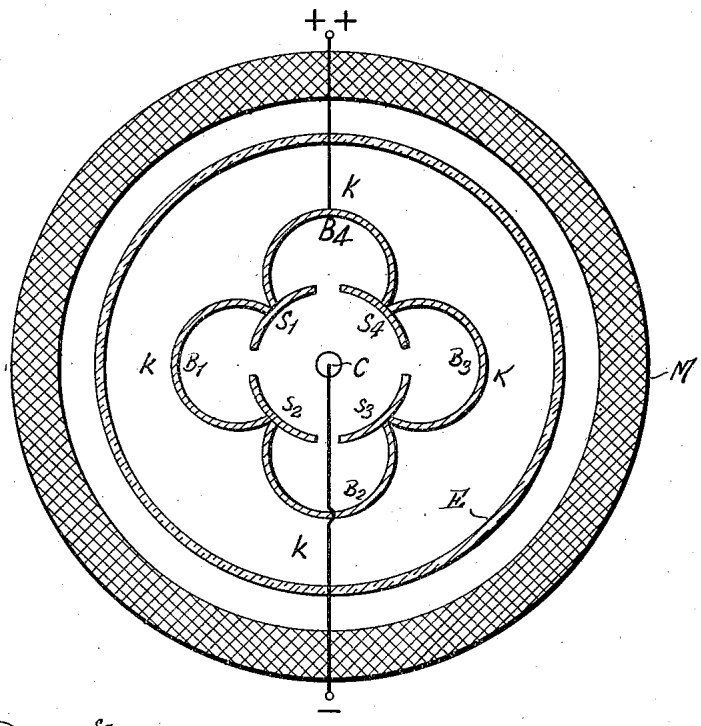
July 12, 1938. H. E. HOLLMANN 2,123,728

MAGNETRON

Filed Nov. 27, 1936

Fig. 1



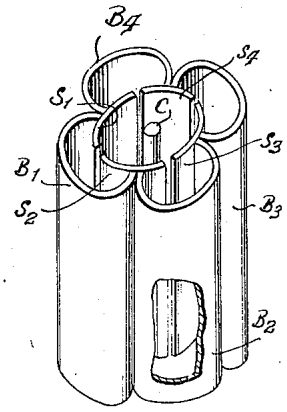
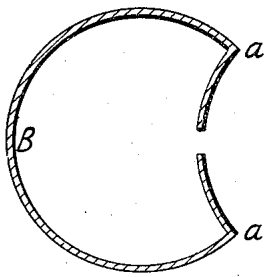


Fig. 3

Fig. 2



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2,123,728

MAGNETRON

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1 Claim. (Cl. 250—27.5)

My invention relates to electron discharge devices, more particularly to improvements in so-called magnetrons in which the electrode system is positioned in a magnetic field.

Investigations regarding the oscillation mechanism of magnetrons have shown that in a magnetron tube whose anode cylinder is divided by two or more slots into two or more segments, two different forms of oscillations of ultra short waves appear, in accordance with the chosen operating conditions, i. e. plate potential and strength of the magnetic field, and in accordance with the tuning of the outer resonance circuits connected to the segments. In one form of oscillation there is to be dealt with rotations of space charges produced by the action of the electrical field and the magnetic field extending at right angle to each other. This form of oscillation is not only attainable in a split anode magnetron, but also in a solid anode cylinder magnetron, and extends in the present state of the art downwards to waves of about one centimeter. The other type of oscillation has its actual origin in a negative electron resistance produced between the plate segments, and which excites the oscillatory system connected with the segments. The production of such negative electron resistance is to be found in the screw shaped course of the electron movement, such as result from the action of the radial and tangential electrical fields in the vicinity of the separation gaps of the segments in conjunction with the magnetic field extending substantially in the axial direction. This form of oscillation although not attaining the aforementioned high frequency owing to the natural inertia of the electron movement, produces however at 2 to 4 times longer waves a very much higher useful energy and a much more favorable efficiency.

The object of my invention is to provide an electrode arrangement and connection for a magnetron for increasing its efficiency.

To increase the efficiency and use of the energy of a magnetron I divide the plate cylinder into several segments, and so combine the segments that the negative electron resistances existing between the separating gaps of the segments, operate in parallel. However this can apparently only be assured when the high frequency potentials at all adjacent segment edges are of opposite phase. In order to secure this optimum state of oscillation of the segments, in the hitherto used structures of magnetron transmitters the segments situated diametrically opposite each other are connected together in pairs by means of one or several bent wire straps reaching around the plate cylinder. In a four part anode, two pairs of segments are obtained in this way each of which is connected to a pole of the resonance circuit to be excited.

When arriving at increasingly shorter waves, the natural frequencies of the small resonance circuits in the tube proper, and which are formed by the mutual capacity of the opposite segments, and the induction of the corresponding closing bend or connecting conductors, cause considerable disturbance, the more so since the connecting conductors when reaching at the outside around the anode cylinder must have a definite minimum length. Waves that are shorter than those which correspond to those small resonance systems thus either cannot be produced at all with such a tube, or only at a very poor useful effect.

Another drawback of these hitherto ordinary constructions of the anode segment system is to be seen in the fact that for instance with a four split anode, segments arranged diametrically opposite to each other have opposite high frequency potentials. This signifies however, that two adjacent segments have equal alternating potentials, and that the split portions situated between them cannot participate in the production of oscillations. Only the edges of the segments on both sides of the other two split portions actually carry opposite potentials and they alone must effect the excitation. Thus the tube is only unilaterally exploited and in an entirely incomplete manner.

By means of the arrangement of the connecting conductors described in the present invention, these drawbacks, namely the excessive length of the conductors as well as the various inclusions of the existing negative electron resistances in the building-up mechanism are safely eliminated. To this end, the invention is based upon the principle joining two adjacent segments by means of connection straps instead of connecting segments situated diametrically opposite to each other.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claim, 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 diagrammatic transverse section of an electron discharge device embodying my invention, Figure 2 shows a detail of construction, and Figure 3 is a perspective of the mount shown in Figure 1 with a part broken away to show details of construction.

All of the four segments S_1 to S_4 around cath-

ode C are connected with each other by four conductors B_1 to B_4, whereby these conductors act, as previously, as inductances, and form small resonance systems with the mutual capacities of the segments. Electrode elements are mounted within an envelope E surrounded by the coil M for inducing a magnetic field parallel to the electrode elements within the envelope. Now when considering the incidental values of the high frequency potentials distributed over the segments, it can be seen that in fact all adjacent segments must oscillate in opposite phase, since at the ends of the bent straps or conductors, only voltages having opposite phase can appear when said ends oscillate in their natural frequency. When considering the electrode assembly, and hence also the state of oscillation as being completely symmetrical, oscillation anodes will be produced on all four culmination points *k* of the conductors. This means, that the inductance of the two adjacent conductor branches up to the culmination points, is to be considered as being placed in parallel to the inductance of each individual strap or conductor.

The arrangement must obviously not necessarily be such that, as indicated in the figure, the points at which the two connections meet the segment, coincide, the points may also be apart from each other, for instance moved towards the edges of the segments. Furthermore, if especially high frequencies are to be produced, it may eventually be of advantage, instead of passing the straps along the outside of the plate cylinder, to arrange them in the extended outer cylindrical surface in which the anodes are situated, and where they can be maintained much shorter. Such bent connections may also be arranged on both sides of the plate cylinder or segments.

In accordance with a further proposition, in place of the wire straps, sheet metal strips may be used to advantage, having the same width as the length of the electrode system for instance. The cross section through such a rosette shaped system remains thereby unchanged as indicated in the figure. The technical construction is especially simple if each strap forms a single piece with the two halves of the adjacent segments, and if the piece is riveted or welded at the bent edges, to the straps on both sides. Such structural part consisting of a strap and two segment halves thus has the cross section shown in Figure 2, and is joined to the following part at the edges *a*. Such sheet metal strips not only have the advantage of very low damping losses, but assure furthermore a uniform state of oscillation of the segments, and prevent undesirable longitudinal oscillations while assuring at the same time a favorable heat delivery, and high load capacity of the tubes.

In order to still further enhance the heat delivery, the straps may be formed as hollow bodies and have a suitable cooling means flow through them. Since the entire system is closed in itself, the cooling fluid may be suitably introduced for instance at the lower culmination point (see Figure 1) from where it will be branched towards the right and the left, and caused to leave at the upper culmination point. The principle of the construction of the segment set in accordance with the invention and relating to the high frequency part has no influence upon the other structures of the generator dealing with measures known as such, as for instance end plates maintained at suitable potential, or several filaments.

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 claim.

What I claim as new is:

An electron discharge device having a straight cathode, a plurality of pairs of sheet metal anode segments coextensive with each other and surrounding said cathode, conductors connecting adjacent anode segments, said conductors comprising sheet metal straps equal in width to the length of said anode segments, and means for producing a magnetic field parallel to said cathode.

HANS ERICH HOLLMANN.