

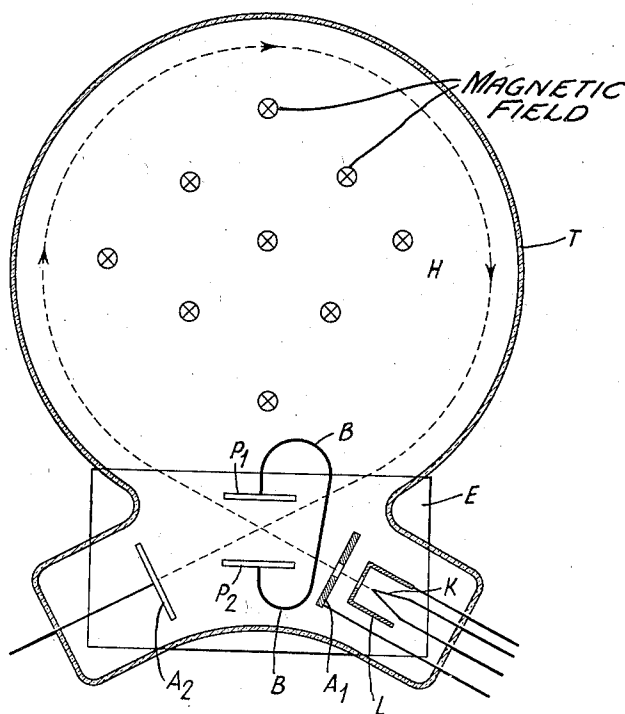
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H. E. HOLLMANN

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OSCILLATOR

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INVENTOR
HANS E. HOLLMANN
BY *H. B. Swer*
ATTORNEY

UNITED STATES PATENT OFFICE

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OSCILLATOR

Hans E. Hollmann, Berlin, Germany, assignor to
Telefunken Gesellschaft für Drahtlose Tele-
graphie m. b. H., Berlin, Germany, a corpora-
tion of Germany

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This invention relates to oscillators, and in particular to electron discharge type oscillators, wherein displacement currents produced by a beam of electrons is utilized.

5 The invention described in the following represents the further development of the arrangement described in my copending application entitled "Electronic system", filed February 24, 1937, and bearing Serial No. 127,343, and relates to an
10 arrangement for the production of ultra-short wave oscillations in accordance with the principle of lateral control. The arrangement is such that a filament-like or flat electron ray is transversely deflected by an electrical cross field, and at the
15 same time formed into a closed curve such as a circular curve for instance, so that it intersects its own course. In this way it is accomplished that the ray passes a second time through the controlling field thereby delivering to said field
20 its energy of oscillation. Thus only a single lateral field is present which takes care at the same time of the deviation of the ray and the decoupling of its energy. Through proper matching of the electron travel times in the ray it can be achieved that the building up resistance
25 between the cross field plates becomes negative at corresponding frequencies, so that a resonance system connected to the plates can be caused to oscillate.

30 The arrangement for producing electrical oscillations and more especially ultra-short wave oscillations described in the above identified copending application, operates with a transversal control of an electron ray through an electrical
35 cross field in contrast to the hitherto customary control of the longitudinal density of an electron current. The characteristic feature of the above identified application does not reside in this cross field control as such, but in the fact that the
40 electron ray instead of delivering its energy through impinging on anode plates, passes after leaving the controlling deflection field, through a second lateral field to which it delivers its energy of oscillation contained in its transversal space
45 charge movement, through influence action. When operating with very high frequencies the advantage is hereby obtained that space charge congestions appearing at the transit of the ray which carries out a very rapid to and fro movement, to one or several plates, and which more
50 and more flatten out the building up characteristics, do not any longer play an important part. In fact, the steepness of the dynamical working characteristics continuously increases with an in-
55 crease in frequency, since the induced component

of the displacement current is a direct function of the velocity amplitude of the space charge oscillating between the collector plates. The travel times which the electrons require for the move-
5 ment from the control field to the absorption field cannot be chosen freely in view of a sufficiently high geometrical sensitivity of the deflection and amplitude increase, and therefore, they must be
10 so chosen in accordance with the feed back conditions of the circuit, that the phase angle between the control potential and the influence output currents is a whole number multiple of
180°.

In the arrangement according to the above identified copending application, the plates of the
15 two lateral fields through which the ray passes in succession, have each a resonance circuit connected thereto, and the building up of the oscillations depends on the phase correct feed
20 back which may be an inductive feed back or direct feed back, whereby in the simplest case, the two oscillatory systems have the form of a pair of parallel wires connecting both pairs of
25 plates in the same sense or in a crosswise fashion.

The push-pull arrangement described in my
30 copending application above identified, avoids a special circuit type or external feed back. In this arrangement in place of the external feed back channel a second electron ray is provided
35 whose direction is opposite to that of the first ray, and which likewise permeates the two lateral fields but in reversed sequence. In this push-pull arrangement the circular course of the feed
40 back is so closed between the two lateral fields that each lateral field serves at the same time as control field and decoupling field.

This idea, namely to save a special feed back channel and to place the feed back instead ex-
45 clusively into the electron rays, is now applied to a single electron ray in accordance with the present invention. To this end, an electron ray after leaving the control field is so bent into
50 a circular course through any type of fields such as electron optical systems, magnetic or electrostatic lens systems or prismatic systems, or through a constant homogeneous magnetic field
45 transversal to the direction of the ray, that it passes a second time through the control field before it is absorbed by an absorption electrode.

An arrangement embodying the idea of the in-
55 vention is shown as an example of construction schematically in the figure. Herein item K is the cathode whose electrons after concentration by means of a lens system L pass through the anode A₁ in the form of a sharp beam of rays having

a round or rectangular cross section. Items P₁ and P₂ represent the two deflection plates forming together with the inductive loop B an oscillatory circuit having a very high natural frequency. By means of a magnetic field H directed perpendicularly to the drawing plane and indicated by the circle embracing the crosses, the ray after leaving the space between the plates is deflected into a circular course so that it passes for the second time through the lateral field P₁, P₂ thereafter impinging on the anode A₂. Iron sheets E forming a magnetic shield prevent the ray from being already deflected ahead of its first entrance into the lateral field, and likewise after its second exit, as a result of which the electron course shown is obtainable. If the ray is deflected out of position of rest through a potential difference appearing between P₁ and P₂, then also the returning ray is subjected to a greater deflection in a corresponding manner, and delivers its energy through influence action to the resonance circuit P₁, P₂, B. If the electron travel time along the circular course is brought into a definite relationship to the natural frequency of the circuit P₁, P₂, B, namely such that the influencing resonance potentials just act in opposition to the original deflection potentials, a regenerative performance takes place, and the oscillatory circuit P₁, P₂, B will be excited. Since the entire building-up mechanism, i. e. the energy feedback as well as the external or circuit type feed back is displaced into the electron ray, it can be said: The dynamical electron resistance between the two lateral plates P₁ and P₂ becomes negative at the respective frequency for the properly matched arrangement.

Next it is assumed for the sake of simplicity, that the electron pass only once through the circular path shown in the figure. This assumption need not necessarily be made, and the case may obviously occur that a large number of electrons prescribe this course several times, and therefore, contribute several times to the delivery of energy before reaching the anode A₂ in the tangential direction. This will be particularly the case if the absorption electrode A₂ is inserted in the path of the ray in the form of a ray stop.

The invention is susceptible of numerous modifications without departing from the principle of the idea of the invention. The lateral field between the plates P₁ and P₂ may for instance be divided into several partial fields connected alternately in opposite phase so as to render its length independent of the time of passage of the electrons such as has already been proposed in oscillograph tubes at extremely high frequencies for increasing the sensitivity. At any rate it is seen that the new arrangement is capable of supplying undamped short wave oscillations at sufficient ray amperage, such as are not obtainable with the hitherto known arrangement.

Having described my invention, what I claim is:

1 The method of producing oscillations comprising the steps of producing a beam of electrons, directing the produced beam along a predetermined path, producing displacement currents from the directed beam of electrons, producing oscillatory energy from the produced displacement currents subsequently directing the beam of electrons to cross the predetermined path, and augmenting the produced oscillatory energy at the point of crossing the predetermined path by the directed beam of electrons.

2. An electronic oscillator comprising an en-

velope, electron beam producing means positioned within the envelope, a target electrode positioned in angular relation to the beam producing means, and an oscillatory circuit having opposed plates positioned at an angle to the axis of the beam producing means and intermediate the beam producing means and the target electrode.

3. An electronic oscillator comprising an envelope, electron beam producing means positioned within the envelope, a target electrode positioned in angular relation to the beam producing means, an oscillatory circuit having opposed plates positioned at an angle to the axis of the beam producing means and intermediate the beam producing means and the target electrode, an electromagnetic field displaced laterally from the oscillatory circuit, and electromagnetic shield members positioned to shield the oscillatory circuit.

4. The method of producing oscillations comprising the steps of producing a beam of electrons, directing the produced beam along a predetermined path, producing displacement currents from the directed beam of electrons, producing oscillatory energy from the produced displacement currents, subsequently directing the beam of electrons to cross the predetermined path, producing further displacement currents by the directed beam of electrons in the region at which the beam crosses a predetermined path, and producing oscillatory energy in phase with the first named oscillatory energy by the said further displacement currents.

5 The method of producing oscillations comprising the steps of producing a beam of electrons, directing the produced beam along a predetermined path, producing displacement currents from the directed beam of electrons, producing oscillatory energy from the produced displacement currents, subsequently directing the beam of electrons to cross the predetermined path, producing further displacement currents by the directed beam of electrons in the region at which the beam crosses a predetermined path, producing oscillatory energy in phase with the first named oscillatory energy by the said further displacement currents, and subsequently collecting the electrons of the directed beam.

6. The method of producing oscillations comprising the steps of producing a beam of electrons, directing the produced beam along a predetermined path, producing displacement currents from the directed beam of electrons, producing oscillatory energy from the produced displacement currents, subsequently electromagnetically directing the beam of electrons to cross the predetermined path, producing further displacement currents by the directed beam of electrons in the region at which the beam crosses a predetermined path, and producing oscillatory energy in phase with the first named oscillatory energy by the said further displacement currents.

7. The method of producing oscillations comprising the steps of producing a beam of electrons, directing the produced beam along a predetermined path, producing displacement currents from the directed beam of electrons, producing oscillatory energy from the produced displacement currents, subsequently electromagnetically directing the beam of electrons to cross the predetermined path, producing further displacement currents by the directed beam of electrons in the region at which the beam crosses a predetermined path, producing oscillatory energy in phase with the first named oscillatory energy by the said further displacement currents, and

subsequently collecting the electrons of the directed beam.

8. An electronic oscillator comprising means for producing a beam of electrons, means for directing the produced beam along a predetermined path, means for producing displacement currents from the directed beam of electrons, means for producing oscillatory energy from the produced displacement currents, means for subsequently directing the beam of electrons to cross the predetermined path, means for producing further displacement currents by the directed beam of electrons in the region at which the beam crosses a predetermined path, and means for producing oscillatory energy in phase with the first named oscillatory energy by the said further displacement currents.

9. An electronic oscillator comprising means for producing a beam of electrons, means for directing the produced beam along a predetermined path, means for producing displacement currents from the directed beam of electrons, means for producing oscillatory energy from the produced displacement currents, means for subsequently directing the beam of electrons to cross the predetermined path, means for producing further displacement currents by the directed beam of electrons in the region at which the beam crosses a predetermined path, means for producing oscillatory energy in phase with the first named oscillatory energy by the said further displacement currents, and means for subsequently collecting the electrons of the directed beam.

10. An electronic oscillator comprising means for producing a beam of electrons, means for directing the produced beam along a predetermined path, means for producing displacement currents from the directed beam of electrons, means for producing oscillatory energy from the produced displacement currents, means for subsequently electromagnetically directing the beam of electrons to cross the predetermined path, means for producing further displacement currents by the directed beam of electrons in the region at which the beam crosses a predetermined path, and means for producing oscillatory energy in phase with the first named oscillatory energy by the said further displacement currents.

11. An electronic oscillator comprising means for producing a beam of electrons, means for

directing the produced beam along a predetermined path, means for producing displacement currents from the directed beam of electrons, means for producing oscillatory energy from the produced displacement currents, means for subsequently electromagnetically directing the beam of electrons to cross the predetermined path, means for producing further displacement currents by the directed beam of electrons in the region at which the beam crosses a predetermined path, means for producing oscillatory energy in phase with the first named oscillatory energy by the said further displacement currents, and means for subsequently collecting the electrons of the directed beam.

12. The method of producing oscillations comprising the steps of producing a beam of electrons, directing the produced beam along a predetermined path, producing displacement currents from the directed beam of electrons, producing oscillatory energy from the produced displacement currents, subsequently electromagnetically directing the beam of electrons to cross the predetermined path, and augmenting the produced oscillatory energy at the point of crossing the path by the directed beam of electrons.

13. An electronic oscillator comprising means for producing a beam of electrons, means for directing the produced beam along a predetermined path, means for producing displacement currents from the directed beam of electrons, means for producing oscillatory energy from the produced displacement currents, means for subsequently directing the beam of electrons to cross the predetermined path whereby the oscillatory energy is augmented at the point of cross-over by the subsequently directed beam of electrons.

14. An electronic oscillator comprising means for producing a beam of electrons, means for directing the produced beam along a predetermined path, means for producing displacement currents from the directed beam of electrons, means for producing oscillatory energy from the produced displacement currents, means for subsequently electromagnetically directing the beam of electrons to cross the predetermined path whereby the oscillatory energy is augmented at the point of cross-over by the subsequently directed beam of electrons.

HANS E. HOLLMANN.