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K. FRITZ

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MAGNETRON

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FIG 1

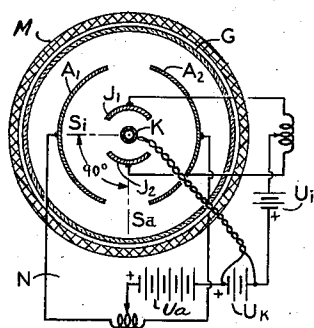


FIG 2

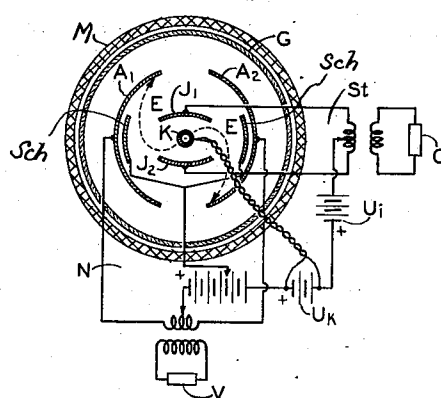


FIG 3

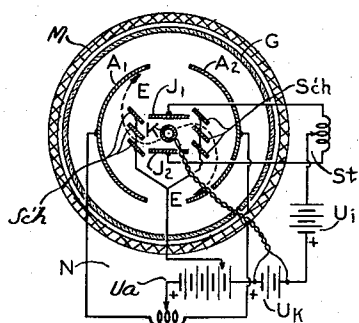


FIG 4

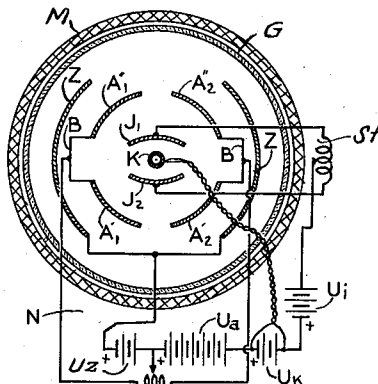
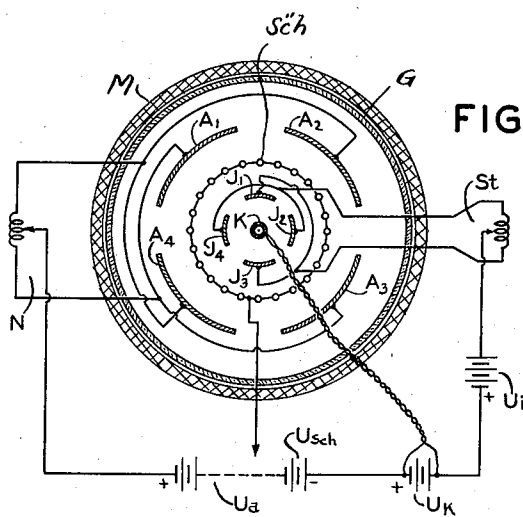


FIG 5



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MAGNETRON

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5 Claims. (Cl. 250—27.5)

The present invention relates to electron discharge devices of the so-called magnetron type and which are furnished with several electrode assemblies or systems spaced different distances away from the cathode and disposed one behind the other.

These tubes comprise several electrodes of dissimilar size and are arranged in pairs or groups symmetrically with respect to the cathode. The electrode system mounted nearest to the cathode is mostly employed for controlling the discharge action, while the system spaced farther from the cathode mostly plays the part of the energy absorbing system.

The principal object of the present invention is to provide an improved electron discharge device of the magnetron type suitable as oscillator driven amplifiers, frequency multipliers, and in various circuit arrangements.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 is a schematic diagram of an electron discharge device of the magnetron type having inner and outer electrode systems and a circuit therefor, Figures 2 to 5 inclusive are diagrammatic representations of electron discharge devices made according to my invention and their associated circuits.

In order to facilitate proper understanding of the invention Figure 1 shows a simple exemplified embodiment of a tube of the type described and by reference to this figure the actions and phenomena occurring in operation will be described and explained.

Figure 1 is a section at right angles to the axis of the electrode system. At the axis of the system is the straight thermionic cathode K. The cathode is surrounded by two inner electrode segments or sections J₁ and J₂ coaxial and parallel with cathode K. Surrounding the said inner electrodes are two further outer electrodes or anode segments A₁ and A₂. The electrodes are mounted within an envelope G. The plane which may be taken through the gap S₁ of the inner system is at right angles to the corresponding plane laid through the gaps S_a of the outer system. A magnetic coil M furnishes the magnetic field parallel to the cathode and between the cathode and the electrodes J₁ and J₂ and A₁ and A₂. If then, to both electrode systems similarly tuned oscillatory circuits N, S_t, are connected,

the voltage supply sources being shown at U_a, U_k and U_i, and if one thereof is master-excited, for example by a separate oscillator, no energy will normally reach the unexcited circuit because the electrostatic coupling between the systems is practically zero due to the stagger or displacement of the planes through the gaps, a condition which would be absent in a cup-shaped arrangement where the planes laid through the gaps coincide. Transfer of energy from one circuit to the other by virtue of interelectrode capacitance is unable to take place because two electrodes of the adjacent system excited in phase opposition act upon a given electrode.

Such purely geometric or electrostatic uncoupling (balancing out), however, is not sufficient in the case of a master-controlled amplifier since the alternating current field (cross-field) which is set up between opposite outer electrodes A₁ and A₂ acts upon the paths of the electrons, thereby resulting in a sort of electronic feedback from the outside to the inside. The consequence is that the paths or orbits of the circulating electrons which are merely to be influenced by the control fields of the inner electrode, are straightened out upon approaching the outer electrode being at the high or instantaneous potential, and are more markedly curved upon approaching the outer electrodes being at the lower instantaneous potential than would be true in a case where between the outer electrodes an equality of potential existed. In other words, there arises a kind of dynamic feedback which will arise only when oscillations are generated or more particularly amplified.

By the present invention the undesirable reactions arising in master-excited or driven amplifiers, frequency multipliers, receiving circuit organizations and other circuit schemes are lessened or avoided.

The magnetron tube of the invention comprising several electrodes or electrode assemblies spaced different distances from the cathode has this outstanding feature, that opposite the gaps between the electrodes of the inner electrode assembly and between the inner electrodes and outer electrodes or the next following electrode system (power system) there are positioned screen electrodes or shields, or a gap is provided in the electrodes of the outer system.

The screen electrodes may be accommodated either in the neighborhood of the inner system in which case they may have the form of a shutter arrangement or else they may be disposed in the neighborhood of the power or outer system, the shields also in this instance being given a form

which will be practically adapted to the paths of the electrons.

If the idea underlying this invention is to be applied to magnetron tubes in which each electrode system comprises more than two electrodes, the disposition and accommodation of the screen electrodes is attended with difficulties in a large number of cases. However, the problem under such circumstances may be solved by providing a single apertured electrode between the inner system and the power system, say, in the form of a wire coil or wire cage rather than using several distinct screen electrodes.

By reference to Figures 2 to 5 the construction and mounting together with the operation so far as necessary, of the improved tube design here disclosed is explained and described.

Figure 2 shows a tube which fundamentally corresponds to the tube illustrated in Figure 1. The cathode K is surrounded by two inner-system electrodes J_1 and J_2 , between which are two comparatively large gaps. Associated with the inner electrodes J is a master circuit S, which is excited from an outside source of alternating current O. Overlapping the gaps provided in the inner electrode system are the power electrodes A_1 and A_2 which are connected with the output circuit N which delivers amplified energy to a consumer or load V. Now, in order that action by the outer electrodes across the gaps in the inner system may be avoided, such portions of the power electrodes as are placed opposite the gaps of the inner system are covered by screen or shielding electrodes S_{ch} . These screening electrodes S_{ch} are so shaped and mounted that they will not block the path E of the electrons. The whole discharge system is confined within a gas-tight vessel G. Cathode K is supplied with heating current from a battery U_k . The connecting leads for the cathode K are arranged in a way similar to Figure 1. On the inner system is impressed by the battery U_i either a negative or a feebly positive biasing potential in reference to the cathode. The power electrodes A receive from battery U_a a comparatively high positive potential. The shielding electrodes S_{ch} which practically have no a.-c. voltage, are given a positive bias potential, the latter being, however, less than the biasing potential of the power electrodes A_1 and A_2 . The biasing voltage imparted to the screening electrodes must always be so proportioned that, in the absence of alternating voltages on the electrodes of the tube, substantially the same field conditions will prevail inside the space between the shielding electrodes as would obtain in the absence of the latter electrodes by the influence of the power electrodes A_1 and A_2 . As regards the dimensions of the screen electrodes, to give an average value, the length should be equal to, or slightly greater than, that of the other electrodes, in order that screening effects may be assured also at the ends of the discharge system. In peripheral direction, the screen electrodes should be preferably made of a width roughly equal to, or slightly greater than, the width of the gaps of the inner system.

Figure 3 shows a similar tube in a suitable circuit arrangement. Like reference letters denote similar elements. It is only the form and the mounting of the screen electrodes that are modified. The screen electrodes S_{ch} are disposed in the vicinity of the inner system directly anteriorly of the gaps, and they consist of several narrow

segments placed parallel to the axis. Similar to a shutter or blind arrangement, they are so positioned and formed that they will readily allow the passage of the circulating electrons, while precluding chances of an electrostatic action of the outer electrodes being brought about there-through in that part of the discharge space between the inner electrodes. The constituent parts of these shutter or blind-like electrodes are preferably connected inside the tube with each other, and they are also in this instance impressed with a positive biasing potential with respect to the cathode in order that the form of acceleration field (direct voltage) may approach the ideal case of cylindric symmetry which may be roughly attained.

In a tube as shown in Figure 4 the screening electrodes have been dispensed with. Instead those parts of the outer electrodes which are opposite the gaps between the inner electrodes have been cut out. These parts of the electrodes normally take no electrons. However, they are not dispensable for they are required for the production of the accelerator field. For this reason, posteriorly of the gaps between the outer electrodes, electrodes Z are mounted. These electrodes Z are maintained at a constant positive potential with respect to the cathode, and they merely serve to insure a uniform distribution of the field. Instead of several separate electrodes Z, a single solid electrode Z closed all around the cylinder circumference would be suitable. Inasmuch as these electrodes are mounted a comparatively great distance from the cathode, the biasing potential impressed thereon must be correspondingly high, that is higher than the biasing voltage applied to the power electrodes A_1 and A_2 , for the reason that inside the discharge space properly so-called the direct current field conditions are to prevail which would be expected in the presence of normal construction of the power electrode according to Figure 1. The corresponding parts of A_1' and A_1'' and A_2' and A_2'' of each electrode are interconnected by wire or ribbon shaped clips or bow pieces B.

Figure 5 shows a magnetron tube in which each of the various electrode systems consists of a plurality of electrodes, say, four electrodes. Now, in the case of such a tube it would be extremely difficult to accommodate between the inner system and the power system several separate shielding electrodes conjointly with the requisite connection wires. An efficient solution of this problem is found if between the inner system and the power system an apertured electrode S_{ch}'' preferably in the form of a wire helix or coil is provided with a cylindrical surface. The use of a wire coil whose axis coincides with the cathode, offers the advantage over a wire cage presenting individual wires placed parallel to the axis that the electrons which move in planes at right angles at right angles to the cathode, will be but little impeded or obstructed. Such a grid-shaped screen electrode, of course, could fundamentally speaking be employed also with bipartite electrode systems.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the

purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What I claim as new is:

5 1. An electron discharge device having an envelope containing a straight thermionic cathode, an inner group of electrode segments surrounding said cathode and an outer group of electrode segments surrounding said cathode and inner
10 group of electrode segments, and shielding means positioned between the inner and outer segment groups and opposite the gaps between the inner electrode segments, and means for inducing a magnetic field between said cathode and electrode
15 segments parallel to said cathode.

2. An electron discharge device having an envelope containing a straight thermionic cathode and a plurality of electrode segments surrounding and parallel to said cathode and forming a
20 first group of electrode segments, a second group of electrode segments coaxial with said cathode and said first group and outside of said first group, and shielding means comprising segments positioned between the outer and inner group of
25 segments and opposite the gaps between the inner electrode segments, and means for inducing a magnetic field between said cathode and electrode segments and parallel to said cathode.

3. An electron discharge device having an envelope containing a straight thermionic cathode and a plurality of electrode segments surrounding and parallel to said cathode and forming a
30 first group of segments, a second group of electrode segments coaxial with said cathode and said first group and outside of said first group,
35 and shielding means comprising a plurality of

narrow segments parallel to the cathode and between the outer and inner groups of electrode segments and opposite the gaps between the inner electrode segments, and means for inducing
5 a magnetic field between said cathode and electrode segments parallel to said cathode.

4. An electron discharge device having an envelope containing a straight thermionic cathode and a plurality of electrode segments surrounding and parallel to said cathode, a group of anode
10 segments coaxial with said cathode and outside of said electrode segments, and shielding means comprising a plurality of segments parallel to said cathode and mounted in spaced relation and parallel to each other and positioned so that elec-
15 trons from the cathode may pass freely from the cathode to the anode segments, said shielding means being positioned between the electrode and anode segments and opposite the gaps between
20 the electrode segments, and means for inducing a magnetic field between said cathode and anode segments and parallel to said cathode.

5. An electron discharge device having an envelope containing a straight thermionic cathode, and a plurality of pairs of inner electrode seg-
25 ments surrounding and parallel to said cathode, an outer group of electrode segments comprising a plurality of pairs of segments surrounding said cathode and inner group of segments and a per-
30 forated cylindrical electrode coaxial with said cathode and positioned between the inner and outer group of segments, and means for inducing a magnetic field between said cathode and
35 segments parallel to said cathode.

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