C. R. FOUNTAIN.

RADIOELECTRON OSCILLATOR.

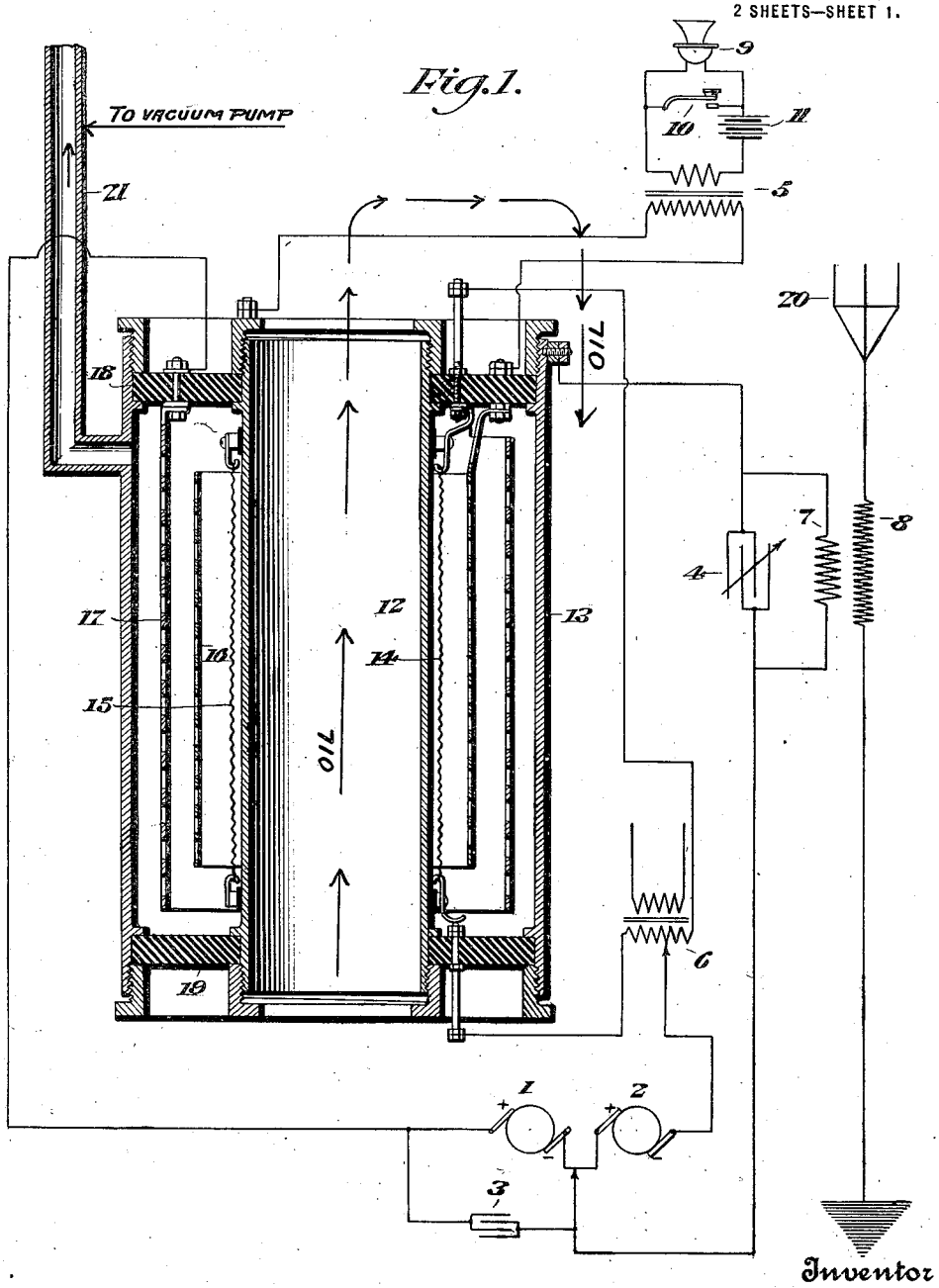
APPLICATION FILED JAN. 21, 1919.

1,424,091.

Patented July 25, 1922.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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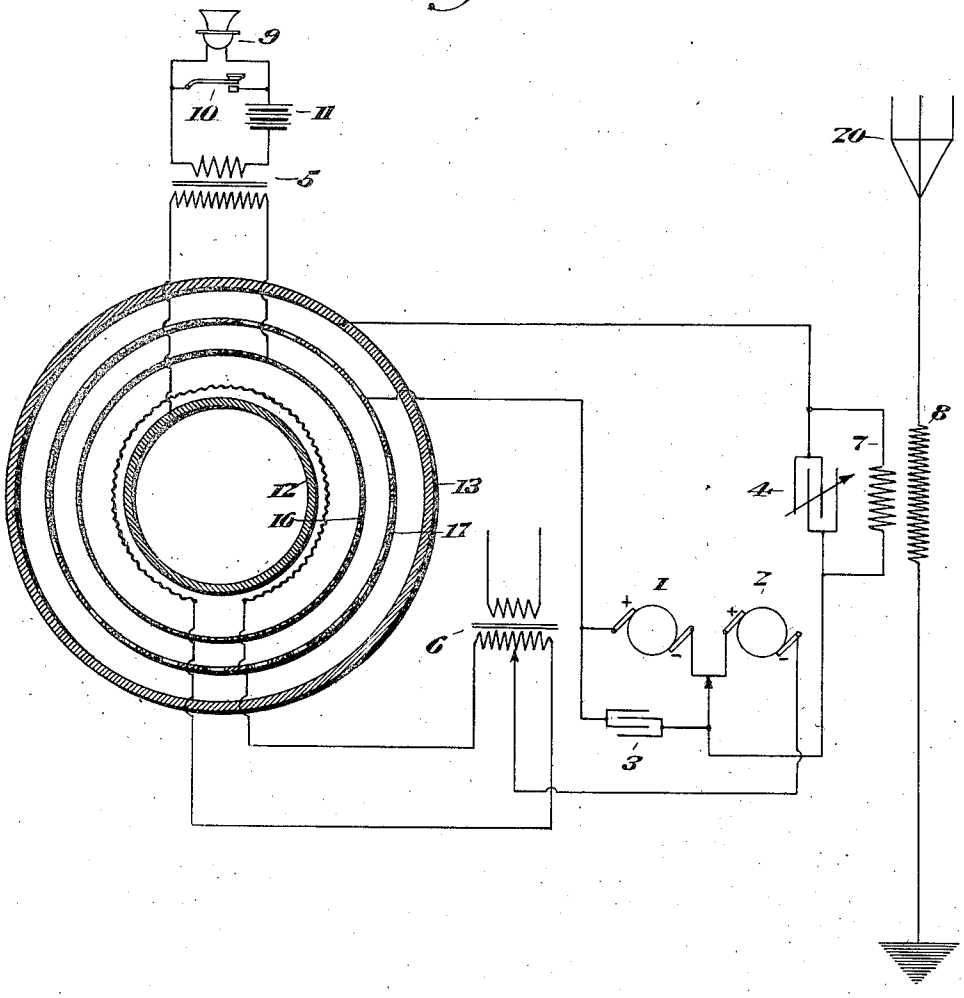
2 SHEETS—SHEET 2.

Fig. 2.



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UNITED STATES PATENT OFFICE.

CLAUDE R. FOUNTAIN, OF MACON, GEORGIA.

RADIOELECTRON OSCILLATOR.

1,424,091. Specification of Letters Patent. **Patented July 25, 1922.**

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To all whom it may concern:

Be it known that I, CLAUDE R. FOUNTAIN, a citizen of the United States, residing at Macon, in the county of Bibb and State of Georgia, have invented new and useful Improvements in Radioelectron Oscillators, of which the following is a specification.

My present invention relates to radio-electron oscillators, and consists in such an oscillator as affords a double control by means of a medium, preferably a grid, in front and a medium, preferably a cylinder, behind a common source of electrons; both operating in concert to change the speed or direction of the electrons which are being emitted at their common source and are attracted toward other media.

This invention relates especially to that type of electron oscillator wherein secondary electrons are emitted by the impact of rapidly moving electrons upon other media.

The essential elements for this latter type of the invention include a common source of electrons, two control elements, one on either side of this source of electrons, a perforated medium strongly attracting electrons, and another medium capable of liberating electrons under violent electronic impacts.

The number of these liberated or secondary electrons determines the amount of current in the oscillating circuit of the ordinary transmitting station.

There are also provided means for insulating the various elements from each other, means for keeping the space between the elements in a highly vacuous state, and means for keeping the device from becoming too hot.

A primary object of this invention is to provide a radio-electron oscillator capable of handling a very large energy output. A further object is to provide a simple means for controlling this energy output.

In the installation of my novel oscillator which I denominate a Radiotron, there may be used any of the standard methods of combining an oscillator with capacities, inductances, antenna, electric generators, batteries, etc. for the radiation of electromagnetic waves. I will confine my description to one of the simple arrangements.

This invention will be fully understood from the following description and claims when read in connection with the accompanying drawings, hereby made a part thereof, in which:

Figures 1 and 2 are views partly diagrammatic, illustrative of the best reduction to practice of my invention of which I am cognizant.

Similar numerals of reference designate corresponding parts in both views of the drawings.

Referring to the diagrams, Figures 1 and 2, it will be found that the Radiotron (12 to 19 inclusive) is used in conjunction with direct current generators 1 and 2, a fixed condenser 3, a variable condenser 4, a telephone transformer 5, a power transformer 6, a radio transformer 7—8, a microphone transmitter 9, a key 10, and a battery 11. The Radiotron or oscillator alone consists of an inner metallic clyinder 12, an outer metallic cylinder 13, incandescent light filaments 14 and 15, acting when hot as sources of electrons, a light metallic grid 16, of annular form, interposed between and spaced from the cylinders 12 and 13, a comparatively heavy metallic grid 17, of annular form preferably interposed between and spaced from the grid 16 and the outer cylinder 13, and annular insulating closures 18 and 19, interposed and secured between the cylinders 12 and 13.

The two generators 1 and 2 are connected in series. The negatively charged end of the generators is connected to the middle of the secondary coil of the transformer 6. The positive end of the generators is connected to the heavy grid 17. The outer cylinder 13 is joined to one side of the oscillation circuit 4—7, while the other side of said oscillation circuit is connected to a point between said generators as shown.

The incandescent lamp filaments 14 and 15 represent two of a number of parallel filaments arranged in a cylindrical form around the cylinder 12. These filaments electrically joined in a parallel, are connected to the two terminals of the power transformer 6, from which power is drawn to keep the filaments at the desired temperature for the proper emission of electrons.

The control elements 12 and 16 are connected to the secondary terminals of the telephone transformer 5. The current in the primary coil of 5 is determined by the battery 11 and the microphone transmitter 9, or the

key 10. The condenser 3 is shunted across the generator 1 to allow a greater effect of the oscillations in the circuit 4—7, upon the heavy grid 17.

A high vacuum is maintained in the space between the inner and outer cylinders 12 and 13, a conduit 21 leading from said space to vacuum creating means, which is not of my invention and is, therefore, not shown. Moreover the cylinders are immersed in oil with a view to preserving the vacuum and increasing the insulation while tending to maintain the instrument as a whole in a cool state. See labeled arrows in Fig. 1.

From the foregoing it will be noted that the filaments 14, 15 being heated by power from the transformer will be radiating electrons, which will be strongly attracted toward the heavy grid 17, since the latter is maintained at a high positive potential by the generators 1 and 2.

It will also be noted that the outer cylinder 13, being connected through the inductance 7 to a point between the generators 1 and 2, will be maintained at a potential less positive than the heavy grid 17. The voltage of the generators 1 and 2 may be independently varied so as to afford any desired potential difference between the grid 17 and the cylinder 13, and also between said grid and cylinder and the filaments 14 and 15.

It will be apparent that if the electrons given off by the filaments 14 and 15 and attracted by grid 17 and cylinder 13 impinge against said cylinder 13 with sufficient speed, more electrons will be driven off from the cylinder 13 than plunge into it, and these electrons emanating from the cylinder 13 will be attracted to the grid 17. An electron current will thus flow from cylinder 13 to grid 17. In the event that the speed of the electrons is below a predetermined point less electrons will be released by their impacts than plunge into it with the result that the electron current will flow from the grid 17 to the cylinder 13. If an oscillation circuit consisting of the variable condenser 4 and the radio transformer element 7 momentarily causes an increase in the electron density on the cylinder 13 and synchronously renders the grid 17 more positive, thereby accelerating the speed of the electrons, an amplified volume of electrons will be released by their impacts on the cylinder 13, and these electrons will be more strongly attracted toward the grid 17, and in consequence more electrons will pass from the variable condenser 4 to the cylinder 13. Inasmuch as the Radiotron like the dynatron has a negative resistance, it is unstable and any slight variations in potential in any of the connecting circuits will start the oscillations in the oscillation circuit 4—7. The power is supplied by the generators 1 and 2. In case the oscillation circuit 4—7 lessens the electron density on the cylinder 13 and increases the number of electrons on the grid 17, thereby lessening the speed of the electrons, fewer secondary electrons will be driven off at 13 and a smaller electronic current will flow from the condenser 4. The magnitude of this electron current determines the energy supplied by the generators 1 and 2 and also the energy in the oscillation circuit 4—7, which in turn determines the energy radiated from the antenna 20.

The circuits that I illustrate are not materially different from those shown in "Radio telephony" by Goldsmith, Figure 176, page 177. The chief differences are those required for large capacity circuits. The two generators 1 and 2, taking the place of the two parts of the battery B′, while the transformer 6 takes the place of the battery B^2. In my improvement one terminal of the telephone transformer 5 is connected to the inner cylinder 12 instead of being connected directly to the filaments as in all other types of vacuum tube oscillators and amplifiers extant. The inner cylinder is new, as is the design that obviates the necessity of employing a glass container for the elements in vacuo. The inner cylinder, by its proximity to the hot elements, becomes negatively charged, and the grid 16 will also be negatively charged under normal conditions. The driving of electrons off the cylinder 13 under increased bombardment, even though it is maintained cool by the cooling vat, will be understood when attention is directed to the operation of the dynatron in which the heavy plate P, at no time reaches a temperature at which it would release many electrons due to its heat. But a violent impact by one electron, at ordinary temperatures, shakes loose many electrons.

Since variations in the current of the primary of the transformer 5 will cause differences in the potentials at the terminals of the secondary coil of 5, it will be evident that the potentials of 12 and 16 will be synchronously but oppositely changed by such variations of current in 5.

It will also be evident that these changes in potential of 12 and 16 will operate in concert to change the speed of the electrons from the filaments 14 and 15 toward 13 and 17. That is, at one instance when 12 is positively charged and 16 is negatively charged, the effect of each will be to decrease the speed of the electrons toward 13 and 17. At another instant, the charges on 12 and 16 will be reversed and both will act to increase the speed of the electrons striking 13 and this will liberate a greater number of electrons, thus increasing the electron current from 13 to 17.

Irrespective of the theory of operation of such a device, the energy supplied by the generators 1 and 2 will cause strong oscil-

lations to develop in the circuit 4—7. Variations in this energy may be obtained by the impact of air waves upon the microphone transmitter 9, or by making and breaking the battery circuit through the key 10.

Manifestly in my novel oscillator duplex control is afforded by the grid and cylinder or equivalents thereof at opposite sides of a common source of electrons, and said elements acting synchronously to amplify or diminish the speed of the electrons toward the element 13, constitute an important characteristic of my invention.

It will also be noted that my novel oscillator eliminates the glass container usually necessary for such a device. In order to obtain a space in which a sufficiently good vacuum may be maintained, the cylinders 12 and 13 have annular insulating closures 18 and 19. Such metallic and insulating materials are not completely impervious to gases. My novel device is so adapted that it may be placed in a bath, preferably of oil, thereby excluding the air from the joints and pores of its outside walls. This bath also serves as an efficient method for keeping the device from becoming too hot. These features constitute important characteristics of my invention.

Having described my invention, what I claim is:

1. In a radio-electron oscillator, a source of electrons, an attracting medium, a grid in front and a medium behind said source and possessed of the capacity of synchronous action to change the speed of electrons toward the attracting medium, the said attracting medium being so perforated that some of the electrons may pass on to another medium, where their impacts may free other electrons, and the said second named medium.

2. In a radio-electron oscillator, a source of electrons, an attracting metallic grid, an outer metallic cylinder, a grid in front and a cylinder behind said source and possessed of the capacity of synchronous action to change the speed of electrons toward said attracting metallic grid, through which some of these electrons may pass to said outer metallic cylinder less strongly attracting electrons.

3. In a radio-electron oscillator, an inner metallic cylinder, an outer metallic cylinder, lamp filaments spaced and insulated from said cylinders, metallic grids spaced and insulated from said cylinders and filaments, insulating closures for space between said cylinders, electric connections for said cylinders, filaments and grids, said closures adapted for excluding gases from contact with said cylinders, and means for removing practically all gases from the space enclosed between said cylinders and closures.

4. In a radio-electron oscillator, an inner metallic cylinder, an outer metallic cylinder, electric light filaments spaced and insulated from said cylinders, metallic grids spaced between said filaments and outer cylinder and insulated therefrom, closures for the space between said cylinders, electric connections for said cylinders, filaments and grids, means for removing the gases from said enclosed space, and a fluid bath for excluding gases from contact with the outer wall of elements enclosing said space.

In testimony whereof I affix my signature.

CLAUDE R. FOUNTAIN.