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METHOD AND APPARATUS FOR GENERATING ELECTRICAL OSCILLATIONS

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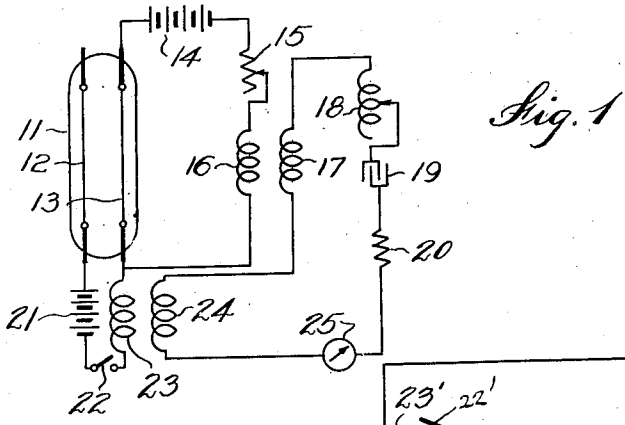

Fig. 1

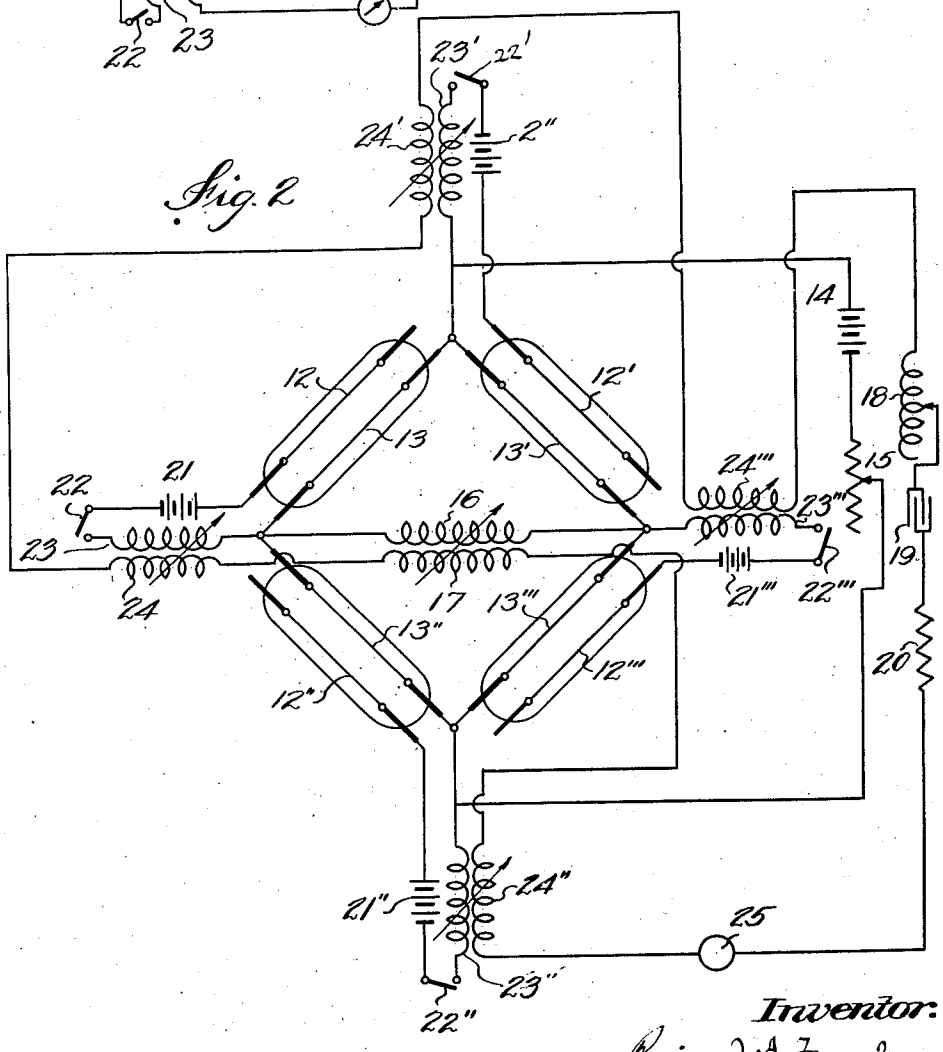

Fig. 2

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METHOD AND APPARATUS FOR GENERATING ELECTRICAL OSCILLATIONS.

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To all whom it may concern:

Be it known that I, REGINALD A. FESSENDEN, of Chestnut Hill, in the county of Middlesex and State of Massachusetts, a citizen of the United States, have invented new and useful Improvements in Methods and Apparatus for Generating Electrical Oscillations, of which the following is a specification.

My invention relates to the generation of electrical oscillations and more particularly to improvements in the methods and apparatus described in applicant's U. S. Patents 915,280, filed February 8, 1907 and 1,133,435, filed February 9, 1914.

My invention has for its object increased efficiency and reliability in the production of said oscillations.

Figures 1 and 2, forming a part of this specification, show partly diagrammatically, suitable arrangements for carrying out my invention.

In Fig. 1, 11 is a vacuum tube, 12 and 13 are electrodes in the vacuum tube of tungsten, molybdenum, cerium, or other suitable material, 14 is a battery, 15 an adjustable resistance, and 16 the secondary of a transformer; the whole forming a heating circuit operatively attached to the electrode 13 and the amount of heating being adjusted by varying the adjustable resistance 15.

17 is the primary of the transformer, 18 a variable inductance, 19 a capacity, 20 a resistance or other power absorbing device, 25 an ammeter, and 24 a secondary of a transformer; the whole forming an oscillatory circuit, the frequency being adjustable by means of the variable inductance 18 or in any other suitable manner.

21 is a source of voltage and 23 the primary of a transformer (whose secondary is 24), forming a circuit which is connected as shown to the electrodes 13 and 12 in such a way that when the key 22 is depressed and the electrode 13 is heated a current flows through the circuit 21, 22, 23, 13, 12—i. e. forms an Edison valve. By the term Edison valve I mean a valve of the type shown in the Edison U. S. Patent No. 307,031, dated Oct. 21, 1884, i. e. a hot cathode vacuum tube rectifier, and as so defined I use the term in the claims.

The coefficient of coupling of the transformers 16, 17 and 23, 24 may be varied in any suitable manner well known in the art, for example by moving the coils further apart.

In the practical use of my invention the circuits are connected up as shown and the resistance 15 varied until the electrode 13 assumes a suitable temperature.

The key 22 is then depressed and the ammeter 25 observed to see if sustained oscillations are produced in the circuit containing the ammeter. If they are not produced or if not of sufficient amount the key is opened and the coefficient of coupling of the transformers 16, 17 and 23, 24 is varied until the amount of sustained oscillations reaches a maximum. In certain cases better effects are obtained by reversing the connections of the sources of voltage. Also the effect depends very largely upon the exact amount of the variable resistance 15.

The production of these sustained oscillations is believed to be due to the fact that the oscillations in the circuit 17, 18, 19, 20, 25, 24, being impressed upon the circuit 16, 13, 14, 15, produce an oscillatory heating of the electrode 13 and hence a still larger oscillatory variation in the flow through the circuit 21, 22, 23, 13, 12. This effect is believed to be still further affected by the fact that these oscillatory currents flow only on the surface of the electrode 13 and consequently, since the heat flow from the surface to the interior is comparatively slow, only a very thin film of the electrode experiences this oscillatory heating.

As is well known in the art the electrode may be so constructed and magnetic material so used as to still further confine this electrode heating to the surface, or very thin tubes used.

The arrangement shown in Fig. 1 has been used to illustrate the method, but applicant prefers to use a method in which a divided circuit is used with Edison valves on each side of the circuit.

Such a modified arrangement is shown in Fig. 2, where 12, 12′, 12^2, 12^3 are the cold electrodes and 13, 13′, 13^2, 13^3 are the hot electrodes of four Edison valves, the four hot electrodes being arranged as shown to form a Wheatstone bridge.

The heating circuit 14, 15 is connected, as shown, across two opposite points in the bridge and the transformer secondary 16 is connected between the other two points of

the bridge, as shown the other circuits being similar to the circuits shown in Fig. 1. In this figure 21, 21′, 21″, 21‴ åre sources of voltage and 22, 22′, 22″, 22‴ are keys. 23, 23′, 23″, 23‴ are primaries and 24, 24′ 24″, 24‴ are secondaries of the respective circuits as shown in Fig. 1.

With this method, when the electrode currents flowing in the oscillatory circuit generate current in the secondary 16, during one portion of the wave the electrodes 13, 13^3 will be heated and the electrodes 13′, 13^2 cooled. During the other half of the wave the reverse will be the case.

This method has the great advantage over the simpler method shown in Fig. 1 in that the increase of heating due to the current from the transformer 16 is very much greater per watt of energy transferred from the oscillatory circuit to the transformer 16 than in the case shown in Fig. 1. For assume that the electrodes each had a resistance of one ohm and that the battery 14 was 200 volts. Then there will be 100 amperes flowing through each electrode and 100 volts across each electrode, so that the total amount of heating in each electrode will be 10,000 watts.

Now if the energy furnished to the transformer 16 by the oscillatory circuit were only two watts, then with the arrangement shown in Fig. 1 the change in heating would only be one five-thousandth of the total heating.

But by connecting the circuits as shown in Fig. 2, if the energy furnished to the transformer 16 is still only two watts nevertheless by the well known principles of the Wheatstone bridge there will now be during part of the wave 101 volts and 101 amperes in the hot electrodes 13, 13^3, or a total of 10,201 watts. Also there will be a deficiency of equal amount in the hot electrodes 13′, 13^2.

In other words, with the arrangement shown in Fig. 2 with an expenditure of only two watts from the oscillatory circuit to the transformer 16 an unbalanced heating effect of 402 watts has been effected in the hot electrodes.

In other words, the effect of the arrangement shown in Fig. 2 is to amplify the heating effect more than 200 times and this makes a very large change in the current flowing from the hot electrodes and produces a very large oscillatory effect, which can also be used for amplifying as well as for producing oscillations.

What I claim is:—

1. The method of maintaining sustained high frequency electrical oscillations in an electrical circuit by means of a hot cathode and an anode, which consists in maintaining said hot cathode and said anode at different electrical potentials, in said electrical circuit; thereby causing a flow of electric current between said hot cathode and said anode determined as to amount and energy by the temperature of the surface of said hot cathode; using a portion of the oscillating current and oscillating energy of said electrical oscillations to produce an oscillating surface flow of current on the surface of said hot cathode and an oscillatory surface variation in temperature of the surface of said hot cathode, of the same frequency as that of said sustained electrical oscillations; thereby causing oscillations of the current and energy of the current flowing between said hot cathode and said anode, said current and energy oscillations being of the same frequency as said sustained oscillations; suitably adjusting the heating of said hot cathode and the amount of said portion of the energy of the sustained oscillations that the oscillations in the energy of the current flowing between said cathode and anode are greater in amount than that of said portion of the oscillations which is used to produce said oscillating surface variations in the surface temperature of said hot cathode.

2. In the art of producing sustained high frequency electrical oscillations in an electric circuit by oscillatory variation of the electron emission from the hot cathode of a hot cathode tube; means for producing substantially all of said oscillatory variation of electron emission by oscillatory surface heating of the surface of said hot cathode, and substantially independent of oscillatory potential difference between said hot cathode and other electrodes of said hot cathode tube and substantially unaccompanied by oscillatory heating of the interior of said hot cathode.

REGINALD A. FESSENDEN.