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MAGNETRON MODULATION SYSTEM

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The present invention concerns ways and means designed to make the starting of oscillations in telegraph transmitters or oscillators known in the art as magnetron transmitters subject to the control of modulation voltage. Although the invention is described more particularly as applied to magnetron transmitters and oscillators, it could be applied also to transmitters having characteristic features like those on which the invention is predicated and which shall be described in the specification which follows:

It is known from the practice of producing oscillations that a magnetron comprising one or more anodes placed inside a vacuous container in the presence of an electron emitting cathode, when suitably placed within a magnetic field will produce oscillations in a circuit connected with said anodes.

The produced oscillations may cover an extremely wide band or range of frequencies. The invention is more particularly useful in the case of waves known as short waves, though it may likewise be applied to the whole spectrum of frequencies which these oscillators will produce.

In describing my invention reference will be made to the attached drawing wherein Figure 1 illustrates a magnetron oscillator and control means therefor, arranged in accordance with the present invention; Figures 2, 3, 4, and 5 are graphs or curves illustrating the operating characteristics of the magnetron oscillator in the presence of a variable anode potential or a variable field or both, while, Figure 6 illustrates a signalling system including modulating means connected with the magnetron oscillator of the present invention.

Figure 1 shows schematically a magnetron M located in a field H and connected and arranged to generate oscillations of an extremely high frequency in circuit 3. The magnetron M is here shown as containing two plates, though this condition is evidently not restrictive because obviously other plate arrangements may be used. The magnetron M consisting of anodes 1 and filament 2 is placed inside a magnetic field H and with it circuits 3 and sources 4 and 10 are arranged to excite oscillations in circuit 3. The magnetron plates 1 are fed from generator 4 setting up a positive potential denoted by V_p , while the current produced by the said generator is denoted by I_p . The oscillating current measured, for instance, in the current loop of an antenna A coupled to circuit 3 shall be designated I_A .

The characteristics of the oscillator will now be described. They will be clearly understood by reference to Figures 2 and 3 which represent the variations of I_p and I_A as a function of V_p . With the magnetic field H being stabilized or fixed, the assumption shall be made that the potential V_p is gradually raised from zero. For a certain value of V_p , I_p rises but slowly until, in the presence of an extremely small variation of voltage V_p , it suddenly rises to the maximum value of electron emission of the filament known as the saturation current and herein designated as I_s , the plate current thereafter remaining constant or unvaried as V_p increases. The oscillating current I_A commences as V_p begins to grow, and suddenly rises with increased V_p , and passes through a broad maximum and finally decreases as V_p continues to grow. However, the fall of the value of the current I_A is slower and more gradual than its first appearance and rise with growth of V_p .

Figure 3 shows the same characteristics taken for growing values $H_1 H_2 H_3 H_4 \dots$ of the magnetic field H. These characteristics are plotted while disregarding possible hysteresis of the device which produces the magnetic field H.

The graph in Figure 4 shows what happens when, V_p is held constant or stable and H is varied. As the field H grows gradually from zero, the oscillatory current I_A starts to flow when the field has attained the value H_1 . The current I_A grows linearly from zero as the field grows, passes through a broad maximum, decreases thereafter, and disappears suddenly in the presence of a field intensity H_2 .

The anode current I_p which initially is equal to the saturation current I_s decreases later at about the same time as I_A and it disappears after the latter.

Figure 5 shows the same characteristic curves taken with growing values of V_1, V_2, V_3, V_4 , etc., of the anode potential V_p .

In the light of what precedes it may be said, as shown in Figure 4, that the graph giving the variations of I_A as a function of H, comprises two zones, namely, one extending from 0 to H_1 and the other from H_2 to infinity where the oscillatory current is zero.

Now, according to the present invention this property is utilized for the automatic control of the initiation of oscillations by the modulation voltage. In fact, the use of this property makes it feasible for the oscillations to begin only when the transmitter is being modulated, for as soon as this modulation ceases, these oscillations au-

tomatically discontinue as they are no longer produced.

In order to modulate a magnetron oscillator, the field H and the plate or anode voltage V_p are regulated in such a way that the strength I_a of the oscillation current lies between the points MA and N of the curve $I_a = f(V_p)$ represented in Figure 2. To this point corresponds the anode voltage V_0 and the field H_0 . There is then superposed upon V_0 the desired alternating modulation potential, this resulting in a variation of the amplitude of I_a in proportion to the amplitude of this modulation potential and at the same frequency.

Referring to curve $I_a = f(H)$ of Figure 4 in which is shown the field H_0 corresponding to the anode voltage V_0 , it will be noted that in order that the oscillations may be stopped all that is necessary is to diminish the field by an amount $H_0 - H_1$. Practically, it must be reduced as far as H_3 if the variation of the anode potential of tube M, which is due to the modulation is taken into consideration.

It may be noted that blocking of the oscillations is likewise feasible by raising the field as far as H_2 (Figure 4) though the first named procedure, e. g., lowering the field to H_1 is preferable because the requisite change in the magnetic field is smaller, and the operating point of the magnetron while the blocking action persists, stays inside a region where the oscillations are very stable.

Whichever method may be used, variation of the magnetic field is secured by the aid of an auxiliary coil which is connected in the magnetic circuit and which contains the number of ampere turns required for the production of the field variation in question. These ampere turns are either in opposition, first method, or act additively, second method, in reference to the ampere turns setting up the fixed field H_0 .

According to this invention, the blocking of the oscillations by action of the modulation voltage will be accomplishable best by following one of the methods hereinafter outlined, though it will be understood that any other method using the principle before described, would likewise fall inside the scope of the invention.

In Figure 6 is shown a magnetron M comprising a field coil N_1 setting up the fixed field H_0 and a coil N_2 producing the auxiliary blocking field H_m . This field H_m in this embodiment is in opposition to the field H_0 . The coil N_2 is traversed by the plate current of tube L_3 whose plate is connected by N_2 to a point on resistance 20 in shunt to a source of potential 22.

The magnetron M is modulated on its anode electrodes by the tube L_1 , the modulation potential being applied from any source to the primary of transformer T_1 . The secondary of the said transformer T_1 also excites the control grid of amplifier tube L_2 whose plate is connected with transformer T_2 . The secondary of this transformer is closed upon a resistance R by way of a rectifier D . The rectifier D may be either a contact type detector or a diode. If the latter is provided, it may be combined with tube L_3 and both D and L_3 may be confined inside one and the same bulb or envelope. The resistance R is connected between the grid and the cathode of the tube L_3 so that when the rectifier is operative, the grid of tube L_3 is rendered negative. In the absence of current through D the grid of L_3 is less negative and plate current flows in L_3 and N_2 to produce a field opposing the field of N_1 . The

condenser C serves the purpose of imparting a certain time constant to the assembly. For simplicity the filament heating circuits for M L_1 L_2 and L_3 have been omitted.

The operation of the arrangement is as follows:

In the absence of modulation potentials in T_1 , the oscillations in M and 3 are blocked by the auxiliary field produced by the plate current of tube L_3 through the coil N_2 which opposes the field produced by N_1 . When a modulation voltage is applied to the primary of transformer T_1 , the same will be amplified by L_2 and rectified by D . The result is that the grid of L_3 becomes negatively biased. This biasing action has been adjusted in such a fashion that it will be sufficient to block the flow of plate current in L_3 , even for very low potentials applied to T_1 . In these conditions the auxiliary field produced by N_2 is eliminated or suppressed and the magnetron may be considered as operating at, say, point H_0 of Figure 4 and is capable of oscillating. The modulating potentials are at this time acting through T_1 , L_1 and the coupling 30 to modulate the anodes 1 of M. As to the plate potential plate alternating current characteristics, the tube may now be considered as operating between MA and N of Figure 2. The ensuing oscillations will persist as long as the modulation lasts, and they will disappear as soon as modulation ceases. The values of R and of C may be regulated in such a way that the starting of oscillations is able to follow the rhythm of an intermittent modulation such as a telephone conversation. In these conditions the oscillator is readily adapted to the establishing of duplex telephony on one and the same wave-length, with the sending and receiving antennae placed at close proximity to each other. The transmitter is then blocked during the receiving intervals and blocked during sending intervals, while the opposite happens in the receiver. The blocking and unblocking of the receiver are then subject to the control of the transmitter using an arrangement similar to the one before described. All that is necessary is to provide the transformer T_2 with another secondary closed upon the rectifier and apply the rectified voltage, in suitable sense, to the grids of the amplifier tubes in the receiver.

Although magnetron tube arrangements of different structural dimensions may be used, we have found that a tube structure having the following dimensions operates satisfactorily: Anode diameter 5 mm. cathode axially arranged within the anode; plate voltage (optimum value at rest) 550 volts; magnetic field 780 gauss. The oscillator circuit may comprise two parallel rods or conductors of 3 mm. diameter separated by 25 mm. Oscillations of a wave-length of 85 cm. are produced.

We claim:

1. In a telegraphy system, a tube having an anode and a cathode connected in an oscillatory circuit, means for applying energizing currents to said electrodes, means for producing a magnetic field surrounding said electrodes of sufficient value to produce oscillations in said tube and circuit, means for opposing said field by an additional field of sufficient value to stop oscillations in said tube and circuit, and means for modulating said additional field in accordance with signals to produce oscillatory energy in said tube and circuit characteristic of said signals.

2. In a signalling system, a source of modulating potentials, an electron discharge tube hav-

ing an anode and a cathode electrode, an oscillatory circuit connecting said anode and cathode, means for applying energizing currents to said anode and cathode and a magnetic field to said electrodes, whereby oscillations are produced in said tube and circuit, means for producing an additional field opposing said first field an amount sufficient to prevent the production of oscillations in said tube and circuit, means connected

with said last named means and with said source of signals for reducing said last named field in the presence of signaling energy, and means connected with the anode of said tube and with said source of signals for modulating the anode potential of said tube in accordance with signals.

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