R. A. WEAGANT.

WIRELESS SIGNALING APPARATUS.

APPLICATION FILED APR. 5, 1915.

1,278,535.

Patented Sept. 10, 1918.

2 SHEETS—SHEET 1.

Fig. 1.

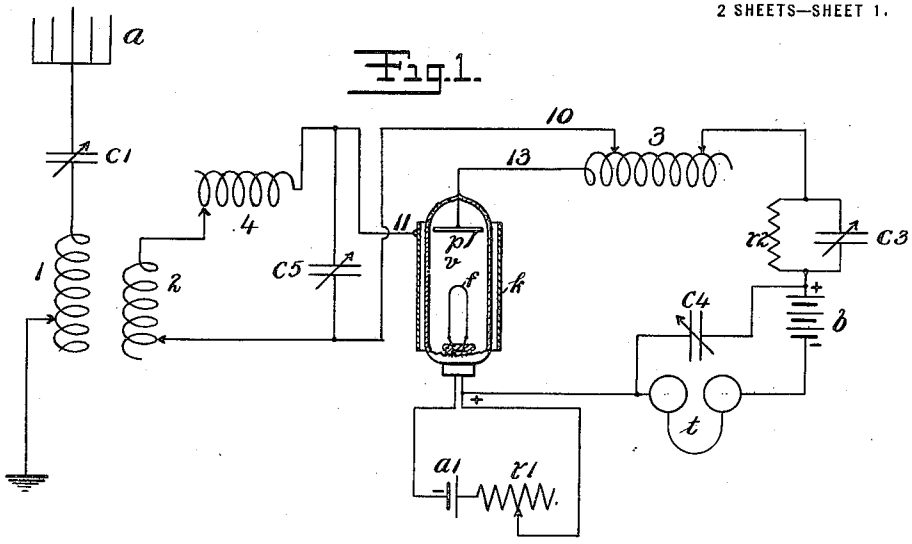
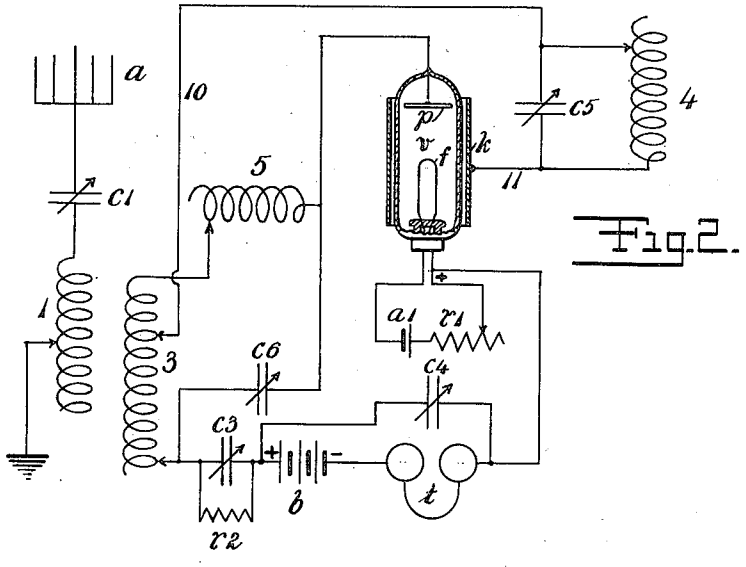


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 3.

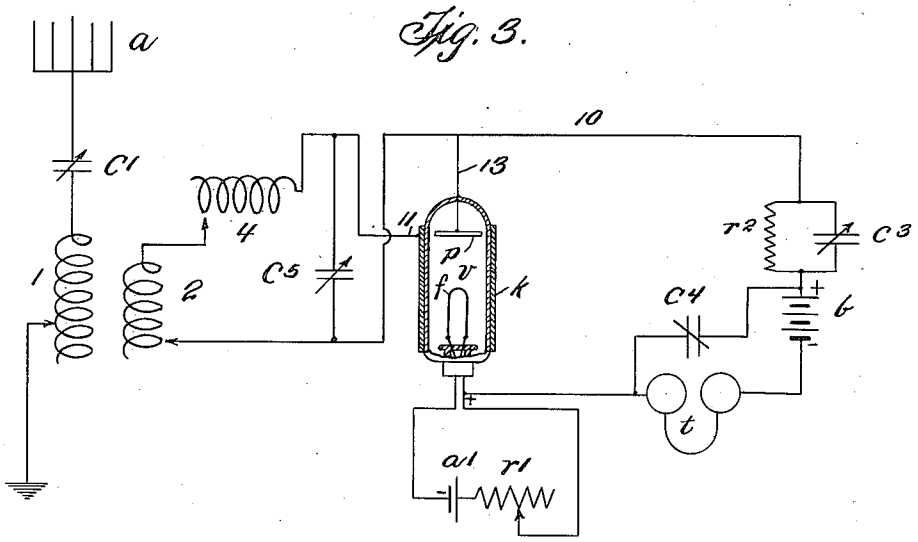
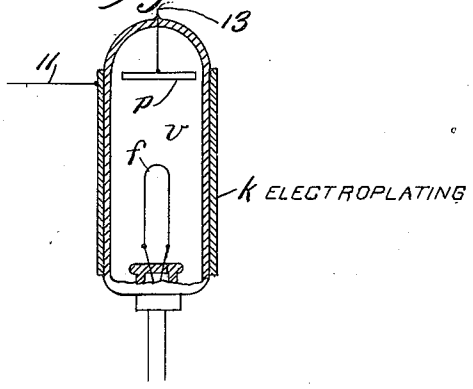


Fig. 4.



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WIRELESS SIGNALING APPARATUS.

1,278,535. Specification of Letters Patent. Patented Sept. 10, 1918.

Application filed April 5, 1915. Serial No. 19,184.

To all whom it may concern:

Be it known that I, ROY A. WEAGANT, a citizen of the United States, and a resident of Roselle, county of Union, State of New Jersey, have made certain new and useful Improvements in Wireless Signaling Apparatus, of which the following is a specification.

This invention relates to apparatus for use in radio communication and its object is to provide means for detecting and amplifying electrical impulses or variations.

In the accompanying drawings, Figure 1 shows one form of the invention, Fig. 2 shows a modification adapted for generating high frequency oscillations, Fig. 3 shows a modification in which an inductance is omitted and Fig. 4 shows a valve having its outer element electroplated onto the outer surface of the valve chamber.

The invention is an improvement on the well-known Fleming valve shown and described in U. S. Letters Patent No. 803684, dated November 7th, 1905. In this improved apparatus shown and described herein, there is employed a vacuum chamber containing a hot element and a cold element, and outside the chamber an element is fixed in position, this element has extended capacity area and is in close proximity to the outer surface of the chamber; the outer element is preferably a metal, like copper, electroplated onto the outer surface of the valve chamber as shown in Fig. 4; it is arranged with its surface area parallel with the path of the electrons moving from the hot element at one end of the chamber toward the cold element at the other end of the chamber; this outer element is preferably of sufficient superficial area to surround both elements and the space between said elements; the object being to establish an extensive and intimate relation between the path of the electrons and the surface of the outer elements. As shown and described herein, the apparatus can be operated to generate groups of oscillations following each other at any desired time interval, which time interval may be either within or without the range of audibility. By reason of this action, when adjustments are so made that these groups of oscillations follow each other at a rate which is nearly or quite beyond the upper limit of audibility, the device becomes a receiver of continuous or undamped oscillations, due to the fact that the oscillation frequency of these groups may be so adjusted as to be slightly different from that of the incoming signal; the result produced being a beat between these two trains of oscillations, producing an audible note in the telephone receiver of any desired pitch. This result is due to the fact that with the described arrangement, the valve automatically opens and closes the battery circuit at a rate which depends upon the adjustment of the constants of the circuit, the establishment of the required filament temperature and the employment of a valve exhausted to the proper point or degree. Generally speaking, the vacuum is such that the application of 100 volts or less between the inclosed electrodes will produce a visible blue glow or arc-like effect. The oscillation frequency, however, is controllable by means of the associated oscillation circuit, which includes the well-known tuning elements, that is, adjustable inductance and adjustable capacity, and the electrical association of this circuit with the outer element of the valve.

The utility of the resistance, and the capacity shunting it, in the battery circuit, is that it enables the amplification of the effect of small electrical impulses impressed upon the valve. When this resistance, which is very high, and of the order of that of the valve itself, is employed, an adjustment of the potential of the battery to a point higher than is desirable without the use of this resistance is possible, and we are enabled to get a critical adjustment of the ionization of the gas within the valve such, that the effect of minute electrical disturbances impressed thereon, causes the flow of a greatly increased amount of electrical energy through the indicating device and battery circuits, and these variations, follow in intensity and rate the variations of the impressed electrical energy.

The resistance contributes materially in attaining the condition of automatic interruption of the battery circuit previously referred to and enables the valve to operate as a generator of alternating current or groups of damped oscillations.

In explanation of this action the theory

appears to be as follows: When the battery circuit is closed, the temperature of the filament being assumed to be correct, the current starts to flow through the battery circuit. As this current builds up, however, a considerable proportion of the impressed electromotive force is consumed in the resistance outside of the valve with the result that, as the current flow through the valve from the battery increases, the potential across the electrodes within the valve decreases and when all conditions are properly adjusted this decrease appears to be of such an extent that the electric conductivity between the two electrodes in the valve is greatly reduced, so that the circuit in effect opens. This is a theory which partly explains the operation, but there may be other and additional conditions established, not at present fully appreciated.

The adjustable inductance as shown in the battery circuit performs several novel and important functions. When all adjustments for maximum response are made, this inductance is adjusted to a particular value, depending on the wave length of the incoming signal and a great increase in the effect on the indicating device will result; generally speaking, this appears to be when the time period of this battery circuit corresponds closely to that of the associated circuit to which the outside capacity is connected; at times, however, considerable variation from this is desirable. When this adjustment is made as described, it will be found that in addition to the amplification effect on the received signals another phenomenon becomes apparent; that is, when these adjustments are made in a certain way the arrangement becomes a generator of oscillations, which oscillations are of a different type from those previously described as obtainable without the use of this inductance. This additional new type of oscillations is not broken up into groups and damped, but is strictly continuous and sinusoidal in form. This type of oscillation does not require a particular and moderate order of vacuum within the valve chamber and the presence of small quantities of ionizable gas therein, but is produced in a vacuum which is as nearly perfect as possible; in fact the more nearly perfect the vacuum within the valve the more vigorous and stable is this action. When the valve is used as a receiver of spark signals the adjustment of the circuits should be such that the valve is just ready to start oscillating but does not do so; while for the reception of signals due to undamped waves, the valve is used in the oscillating condition and as in the previously described action, a note is produced in the telephone due to the difference in frequency of the incoming signal and the oscillation frequency produced in the valve circuit.

Another function which this inductance performs is the following:

When we are using the device without the inductance as shown in Fig. 3, it is found that the arrangement has a low limit, that is, there is a minimum strength of signal below which the arrangement will not amplify. When, however, the inductance is present in the circuit, there is no such low limit and any signal however weak is amplified. In using the inductance in combination with the other elements of the arrangement already described it is possible to start with a signal which is below the low limit of the device when the inductance is not present, amplify it to a point which is above the low limit and to superimpose upon the amplification due to the adjustment of this inductance, the amplification due to the critical condition of ionization within the valve, the combined effect being an enormous increase of the original signal strength. It will be found in the operation of this device that the type of amplification produced by the adjustment of the inductance in the battery circuit is of a more stable character than that due to the resistance and shunting capacity when employed alone, but is of a smaller order; when the two are employed together or in coöperation the result partakes somewhat of the characteristics of each when used separately and the joint result is exceedingly beneficial. This action may be due to the fact that the conditions are such that operation upon the upper portion of the characteristic curve of the detector is possible, either by reason of a species of compensating action or a change of the curvature of the characteristic so that it becomes less steep and the operating point of the detector may therefore be located upon it. It is probable, however, that other actions enter into the operation of the device since the phenomena is an extremely complicated one.

The beneficial result due to using the inductance in the battery circuit is further increased by providing coupling between this battery circuit and the oscillating circuit attached to the outer member of the valve. This coupling is preferably variable and in the drawings it is shown as a direct coupling, the variation being accomplished by varying the point of attachment of the wire 10 to the inductance 3, or the inductance in the battery circuit, but it may equally well be secured by an inductive coupling or by an electrostatic coupling.

Capacity c^4 forms a path around the battery b and telephone t, for the high frequency oscillations.

In the drawings Fig. 1 shows the improved valve with a local circuit associateing it with the antenna circuit and a second local circuit containing a source of direct current

and indicating devices; in Fig. 2, the two local circuits are interchanged and better adapted for use when the valve is utilized for generating high frequency oscillations, as in a wireless telegraph transmitter.

The valve consists of a vacuum chamber v, having within it at one end, a hot electrode f, at the other end, a cold electrode, such as a plate of metal p; outside the vacuum chamber is an electrode k of extended area, by preference cylindrical and arranged substantially parallel with the path of electron movement between electrodes f and p and as close as possible to the path of such movement; in extent this electrode or element k incloses the space between the electrodes f and p and laps said electrodes, more or less. This valve when associated with local circuits, and the antenna circuit, possesses many features of merit as a detector and as a generator of oscillations of high frequency derived from a direct current. The antenna is shown at a, the variable condenser c^1 is in series in its circuit and an inductance 1, forms the primary of an inductorium; the secondary 2 of this inductorium is in a closed oscillating circuit with a second section of inductance 4; the terminals of this oscillating circuit are connected, one by terminal 11 to the exterior element k of the valve; the other terminal 10 is connected to the inductance 3 and by means of wire 13 with the cold element p of the valve. In the second local circuit is a source of direct current, as a battery b, a high resistance r^2 shunted by a variable capacity c^3 and a variable inductance 3. The telephone t and battery b are shunted by variable capacity c^4. For the purpose of heating the hot element in the valve, there is provided the usual variable battery a^1 and a rheostat r^1.

It results from the described arrangement and connection that, assuming inductance 3 to be adjusted to a value depending on the wave length of the incoming signal a marked increase in the effect of the incoming signal is noticeable in the telephone; this appears to be when the time period of the battery circuit corresponds closely to that of the associated circuit to which the outside capacity is connected. When this adjustment is made as above described and the vacuum in chamber v is high the apparatus becomes a generator of oscillations of a different type from those obtainable without the use of inductance 3. This new type is not broken up into damped groups but is strictly continuous and sinusoidal in form. The more nearly perfect the vacuum the more vigorous and stable is this action. When the valve and its circuits are used as a receiver of spark signals, the adjustment of the circuits should be such that the valve is just ready to start oscillating. When receiving signals due to undamped waves the valve is used in its oscillating condition. When the valve and its circuits are used without the inductance and resistance r^2 and its shunted capacity c^3 are in position, as shown, there is a minimum strength of signal below which the apparatus will not amplify, but by using inductance as shown in combination with the other elements as described, it is possible to start with a signal which is below the low limit of the device when the inductance is absent, amplifying it to a point above the low limit and superimposing upon the amplification due to the adjustment of this inductance the amplification due to the critical condition of ionization within the valve, the combined effect being an enormous increase of the original signal strength.

When operating with extremely short wave lengths the inductance employed would be limited to small amount and in some cases, the inductance due to the circuit connections might alone suffice.

In Fig. 2, the antenna a, capacity c^1, coil 1, are the same as in Fig. 1; the secondary coil 3 and supplemental coil 5, are substituted for coil 3 appearing in Fig. 1 and the coil 4 in Fig. 2 is substituted for coils 2 and 4 in Fig. 1; the antenna circuit a in Fig. 2 is coupled to the battery circuit instead of to the local circuit used for coupling in Fig. 1. The arrangement shown in Fig. 2 is preferred for a transmitting circuit and that in Fig. 1 for receiving, but either arrangement is useful for either purpose.

What I claim is:

1. In a wireless signaling apparatus, the combination of a vacuum valve having a hot element and a cold element within the chamber, an electro-static control element outside said chamber adapted to project a field of force into the space within the chamber at an angle to the stream of electrons, two local circuits, one of which includes inductance, associated with the antenna circuit, an electrical connection from one terminal of said inductance circuit to the outside control element and a connection from the other terminal of said inductance circuit to a point in the second local circuit, said second local circuit also including a variable inductance, a battery, an indicating device, and electrical connections between the terminals of said circuit and the hot and cold elements, respectively.

2. In a wireless signaling apparatus, the combination of a vacuum valve having a hot element and a cold element within the valve chamber, an electro-static control element outside said chamber, the electro-static field due to said control element being at an angle to the electron stream within the chamber, a closed oscillating circuit, of which said outside element forms part, a battery circuit, a variable inductance in said battery circuit, and electrical connections between the ter-

minals of said battery circuit and the inside elements of the valve.

3. In wireless signaling apparatus, the combination of a vacuum valve having a hot element and a cold element within the valve chamber, an electro-static control element outside said chamber, adapted to project a field of force into the space within the chamber at an angle to the stream of electrons, a closed oscillation circuit with which said outside element and a second valve element are connected, a battery circuit having its terminals connected to the inside valve elements and means for adjusting the electrical time period of one circuit to that of the other.

4. In a wireless signaling apparatus, the combination of a vacuum valve having a hot element and a cold element within the valve chamber, an electro-static control element outside said chamber, the electro-static field due to said control element being at an angle to the electron stream within the chamber, a closed oscillating circuit with which said outside element and a second valve element are associated, a battery circuit connected to the elements in the valve chamber and means for adjusting the electrical time period of one of said circuits.

5. In a wireless signaling apparatus, the combination of a vacuum valve having a hot element and a cold element within the valve, an electro-static control element outside said chamber, the electro-static field due to said control element being at an angle to the electron stream within the chamber, an oscillating circuit associated with said outside element and one of the inside elements, and a battery circuit including an inductance, a non-inductive resistance and capacity in parallel with said resistance, said battery circuit being connected to the elements within the valve.

6. In a wireless signaling apparatus, the combination of a vacuum valve having a hot element and a cold element within the valve, an electro-static control element outside said chamber, adapted to project a field of force into the space within the chamber at an angle to the stream of electrons, an oscillating circuit associated with said outside element and one of the inside elements and a battery circuit including an adjustable inductance, an adjustable, non-inductive resistance, and an adjustable capacity in parallel with said resistance, said battery circuit being connected to the elements within the valve.

7. In a wireless signaling apparatus, the combination of a vacuum valve having a hot element and a cold element within the valve, an electro-static control element outside said chamber, the electro-static field due to said control element being at an angle to the electron stream within the chamber, an oscillating circuit associated with said outside element and one of the inside elements, a battery circuit including inductance and coupling means exterior to the valve for transferring radio frequency energy from one of said circuits to the other by associated portions of said circuits.

8. In a generator of alternating electric current, the combination of a vacuum valve having a hot element and a cold element within the chamber, an electro-static control element outside said chamber, adapted to project a field of force into the space within the chamber at an angle to the stream of electrons, a circuit having means for varying its time period, a circuit including in series a source of direct current and the two elements within said chamber and coupling means for establishing reactions between said circuits.

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