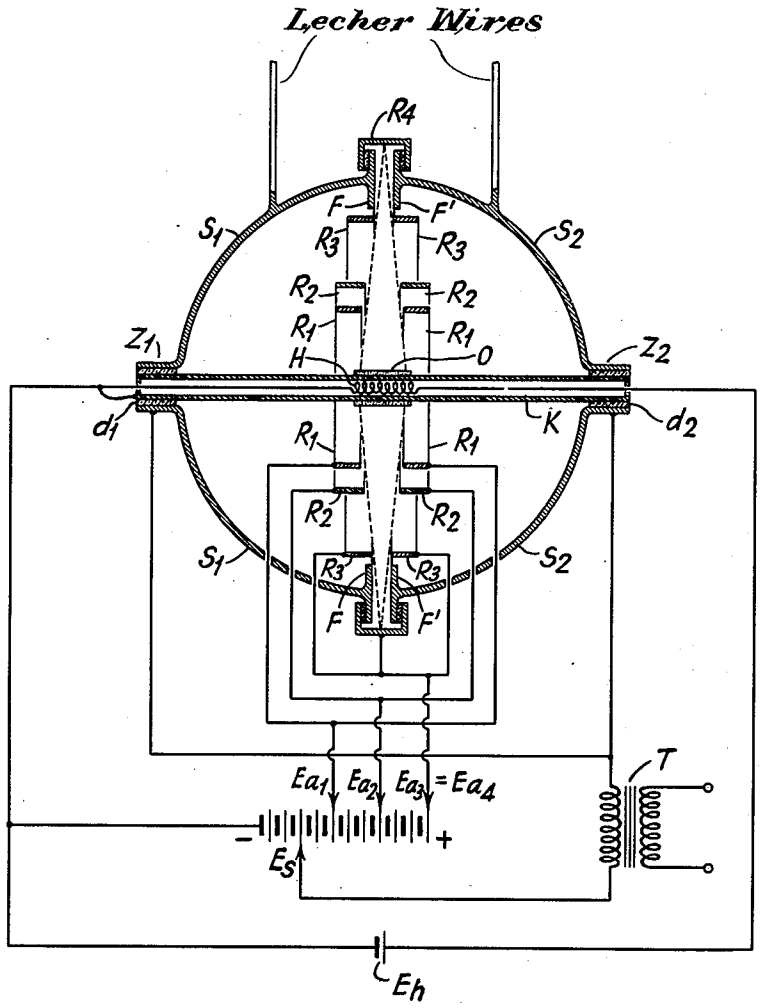
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DEVICE FOR GENERATING ELECTRICAL OSCILLATIONS

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Fig. 1



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Fig. 2

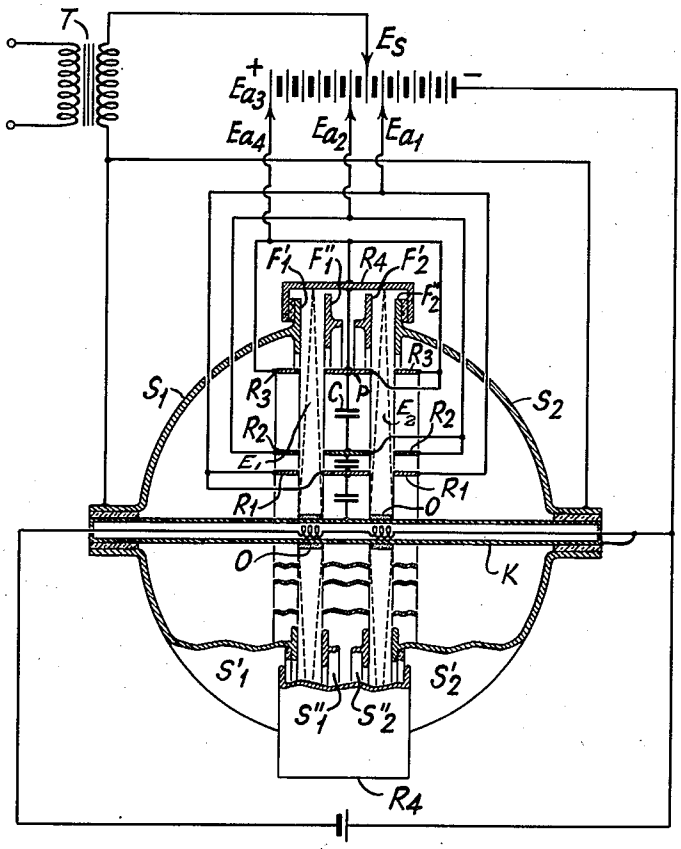
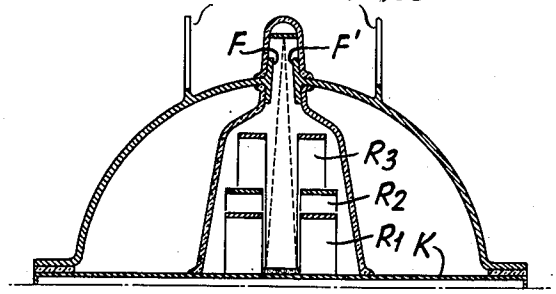


Fig. 3

Lecher Wires



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DEVICE FOR GENERATING ELECTRICAL OSCILLATIONS

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6 Claims. (Cl. 250—36)

The production of ultra-short waves with the standard type of space-charge control tubes, as well known from practical work, is attended with serious difficulties due to various causes, as soon as waves having a length less than one meter are dealt with. In order to overcome these difficulties, an arrangement has been suggested in the prior art which utilizes the finite time of transit or flight of the electrons (which, in normal tubes, hinders the production or start of the oscillations) for the purpose of controlling the electron stream, and which is adapted to the use of extremely small electrodes carrying high frequency currents and of electrodes so arranged as to result in a resonant system, without any electrons being allowed to impinge thereon. The electron current or stream which furnishes the oscillatory energy flies through between the oscillating electrodes and is caused to impact onto a separate electrode kept at a constant direct current potential; hence, heating of said small oscillating electrodes is entirely avoided and no limitations are imposed upon the density of the electron pencil.

The principle of wave generation, according to the foregoing scheme, is that an electron pencil or beam, by the action of the electrodes picking up the high frequency energy, is retarded and thereupon re-accelerated. Due to the fact that the control action as a result of radio frequency potential (in the presence of proper tuning and regulation of the velocity of the electrons) is accomplished at the correct cophasic rhythm, the oscillatory energy, as it were, is "uncoupled" or released from the electron pencil (i. e., is extracted by virtue of electrostatic induction). In other words, in the presence of certain presuppositions and circumstances, the electron pencil exhibits a behaviour resembling that of a so-called ultra-dynamic negative resistance. Apart from the phase balance (which, by resonance tuning and suitable choice of the accelerator and retarding fields must naturally be positive if oscillations are to be produced at all), the amplitude balance must be as favorable as feasible if appreciable powers and practically useful efficiencies are to be secured.

The resultant oscillatory energy, of course, depends in the first place upon the energy content of the electron pencil; in other words, upon the velocity of the electrons and the density of the pencil current. Inasmuch as only small electrodes may be employed for ultra-short waves, and since the pencil must shoot through these small oscillating electrodes, it will be seen that limitations are imposed upon the intensity (degree of concentration) of the pencil current by electron-optic focusing. The radio frequency oscillation energy moveover is a function of the natural or inherent damping of the excited resonance system, and this damping should be kept as low as possible by avoiding ohmic and dielectric losses as far as feasible.

The following describes an arrangement which satisfies the foregoing requirements, namely, freedom from losses on the one hand, and high pencil (beam) current intensity on the other hand, in an ideal manner by imparting to the electron pencil or beam the form of a disc and by causing the same to pass through the zone of symmetry of an oscillation structure which is hollow and presents rotational symmetry and which consists of two hemispheres or similar hollow bodies (ellipsoids). Owing to the fact that the disc pencil is caused to act upon these hemispheres at a point where the same has its greatest circumference, that is, in the equatorial zone, the specific current density is minimized in spite of the smallest possible interelectrode distances. The disc pencil is emitted from the axis of the said oscillatory system (which is in the form of a hollow body presenting symmetry of revolution) and the pencil or beam is concentrated or focussed by annular cylinder lenses disposed within the resonance system. Outside the oscillatory system is a ring electrode which is designed to concentrate the disc pencil after it has issued from the hollow body, and which carries off the electrons.

In order to explain in more detail the basic idea of the invention, a practical embodiment of an ultra short wave generator is shown in section in Fig. 1 of the accompanying drawings. Fig. 2 shows a modification of the invention, while Fig. 3 is a modification of Fig. 2.

Referring to Fig. 1 in more detail, the oscillatory system which is caused to experience undamped oscillations by virtue of electronic discharge, comprises the metallic shaft or spindle K and the two hemispheric metal shells S_1 and S_2 which constitute the inductance, while the capacity contained in the oscillation circuit consists of the two equatorial flanges F and F'. The state of oscillation of such a hollow structure or body, as is well known, is such that in the center (that is to say, in the middle point of the shaft K) a voltage node is set up, while on the periphery, that is, at the two flanges F and F', a loop is set up. Hence, the two flanges have radio frequency potentials in phase opposition. In lieu of shells or cups of hemispherical shape, recourse could

be had also to any other desired shapes, say cone shells or cylindric shells.

The axial tube K at the same time forms an electron-emitting cathode. For this purpose it is centrally provided with an electron-emissive coat of oxide O, while it is heated by an interiorly arranged heater spiral H. The electrons issued from the center in all directions impinge upon the electron-optic annular (ring-shaped) cylinder lens, which consists of the electric fields of force between the two rings R_1 and R_2 between which a slit is formed and on which different potentials are impressed. By the aid of these cylinder lenses, whose action, if desired, may be improved by additional means insuring electron-optic action, the divergent pencil of electrons is concentrated or focused so as to result in a disc-shaped electron pencil which passes between the flanges F_1 and F_2, as indicated by the broken lines in Fig. 1. In order that the electrons reaching the flange field F_1, F_2 may have a maximum rate of speed, an anode R_3 mounted a short distance ahead of the flanges and impressed with a high positive potential is provided. Outside the flanges F_1 and F_2 is disposed a closure ring R_4 which is designed to collect and carry off the electron pencil. The electron pencils passing through R_3 at a high rate of speed and being highly focussed are suddenly subjected by the field set up between the pair of flanges and R_3 (both flanges of which may have the same quiescent potential as the cathode, or different from the cathode, as shown) a braking or retarding action, and they are thereupon just as suddenly re-accelerated by the following anode R_4. When in a state of full oscillation, the retarding flange field has superimposed upon itself a radio frequency component, and if the electrode potentials and the interelectrode distances have been suitably chosen, conditions can be made so that during the positive alternation the flowing away (afflux) of electrons from the flange field will predominate, and during the negative alternation the influx of electrons into the flange field will predominate. This, however, means a boost and a de-attenuation or regeneration of the existing oscillations by the pulsating space-charge between the flanges.

It will be understood that in order that an electronic discharge may be possible, the assembly must be confined inside a vacuous vessel, though it will be possible, under certain circumstances, to make arrangements also so that only the discharge space properly so-called is confined within an evacuated vessel, while the metallic shells S_1, S_2 are mounted outside the said vessel. If the flanges F_1, F_2 are to possess a potential different from K, for instance a negative retarding potential, then the two hemispheric shells S_1 and S_2 must be suitably insulated from and disposed upon K, say by the aid of small intermediary tubes z_1 and z_2 and a tube-shaped dielectric d_1 and d_2.

The arrangement as hereinbefore described utilizes the energy contained in the decelerated and accelerated electrons only in part in so far as the two flanges F_1 and F_2 oscillate in phase opposition (push-pull fashion). As a result, there is produced in the middle between the two flanges an indifferential or neutral zone whose electrons fail to contribute to the supply of energy and flow unutilized to R_4. In order that this waste zone may be avoided, arrangements (according to another object of this invention) could be made so that in lieu of a uniform disc-shaped pencil in Fig. 1, two such disc pencils are set up which are spaced a small distance apart, one of the said two pencils being caused to pass through a distinct cross field of shell S_1, while the other one is made to pass through a similar field of shell S_2. The push-pull arrangement which is thus obtained is illustrated in more detail in Fig. 2, the upper half showing the whole system, while the lower one contains only the shell-shaped portion in section. There are produced two disc-shaped pencils E_1 and E_2 which are caused to pass through two cross fields set up between the flanges F_1' and F_1'', and F_2' and F_2'', the said cross fields being positioned on the circumference of the two shells S_1 and S_2. By means of radial metallic surfaces, a uniform state of oscillation of the two shells (the edges of which are placed opposite each other) will be insured. The rest of the assembly and its disposition will be readily comprehensible from the foregoing description by reference to Fig. 1, so that repetition may be avoided. Since the outer ring R_4, as well as the accelerator and lens rings R_1 to R_4, are not to carry radio frequency potentials, they are suitably grounded or kept at a fixed radio frequency potential by way of a central disc P seated upon the cathode tube K, the said disc P being divided by blocking capacities C at the points where potential differences exist.

The delivery or output of the oscillatory energy may be accomplished by the aid of Lecher wires which are connected to a pair of points located symmetrically on opposite sides of a neutral voltage plane or plane of symmetry of the assembly. Modulation may be effected preferably by means of emission control by the aid of a control electrode disposed in the vicinity of the cathode, say by the aid of a grid because in that case the velocity of the electrons is stabilized most efficiently so that undesirable frequency modulation will be avoided.

Referring to Figs. 1 and 2 in addition, it should be noted that each of the rings R_1, R_2 and R_3 consists of two halves placed at both sides of the electron beam and connected together. The potentials E_{a1}, E_{a2} and E_{a3} supplied to rings R_1, R_2 and R_3, respectively are positive and so chosen that E_{a2} is higher than E_{a1} and E_{a3} higher than E_{a2}. The outer ring or anode R_4 suitably has the same potential as R_3. The output rings F' and F'' receive a lower potential than R_3 and R_4 through the shells. Therefore the electrons after having left R_3 are decelerated upon entering the space between F' and F'', and afterwards accelerated again.

The modulation may be effected by superposing modulation voltages on the potential of one of the ring-shaped electrodes R_1 to R_3 but one may as well modulate the potential of the output rings F and F', e. g. such as by means of the transformer T shown in Figs. 1 and 2.

In Fig. 3 an evacuated vessel is shown containing only the electron beam and the focusing system, the oscillatory hemispheric shells S_1 and S_2 being outside the container. The output rings F and F'' may be mounted within the vacuum tube or may as well rest upon the outer wall of the vessel and be assembled with the shells.

The cathode layer K is heated by means of a coiled filament connected to a voltage source E_h in the manner shown in Fig. 1.

I claim:

1. An oscillation generator comprising a low-loss resonant system having a conducting straight shaft, and a pair of hollow hemispherical metallic shells at opposite sides of the center of said shaft

and facing one another, said shells being so arranged that there is a space between adjacent edges thereof in a plane transverse of said shaft, an electron emitting cathode on said shaft in said plane, and means for concentrating the electrons emanating from said cathode into a disc-like beam in said plane.

2. An oscillation generator comprising a low-loss resonant system having a conducting straight shaft, and a pair of hollow hemispherical metallic shells at opposite sides of the center of said shaft and facing one another, said shells being so arranged that there is a space between adjacent edges thereof in a plane transverse of said shaft, an electron emitting cathode on said shaft in said plane, means for concentrating the electrons emanating from said cathode into a disc-like beam in said plane, and a closure ring external of said shells and surrounding said space for collecting said electrons.

3. An oscillation generator comprising a low-loss resonant system having a conducting straight shaft, and a pair of hollow hemispherical metallic shells at opposite sides of the center of said shaft and facing one another, said shells being so arranged that there is a space between adjacent edges thereof in a plane transverse of said shaft, rim-like flanges on said adjacent edges to increase the capacity between said shells, an electron emitting cathode on the periphery of said shaft in said plane, a pair of annular lenses within said shells and located on opposite sides of said plane for producing electric fields of force to influence said electrons, and an element mounted between said flanges and said lenses for causing said electrons to reach the space between said flanges with maximum velocity.

4. An oscillation generator comprising a low-loss resonant system having a conducting straight shaft, and a pair of hollow hemispherical metallic shells at opposite sides of the center of said shaft and facing one another, said shells being so arranged that there is a space between adjacent edges thereof in a plane transverse of said shaft, rim-like flanges on said adjacent edges to increase the capacity between said shells, an electron emitting cathode on the periphery of said shaft in said plane, a pair of annular lenses within said shells and located on opposite sides of said plane for producing electric fields of force to influence said electrons, an element mounted between said flanges and said lenses for causing said electrons to reach the space between said flanges with maximum velocity, and a closure ring external of said shells and surrounding said space for collecting said electrons.

5. An oscillation generator comprising a low-loss resonant system having a conducting straight shaft, and a pair of hollow hemispherical metallic shells at opposite sides of the center of said shaft and facing one another, said shells being so arranged that there is a space between adjacent edges thereof in a plane transverse of said shaft, rim-like flanges on said adjacent edges to increase the capacity between said shells, in electron emitting cathode on the periphery of said shaft in said plane, a pair of annular lenses within said shells and located on opposite sides of said plane for producing electric fields of force to influence said electrons, an element mounted between said flanges and said lenses for causing said electrons to reach the space between said flanges with maximum velocity, a source of heat located within said shaft for heating said cathode, a source of potential, and connections from said source of potential to said cathode, lenses and said anode such that said lenses are maintained at a positive potential and said element at a higher positive potential relative to said cathode, a closure ring external of said shells and surrounding said space for collecting said electrons, and a connection from said closure ring to said source of potential for maintaining said ring at a positive potential higher than the potential on said element relative to said cathode.

6. A system in accordance with claim 2, including a source of potential for maintaining said shells at a positive potential relative to said cathode, and means for modulating the oscillations produced in said generator.

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