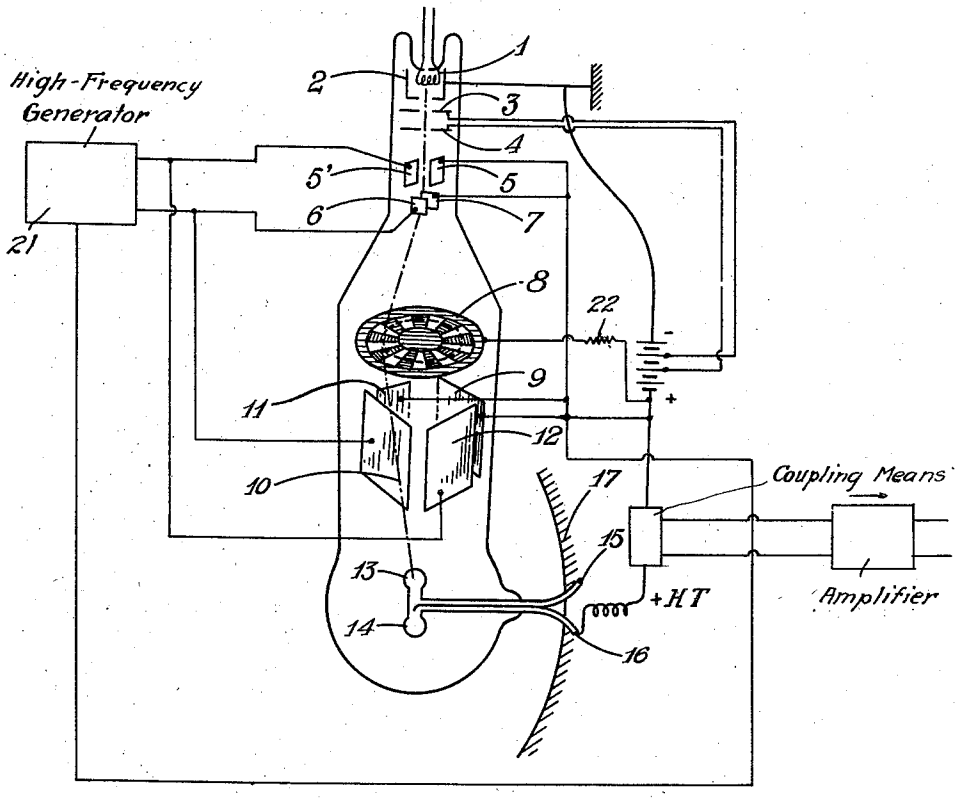
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PROCESS AND APPARATUS FOR PRODUCING EXTREMELY SHORT WAVES

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*Fig. 1.*



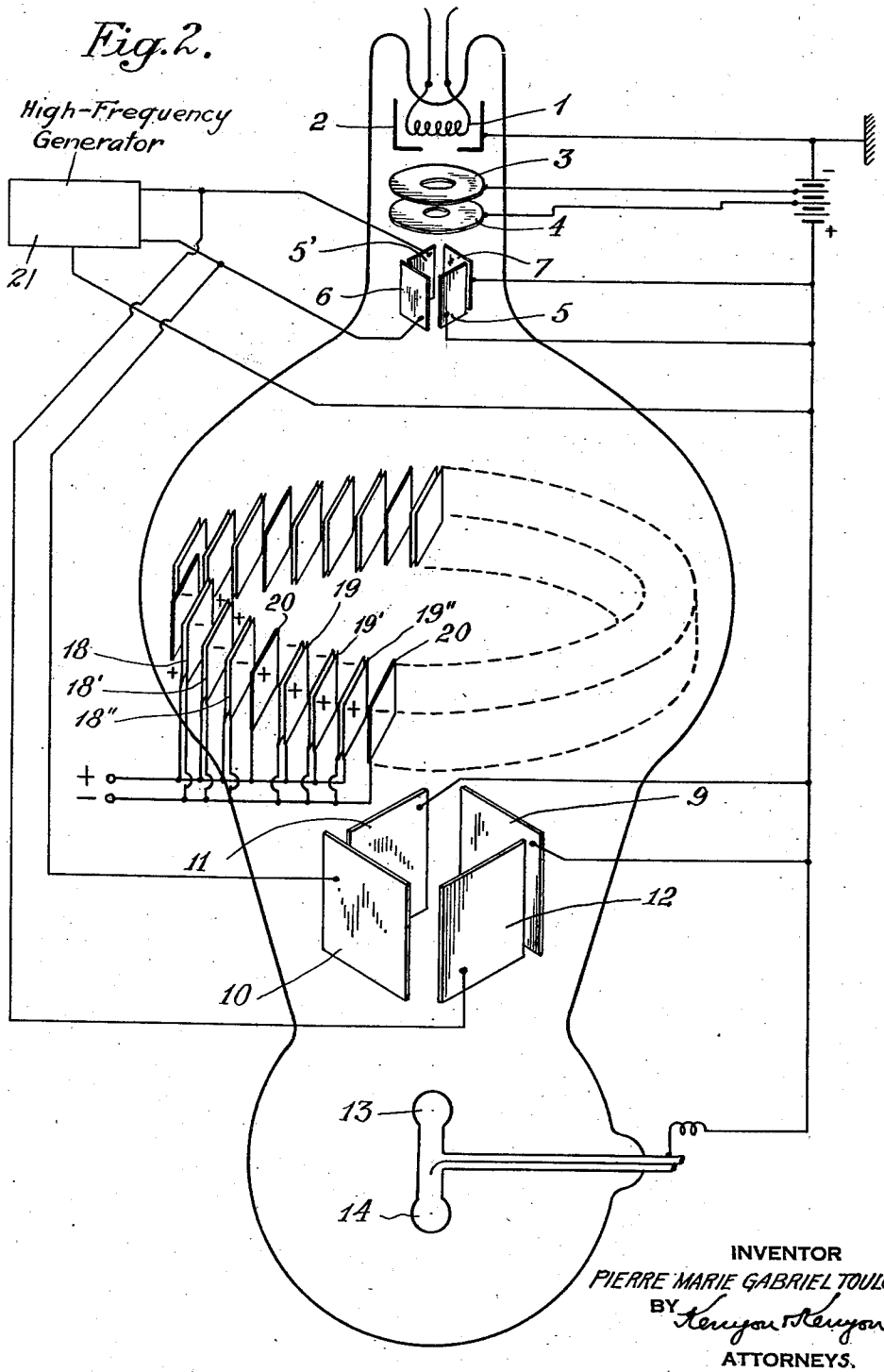

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Fig. 2.




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## PROCESS AND APPARATUS FOR PRODUCING EXTREMELY SHORT WAVES

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4 Claims. (Cl. 250—36)

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When it is desired to produce extremely high frequencies, above $1000\times10^6$ periods per second, that is wave lengths of 30 centimeters or less, the normal circuit arrangements are made useless by grid and plate capacitances.

The object of the present invention is to provide a new process of producing very short waves, that will make it possible to obtain sustained waves of only a few millimeters wave length (i. e., a frequency up to $100{,}000\times10^6$ periods per second) without any hindrance due to electrode capacitance or to electron propagation velocity. A further object is to obtain such frequency with great stability and power, and to vary at will the oscillator frequency, thus making it possible to realise frequency changing devices.

In accordance with my invention, I use a continuous flow of electrons (electron gun) at very high velocity, which I shoot by means of a system of deflecting electrodes onto a suitably adjusted and arranged shutter screen or diaphragm. The electron flow collected beyond the screen or diaphragm is periodically interrupted so that the collected current is of pulsatory or undulatory form, the frequency being determined only by the constitution of the screen and by the velocity of the electron beam sweep.

In a very convenient embodiment of my invention I use an electron gun of a cathode-ray oscillograph provided with an electronic lens, a group of two pairs of deflecting electrodes fed by a suitably biased alternating-current distribution, so as to create a revolving field, a screen with alternating opaque and transparent sectors, and an electronic lens adapted to gather all the electrons past the screen and collect them on a collector adapted to oscillate at the very high frequency considered.

Instead of absorbing the electrons by means of an opaque screen I may also cause them to be deflected alternately in two directions.

The new features and the advantages of the invention will be more fully understood with reference to the following description, in connection with the accompanying drawing which illustrates by way of example an embodiment of my invention. In the drawing:

Fig. 1 diagrammatically shows a system of great sensitiveness and illustrates the operation of my improved process.

Fig. 2 shows a modification of the arrangement of Fig. 1, in which a group of electrodes is employed to deflect the electrons without causing them to be absorbed, whereby the output is increased.

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As shown in Fig. 1, the filament 1 heats the cathode 2 which emits a large flow of electrons.

Diaphragm 3 serves, as usual, to shape this flow as a narrow beam. The electrons then are strongly accelerated by an electrode 4 kept at a positive potential adapted to impart to said electrons, a substantially uniform velocity. Pairs of electrodes 5, 5′ on the one hand and 6, 7 on the other are connected to a local high-frequency generator 21, adapted to generate for example dephased sine waves of a few meters (for example $100\times10^6$ periods per second). It follows that the electronic beam will move along a circular path. The electrons then are shot on the shutter screen or diaphragm 8 which is provided with a large number of holes arranged in a circle. As the propagation velocity of the electrons is almost of the same order as the sweeping speed of the beam, there will be beyond the diaphragm, for each complete sweeping revolution, a number of clusters of electrons corresponding to the number of holes in the diaphragm. These clusters will be axially offset with respect to each other. In order that the several clusters may be worked in phase, it is desirable to collect them on a single electrode. To this end I use a converging electronic lens, or a system comprising deflecting plates 9, 10 on one side, 11, 12 on the other, fed by the same generator 21 that feeds the plates 5, 5′ and 6, 7.

If the number of holes is say 100, the frequency which I am able to collect will correspond to 100 times the sweeping frequency and if this is $100\times10^6$ periods per second, the newly generated frequency will be $10{,}000\times10^6$ periods per second.

As a collecting electrode, I preferably use an antenna of a length of a few millimeters, so that it will vibrate on half wave. This antenna has its mean potential kept at very high voltage by an extraneous source, connected to the middle point of the antenna. The antenna preferably comprises a hollow metal tube 13, 14 through which water is circulated at 15, 16 so as to provide a high evacuation of heat. I use one of the refrigerating tubes to apply the positive potential. This emitting antenna may advantageously be placed at the focus of a spherical or of a parabolical reflector 17 adapted to direct the beam towards the receiving station.

The screen 8 is connected by a resistance 22 to a feeder point, in order to give off the charges deposited thereon.

The resistance 22 absorbs a substantial amount of energy, which is lost. I have found it possible

to improve this system and utilize the whole of the electronic beam. To this end, I alternately deflect the electron beam in several different directions.

A method of carrying this into practice consists of using, instead of the screen 8 provided with holes, a multiple electrode comprising alternating sectors adapted to deflect the electron beam in predetermined directions. Thus, the sectors of even number deflect it towards one concentration point and the sectors of odd number deflect it towards another concentration point. To obtain this I have to cause in any one of the sectors (of even number for example) a constant deflection of the beam in one direction and in the adjacent sectors (of odd number) a deflection in another direction.

Fig. 2 illustrates an arrangement of electrodes whereby this result may be attained. In this figure 18, 18', 18'' are the set of electrodes forming one sector (say of even number) and 19, 19', 19'' are the set of electrodes forming the adjacent sector (of odd number). The two sectors are separated by solid electrode 20.

Electrodes 18, 19 and 20 comprise plates which are parallel to the axis of the electron gun. In each sector the plates are arranged in pairs, and the plates of each pair are as close to each other as possible, and they are so energized that when one of the plates is positive, the plate immediately adjacent thereto is negative to the same degree.

Under these conditions I produce a constant electrostatic field between successive pairs. Into this field is shot the electron beam which, as in the foregoing example, has a rotational movement.

The direction of the electrostatic field produced between the three electrode pairs 18, 18' and 18'' is opposite to that produced between 19, 19' and 19'', so that when the electron beam passes from one sector to the next sector, it is deflected in two opposite directions. Since plates 18, 19 and 20 are parallel to each other, as shown in Fig. 2, the trains of electrons are concentrated alternately on two main foci 13 and 14, which may be constituted by the emitting or by the receiving antenna.

The generator according to my invention may also be used for receiving purposes. It enables demodulation of the frequency to be produced automatically. To this end it suffices that the beat frequency, corresponding to the interference between the received very high frequency and the own frequency of sustained oscillations of the antenna 13—14 produced by the electron gun, shall fall within the range of frequencies adapted to be easily amplified by triodes. The small collecting antenna 13, 14 is the seat of two superposed frequencies: the first from the received beam, the second being generated locally by the apparatus forming the heterodyne. The voltage imposed upon the antenna by the hertzian waves from the emitting station slightly modifies the path of the electrons corresponding to the local heterodyne; under these conditions the



mean current of the tube circulating between its cathode and its collecting electrode (antenna) varies periodically at beat frequency. This current then may be amplified by known means as used in wireless receiving sets, by using a coupling device inserted in the outer circuit for feeding the antenna.

While I have described herein a particular manner of carrying out my invention, it will be understood that my improved process may be carried out in other ways and applied to other uses, without departing from the scope of the appended claims.

I claim:

1. In an apparatus for producing extremely short waves, an evacuated vessel containing the combination of an electron gun, means for imparting a circular sweeping motion to the flow of electrons from said gun, means for dividing said flow of electrons into a train of electron clusters, and an electrode for collecting said electron clusters, said electrode being tuned in length to the frequency of said short waves.

2. In an apparatus for producing extremely short waves, an evacuated vessel containing the combination of an electron gun, deflecting means for imparting a circular sweeping motion to the flow of electrons from said gun, means for periodically intercepting said flow of electrons and dividing same into a train of electron clusters, and an electrode for collecting said electron clusters, said electrode being tuned in length to the frequency of said short waves.

3. In an apparatus for producing extremely short waves, an evacuated vessel containing the combination of an electron gun, deflecting means for imparting a circular sweeping motion to the flow of electrons from said gun, a perforated screen interposed in the path of said sweeping flow of electrons, a collecting electrode and means for concentrating on said collecting electrode the clusters of electrons shot past said screen, said collecting electrode being tuned in length to the frequency of said short waves.

4. In an apparatus for producing extremely short waves, an evacuated vessel containing the combination of an electron gun, means for imparting a circular sweeping motion to the flow of electrons from said gun, means interposed in the path of said sweeping flow of electrons for dividing it into trains of electron clusters and separate means for collecting said trains of electron clusters, said collecting means being tuned in length to the frequency of said short waves.

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