

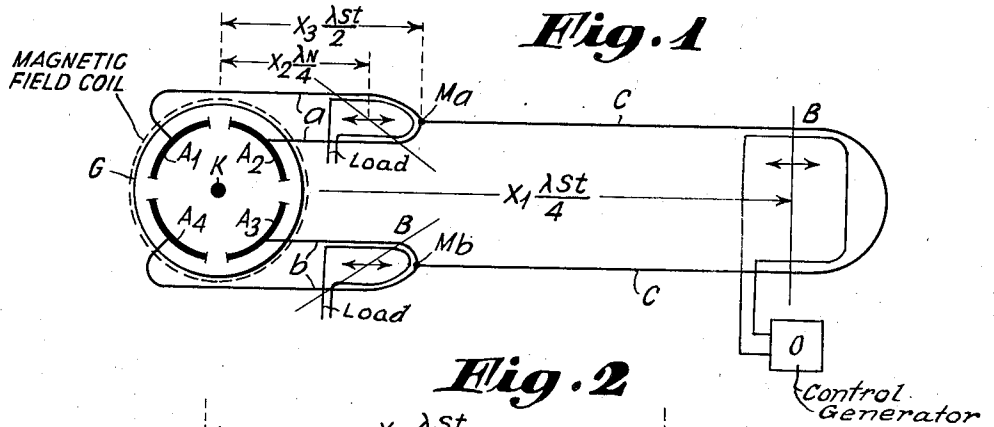
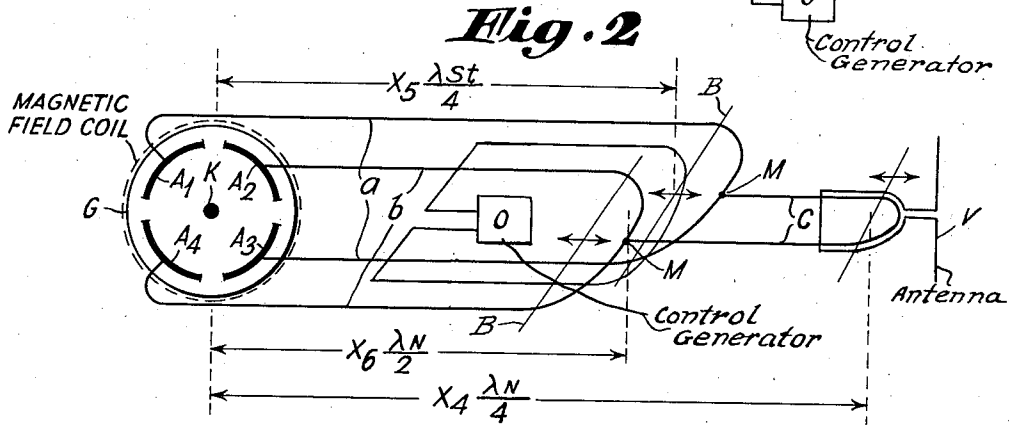
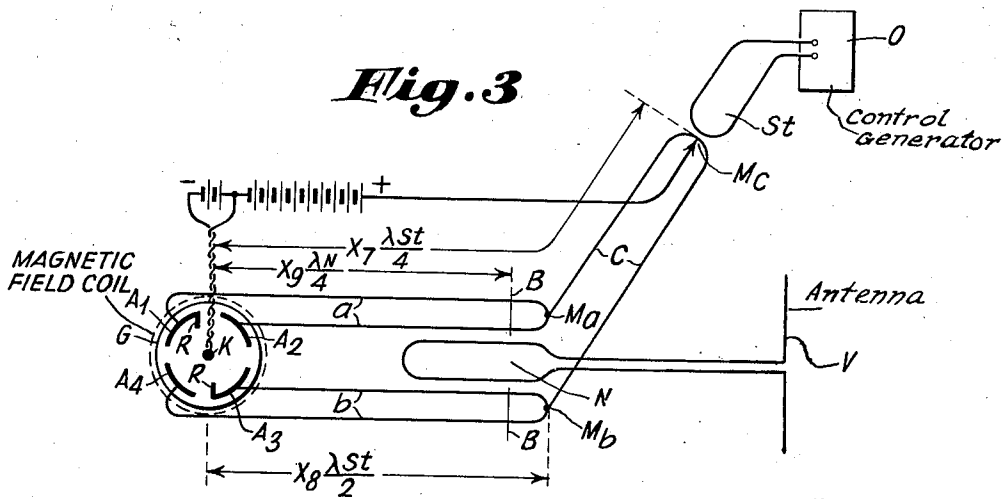
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MAGNETRON DISCHARGE TUBE OSCILLATOR AND FREQUENCY MULTIPLIER

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MAGNETRON DISCHARGE TUBE OSCILLATOR AND FREQUENCY MULTIPLIER

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The present invention is concerned with circuit organizations adapted to master control or excitation of a magnetron tube, especially for the frequency multiplication of ultra-short waves.

Circuit organizations are known for the master oscillation of split-anode magnetron tubes which require the use of special electrodes which serve solely for control or modulator action. It has also been suggested in the earlier art to operate a four-split anode type of magnetron as a master-driven amplifier in such a way that two opposite segments play the part of control electrodes, and the other pair the part of working electrodes.

In the present invention, contradistinct to earlier suggestions, circuit organizations are dealt with designed to insure master action without distinct control electrodes.

The circuit arrangement here disclosed for master control, especially frequency multiplication, comprising the use of split-anode magnetron tubes with a number of segments divisible by four has the outstanding feature that one and the same segments play at the same time the part of control and working electrodes in such a manner that the segments designed to set up the control field are combined in a different manner than for the production of the useful field, in electrical regard.

As a general rule this is accomplished by so combining the segments that, as regards the control field, they function like a split-anode magnetron, and as regards the useful field, they operate like a four-split magnetron.

In carrying out my invention I provide a magnetron discharge tube of the type which includes preferably four anode segments surrounding a linear cathode. These segments are arranged in interconnected pairs and the conductors which form the interconnections and which possess nodal points are also interconnected at said nodal points by a resonant loop, the distributed inductance and capacitance of which are such as to provide resonance at a frequency harmonically related to the frequency of each conductor extending between individual segments of a pair. The segments of a pair may in accordance with one embodiment be adjacent one another circumferentially. According to another embodiment of the invention diametrically opposed segments may constitute a pair.

Figs. 1 and 2 show the forms of circuit arrangements that are fundamentally feasible, while Fig. 3 shows an electrically complete circuit scheme. Numerical factors x added to the

electrical data are to indicate whole numbers of integers. In connection with $\lambda/4$ the numbers are throughout odd. Thus, for example, the factors x_1, x_2, x_3, x_4, x_5 and x_6 represent any convenient odd integers which may be selected in accordance with a practical design of the circuit arrangement.

Fig. 1 shows the principle of an embodiment of the circuit organization here concerned comprising the use of a four-split anode magnetron. The anode segments A_1 — A_4 are mounted symmetrically in reference to the cathode K . Pairs of adjacent segments are interconnected through a parallel-wire system a and b , respectively. Both parallel-wire systems are so proportioned that they correspond to a double-wire line of $\lambda/2$ length so far as the control-wave length (control frequency) is concerned. It will be remembered that a double-wire line of a length of $\lambda/2$ represents a short-circuit for the reference wave. The segments A_1 and A_2 , and A_3 and A_4 , respectively, as will thus be noted, are practically short-circuited so far as the control frequency is concerned just as if they were directly united through a non-inductive clip or loop.

Now, the situation is entirely different for the useful (signal) frequency. So far as this frequency is concerned, it is possible, for instance, by the aid of a tuning bridge piece B shiftable in the direction of the arrow, to find a setting which will correspond to $\lambda/4$ or a multiple of $\lambda/4$ as regards the useful wave length. What is insured by this latter step is that the adjacent or juxtaposed segments are united just as by an oscillatory circuit tuned to the useful or signal frequency and are able to excite the same. Connected with each of the electrical midpoints M_a and M_b of the parallel-wire systems a and b are the respective conductors of a third parallel-wire system c . In a circuit arrangement of the kind shown in Fig. 1, the said third system c serves to supply the control potential, and the same, including its extensions consisting of the parallel conductors of systems a and b is tuned to $\lambda/4$ or a multiple thereof in reference to the control wave length. The control generator, in a scheme as in Fig. 1, is in coupling relationship with system c , and the useful (load) circuit with the two systems a, b .

Fig. 2 shows the second fundamentally feasible form of construction of the basic idea of this invention. Symmetrically mounted in reference to a cathode K are four anode segments A_1 to A_4 . In this instance, contradistinct from Fig. 1, two opposite segments are interconnected through a

parallel-wire system *a* and *b*, respectively. Both parallel-wire systems are so proportioned that they correspond to a double-wire line of a length of $\lambda/2$, so far as the useful wave length is concerned. The segments *A*₁, *A*₂, and *A*₃, *A*₃, respectively, so far as this last named wave length is concerned, may be regarded as being short-circuited just the same as if they were connected through a non-inductive loop.

The conditions are totally different as regards control frequency, for so far as the latter is concerned it is possible for instance, by the aid of tuning bridges *B* shiftable in the direction of the arrow to determine a setting which corresponds to $\lambda/4$ or a multiple thereof, so far as the control-wave length is concerned. The result is the same as if the segments *A*₁, *A*₂, and *A*₃, *A*₄, respectively, were connected through an oscillatory circuit tuned to the control frequency. The introduction of the control energy, and the taking off of the useful energy, of course, must be effected in this circuit organization in a way different from that in Fig. 1. The control potential must be impressed upon the two systems *a* and *b* in such a way that the adjacent segments have control potentials that are in phase, in order that the tube, so far as the control field is concerned, may function like a two-split magnetron. The useful energy is put out at the third system *c* which, including its extensions, is tuned to $\lambda/4$ or a multiple of the useful wave.

Fig. 3 shows a complete electrical circuit scheme which includes also the source of D. C., the control potential source, and the consumer or load.

The magnetron tube which is comprised in this circuit organization is confined within a gas-tight vessel *G*. For instance, the segments *A*₁ and *A*₃ have fitted to the edges thereof radial extensions *R* which are designed to suppress any tendency towards self-oscillation of the segments *A*₁, *A*₂, and *A*₃, *A*₄, operating in synchronism in reference to the control frequency. The radial (baffle) sheets or extensions are intended to prevent segments working in parallel as regards the control frequency from directing electrons towards each other.

But as to the rest, this circuit organization corresponds to the fundamental embodiments shown in Fig. 1. The parallel-wire systems *a* and *b* are so proportioned that they result in a circuit tuned to $\lambda/2$ or a multiple thereof, so far as the control-wave length is concerned. The same parallel-wire systems, with due regard for the mutual capacitance of the segments (intersegment capacitance) are moreover tuned by the aid of shiftable tuning bridges *B* to $\lambda/4$ or a multiple thereof, as regards the useful wave-length. The output circuit *N*, which is brought to a consumer or load, say, antenna *V* is coupled with both parallel-wire systems *a* and *b* in such a way that in the circuit *N* the oscillations of both systems multiplied in their frequencies will become added. Connected with each of the electrical mid-points *M*_a and *M*_b of the two systems *a* and *b* is the respective conductor of the third parallel-wire system *C*. This last named system together with its extensions which consist of the parallel-connected conductors of the systems *a* and *b*, respectively, is tuned to $\lambda/4$ or a multiple thereof, as regards the control wave-length, and coupled with a separate oscillation circuit *St* which is excited from a master oscillator or transmitter *O*. The supply of the positive biasing potential to the anode segments is effected suitably at the electrical mid-point *M*_c (point of symmetry) of the third sys-

tem. As far as possible intercoupling of the two loops *A* and *B* may be avoided by mounting these loops at an angle to one another. Furthermore, the loop *C* may be advantageously disposed in a plane which intersects the planes occupied by each of the loops *A* and *B*. In this manner objectionable intercoupling between the input and output circuits is avoided.

As regards Fig. 3, the following example is given:

A control frequency is assumed which has a wave length $\lambda=100$ cm. The derived frequency is assumed to have a wave length $\lambda_n=50$ cm. The resonant characteristics of the various loops *A*, *B* and *C* are preferably obtained by fixing their effective electrical lengths so that their ratios are in accordance with odd integral numbers. More specifically, it is preferable that these ratios should be as follows:

$$x_2=1; x_3=3 \text{ and } 5; \text{ and } x_7=3$$

So far as $\lambda/2$ is concerned, the inter-electrode capacitance is negligible because the electrodes are excited in phase for the place in question. But for tuning to $\lambda/4$ the mutual capacitances are appreciable, with the result that the oscillatory circuit becomes smaller in geometric respect.

The idea underlying the present invention is not restricted to the exemplified embodiments hereinbefore described and illustrated in the drawing. The useful circuit and the control circuit, if desired, could be coupled also conductively.

I claim:

1. A master-oscillation circuit system adapted for frequency multiplication comprising a split-anode magnetron discharge tube having a number of anode segments divisible by four, means including circuits having resonance at a control frequency interconnecting certain of said segments for causing the same to be operated as control electrodes, and means including a circuit having a resonance frequency harmonically related to that of the aforementioned circuits, and being connected to nodal points on the same for causing all of said segments to be operable as output electrodes.

2. A high frequency oscillation generator and frequency multiplier comprising a magnetron discharge tube having a plurality of pairs of anode segments, a plurality of resonant parallel-wire systems directly connected across different pairs of anode segments and another parallel-wire system constituting an oscillatory circuit tuned to one-quarter of the wave length of the fundamental frequency generator, the last said system being connected across nodal points of two of the first said parallel wire systems.

3. An oscillation generator comprising a magnetron discharge tube having a cathode and a plurality of surrounding segmented anodes, and having radial baffle plates attached to and extending inwardly from certain edges of said segmented anodes.

4. An oscillation generator comprising an electron discharge device including a centrally disposed linear cathode and two pairs of anode segments surrounding said cathode, a magnetic field producer effective upon the discharge space within the anode segments, two conductors each interconnecting the two segments of an appropriate pair, said conductors being tuned by their distributed inductance and capacitance to a given frequency, a resonant loop interconnecting nodal points on each of said two conductors, said loop providing resonance at a frequency harmonically

related to said given frequency, means for impressing frequency control impulses upon certain of said anode segments, and means for delivering output energy at said harmonically related frequency from all of said anode segments.

- 5 5. An oscillation generator in accordance with claim 4 and having said two conductors which interconnect individual segments tuned to the frequency of said control impulses.
- 10 6. An oscillation generator in accordance with

claim 4 and having said resonant loop coupled to said means for impressing frequency control impulses upon certain of said anode segments.

7. An oscillation generator in accordance with claim 4 and having one segment in each pair arranged with an edge folded inwardly, thereby to intersect the spiral paths of certain electrons as produced under the influence of said magnetic field.

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