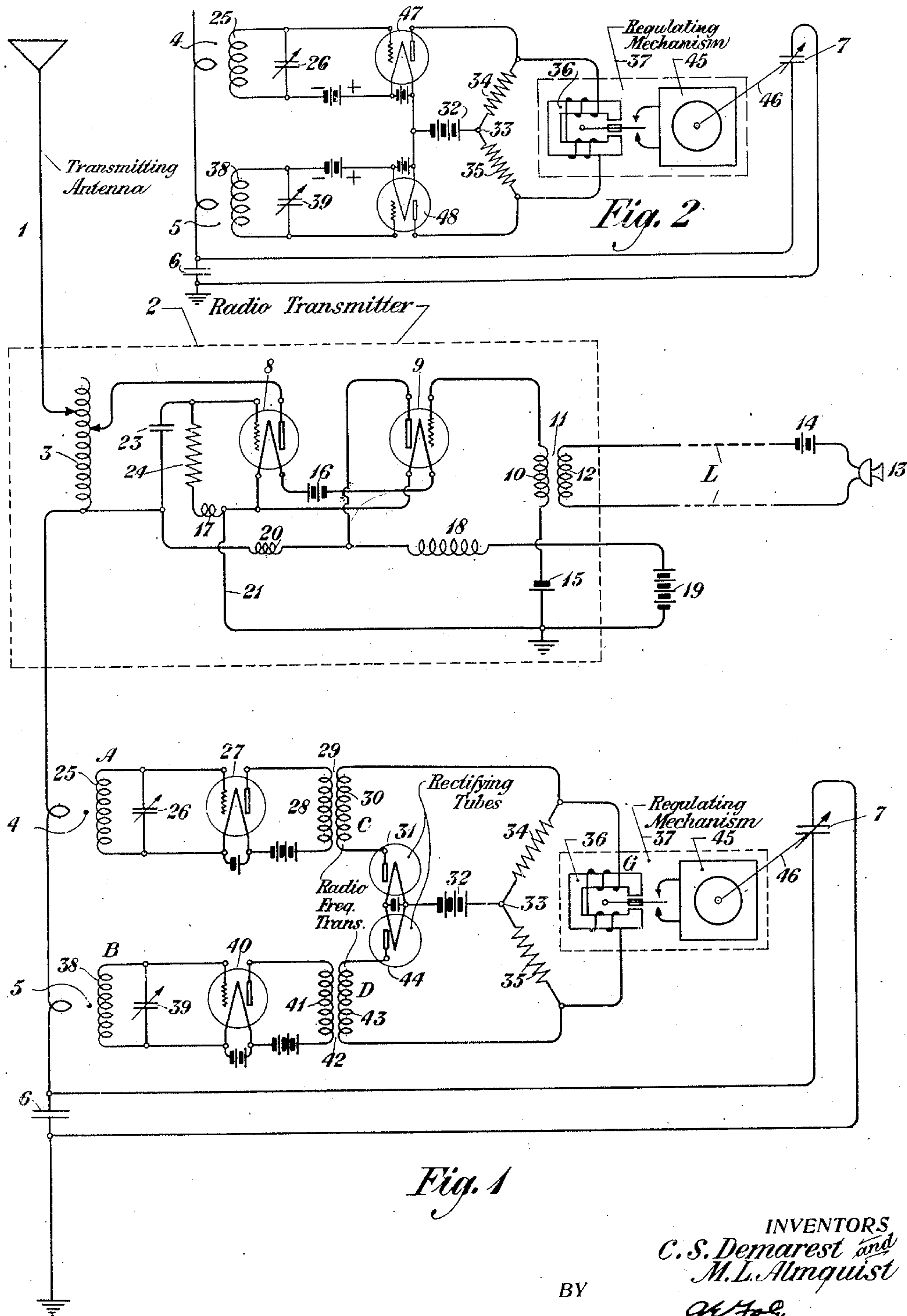


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C. S. DEMAREST ET AL
FREQUENCY CONTROLLING SYSTEM

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FREQUENCY-CONTROLLING SYSTEM.

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This invention relates to radio signaling systems, and particularly to means for maintaining constant the frequency of the transmitted waves.

While it is usually desirable in all systems of radio communication to maintain constant the carrier frequency by which signals are transmitted, it is particularly so in multi-station systems in which every station is equipped with a receiving device, responsive to a particular frequency, namely, the calling frequency of that particular station.

One of the objects of this invention is to provide a method and means for maintaining substantially constant the frequency of the transmitted carrier current of a radio transmitting station.

Other objects of this invention will be apparent from the following description when read in connection with the attached drawing of which Fig. 1 shows schematically one form of embodiment of the invention, and Fig. 2 shows a modification of the frequency control circuit.

In Fig. 1, the transmitting antenna 1 is connected with a radio transmitter 2 (shown within the dotted lines) by means of the coupling inductance 3. The antenna is also coupled, preferably loosely, by means of the coupling transformers 4 and 5 with the sharply tuned circuits A and B of the frequency control arrangement which will later be described more fully. The antenna is connected to ground through the condenser 6 with which the variable condenser 7 is connected in parallel.

The form of radio transmitter herein disclosed for the purpose of illustrating and describing the invention is that which is well known in the art as the Heising system of modulation which is described in the patent to Heising 1,442,147 dated January 16, 1923. The circuit includes the vacuum tube 8 which forms part of the oscillation circuit and the vacuum tube 9 which serves to modulate the high frequency oscillations in accordance with the impressed signaling currents. The grid of the modulator 9 is connected with the winding 10 of the transformer 11, which winding has also connected therewith the negative grid battery 15. The other winding 12 of the said transformer is connected with the signal input circuit L having the transmitter 13 and a source of

current 14 connected therewith. It is to be understood, of course, that the circuit L may have connected therewith any means for impressing currents upon the modulator 9 such, for example, as the code transmitting device shown in the copending application of Demarest and Almquist, Serial No. 646,903, filed June 21, 1923. The source of plate voltage 19 is connected with the plate of the modulator 9, the said connection including the low frequency choke coil 18. This source of plate voltage is also connected with the plate of the oscillator 8, the connection including the low frequency choke coil 18, a high frequency choke coil 20 and the coupling inductance 3. The grid of the oscillator 8 is connected through the condenser 23 with the coupling inductance 3 and also through the grid leak resistance 24 and the high frequency choke coil 17 with the filament of the oscillator. The filaments of the oscillator and modulator, which are heated by the source of current 16, are connected by conductor 21 with the grounded side of the source of plate voltage 19.

The means for adjusting the constant of the antenna circuit, in order to maintain constant the transmitted frequency, comprises two circuits connected with a bridge network having connected therewith a controlling mechanism responsive to a difference of frequency in the said two circuits. These circuits, which are coupled with the antenna by means of the transformers 4 and 5, are sharply tuned by means of the resonant circuits A and B, circuit A comprising the secondary winding 25 and the variable condenser 26; the circuit B comprising the secondary winding 38 and the variable condenser 39. The circuit A is adjusted to be resonant at a frequency slightly higher than the frequency at which it is desired to maintain the antenna constant. The other circuit B is adjusted to be resonant at a frequency lower than the desired antenna frequency by the same amount that the circuit A is higher. The circuit A is connected with the input side of the vacuum tube amplifier 27, the output side of which is connected with the primary winding 28 of the transformer 29. In similar manner the circuit B is connected with the input side of the amplifier 40, the output side of which is connected with the primary winding 41

of the transformer 42. The secondary windings 30 and 43 of transformers 29 and 42, respectively, together with the rectifying tubes 31 and 44 respectively, constitute two arms of a Wheatstone bridge network, the other arms of which are the equal resistances 34 and 35. The rectifying tubes 31 and 44 connected between the windings 30 and 43 respectively, and the junction point 33 of the arms 34 and 35 have a source of plate voltage 32 connected in series. Bridged across the outer ends of the arms 34 and 35 is a sensitive galvanometer 36 which forms part of the controlling mechanism represented within the dotted lines 37. This mechanism is preferably a slightly modified form of that shown in the patent to Leeds 1,125,699, dated January 19, 1915. In Leeds device the galvanometer controls a mechanism for the recording, for example, of changes in the current in a circuit. This mechanism, which is represented by 45, may, however, be readily adapted for varying the adjustment of the variable condenser 7, which, as stated, is connected in parallel with the condenser 6 and thereby will serve to control the frequency of the transmitting antenna 1.

The manner in which the radio transmitter 2 operates for the transmission of signals is generally well understood and requires but brief explanation here. Since the plate of the oscillator 8 is connected with the grid thereof by means of the coupling inductance 3 and the condenser 23, any variations in the current between the plate and the filament will produce resultant variations of potential to the grid. In this manner oscillations are set up, the frequency of which is governed by the constants of the transmitting antenna which includes the distributed capacity to ground of the antenna and also the lumped capacity represented by condensers 6 and 7 and the inductance represented by the winding 3 and the windings of transformers 4 and 5. When the signaling apparatus 13 connected with the line L is actuated, variations in potential are created in the winding 10 connected with the grid of the modulator 9. These variations of potential cause variations in the current that flows from the plate of the modulator 9 to the filament thereof, which current is derived from the source of plate voltage 19. Since, as stated, this same source of voltage is connected with the plate of the oscillator 8 as well as with the plate of the modulator 9, these variations in the plate filament current of the modulator 9 will cause resultant variations in the voltage applied to the plate of the oscillator 8, thus modulating the high frequency oscillations set up in the oscillation circuit by and in accordance with the signals impressed upon the line L by the device 13.

If the transmitting frequency remains constant at the desired value, and the circuits A and B of the frequency controlling circuit are each sharply tuned for resonance at equal distance in the frequency range above and below the desired fixed value of the antenna, currents of equal magnitude will be set up in the said resonant circuits A and B. The current in A will produce a voltage across the winding 30 which, by the action of the rectifying tube 31, will cause a direct current to flow through the resistance 34. In like manner the current in circuit B will cause a voltage in winding 43 which, by the action of the rectifying tube 44, will produce a direct current in the resistance 35 which will be equal to that in 34 because the frequency of the oscillations in the transmitting antenna is midway between the frequencies at which the circuits A and B are resonant. Since the currents in resistances 34 and 35 are equal, no potential difference will exist across the outer terminals thereof, and consequently the galvanometer 36 of the regulating mechanism will remain undeflected.

If the frequency of the transmitted oscillations varies from the desired fixed value, it will become closer in the frequency scale to one of the resonant circuits A and B and farther from the other. Assuming that it is closer to A than to B, more current will be set up in A than in B, and consequently the rectified current flowing through resistance 34 will be greater than that flowing through 35. The galvanometer 36 will be deflected and will start the operation of the mechanism 45 which will begin to adjust the setting of the variable condenser 7 so as to bring the transmitted frequency of the transmitting antenna 1 back to the desired fixed value. This mechanism 45, which is described in Leeds Patent 1,125,699, will continue to operate until the variable condenser 7 has been moved sufficiently to restore the frequency of the transmitting antenna to normal. When this condition exists the currents in the resonant circuits A and B will again be equal, and consequently the galvanometer 36 will not be affected.

The arrangement shown in Fig 2 is a modification of the structure shown in Fig. 1. The modification consists in combining the functions of amplification and rectification and performing them by a single tube. The same designating numerals have been used in both figures to indicate similar parts. In Fig. 2 the tubes 47 and 48 are detectors which, as is well known, not only detect the low frequency component of a modulated carrier but also produce some amplification. The circuit arrangement of Fig. 2 is therefore useful in such instances where the amount of energy set up in the joint circuits 25—26 and 38—39 is sufficiently great to pro-

duce without much amplification a detected signal capable of operating the relay 36. The manner in which the arrangement of Fig. 2 operates to control the transmitted frequency is similar to that described in connection with Fig. 1 and need not be set forth again.

In Fig. 1, the antenna and the radio transmitter are shown as being directly coupled. Where loose coupling is employed, the mutual inductance is a factor common to both the antenna and the transmitter circuits, and the wave length or frequency may be changed by varying the factor of mutual inductance. This may be accomplished by either changing the relative positions of the coils, or by introducing a metal disc between them.

While this invention has been described in connection with a radio transmitting circuit, it is in reality broader inasmuch as it is capable of controlling the frequency of any type of oscillation circuit. Nor is the invention limited to the particular form of regulating mechanism shown in the said patent to Leeds, since other forms of apparatus may be used in connection with the control circuit which is schematically shown in the drawing.

This invention is not limited to the particular form disclosed, since it is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a radio signaling system, the combination with a radio transmitting system having an antenna, a source of current connected therewith the frequency of which is determined by the constants of the said antenna, of a frequency controlling device connected with the said antenna comprising a Wheatstone-bridge network having ratio arms each including a tuned circuit and a rectifier, one of said tuned circuits being resonant above the normal and the other below the normal frequency of said source, and electro-responsive means connected across said network to automatically adjust the said antenna constants whereby the frequency of the carrier current may be maintained substantially constant.

2. In a radio signaling system, the combination with a source of oscillations, of a tuned circuit connected therewith and arranged to govern the frequency thereof, a modulator connected with the said source of oscillations, a source of signaling current connected with the said modulator and means comprising a Wheatstone-bridge network having ratio arms each including a tuned circuit and a rectifier, one of said tuned circuits being resonant above the normal and the other below the normal frequency of the said source of oscillations, and

electro-responsive means connected with the said network to automatically vary the adjustment of the said tuned circuit whereby the frequency of the said oscillations may be maintained substantially constant.

3. In a radio signaling system, the combination with a source of oscillations, of an antenna connected therewith and arranged to govern the frequency thereof, modulating means connected with the said source of oscillations, and means to automatically control the adjustment of the said tuned circuit, said means comprising complementary circuits tuned respectively for frequencies equally above and below the desired frequency of the said antenna, a Wheatstone-bridge network having a vacuum tube rectifier in each of the ratio arms thereof and having balanced resistances in the remaining arms, and an electro-responsive device bridged across said network having means to vary the constants of said antenna, the change being such as to restore to normal the frequency of the said source of oscillations.

4. In a radio signaling system, the combination with an antenna tuned for a particular frequency, of tuned circuits connected therewith, one of said circuits being resonant above the said particular frequency and the other resonant below the particular frequency, a balanced rectifier circuit having rectifying means individual to the said tuned circuits to rectify the voltages set up in the said tuned circuits, a current responsive device connected differentially with said rectifying means, means controlled by the said responsive means to restore the tuning of the said antenna to its normal frequency.

5. In a signaling system, the combination with a transmission circuit of a source of oscillations connected therewith and controlled as to frequency by the constants of the said circuit, a frequency controlling circuit also connected with the said transmission circuit comprising branches tuned respectively above and below the normal frequency of oscillation of the said source, a Wheatstone-bridge circuit having one arm connected with one tuned circuit and another arm with the other tuned circuit, each arm having means to rectify the oscillations set up in the said tuned circuits, an electro-responsive device connected across the other arms of the said bridge, and means controlled thereby to vary the constants of the said transmission circuit in such way as to restore to normal the frequency of oscillation of the said source.

In testimony whereof, we have signed our names to this specification this 29th day of December, 1923.

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