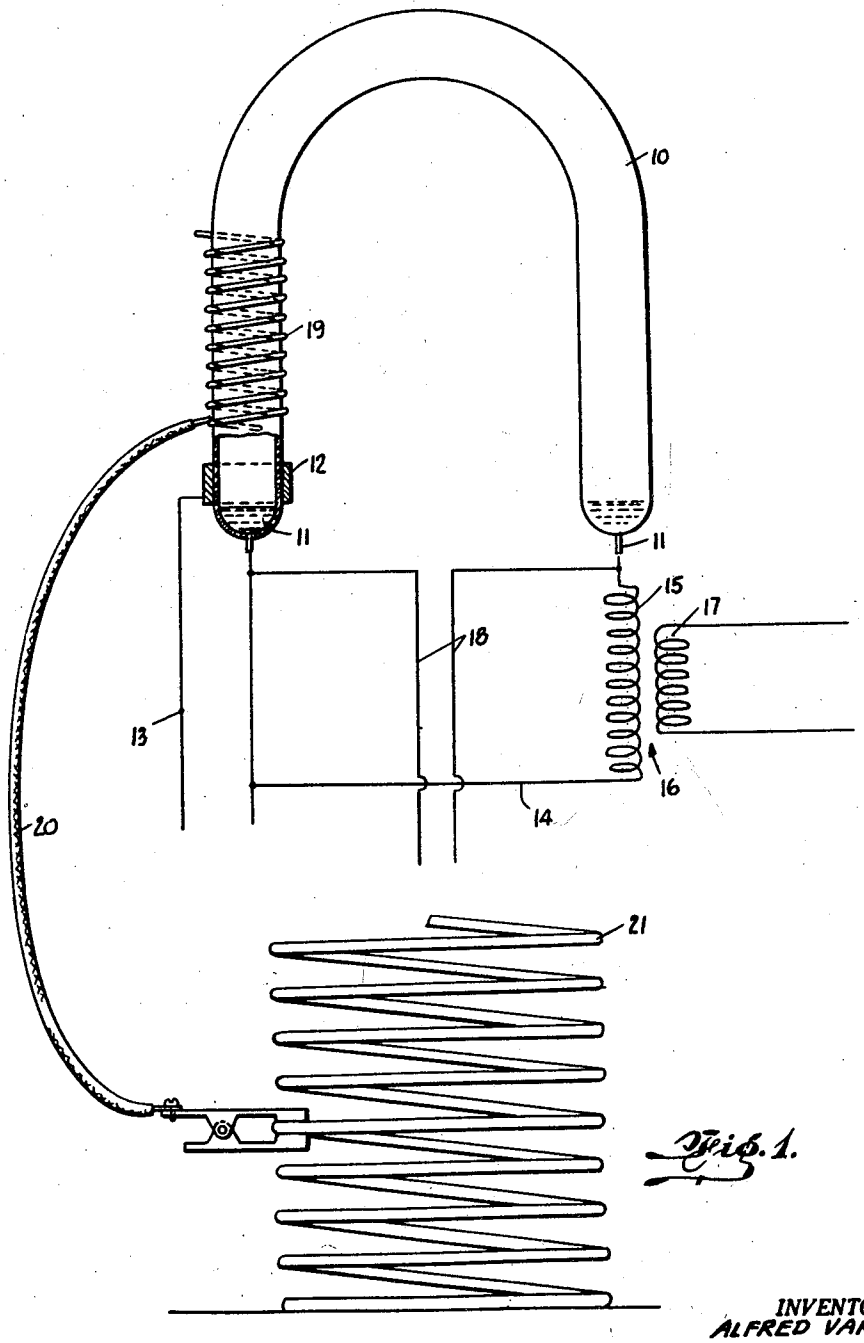


Fig. 1.

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Filed Feb. 24, 1944 3 Sheets-Sheet 2

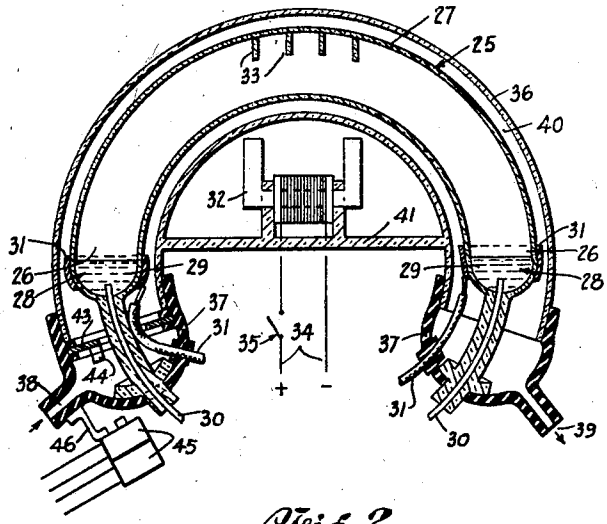


Fig. 2.

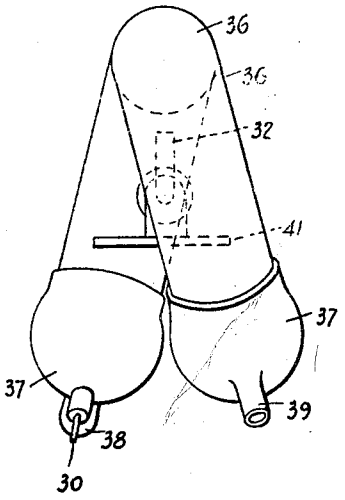


Fig. 3.

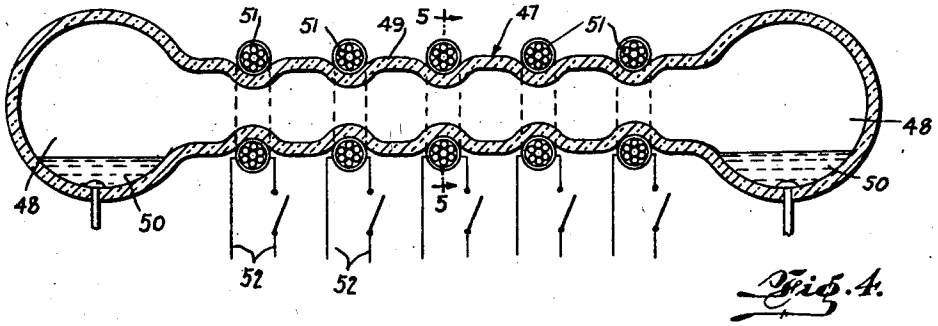


Fig. 4.

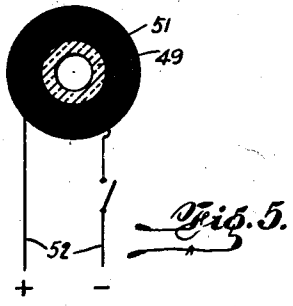


Fig. 5.

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ELECTRIC DISCHARGE, ULTRA HIGH FREQUENCY GENERATING, AND SWITCHING TUBE

Filed Feb. 24, 1944 3 Sheets-Sheet 3

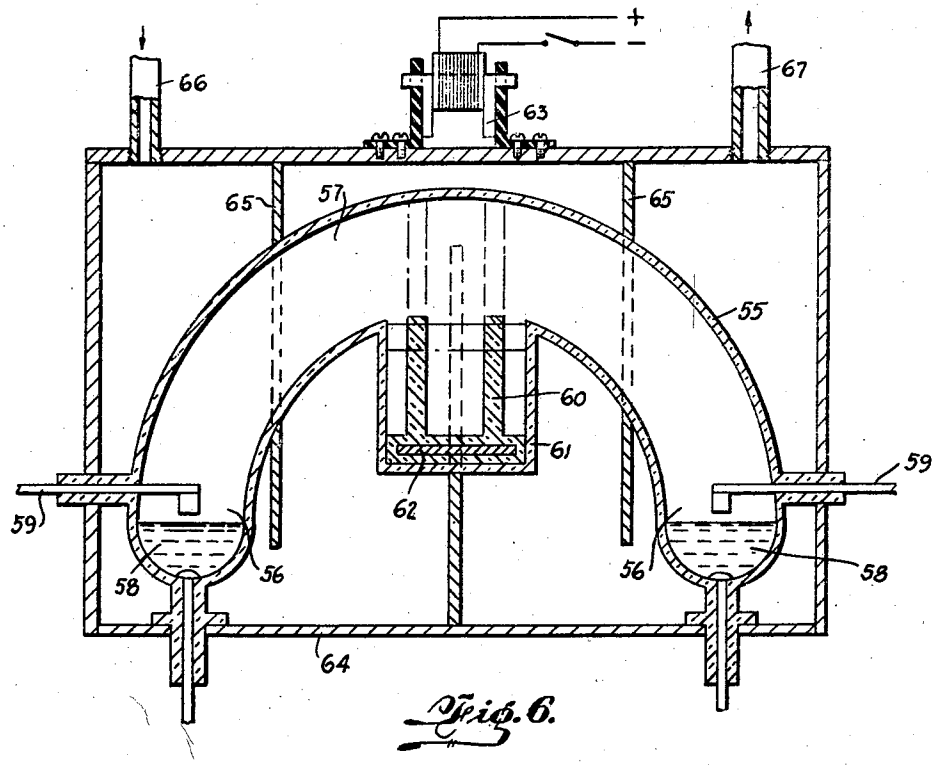


Fig. 6.

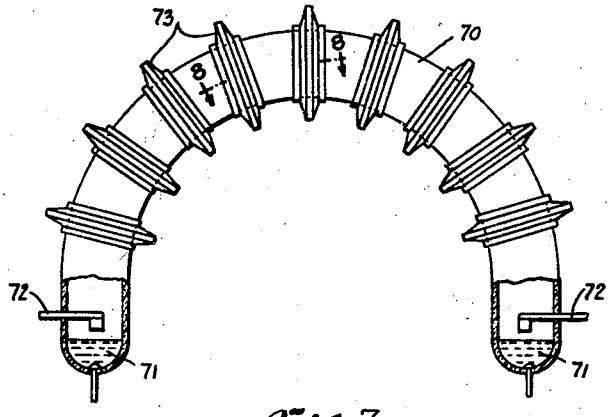


Fig. 7.

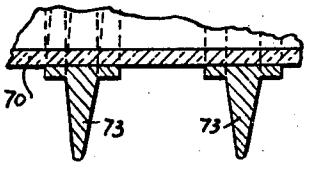


Fig. 8.

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UNITED STATES PATENT OFFICE

2,423,858

ELECTRIC DISCHARGE, ULTRA HIGH FREQUENCY GENERATING, AND SWITCHING TUBE

Alfred Vang, New York, N. Y.

Application February 24, 1944, Serial No. 523,634

4 Claims. (Cl. 250—27.5)

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This invention relates to new and useful improvements in electric discharge, ultra high frequency generating, and switching tubes, and it has more particular reference to improvements on my electrical discharge tubes of the United States Patent No. 2,287,541, issued June 23, 1942, which improvements will make them more valuable for discharging, or switching heavy electric currents, or generating ultra high frequency currents.

Under the impetus of the great strides made in industrialization, the electric industry is growing very rapidly. Great demand has developed for better and improved equipment to handle the ever increasing volume of electric power at rapidly increasing frequencies, voltages and amperage. The equipment now used for handling heavy currents is inadequate and quite dangerous.

The use of my discharge tubes for generating high frequency currents is of immense value in numerous industries. Its present greatest value is in the welding art, though this is but one art of many in which it may be used. In accordance with this invention it is proposed that the discharge tube be used as a generator of ultra high frequency currents, by converting relatively low frequency currents. It is contemplated that the low frequency feeding current and the delivered ultra high frequency currents may be separated and independently used.

The invention also contemplates the use of a conductor coil arranged externally of the envelope and within the field of the ultra high frequency current, generated by said discharge tube for picking up ultra high frequency impulses. This coil may be connected up with a suitable capacitor. The presence of the high frequency impulse may easily be detected by a neon tube and certain electric lights.

At switchboards and other switching points, it is customary to use a switching mechanism in which circuits are made and broken by engaging and disengaging a pair of contacts. Generally, these contacts are exposed and quite dangerous. Often vicious electric arcs are drawn when the contacts are separated to open electric circuits. Such exposed arcs are highly undesirable. Not only do they cause a heavy wear and tear on the contacts themselves by generating high degrees of heat, but there is always the danger present

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that they will be uncontrollable for one reason or another, and short-circuit equipment, and even seriously hurt or electrocute persons and cause explosions of fumes, which may be present. This is particularly true for ultra high frequency currents of large voltage.

Numerous attempts have been made to construct equipment which would be relatively safe. Devices have been provided to blow out these arcs as they occur. Some equipments have used blasts of air to do this. Other systems make use of magnetism to blow out the arcs. In other equipments shields of various types have been made to confine the arcs. In still other equipments the arcs have been surrounded with oil or other fluids.

However, under present day conditions, with a continuous increase in the power being used, it has been found on many occasions that the present equipment does not match up to the job.

My discharge tube, as disclosed in my patent, supra, is well adapted to act as a switching, high frequency current generating and discharge device. An important feature of its construction resides in the fact that the arc is at all times confined within an insulation envelope, of which the tube is made. With this arrangement, the dangers previously pointed out have been materially decreased. Moreover, my design of tubes is especially well adapted to handle very large currents. For this reason, it offers a simple solution for the problems pointed out above.

However, it has been found desirable to add certain important improvements to my said patented invention, to adapt the tube for the new purposes stated.

In the first place, it is proposed to provide means externally of the tube for restricting the flow of current through the tube. With this addition the discharge tube also becomes a switching tube. The external means, thus referred to, may take any number of different forms, or designs, and work in accordance with any number of different methods. Several of said forms of the invention have been disclosed in this application. In one form, the restricting means has been disclosed in the nature of electro-magnetic means for blowing the internal arc against a series of baffle plates to increase its length and in this manner cause the arc to break and thus discontinue the current. In another form of the inven-

tion, one or a plurality of electro-magnetic coils is proposed, arranged around the tube for constricting the arc at these points within the tube. This restriction of the flow of current may be used for many different purposes.

The invention also proposes the provision of novel cooling means for the discharge tube. When the tube is used for extra high currents, for discharge and switching purposes for long periods of time, there is a tendency for the envelope to heat up. This invention discloses several ways for radiating the heat to keep said temperature down. With the constructions suggested and disclosed, it is possible to use the tube for the control of greater power discharges.

The invention contemplates characterizing the cooling means by circulating a coolant around the discharge tube, numerous coolants are proposed, both liquid and gaseous. In one form of the invention water or other vapors are proposed and supersonic vibrations are used for speeding up the transfer of heat from the discharge tube to the cooling vapors.

With the above and other objects in view, this invention consists of the novel features of construction, combination, and arrangement of parts, hereinafter fully described, claimed and illustrated in the accompanying drawings, forming part of this application, and in which similar characters of reference indicate corresponding parts in all views, and in which:

Figure 1 is a schematic view, illustrating the manner in which my tube may be used as a high frequency generator.

Figure 2 is a longitudinal sectional view of my electric discharge and switching tube, constructed in accordance with another form of this invention.

Figure 3 is an end elevational view of the tube in Figure 2.

Figure 4 is a longitudinal sectional view of another electric discharge and switching tube constructed in accordance with another form of the invention.

Figure 5 is a sectional view taken on the line 5—5 of Figure 4.

Figure 6 is another longitudinal sectional view of an electric discharge and switching tube constructed according to still another form of this invention.

Figure 7 is a side elevational view of another electric discharge tube constructed in accordance with a somewhat different form of this invention.

Figure 8 is a fragmentary enlarged sectional view taken on the line 8—8 of Figure 7.

Referring more particularly to the drawings, in Figure 1, one arrangement has been shown of the improved electric discharge tube in which it has been connected up as a generator for ultra high frequency currents. This generator tube includes the usual insulation material envelope 10, containing a pair of mercury electrodes 11, or electrodes of other suitable material. The interior compass of the envelope 10 is rarefied and charged with a conducting gas or other media. A starting electrode 12 is associated with the tube and connected with a starting circuit 13.

The electrodes 11 are connected up in a circuit 14, which includes the secondary 15 of a transformer 16, having a primary 17. It is intended that the primary 17 be connected with an alternating current, such as is usually supplied for commercial purposes. The transformer 16 should be of a design to step up the voltage to

several thousand or more volts. An experimental tube which I have used in the laboratory was supplied with twenty-five thousand volts and worked excellently. The electrodes 11 are also connected up with a circuit 18 for the ultra high frequency current which is generated by the discharge tube. It is intended that this circuit 18 be associated with suitable choke mechanism which permits passage only of the high frequency current desired.

A coil 19 of conducting material is wound externally around the envelope 10. This coil is connected by a lead 20 with a capacitance coil 21. The ultra high frequency current generated within the discharge tube will produce an ultra-high frequency field, which will set up induced currents in the coil 19. These currents may be detected by a neon lamp, other types of lamps, wave meters, and other measuring instruments.

The electric discharge and switching tube, disclosed in the Figures 2 and 3, includes a closed envelope 25 of insulation material, having a pair of spaced portions 26, which are lower than the portion 27 between said spaced portions 26. A mercury electrode 28 is provided for each of said pair of spaced portions 26 for connection in an external electric circuit for conducting current through said tube 25. Each electrode 28 includes a pool of mercury 29, disposed in said low portions, an electric lead 30 extending through the material of the envelope 25 to the exterior. Starting and control electrodes 31 located outside of the envelope 25 is provided for controlling the flow of electric current through the tube. Up to this point the electric discharge tube is substantially identical to the tube disclosed in my patent referred to above.

The improved tube now distinguishes in the provision of means external of the tube for restricting the flow of current through the tube. This means includes an electro-magnet 32 located between the said pair of spaced portions 26 and opposed to a plurality of baffle plates 33, located within the envelope 25 at the side remote from the electro-magnet 32. The electro-magnet 32 is connected in an electric circuit 34, controlled by a switch 35. When the switch 35 is closed, the electro-magnet 32 becomes energized and the magnetism will blow the electric arc within the envelope 25 against the baffle plates 33, lengthening the arc and thus increasing the resistance within the tube and causing the arc to break and thus turn off the current through the tube.

The improved tube is also equipped with cooling means characterized by an outer envelope 36, encasing said envelope 25. Nipples 37 are mounted on the ends of the envelope 36 and are provided with an inlet 38 and an outlet 39, through which a cooling fluid may be circulated. It is proposed that the space 40 between the envelopes 25 and 36 be very small, so that the efficiency of the radiating system will be relatively great. However, in order to make the space 40 small, it becomes a problem to insert the envelope 25 within the envelope 36. This problem has been solved by making the envelopes annular, concentric and helical. With this arrangement, it is an easy matter to screw the envelopes together. The helical construction of the envelopes may easily be recognized by an inspection of Figure 3. The electro-magnet 32 is shown mounted on a bridge 41 constructed between the sides of the outer envelope 36.

The coolant which is to be circulated through

the space 40 may be either liquid or gaseous. If liquid, any of the cooling substances generally known may be used. If gaseous, I would prefer a water vapor or other vapor. In order to increase the efficiency of heat absorption by this vapor a vibration diaphragm in the nature of a sheet metal ring 43 is mounted across one end of the outer envelope 36. This ring 43 is provided with an armature 44 which may be attracted and repelled by the positive and negative electro-magnet 45, suitably supported by a bracket 46. The electro-magnet 45 is capable of vibrating the diaphragm 43 with sonic or supersonic vibrations. These vibrations will be transmitted to the gaseous substance circulating through the space 40, facilitating the transfer of heat from the envelope 25 to the cooling medium.

In the Figures 4 and 5, a modified form of the invention has been disclosed in which the electric discharge and switching tube includes a closed envelope 47 of insulation material, having a pair of spaced portions 48 which are lower than the portion 49 between said spaced portions. It should be noted that the envelope 47 is in the shape of a semi-circle. It is desired to point out that the envelope 25 described above is of inverted U-shape. A mercury electrode 50 is located in each of said pair of spaced portions 48 for connection in an external electric circuit for conducting current through the tube. A plurality of coils 51 are arranged transversely of the envelope 47 at spaced points along the tube. Electric circuits 52 control the passage of current through the coils 51. One of the coils 51 may be used as a starting electrode for the electric current which is to flow through the tube. The series of coils 51 may be used for restricting the flow of current through the tube. As current flows through the coils 51, the magnetism from the coils will constrict the arc through the envelope 47. For each coil 51 there will be a separate constriction. This restricted current may be used for various purposes. By suitably operating the circuits 52, it is possible to modulate a direct current into a pulsating current of various characteristics.

In Figure 6 another form of the invention has been disclosed, in which an electric discharge tube 55 of insulation material is provided with a pair of spaced portions 56, which are lower than the portion 57 between said spaced portions. Mercury electrodes 58 are located within and through said spaced portions 56 for connection in an external electric circuit for controlling current through said tube. Starting and control electrodes 59 from the outside are mounted through the envelope 55. The envelope 55 is also provided with means for restricting the flow of current through the tube. This means is in the nature of a slidably mounted shutter 60, capable of extending across the envelope 55 at a point between the spaced portions 56. The shutter 60 is slidably mounted in an offset portion 61, formed at one side of the envelope 55. An armature 62 is mounted on or within the shutter 60. This armature is attractable by an electro-magnet 63, mounted externally of the envelope 55. Gravity or other forces is depended upon to move the shutter 60 to a down or open condition. The electro-magnet 63 is for the purpose of raising the shutter 60 across the envelope 55 to cut the electric arc.

The envelope 55 is shown mounted within a container 64, having several baffles 65 for guiding the circulation of a cooling fluid. This container

64 has an inlet 66 and an outlet 67 for the cooling fluid. The cooling fluid may be oil, water, or brine, or other material capable of conducting heat given off by the envelope 55 to prevent overheating.

In Figures 7 and 8 still another form of the invention is disclosed, in which the electric discharge and switching tube includes a closed inverted U-shaped envelope 70, having mercury electrodes 71 at its ends. This tube is provided with starting and control electrodes 72. A plurality of fins 73 are mounted upon the envelope 70 at spaced positions for the purpose of air cooling the tube by convection.

It is obvious that slight changes may be made in the form, construction and arrangement of the several parts, as shown, within the scope of the appended claims, without departing from the spirit of my invention, and I do not, therefore, wish to limit myself to the exact construction and arrangement shown and described herein.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. An electric discharge and switching tube, comprising a closed envelope of insulation material, having a pair of spaced electrodes for connection in an external electric current, a medium adapted to be ionized, for conducting current through said envelope, a starting and control electrode outside of said envelope for controlling electric current flowing through said envelope, and means externally of said envelope for restricting the flow of current through said envelope, comprising a shutter slidably mounted to move across said envelope at a point between said spaced portions, and external means for moving said shutter.

2. An electric discharge and switching tube, comprising a closed envelope of insulation material, having a pair of spaced electrodes for connection in an external electric current, a medium adapted to be ionized, for conducting current through said envelope, a starting and control electrode outside of said envelope for controlling electric current flowing through said envelope, and means externally of said envelope for restricting the flow of current through said envelope, comprising a shutter slidably mounted to move across said envelope at a point between said spaced portions, and external means for moving said shutter, including an external electro-magnet, and an armature mounted on or within said shutter.

3. An electric discharge and switching tube, comprising a closed envelope of insulating material, having a pair of spaced electrodes for connection in an external electric circuit, a medium adapted to be ionized, for conducting current through said envelope, a starting and control electrode for ionizing said medium and controlling the electric current flowing through said envelope, and means for distorting an arc flowing in the envelope and comprising transverse baffles of insulating material projecting into the interior of the envelope, and magnetic field producing means exterior of the envelope and substantially opposite said baffles.

4. An electric discharge and switching tube, comprising a closed envelope of insulating material, having a pair of spaced electrodes for connection in an external electric circuit, a medium adapted to be ionized for conducting current through said envelope, a starting and control electrode for ionizing said medium and controlling electric current flowing through said envelope,

means for cooling said envelope, and comprising a container encasing said envelope and having an inlet and outlet, and baffle means within said container for guiding cooling fluid through the container, and means for distorting an arc flowing in the envelope, said means comprising transverse baffles of insulating material projecting into the interior of the envelope, and magnetic field producing means exterior of the envelope and substantially opposite the baffles.

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