July 5, 1932. E. F. W. ALEXANDERSON 1,866,337

SYSTEM FOR PRODUCING HIGH FREQUENCY OSCILLATIONS

Filed March 30, 1927

Fig. 1

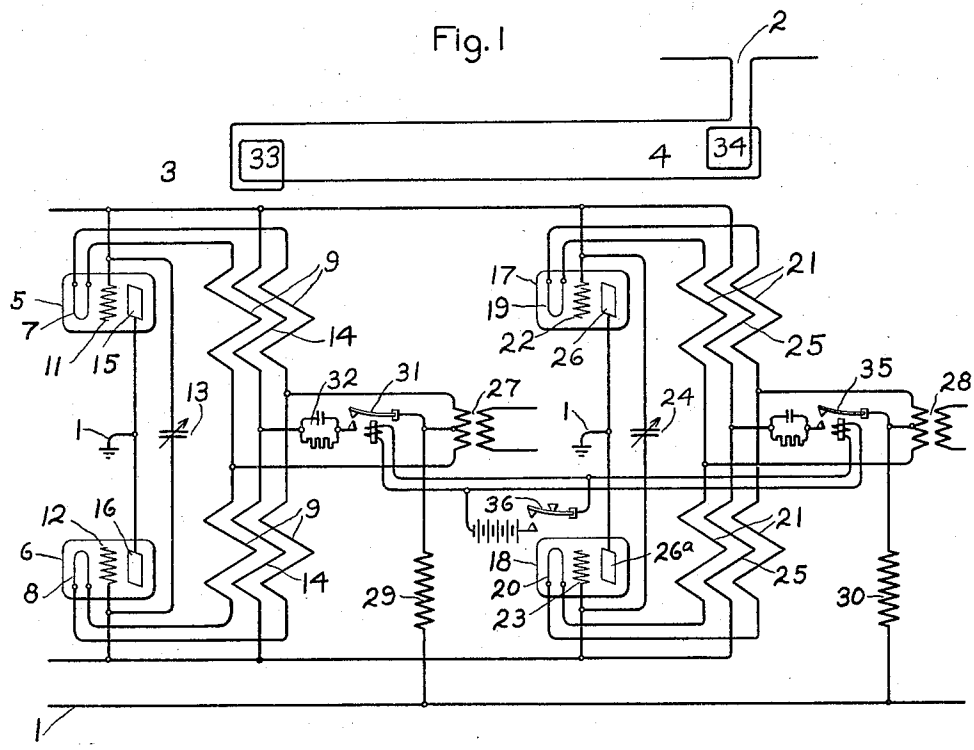
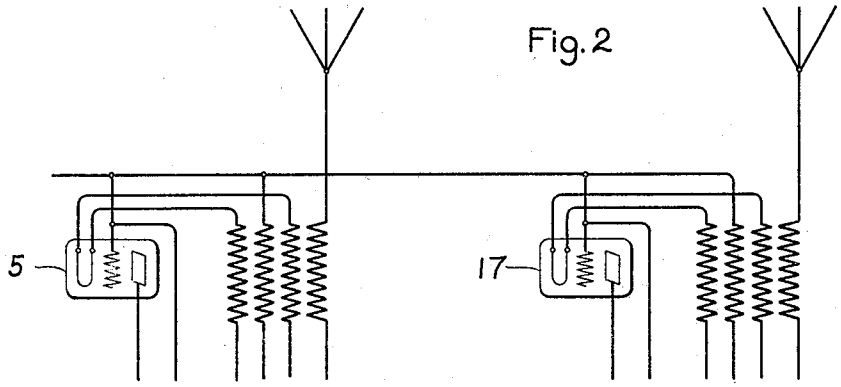


Fig. 2



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UNITED STATES PATENT OFFICE

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SYSTEM FOR PRODUCING HIGH FREQUENCY OSCILLATIONS

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My invention relates to apparatus for producing high frequency electrical oscillations, and has for its principal object the provision of an improved apparatus of this character which may be operated efficiently at very high frequencies to supply comparatively large amounts of power.

Where large amounts of power are supplied through an oscillation apparatus it is frequently desirable to utilize a plurality of space discharge devices. This involves certain power losses at all frequencies and additional power losses at very high frequencies. The resistance loss of such a device is dependent on the product of current and voltage drop between its cathode and anode. In order to reduce this resistance loss to a minimum, it is necessary that the voltage between the cathode and anode of the device be maintained just high enough during the period of current transmission to overcome the space charge of the device and that the changes between the zero and the full value of the current be produced quickly both at the beginning and at the end of this period. This requires that current be supplied to the devices from a source which tends to maintain a comparatively low voltage during the period of current transmission.

The operation of an oscillation apparatus at very high frequencies, for example of a few million cycles per second, involves additional power losses which are largely due to the internal capacities of the space discharge devices, to the internal capacities of the coils which form a part of the apparatus, and to the capacities between the various conductors through which the different parts of the apparatus are interconnected with one another.

In accordance with my invention, these resistance and capacity losses are largely avoided by the provision of an improved arrangement wherein power is supplied from a substantially constant source and wherein the various parts are grouped closely together and interconnected by conductors having negligible capacity with respect to one another.

My invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring to the drawing, Fig. 1 is a wiring diagram of a transmitting system wherein my invention has been embodied; and Fig. 2 illustrates a modified embodiment of the invention.

Fig. 1 illustrates an apparatus wherein power is transmitted between direct current terminals 1 and an antenna 2 through a pair of parallel-connected oscillators 3 and 4 of the push-pull type. The oscillator 3 comprises space discharge devices 5 and 6 which are respectively provided with cathodes 7 and 8 interconnected through a two-wire inductive circuit 9, with grids 11 and 12 interconnected both through a tuning capacity 13 and an inductive circuit 14, and with anodes 15 and 16 which are grounded through one of the direct current terminals 1. The oscillator 4 likewise comprises space discharge devices 17 and 18 which are respectively provided with cathodes 19 and 20 interconnected through a two-wire inductive circuit 21, with grids 22 and 23 which are interconnected both through a tuning capacity 24 and an inductive circuit 25, and with anodes 26 and 26[a] which are grounded through one of the direct current terminals 1.

Heating current is supplied to the cathodes 7 and 8 through a transformer 27 and opposite halves of the two-wire circuit 9, and to the cathodes 19 and 20 through a transformer 28 and opposite halves of the two-wire circuit 21. The anode currents of the oscillators 3 and 4 are supplied from the direct current terminals 1 respectively through a reactor 29 and the secondary circuit of the transformer 27 and through a reactor 30 and the secondary circuit of the transformer 28.

It will be observed that the grid 11 and cathode 7 are arranged to be interconnected through the upper half of the two-wire circuit 9, the secondary circuit of the transformer 27, a control key 31, a grid bias element 32 and the upper half of the circuit 14; and that the cathode 8 and grid 12 are arranged to be interconnected through the lower half of the two-wire circuit 9, the secondary circuit of the transformer 27, the control key 31, the grid leak element 32 and the lower half of the circuit 14. With these connections, current is transferred from the device 5 to the device 6 and vice versa, thus reversing the electromotive force of the circuit 9 at a frequency dependent on the resonant frequency of the circuit formed by the capacity 13 and the circuit 14 which is diagrammatically shown as comprising a few turns but may be a single turn conductor where the apparatus is operated at very high frequencies. It should be noted that two-wire circuit 9 may also comprise a single turn conductor which is inductively related to the grid circuit 14 and to a secondary coil 33 through which power is supplied to the antenna 2 at a frequency dependent on the tuning of the circuit 13—14.

The connections of the oscillator 4 are similar to those of the oscillator 3 and will be readily understood without detailed explanation. Power is supplied to the antenna 2 from this oscillator through a secondary coil 34 and a key 35, similar to the key 31, is provided for controlling its operation. Simultaneous control of the two oscillators is effected by a master key 36 arranged to control the operation of the keys 31 and 35.

At the very high frequencies of two or three million cycles per second, it has been found that the internal capacity of the space discharge devices, the capacity of the wiring, and the capacity of the coils play an important rôle in the operation of the apparatus. For efficient operation, these capacities should be kept as low as possible. The most efficient and stable operation of such an apparatus is obtained on a true constant current circuit for the reason that, under these conditions, the space discharge devices do not develop negative resistance which tends to create parasitic oscillations. Thus when current is supplied to the anode circuits of the oscillators 3 and 4 through the reactors 29 and 30 respectively, there is no tendency to generate parasitic oscillations because the anode potential is decreased as soon as the grid potential becomes positive and current starts through the device.

When a constant current apparatus of the character illustrated by the drawing is operated at very high frequencies, there is a period during each half cycle when the static charge accumulated on the coils and wiring maintains the potential while the grid is positively charged. The energy stored in the static field is then partly dissipated in the space discharge devices. The higher the frequency, the greater is the loss from the absorption of these static charges. It is therefore important that such capacity effects be made as small as possible where the apparatus is to be operated at very high frequencies. This is accomplished by placing the oscillators 3 and 4 in juxtaposition to one another and interconnecting their various circuits by short bus bars so that they will operate in synchronism with one another and each coil system will absorb the capacity currents of its part of the oscillation apparatus. It should be understood that the number of oscillators utilized will depend on the magnitude of the power to be transmitted and that each oscillator may supply power to a separate antenna is indicated by Fig. 2.

The embodiment of the invention illustrated and described herein has been selected for the purpose of clearly setting forth the principles involved. It will be apparent, however, that the invention is susceptible of being modified to meet the different conditions encountered in its use and I therefore aim to cover by the appended claims all modifications within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. The combination, in a high power generator of oscillations of short wave length, of a plurality of separate generators, each of said generators comprising an electron discharge device having small internal capacity, and each device having an anode, a cathode, and a grid, a separate oscillatory circuit for each electron discharge device, means for exciting each of said oscillatory circuits from the grid and anode of the respective discharge device, a pair of bus bars connecting said oscillatory circuits in parallel, said bus bars being directly connected to opposite sides of each of said oscillatory circuits, whereby said generators operate in synchronism, separate means for supplying potential to the cathode and grid of the different devices, separate means for interrupting operation of each of said generators, and a common means for controlling each of said last means.

2. The combination, in a high power generator of oscillations of short wave length, a plurality of separate generators, each of said generators comprising a pair of electron discharge devices having small internal capacity and each device having an anode, a cathode, and a grid, means for maintaining one electrode of each device at ground potential, means connecting each of said pair of devices in push-pull relation, said means including an oscillatory circuit comprising the grid and anode of each device of the respective pair, a pair of bus bars connecting said

oscillatory circuits in parallel, each bus bar being directly connected to one side of all of said oscillatory circuits, whereby all of said circuits operate in synchronism and the potential on said bus bars vary equally and in a balanced relation with respect to ground potential, energizing circuits for the anode and cathode of each device, and means for preventing interaction between different pairs of devices producing parasitic oscillations in any of said circuits.

In witness whereof, I have hereunto set my hand this 29th day of March, 1927.

ERNST F. W. ALEXANDERSON.