

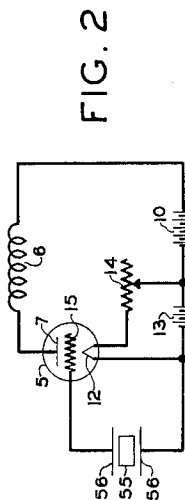
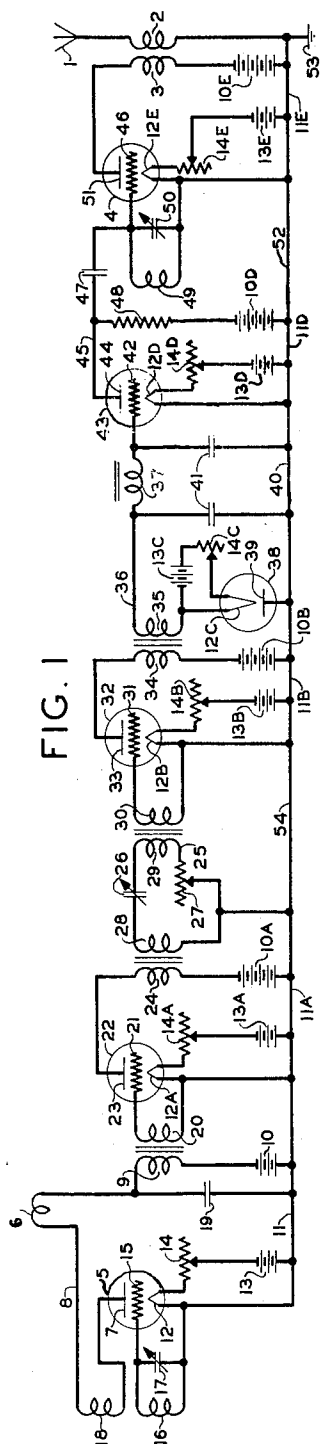
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G. T. ROYDEN

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APPARATUS FOR CONTROLLING TRANSMITTERS

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INVENTOR  
GEORGE T. ROYDEN

BY  
*William F. Nickel*  
ATTORNEY

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APPARATUS FOR CONTROLLING  
TRANSMITTERS

George T. Royden, Palo Alto, Calif., assignor to  
International Communications Laboratories,  
Inc., New York, N. Y., a Corporation of New  
York

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5 Claims. (Cl. 250-17)

This invention relates to improvements in controlling apparatus for radio transmitters; and more particularly to apparatus by which the frequency of the electrical oscillations sent by the transmitter is rendered substantially constant.

5 An object of the invention is to provide a controlling apparatus for automatically preventing in an effective, practical and inexpensive manner, material variations in the frequency of the electrical oscillations or waves radiated by the trans-  
mitter.

10 Another object of the invention is to provide a controlling apparatus of simple construction for precluding an increase or a decrease in the frequency of the oscillations emitted by the trans-  
mitter, by means of appliances that are electrical in structure and comprise virtually no actuated  
movable parts; thus making the operation as cer-  
tain as possible and obviating any possibility of  
the elements getting out of order or being de-  
ranged in function.

15 The invention is especially useful in connection with the transmitters designed to transmit oscil-  
lations at high frequency. In radio signaling by means of short waves the devices employed are  
usually very sensitive, and changes in the rate  
of oscillation easily take place, due to "body  
capacity" and other causes, often producing se-  
rious disturbances and even interruptions of serv-  
ice. This invention seeks to eliminate the tend-  
ency of a transmitter working on short waves to  
"drift" off from the desired frequency, and thus  
maintains the apparatus at all times in the best  
operating condition.

20 An additional object of the invention is to provide a controlling apparatus which is responsive to the operation of the transmitter itself and  
which is designed so that its effect is either to  
decrease the number of oscillations when the  
frequency tends to rise; or to increase the number  
of oscillations whenever the frequency of the os-  
cillations sent by the transmitter tends to di-  
minish.

25 The nature and advantages of the invention will be clearly set forth in the following descrip-  
tion, when read together with the drawing on  
which one or more embodiments of my inven-  
tion are illustrated. This disclosure, however, is  
illustrative only and changes may be made in the  
arrangement of the various parts and mode of  
proceeding without exceeding the principle of the  
invention, or exceeding the scope or meanings of  
the terms in which the appended claims are ex-  
pressed.

30 In the drawing, Figure 1 presents one form of

controlling apparatus according to this inven-  
tion; and Figure 2 shows a modification thereof.

The same numerals identify the same parts  
throughout.

Fig. 1 shows a transmitter having an aerial or  
antenna 1 which is coupled by means of a sec-  
ondary winding 2 with the primary winding 3  
of a generator of oscillations in the form of a  
vacuum tube 4. Whenever this tube 4 is in op-  
eration, rapid impulses of current between the  
anode and cathode thereof cause the primary  
coil 3 to energize the secondary 2, and oscilla-  
tions of a high frequency occur in the antenna  
1. Thus oscillations are produced and radiated  
in the usual manner for the purpose of carrying  
messages.

Operatively associated with the antenna 1 and  
oscillator 4 is a second oscillator 5, connected so  
that it can control the oscillator 4 through inter-  
mediate circuits and electrical appliances to be  
described later. The oscillator 5 has an anode  
circuit containing a loop 6 which acts as an aerial  
to pick up electrical energy radiated by the an-  
tenna 1. The oscillation generator 5 is designed  
to produce oscillations at a given frequency  
which are different from the frequency of the  
oscillations sent out by the antenna 1; and when  
the oscillation generator 5 is working and the  
coil 6 picks up electrical waves radiated from  
the antenna, beats are produced in the output  
circuit of the oscillator 5. These beats are trans-  
mitted through the circuits between the oscil-  
lator 4 and the oscillator 5, and by these beats  
the oscillations transmitted by the antenna 1  
and generated by the oscillator 4 are controlled  
and regulated. As the frequency of the oscilla-  
tions or waves emitted by the antenna tends to  
increase or decrease, the beat frequency of the  
oscillations produced by the combination of the  
frequency of the oscillations emitted by the an-  
tenna and that generated by the oscillator 5, of  
course varies accordingly; and this change, as  
is hereinbelow set forth, will make the frequency  
of the oscillations transmitted by the antenna  
decrease in case it tends to rise; or increase in  
case the frequency tends to drop, thus giving the  
desired result.

The oscillator or vacuum tube 5 has a plate  
or anode 7, connected by conductor 8 with one  
terminal of the coil 6. The other terminal of  
this coil is connected to one end of a primary  
coil 9, the other end of which is connected to the  
positive terminal of the usual source of current  
10. The opposite terminal of this source 10 is  
joined by conductor 11 to the circuit of the cath-  
ode of the oscillator 5.

ode 12, which is provided with the usual heating battery 13 and a rheostat or adjustable resistance 14.

The tube 5 also contains a grid 15 connected to the cathode 12 and in the circuit with the grid and cathode are an inductance 16 and the adjustable condenser 17. Between the anode 7 and the coil 6 is a feed-back winding 18 inductively coupled to the coil 16. This tube will operate in the usual manner to produce oscillations of a predetermined frequency according to the adjustment of the grid circuit and the characteristics of the tube, and when the coil 6 picks up oscillations emitted from the antenna 1 of different frequency, the resultant or beat oscillations produced out by tube 5 will have a frequency which is, of course, the difference between the frequency generated by the tube 5 itself and that transmitted by the antenna 1.

The anode circuit of the tube 5 may include condenser 19 shunting the primary 9, and the source of electrical energy 10. The primary 9 is coupled to the secondary coil 20, one end of which is connected to a grid 21 in an amplifying vacuum tube 22. This tube has a plate or anode 23 joined to one terminal of a primary winding 24, the opposite terminal of which is connected to a positive pole of battery 10A; and the tube 22 also has a cathode 12A with heating battery 13A and rheostat 14A, a conductor 11A connecting the battery 10A to the cathode circuit as before.

The primary 24 is coupled to a tuned circuit 25 containing an adjustable condenser 26 and an adjustable resistance 27. A secondary 28 couples one end of the circuit 25 to the primary 24 and a primary winding 29 at the other end of the circuit 25 couples this circuit to a secondary winding 30 connected at one end to the grid 31 of an amplifier tube 32, the other end of the secondary 30 being connected to the filament 12B of this tube. The plate or anode 33 of this tube is connected to one end of a primary winding 34, the opposite end of which is connected to the positive terminal of an anode battery 10B; and a cathode 12B is provided as before with a heating battery 13B and rheostat 14B; a conductor 11B connects the battery 10B to the circuit of the cathode 12B so as to provide the usual path for oscillations between the plate and filament of tube 32.

Beyond the amplifier tube 32 is a filter circuit coupled to the primary 34 by means of a secondary winding 35. One end of the secondary 35 is connected by conductor 36 with an inductance 37 and the other end of the secondary 35 is joined to the filament 12C of a rectifier tube 38. The filament circuit has a heating battery 13C and rheostat 14C; and the rectifier tube 38 contains an anode 39 joined to a conductor 40. These conductors 36 and 40 are shunted by condensers 41 in parallel, joined to the conductor 40 and to the opposite terminals of the inductance 37. The arrangement of inductance and capacity described of course acts to filter or smooth out the rectified pulsations of current produced by the tube 38.

Beyond the inductance 37, the conductor 36 leads to a grid 42 in a regulating device or tube 43. This tube has an anode 44 connected to a conductor 45 leading to the grid 46 of the oscillator 4, and, between this anode 44 and grid 46 is a condenser 47. An impedance, such as a high resistance 48, is connected to the conductor 45 between this condenser and the plate 44, at one end, and is joined at its opposite end to the posi-

tive terminal of a source of direct current 10D. The cathode or filament 12D, of this tube, as before has a heating battery 13D and rheostat 14D, with a conductor 11D connecting the other terminal of the battery 10D or the like to the cathode circuit. The grid 46 of the oscillator 4 is connected to the filament 12E of this oscillator through a parallel circuit containing inductance 49 and adjustable capacity 50. The anode 51 of the oscillator 4 is connected to one terminal of the primary 3, the other terminal of which is connected to the positive terminal of the anode battery 10E. The cathode 12E has the usual heating battery 13E with rheostat 14E and a conductor 11E joins the anode circuit to the cathode. An additional conductor 52 connects the conductors 11D and 11E. The ground for the antenna is shown at 53; and the conductors 11, 11A, 11B, 40, 11D, 52 and 11E may be united to form a single conductor or bus bar 54 extending from the cathode of the oscillator 5 to the antenna 1, and connected to the various parts of the apparatus as shown in Figure 1. This bus bar enables the various elements of the controlling device to be more conveniently connected to a shield (not shown) and to ground 53 so that external capacity and other outside factors will not disturb the operation. The adjustable resistance 27 has a movable contact to regulate it.

In operation, the tuned circuit 25 is adjusted so that the beat frequency is, for example, below resonant frequency, but such that it will fall upon the upward extending portion of the resonance curve in this circuit. Suppose now the frequency of the oscillations or waves radiated by the antenna is somewhat greater than the frequency of those generated by the oscillator 5. The frequency of the beats emitted by the oscillator 5 through primary 9 will then be equal to the difference between the frequency of the oscillations emitted by the transmitter and the predetermined frequency of the oscillations generated by the oscillator 5; and these beats are transferred to the tube 22 wherein they are amplified and passed on to the tuned circuit 25. From this circuit, the oscillations are then passed on to the tube 32; amplified by the tube 32; passed through the transformer windings 34 and 35, and converted into unidirectional fluctuations by means of the rectifying tube 38. These fluctuations are smoothed out more or less in the filter circuit comprising the inductance 37 and condensers 41 and impressed upon the grid 42 of the regulating tube 43, to give it a higher or lower positive potential. The grid 42 thus controls the impedance of tube 43 and consequently connects in series with the condenser 47 a greater or smaller impedance; regulating thereby the effectiveness of the condenser 47 on the reactance of the parallel circuit consisting of inductance 49 and condenser 50.

If, now, the frequency of the waves or oscillations emitted by the antenna becomes still greater than the frequency of those generated by the oscillator 5, the beat frequency will increase and the voltage in the circuit 25 will have greater amplitude as the beats approach the resonance frequency of the tuned circuit. Thus the grid 42 becomes more positive and the impedance of tube 43 is lowered, and the effective capacity of condenser 47 in series with the impedance circuit on the input of the tube 43 becomes greater. This increase in capacity tends to increase the wave length of the electro-magnetic radiations and thus lower the frequency of the oscillations generated by the oscillator 4. If, on the other hand,

the frequency of the oscillations emitted by the antenna decreases, the beat frequency will decrease accordingly and the amplitude of the beat frequency oscillations in the tuned circuit 25 will decrease. Hence the impedance of tube 43 will become greater through the positive potential of the grid 42 becoming lower, and the effective capacity of condenser 47 in series with this impedance becoming less, thus increasing the frequency of the waves generated by oscillator 4.

The purpose of the impedance 48 is to avoid the accumulation of a charge on the condenser 47 and thus keep the tube 43 from becoming inoperative, this impedance being connected to the positive pole of the battery or source of current 10D, which in turn has its negative pole joined to cathode 12D.

The condenser 47, inductance 49, condenser 50, part of the cathode circuit 12E, conductor 52, battery 10D and resistance 48 thus form a circuit in which the capacity of the condenser 47 has the effect desired in controlling oscillator 4.

If the frequency of the oscillations generated by the tube 5 is higher than the frequency of the oscillations emitted by the transmitter, the tuned circuit 25 is adjusted so that it becomes resonant at a frequency lower than the predetermined beat frequency, so that the controlling apparatus will have the same controlling effect as before.

As a modification, the oscillator shown in Figure 2 may be employed in place of the oscillator 5 shown in Figure 1. The oscillator of Figure 2 substitutes a piezo crystal 55 in place of the coil 16 and condenser 17 connected to the grid and cathode. The coil 18 is omitted and the coil 6 is directly connected to the anode 7. The crystal is disposed between plates 56 which may exert a pressure on the crystal, and this pressure can be varied. With this oscillator, the remaining connections to the other parts of the circuit will be the same as before.

As in the first case, with regard to the oscillation generator 5 of Fig. 1, this modified oscillator produces oscillations of a frequency different from that radiated by the antenna 1 and picked up by coil 6. This difference produces beats in the output circuit of the oscillator which are transmitted through the circuits between the oscillators 5 and 4 in the previously described manner.

The apparatus acts very efficiently and requires practically no alteration of the antenna or other attention except to make the necessary adjustments, as there are no constantly moving parts to get out of order. The frequency of the oscillations transmitted by the antenna can be automatically kept within the desired range and the commonly occurring wide variations or "drifts" in the frequency of the oscillations transmitted by antennae utilizing short waves are rendered impossible.

The beat frequency will, of course, be relatively low and for that reason all the transformers between the oscillators 4 and 5 may have iron cores and so may the inductance 37.

The resistance 27 and condenser 26 are utilized to control the resonating characteristics of the tuned circuit 25. For example, if the frequency of the waves radiated by the antenna should have a tendency to rise very rapidly, a broad resonance peak is desirable so that the beat frequency cannot rise so fast as to run over the apex of the peak and reach the descending portion of the curve, where it could no longer bring about constant frequency control of the oscillations gen-

erated by oscillator 4 and those transmitted by antenna 1. Under other conditions a sharper peak for the resonance curve might be more desirable.

Having described my invention, what I believe to be new and desire to secure and protect by Letters Patent of the United States, is:

1. The combination of an antenna, a generator of oscillations therefor having a grid, a condenser connected to the grid, a second generator having means for causing oscillations produced thereby to combine with oscillations of the first generator to produce electrical beats, a tuned circuit having a resonant frequency different from the frequency of said beats, a rectifying circuit and a regulating device connecting the tuned circuit to the condenser, and an impedance associated with said device to prevent electrical charges accumulating on the condenser and rendering said device inoperative.

2. In a frequency control system, the combination of a master oscillation generator for generating oscillations of a substantially fixed frequency, a second oscillation generator having a frequency determining circuit and generating oscillations of a frequency differing from those produced by said first-named generator, a circuit for combining the oscillations produced by said oscillation generators to produce beats, a variable impedance shunting the frequency determining circuit and a tuned circuit coupled to the impedance, said tuned circuit being resonant to a predetermined beat frequency and responsive to any change in the frequency of said beats to cause a corresponding change in said impedance and thereby control the frequency of the oscillations produced by said second oscillation generator.

3. In a frequency control system, the combination of a master oscillation generator for generating oscillations of a substantially fixed frequency, a second oscillation generator having a grid, an anode, and a cathode, and a frequency determining circuit connected between the grid and the cathode, said second generator producing oscillations differing in frequency from those produced by said master generator, a condenser and a regulating device in series in a circuit shunting said frequency determining circuit, a circuit for combining the oscillations produced by said oscillation generators to produce beats, a circuit tuned to a resonant frequency different from the beat frequency, and a rectifying circuit connecting the tuned circuit to the regulating device and responsive to any variation in the beat frequency to control said regulating device.

4. In a frequency control system, the combination of a master oscillation generator for generating oscillations of a substantially fixed frequency, a second oscillation generator having a grid, an anode, a cathode, and a frequency determining circuit connected between the grid and the cathode, said second generator producing oscillations differing in frequency from those produced by said master generator, a condenser and a space charge regulating device in series in a circuit shunting said frequency determining circuit, a circuit for combining the oscillations produced by said oscillation generators to produce beats, a circuit tuned to a resonant frequency different from the beat frequency, and a rectifying circuit connecting the tuned circuit to the space charge regulating device and responsive to any variation in the beat frequency to control said space charge regulating device.

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|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 5  | frequency determining circuit and generating oscillations of a frequency differing from those produced by said first-named generator, a circuit for combining the oscillations produced by said oscillation generators to produce beats, a variable impedance and a condenser in series in a circuit shunting the frequency determining circuit, and a tuned circuit coupled to the impedance, said tuned circuit being resonant to a predetermined beat frequency and responsive to any change in the frequency of said beats to cause a corresponding change in said impedance and thereby control the frequency of the oscillations produced by said second oscillation generator. | 80  |
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