

UNITED STATES PATENT OFFICE.

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WIRELESS SIGNALING SYSTEM.

1,280,768.

Specification of Letters Patent.

Patented Oct. 8, 1918.

Application filed December 29, 1913. Serial No. 809,248.

To all whom it may concern:

Be it known that I, IRVING LANGMUIR, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Wireless Signaling Systems, of which the following is a specification.

My present invention relates to wireless signaling systems and more particularly to a new and improved means for receiving signals sent from a distant station by means of electromagnetic waves of a determined frequency. In carrying my invention into effect I make use of one or more electron discharge tubes such, for example, as those described and claimed in my copending applications, Serial Nos. 795,609 and 795,610, filed October 16th, 1913, arranged in co-operative relation with a local source of energy for producing electromagnetic waves of a given frequency differing slightly from that of the received waves. By arranging the different instrumentalities in the proper relation to the received waves I am able to receive in a suitable receiving device, an ordinary telephone receiver for example, signals produced by the waves of determined frequency to the exclusion of signals produced by waves of a different frequency. By the term "waves" as used in this specification and the claims which follow I mean to imply high frequency current or potential variations irrespective of whether in the course of such variations the current or potential changes in sign.

The novel features which I believe to be characteristic of my invention I have pointed out with particularity in the claims appended hereto. The invention itself, however, both as to the details of its organization and its mode of operation will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figures 1, 2 and 3 show respectively three different combinations whereby the desired result may be accomplished.

In carrying out my invention as shown in Fig. 1 the waves from the distant station having means for sending waves of a determined frequency are received by means of the antenna 1 which may be connected to ground through the condenser 2. The

waves thus received are impressed upon the grid circuit of the electron discharge tube 3 by means of the transformer 4. By this means the grid 5 of the electron discharge tube is given alternately negative and positive potentials, the frequency of the change in the grid potential depending upon the frequency of the received waves. The plate circuit of the electron discharge tube comprises the cathode 6 of filamentary form, provided with a local source of current 7 for heating the same, an anode 8, an indicating device for receiving the signals which in this case is shown as a telephone receiver 9, a local battery 10 and a coil 11 which is supplied with a suitable source of high frequency waves. The local source of high frequency waves here indicated consists of an alternator 12 having in its external circuit a coil 13 inductively coupled with the coil 11. Any other source of high frequency waves may, however, be used, the frequency of which may be adjusted so as to differ slightly from that of the received waves. It will be seen that with this arrangement the anode 8 also becomes alternately negative and positive. When the frequency of the received waves and of the locally generated waves differs there will be periods when the anode 8 is positive and the grid 5 is positive at the same time. The length of these periods will of course depend upon how near the two sets of waves approach phase opposition. There will also be similar periods when the anode is positive and the grid is negative, when the anode is negative and the grid positive, and when the anode is negative and the grid negative. Current will flow freely through the plate circuit, however, only during those periods when the anode is positive and the grid positive. The length of these periods and the amplitude of the current flow will increase from zero when the two waves are in phase, to a maximum when the two sets of waves are directly opposite in phase and will then decrease to zero again. Inasmuch as these periods during which current will flow are of very high frequency, each individual impulse of current will have no effect on the telephone receiver. In combination, however, the impulses will have the effect of a continuous current which gradually increases in amplitude from zero to a maxi-

mum value and then decreases again to zero and as a result beats will be heard in the telephone, the frequency of the beats being dependent upon the group frequency of the current impulses set up in the plate circuit and this group frequency in turn being equal to the difference in frequency of the two sets of waves. With this arrangement the only signals which can be received are those which are transmitted by means of waves which differ in frequency from those produced by the local source by an amount which is within the range of audibility of an ordinary telephone receiver. Waves which differ in frequency from the locally produced waves by a greater or less amount than the audible frequency of the receiver will produce no effect.

In some cases it may be desirable that the positive half wave of the local source which is impressed upon the anode be made greater than the negative half wave. To provide for this a battery 10 may be employed having its positive pole connected to the anode. The successive impulses of current which flow in the plate circuit, having a high frequency, would be choked back by the inductance of the telephone receiver. To prevent this a condenser 14 may be shunted across the terminals of the receiver. In some cases it will be found desirable also to employ a battery 27 in order that the numerical value of the negative potential imposed upon the grids 5 and 24 may be greater than that of the positive potential. It may even be found advantageous in some cases to make the battery so large that the potential of the grid will always be negative. On the other hand, it may be found desirable in some cases to so connect the battery that a positive potential will be imposed on the grid. It will of course be understood that other suitable forms of current operated devices than a telephone receiver may be used for receiving the signals.

In some cases the energy of the received waves may be so small that the amount of energy which may be controlled thereby in the plate circuit of the tube will be too small to give an easily audible signal in the telephone receiver. In such cases, however, the current fluctuations produced may be easily amplified by the arrangement which I have shown in Fig. 2. In place of the telephone receiver in the plate circuit in this case I may use a high resistance 15 which is also connected in the grid circuit of a second electron discharge tube 16. This circuit in addition to the grid 17 and the cathode 18 may also include a battery 19. This battery may be so connected that normally the grid 17 has a positive charge. In this case current from the local battery 20 will always flow in the plate circuit of the second tube in which the receiver 9 is included. When

current flows through the plate circuit of the first tube the drop of potential in the plate circuit will principally take place in the high resistance 15, and this will cut down the positive charge on the grid 17 due to the battery 19. This will decrease the current flow through the plate circuit of the second tube and the current fluctuations set up in this manner will produce beats in the telephone receiver in a similar manner to that described in connection with Fig. 1.

In Fig. 3 I have indicated diagrammatically a system in which the current fluctuations which produce the beats are produced directly in coil 21. In this case the coil 22 in the antenna circuit and the coil 23 in the circuit of the local source of waves are placed in inductive relation to each other. Both of these coils are also located in inductive relation to the coil 21 and the resultant wave set up in that coil is caused to act upon the grid 24 of the electron discharge tube 25. This resultant wave will act on the plate circuit of the tube 25 in such a way as to permit a flow of current through the receiver 9 in that circuit which will produce beats in the receiver. In this case, if the alternator 12 is used it will be found desirable to employ a variable resistance 26 or other controlling device in the circuit of the local wave source in order that the amplitude of the local waves may be adjusted so that it will be approximately the same as that of the received waves. Otherwise the local waves would drown out the received waves and the resultant effect in the coil 21 would be largely due to the local wave source. An adjustable condenser 28 may be placed in the grid circuit of the electron discharge tubes 3 and 25 as a means for making these circuits resonant to the waves impressed thereon.

While I have shown and described only three organizations whereby my invention may be carried into effect, it will be apparent that many modifications thereof may be made without departing from the scope of my invention. I do not wish to be limited to the particular forms of apparatus indicated as other forms may also be used for the same purpose.

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

1. The combination in a receiving system for wireless telegraphy of an electron discharge tube having grid and plate circuits, a local source of alternating current energy connected in the plate circuit of said tube for producing waves having a frequency slightly different from that of the waves which are to be received and means for impressing upon the grid circuit of said tube the received waves to produce in the plate circuit of the tube current fluctuations of regularly varying amplitude having a group

frequency equal to the difference in frequency of the received and locally produced waves.

2. The combination in a receiving system for wireless telegraphy of an electron discharge tube having grid and plate circuits, a local source of alternating current energy connected in the plate circuit of said tube for producing waves having a frequency slightly different from that of the waves which are to be received, means for impressing upon the grid circuit of said tube the received waves to produce in the plate circuit of the tube current fluctuations of regularly varying amplitude having a group frequency equal to the difference in frequency of the received and locally produced waves, and indicating means adapted to give indications of a frequency equal to the group frequency of the current fluctuations.

3. The combination in a receiving system for wireless telegraphy of an evacuated receptacle containing at least two electrodes and a controlling grid, a local source of alternating current energy connected in a circuit which includes said electrodes having a frequency slightly different from that of the waves which are to be received and means for impressing upon said controlling grid the potential of the received waves.

4. The combination in a wireless receiving system of an electron discharge tube having grid and plate circuits, a local source of alternating current energy included in the plate circuit of said tube and having a frequency slightly different from that of the waves to be received, and means cooperating with said tube and said source of energy for producing beats in a telephone receiver having a frequency equal to the difference in frequency of the received waves and the local source of energy.

5. The combination in a wireless receiving system of an evacuated receptacle containing at least two electrodes and a controlling grid, a local source of alternating current energy connected in a circuit between said electrodes and having a frequency slightly different from that of the waves which are to be received, and means for causing a current of regularly varying amplitude having a group frequency equal to the difference in frequency of the received waves and the local

source of energy to flow in the circuit between said electrodes.

6. The combination in a receiving system for wireless telegraphy of an evacuated receptacle containing at least two electrodes and a controlling grid, a local source of alternating current energy connected in a circuit between said electrodes having a frequency slightly different from that of the waves which are to be received, and means for impressing upon said grid the potential of the received waves to cause to flow between said electrodes a current of regularly varying amplitude having a group frequency equal to the difference in frequency of the received waves and the local source of energy.

7. A wireless receiving system comprising an electron discharge device having plate and grid circuits, means for impressing received waves upon the grid circuit and means independent of said device for producing and impressing upon the plate circuit, alternating current of a slightly different frequency from that produced by the received waves.

8. A wireless receiving system comprising an electron discharge device having plate and grid circuits which are entirely independent of each other except for the coupling between the electrodes of the device, means for impressing received waves upon the grid circuit, and means independent of said device for producing and impressing upon the plate circuit alternating current of a slightly different frequency from that produced by the received waves.

9. A wireless receiving system comprising an electron discharge device having plate and grid circuits, means for impressing received waves upon the grid circuit, a source of direct current in the plate circuit, and means independent of said device for producing and impressing upon the plate circuit alternating current of a slightly different frequency from that produced by the received waves.

In witness whereof I have hereunto set my hand this 27th day of December, 1913.

IRVING LANGMUIR.

Witnesses:

WILLIAM C. WHITE,
BENJAMIN B. HULL.