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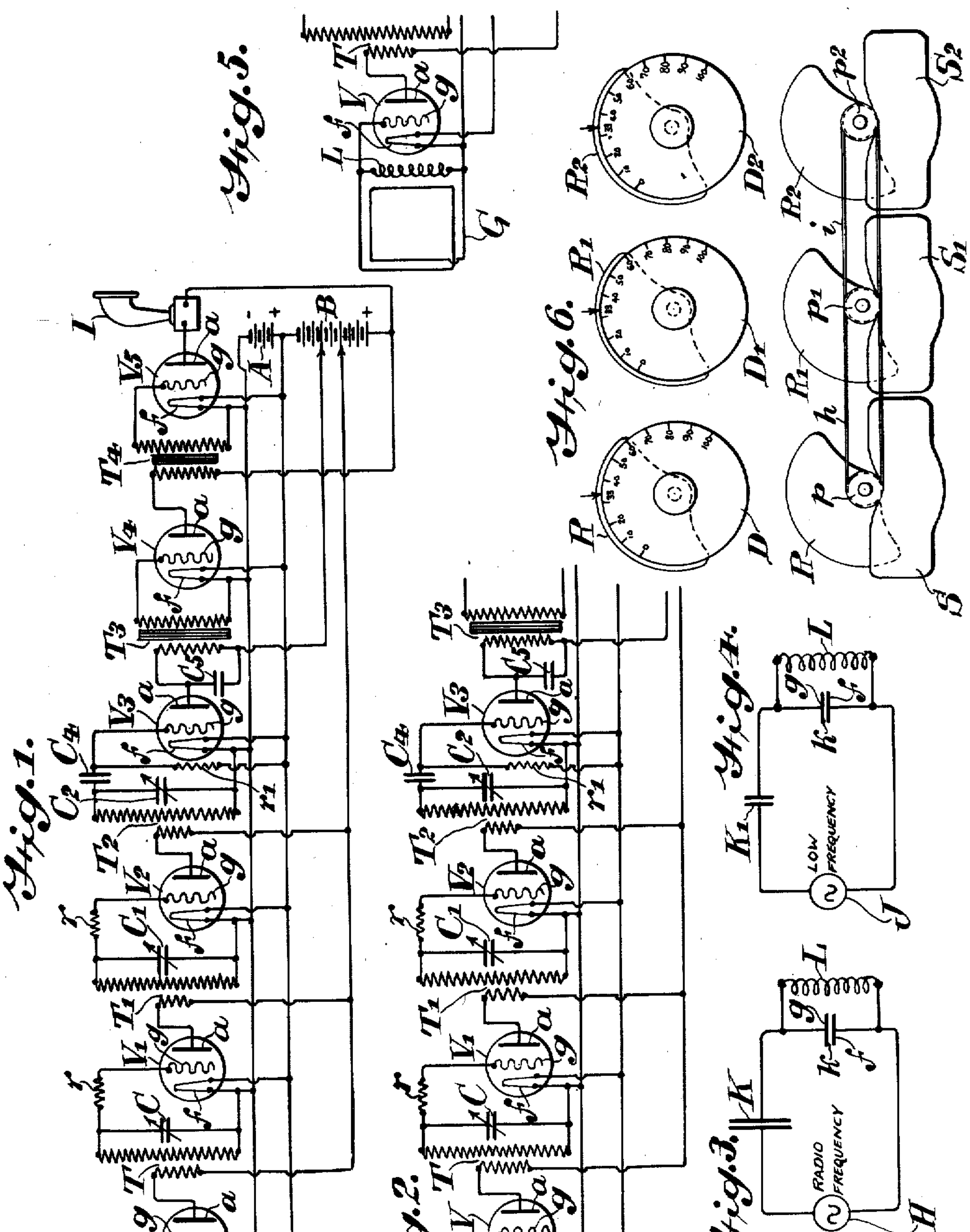
J. M. MILLER

RADIO RECEIVING SYSTEM

Filed June 23, 1926



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Patented Aug. 16, 1927. **1,639,414**

UNITED STATES PATENT OFFICE.

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RADIO RECEIVING SYSTEM.

Application filed June 23, 1926. Serial No. 117,964.

My invention relates to radio receiving systems, and particularly those in which there is utilized a plurality of thermionic devices or vacuum tubes in cascade, with a variable tuning device associated with each of two or more of the thermionic devices or vacuum tubes, and arranged to operate in conjunction with an absorption path, such as an open or looped antenna, or equivalent.

It is an object of my invention to make possible the adjustment to like extents of the tuning devices of a radio receiving system or set involving two or more circuits tuned to the radio frequency of the received energy, for effecting plural stage tuning by moving the several tuning elements to substantially similar positions, either separately or in unison with each other.

In accordance with my invention there is interposed between the first tuned circuit and the antenna, or equivalent absorption path, a radio frequency amplifier tube whose input or grid circuit is operatively related to the antenna or equivalent absorption path; neither the grid or input circuit of the interposed tube nor the absorption path is tunable to the various wave lengths of the wave length range of the received energy for which the receiving system or set is designed, and the capacity and inductance of the input system, comprising the antenna or absorption path and the input or grid circuit of the interposed tube, are substantially constant throughout that wave length range, and the input system accordingly has no effect upon the tuning characteristics of and in effect is reactively isolated from the first tuned circuit.

Further in accordance with my invention the input or grid circuit of the interposed tube is directly connected to or in series with the antenna or equivalent absorption structure.

Further in accordance with my invention, there may be shunted across the input circuit of the interposed tube as by connecting it from grid to cathode, an impedance, preferably an inductance, of such magnitude as substantially to exclude radio frequency current from the shunt path but to permit passage of low or audio frequency current to prevent substantial effect upon the grid of the interposed tube by the effects, inductive or otherwise, upon the receiving system caused by low frequency current in nearby lighting, power or other circuits; and further in accordance with my invention, the shunt impedance or inductance serves as a path for the grid current of the interposed tube.

Further in accordance with my invention, in an arrangement of the character aforesaid, the number of turns in the primary coils of the radio frequency coupling transformers in the anode circuits of the interposed and succeeding tubes may be increased, without loss of stability or tendency to oscillate; and more particularly, the number of turns in the primary winding of the radio frequency transformer in the anode circuit of the interposed tube may be greater than the number of turns in the primary coil or coils of the radio frequency transformer or transformers in the anode circuit or circuits of the succeeding tube or tubes.

My invention resides in a system of the character hereinafter described and claimed.

This application is in part a continuation of my application Serial No. 73,091, filed December 4, 1925.

For an understanding of my invention and for an illustration of some of the various forms it may take, reference is had to the accompanying drawing, in which:

Fig. 1 is a diagrammatic view of a radio receiving system in accordance with my invention.

Fig. 2 is a diagrammatic view of a circuit arrangement substantially similar to that of Fig. 1 with the addition, however, of a shunt inductance in the input circuit of the interposed tube.

Figs. 3 and 4 are diagrams of circuit arrangements explanatory of my invention.

Fig. 5 is a fragmentary diagrammatic view of a modified arrangement involving a loop as distinguished from an open antenna.

Fig. 6 is an illustration of dial settings and of the corresponding positions of the several tuning elements.

Referring to Fig. 1, V^1 and V^2 are radio frequency thermionic amplifiers of the audion type each comprising, as usual, an anode *a*, grid *g* and cathode or filament *f*. The input or grid circuit of the tube V^1 includes the secondary coil of a radio frequency step-up transformer T, and the variable condenser C for tuning the input circuit to the several and various wave lengths lying within the range or wave lengths for which the set or system is designed, as, for example, from 200 to 600 meters.

The output circuit of the tube V^1 is coupled by the radio frequency step-up transformer T^1 to the input circuit of the tube V^2 similarly tunable to the various wave lengths of the same wave length range by the variable condenser C^1. In the grid leads of the tubes V^1 and V^2 may be included resistances r of a magnitude to prevent substantial regeneration or production of oscillations, it being understood that any other suitable arrangement for like purpose may be utilized. The output circuit of the tube V^2 is coupled by the radio frequency step-up transformer T^2 to the input circuit of the detector tube V^3 similarly tunable throughout the same wave length range by the variable condenser C^2. In the grid lead of the tube V^3 is the usual grid condenser C^4; and there may be provided a grid leak resistance r^1.

In the example above described, the adjustable tuning devices are condensers C, C^1 and C^2, and they are similar to each other in the sense that they effect substantially equal changes in tuning when their rotors or adjustable elements are moved or adjusted through the same angular extents. While there may be utilized variable condensers of any suitable characteristic as regards change of capacity with change of position of the rotor or adjustable element, a type particularly suitable for use in carrying out my invention is such as illustrated in a general way in Fig. 6, and of which it is characteristic that for equal increments of angular adjustment of the rotor the capacity increases by substantially equal increments; that is, the increments of capacity are equal for equal angular displacements or increments of adjustment of the rotor.

The output circuit of the detector V^3 is coupled by an audio frequency transformer T^3, whose primary may be shunted by the radio frequency by-pass condenser C^5, with the input circuit of the audio frequency amplifier tube V^4 whose output circuit is coupled by the audio frequency transformer T^4 with the input circuit of the audio frequency amplifier tube V^5 in whose output circuit is the signal-translating instrument I, such as a loud speaker, telephone or the like. As usual, the several filaments f are supplied by current from the source A, the individual filaments or groups thereof having rheostats in series therewith, if desired; and the anode circuits are supplied by the source B, low voltage preferably being impressed upon the anode circuit of the detector V^3, intermediate voltage upon the anode circuits of the tubes V, V^1 and V^2, and high voltage upon the anode circuits of the tubes V^4 and V^5.

As thus far described, the system is an ordinary tuned radio frequency amplifier set, the tuned input circuit of whose first stage tube V^1 is ordinarily coupled to the radiant energy absorption structure, such as an antenna, closed loop or the like.

When the tunable input circuit of the first stage, as V^1, of such an ordinary tuned radio frequency amplifier system is coupled by a transformer or equivalent to an antenna or equivalent absorption structure, which generally has different characteristics or lengths in different installations, the antenna or equivalent absorption structure operates in effect as an inductive or capacitative reactance, generally capacitative, across the terminals of or in shunt with the primary of the coupling transformer, and, therefore, through the coupling introduces reactance into the tunable input circuit of the first stage. This fact and the further fact that the effective reactance of the antenna circuit or path varies with the wave length received, causes the adjustable element of the tuning device of the input circuit of the first stage to take positions, in tuning to the several wave lengths of the range, which do not correspond with and materially differ from the positions of the adjustable element or elements of the tuning device or devices of the succeeding stage or stages. In such cases the extent of adjustment of the adjustable element of the tuning device C for such first stage, as in changing from resonance for one wave length to resonance for another wave length, does not correspond with the extent of adjustment of the adjustable element or elements of the tuning device C^1 or tuning devices C^1 and C^2 of the succeeding stage or stages in changing from resonance for that one wave length to resonance for the other wave length. It is necessary, therefore, for the operator to find the proper setting at a given wave length for the tuning device C and the proper, but different, setting for the tuning device C^1 for the same wave length. Generally the setting of the third tuning device C^2 will correspond closely with that of the second tuning device C^1. However, satisfactory operation of the set involves the delay and uncertainty of making two different settings which are not alike as regards the positions of the tuning elements and the dials co-operating therewith.

In Fig. 6 the dials D, D^1 and D^2 are secured upon the shafts of the rotors or adjustable elements R, R^1 and R^2, respectively, of the tuning condensers C, C^1 and C^2, whose stators are indicated at S, S^1 and S^2, respectively. Each dial may be uniformly graduated from zero to 100, for example, within a half circle, whose ends at zero and 100 correspond, respectively, with the minimum and maximum capacities of the condenser, the maximum capacity exceeding by little or nothing the capacity required to tune to the longest wave of the range for which the set is designed. When, for example, the proper setting for a given wave length of either or both of the dials D^1 and D^2 is, say, 33, the setting of the dial D of the first stage V^1, when coupled as usual to the antenna or absorption structure, without interposition of the tube V later to be described, will be materially different from and not uniform with the settings of the dials D^1 and D^2.

To insure that all the dials shall have substantially the same setting for each of the various wave lengths, enabling the operator to move all dials to the same setting for sharp tuning for all of the tuned circuits for each of the various wave lengths received, or to permit, as indicated in Fig. 6, the adjustment to equal extents in unison with each other of the several adjustable elements of the several tuning devices, I interpose between the first radio frequency amplifier tube V^1, whose input circuit is tuned, and the antenna F, Figs. 1 and 2 or loop antenna G, Fig. 5, or equivalent absorption structure, a radio frequency amplifier tube V, Figs. 1, 2 and 5, whose output circuit is coupled by the radio frequency transformer T to the tunable input circuit of the tube V^1. The tunable input circuit of the tube V^1 is by the transformer T related to the anode circuit of the interposed tube V in substantially the same way that the tuned input circuit or circuits of the later stage or stages is or are related to the immediately preceding anode circuit or circuits to which it or they are similarly coupled by transformers T^1 or T^2. Accordingly, the first tunable system or circuit of the series is not materially influenced as regards its tuning characteristics by the antenna or absorption structure, and, therefore, with similar tuning devices in and for the several tunable systems or circuits, they may be tuned to the several different wave lengths of the range by substantially similar and equal extents of movement of the adjustable tuning elements. By such arrangement, the antenna or absorption structure does not introduce either inductive or capacitative reactance into the first tunable circuit or system of the series, and the first tunable circuit or system accordingly has characteristics dependent upon its own electrical constants, and, therefore, its tuning characteristics are similar to those of the succeeding stage or stages, making possible the adjustment of adjustable tuning elements to like extents and to like positions for each of the several wave lengths of the range for which the set or system is designed.

Referring again to Fig. 1, the absorption or antenna path, comprising the antenna F and the earth or countercapacity E is connected directly, that is, without coupling of any character, to the grid g and cathode f of the interposed tube V. Neither the antenna or absorption path nor the input circuit of the interposed tube V is tuned or tunable to the various wave lengths of the range for which the set or system is to be utilized.

With such an arrangement the electromotive-force of radio frequency corresponding with the frequency of the energy absorbed by the antenna or other absorption structure, is effective in substantially full magnitude for varying the potential of the grid of the interposed tube V, particularly since the small capacity between the grid g and cathode f is effectively in series with the relatively larger capacity of the antenna or absorption structure.

The reactance of the antenna or absorption structure, therefore, does not affect the first tuned or tunable circuit of the series of tunable circuits and, in consequence, all three rotors, R, R^1 and R^2, of condensers having the same characteristic as regards change of tuning with change of position of rotor may be adjusted to similar positions for tuning to the same wave length of the received energy. Where the rotors are adjustable independently of each other and each is provided with a dial, the three dials may, therefore, be moved to corresponding readings to assure tuning to the same wave length.

However, the three rotors may be mechanically coupled as by the bands h and i passing over pulley p^1 on the shaft of rotor R^1 and over the pulley p and p^2 on the shafts of the rotors R and R^2, respectively. A single dial will then suffice secured upon the shaft of any one of the rotors and its rotation will effect adjustment of the rotors in unison, to like extents, for tuning to each of the wave lengths of the range.

Where a receiving system or set of the character described in connection with Fig. 1 is used when adjacent to a circuit carrying low frequency fluctuating or alternating current, as a power circuit or a lighting circuit in the same residence or building with the receiving set, there will be induced in the receiving system low frequency electromotive-forces affecting at like frequency the potential of the grid g of the interposed tube V with the result that a disturbing low frequency hum or note will be produced by the translating instrument I. For example, in the case of a lighting circuit in a residence where the receiving system is utilized, the alternating current of commercial frequency, for example, 25 to 60 cycles per second, will cause a hum or note of corresponding frequency in the instrument I. Or in fact any circuit traversed by low or audio frequency current and disposed within the range of influence upon the receiving system will cause a low or audio frequency note or sound in the instrument I.

In Fig. 2 there is illustrated an arrangement for preventing substantial effect by such low or audio frequency current. Fig. 2 corresponds generally with Fig. 1 except that there is utilized in addition the inductance L shunted across the input circuit of the interposed tube V by connection from grid to cathode thereof.

The inductance L is of such magnitude that it constitutes in effect a choke coil substantially preventing passage therethrough of current of the radio frequency of the received energy. The reaction of the inductance L for low or audio frequency current, however, is low, thereby shunting the low or audio frequency current, due to an adjacent low or audio frequency circuit, from the grid *g* of the interposed tube V thereby preventing production of low or audio frequency sound by the instrument I.

Fig. 3 is a circuit representative of the antenna or absorption structure and the grid to cathode path of the interposed tube V which, as regards the received radio frequency energy comprises in effect a source H of radio frequency electro-motive-force in series with the capacity K of the antenna or absorption structure and the capacity *k* between the grid and cathode of the interposed tube V, the latter shunted by the inductance L. The capacity K, even for a small or short antenna, is large with respect to the capacity *k*, and the inductance L is of such a magnitude as to operate as a radio frequency choke, thereby preventing radio frequency current from by-passing through choke coil around the capacity *k*. In consequence, substantially the full magnitude of electro-motive-force set up in the antenna by the received energy is effective across the grid and cathode of the tube V and the inductance L has substantially no effect in the sense of reducing the potential variations of the grid of the tube V.

As regards low or audio frequency, however, the arrangement of Fig. 2 is substantially that of the circuit indicated in Fig. 4 in which J represents a source of low frequency electro-motive-force impressed upon the receiving system through a capacity K^1 which in this instance is small as compared with the capacity K of Fig. 3, since the capacity between the receiving system and the circuit traversed by low or audio frequency current is quite small. The source J and capacity K^1 are in effect in series with each other and the capacity *k* existing between the grid and cathode of the tube V, the latter capacity again shunted by the inductance L whose magnitude is such as to by-pass the low or audio frequency current around the capacity *k*, causing but slight, if any, difference of potential between grid and cathode of the tube V at low or audio frequency, with the result that the receiving system is not affected by a neighboring low or audio frequency circuit.

The inductance L is of further advantage in that it provides a conductive path from grid to cathode of the tube V to prevent blocking thereof upon occurrence of strong static or other atmospheric disturbances or of powerful signals from other or nearby stations.

In lieu of an open antenna as shown in Figs. 1 and 2, there may be utilized a loop antenna G as indicated in Fig. 5. The loop, as in the case of the antenna F, is directly connected, without coupling of any character, to the grid and cathode of the interposed tube V. Here again the inductance L of the character and for the purposes described in connection with Fig. 2 may be shunted across grid and cathode. The magnitudes of the grid to cathode capacity of the tube V of Fig. 5, of the shunting inductance L and the distributed capacity of the loop G are such or so related to the inductance of the loop G that high radio frequency voltage is impressed upon the grid at the full magnitude of the radio frequency voltage existing across the terminals of the loop G.

In the arrangements of Figs. 1, 2 and 5, the input path or circuit of the interposed tube V is not tuned or tunable to the different wave lengths of the range for which the set is designed.

While in ordinary tuned radio frequency amplifying sets involving, for example, the tubes V^1, V^2 and V^3 with tuned input circuits, and the first of these tuned input circuits coupled to the antenna or absorption structure, the number of turns in the primary coils of the transformers T, T^1 and T^2 has generally been 8 to 10 when 201^A tubes are utilized. By recourse to the interposed tube V related to the antenna or absorption structure as herein described, these primaries may have, without loss of stability of the set, a greater number of turns, effecting increase of amplification and so compensating, at least in part, for the loss or absence of resonance in the antenna or absorption path and in the input path or circuit of the interposed tube V. For example, the number of turns in the primaries of the transformers T^1 and T^2 may be increased to the order of 13, and the number of turns in the primary of the transformer T may be made greater than the number of turns in the primaries of either or both the transformers T^1 and T^2, and may be of the order of 22. In addition to these increases in number of primary turns it is possible to reduce the magnitudes of the stabilizing resistances *r*.

While the variable tuning devices above

described are condensers, it will be understood that my invention comprehends also variation of inductance in lieu of variation of capacity in any one or more of the tuned circuits.

What I claim is:

1. A radio receiving system comprising the combination with an absorption structure, of a receiving set comprising a plurality of three-electrode thermionic devices in cascade and at least one of which amplifies the absorbed radio frequency energy, devices associated with said thermionic devices for tuning circuits in cascade to the same wave lengths throughout the same range of wave lengths, and means for insuring that the adjustable elements of said tuning devices shall partake of equal extents of movement in adjusting from resonance for one wave length to resonance for another wave length comprising a three-electrode thermionic amplifier whose output circuit is coupled to the input circuit of the first of said thermionic devices and whose grid and cathode are directly connected with said absorption structure.

2. A radio receiving system comprising the combination with an absorption structure, of a receiving set comprising a plurality of three-electrode thermionic devices in cascade and at least one of which amplifies the absorbed radio frequency energy, devices associated with said thermionic devices for tuning circuits in cascade to the same wave lengths throughout the same range of wave lengths, means for insuring that the adjustable elements of said tuning devices shall partake of equal extents of movement in adjusting from resonance for one wave length to resonance for another wave length comprising a three-electrode thermionic amplifier whose output circuit is coupled to the input circuit of the first of said thermionic devices and whose grid and cathode are non-reactively conductively connected with said absorption structure, and means mechanically coupling the adjustable elements of said tuning devices to cause them to partake of movements in unison.

3. A radio receiving system comprising the combination with an absorption structure, of a receiving set comprising a plurality of three-electrode thermionic devices in cascade and at least one of which amplifies the absorbed radio frequency energy, devices associated with said thermionic devices for tuning circuits in cascade to the same wave lengths throughout the same range of wave lengths, means for insuring that the adjustable elements of said tuning devices shall partake of equal extents of movement in adjusting from resonance for one wave length to resonance for another wave length comprising a three-electrode thermionic amplifier whose output circuit is coupled to the input circuit of the first of said thermionic devices and whose grid and cathode are directly connected with said absorption structure, and an inductance connected between said grid and cathode and having such magnitude as substantially to prevent passage therethrough of received radio frequency energy and to by-pass low frequency energy from said grid.

4. A radio receiving system comprising the combination with an absorption structure, of a receiving set comprising a plurality of three-electrode thermionic devices in cascade and at least one of which amplifies the absorbed radio frequency energy, devices associated with said thermionic devices for tuning circuits in cascade to the same wave lengths throughout the same range of wave lengths, a radio frequency transformer for transferring radio frequency energy from the output circuit of one of said thermionic devices to the input of another of said thermionic devices, means for insuring that the adjustable elements of said tuning devices shall partake of equal extents of movement in adjusting from resonance for one wave length to resonance for another wave length comprising a three-electrode thermionic amplifier interposed between said absorption structure and the first of the circuits tuned by the first of said tuning devices the input of said last named amplifier and said absorption structure constituting an input system the magnitudes of whose inductance and capacity are substantially constant, and a radio frequency transformer transferring radio frequency energy from the output circuit of said interposed thermionic device to the input circuit of the first of said first-mentioned thermionic devices, the number of turns of the primary winding of said second-named transformer being substantially in excess of the number of turns of the primary of said first-named transformer.

5. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, means for tuning each of said circuits, and a three-electrode vacuum tube interposed between the first of said tuned circuits and said absorption structure, the input of said tube and said absorption structure constituting an input system the magnitudes of whose inductance and capacity are substantially constant and so related to said tunable circuits as to permit equal movements of their tuning devices in adjusting from resonance for one wave length to resonance for another wave length.

6. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, means for tuning each of said circuits, a three-electrode vacuum tube amplifier in-

tervening between a pair of said tuned circuits and having its input tuned by the first of said pair, a resistance for reducing the tendency of said amplifier to produce oscillations connected in series between the input electrodes of said amplifier and the first tuned circuit of said pair, and a three-electrode vacuum tube interposed between the first of said tuned circuits and said absorption structure, the input of said last named tube and said absorption structure constituting an input system the magnitudes of whose inductance and capacity are substantially constant and so related to said tunable circuits as to permit equal movements of their tuning devices in adjusting from resonance for one wave length to resonance for another wave length.

7. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, devices associated with said circuits for tuning them to the same wave lengths throughout the same range of wave lengths, and means for insuring that the adjustable elements of said tuning devices shall partake of equal extents of movements in adjusting from resonance for one wave length to resonance for another wave length comprising a three-electrode vacuum tube interposed between the first of said tuned circuits and said absorption structure, the input of said tube and said absorption structure constituting an input system the magnitudes of whose inductance and capacity are substantially constant.

8. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, devices associated with said circuits for tuning them to the same wave lengths throughout the same range of wave lengths, means mechanically coupling the adjustable elements of said tuning devices for effecting their adjustment in unison to equal extents, and means for insuring that the adjustable elements of said tuning devices shall partake of equal extents of movement in adjusting from resonance for one wave length to resonance for another wave length comprising a three-electrode vacuum tube interposed between the first of said tuned circuits and said absorption structure, the input of said tube and said absorption structure constituting an input system the magnitudes of whose inductance and capacity are substantially constant.

9. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, a variable condenser for tuning each of said circuits, and means for insuring that said condensers shall partake of equal extents of adjustments from resonance for one wave length to resonance for another wave length comprising a three-electrode vacuum tube interposed between the first of said tuned circuits and said absorption structure, said absorption structure and the input of said tube constituting an input system the magnitudes of whose inductance and capacity are substantially constant.

10. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, a variable condenser for tuning each of said circuits, equal increments of adjustments of each of said condensers effecting equal increments of its capacity, and means for insuring that said condensers shall partake of equal extents of adjustments from resonance for one wave length to resonance for another wave length comprising a three-electrode vacuum tube interposed between the first of said tuned circuits and said absorption structure, said absorption structure and the input of said tube constituting an input system the magnitudes of whose inductance and capacity are substantially constant.

11. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, a variable condenser for tuning each of said circuits, equal increments of adjustment of each of said condensers effecting equal increments of its capacity, means mechanically coupling the adjustable elements of said condensers for effecting their adjustment in unison to equal extents, and means for insuring that said condensers shall partake of equal extents of adjustment from resonance for one wave length to resonance for another wave length comprising a three-electrode vacuum tube interposed between the first of said tuned circuits and said absorption structure, said absorption structure and the input of said tube constituting an input system the magnitudes of whose inductance and capacity are substantially constant.

12. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, the inductance of each of said circuits having fixed magnitude and comprising a winding of a coupling transformer, a single variable condenser constituting the sole means for tuning each of said circuits, and means for insuring that the adjustable elements of said condensers shall partake of equal extents of movement in adjusting from resonance for one wave length to resonance for another wave length comprising a three-electrode vacuum tube interposed between the first of said tuned circuits and said absorption structure, said absorption structure and the input of said tube constituting an input system the magnitudes of whose inductance and capacity are substantially constant.

13. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, means for tuning each of said circuits, and a three-electrode vacuum tube having its output operatively related to the first of said tuned circuits and having its input electrodes non-reactively conductively connected with said absorption structure, said absorption structure and the input of said tube constituting an input system the magnitudes of whose inductance and capacity are substantially constant and so related to said tunable circuits as to permit equal movements of their tuning devices in adjusting from resonance for one wave length to resonance for another wave length.

14. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, means for tuning each of said circuits, a three-electrode vacuum tube interposed between the first of said tuned circuits and said absorption structure, the input of said tube and said absorption structure constituting an input system the magnitudes of whose inductance and capacity are substantially constant throughout the wave length range of the received energy and so related to said tunable circuits as to permit equal movements of their tuning devices in adjusting from resonance for one wave length to resonance for another wave length, and an inductance connected between the grid and cathode of said tube and having such magnitude as substantially to prevent passage therethrough of received radio frequency energy and to by-pass low frequency energy from said grid.

15. A radio receiving system comprising the combination with an absorption structure, of a receiving set comprising a plurality of three-electrode thermionic devices in cascade and at least one of which amplifies the radio frequency energy, condensers associated with said thermionic devices for tuning to the same wave lengths throughout a range of wave lengths, each of said condensers comprising rotor and stator elements of such character that the increments of capacity are equal for equal increments of adjustment of the rotor with respect to the stator, and means for insuring that the rotors of said condensers shall partake of equal extent of movement in adjusting from resonance for one wave length to resonance for another wave length comprising a three-electrode thermionic amplifier whose output circuit is coupled to the input circuit of the first of said thermionic devices and whose input is operatively related to said absorption structure, the input of said last named thermionic device and said absorption structure constituting an input system the magnitudes of whose inductance and capacity are substantially constant.

16. A radio receiving system comprising the combination with an absorption structure, of a receiving set comprising a plurality of three-electrode thermionic devices in cascade and at least one of which amplifies the radio frequency energy, condensers associated with said thermionic devices for tuning to the same wave lengths throughout a range of wave lengths, each of said condensers comprising rotor and stator elements of such character that the increments of capacity are equal for equal increments of adjustment of the rotor with respect to the stator, means mechanically coupling the rotors of said condensers for effecting their adjustment in unison to equal extents, and means for insuring that the circuits tunable by said condensers shall be simultaneously resonant to the same wave length comprising a three-electrode thermionic amplifier interposed between the first tuned circuit and said absorption structure for reactively isolating them from each other, the input of said last named thermionic device and said absorption structure constituting an input system the magnitudes of whose inductance and capacity are substantially constant.

17. The method of tuning cascaded circuits throughout a frequency range of energy received upon an absorption structure, which comprises reactively isolating said absorption structure from the first of said tuned circuits while permitting the transfer of received energy from said absorption structure thereto, maintaining said absorption structure non-resonant to the received energy throughout said frequency range, and moving the adjustable tuning elements of said circuits to equal extents in tuning said circuits from resonance for one frequency to resonance for another frequency of said received energy.

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13. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, means for tuning each of said circuits, and a three-electrode vacuum tube having its output operatively related to the first of said tuned circuits and having its input electrodes non-reactively conductively connected with said absorption structure, said absorption structure and the input of said tube constituting an input system the magnitudes of whose inductance and capacity are substantially constant and so related to said tunable circuits as to permit equal movements of their tuning devices in adjusting from resonance for one wave length to resonance for another wave length.

14. A radio receiving system comprising the combination with an absorption structure, of a plurality of circuits in cascade, means for tuning each of said circuits, a three-electrode vacuum tube interposed between the first of said tuned circuits and said absorption structure, the input of said tube and said absorption structure constituting an input system the magnitudes of whose inductance and capacity are substantially constant throughout the wave length range of the received energy and so related to said tunable circuits as to permit equal movements of their tuning devices in adjusting from resonance for one wave length to resonance for another wave length, and an inductance connected between the grid and cathode of said tube and having such magnitude as substantially to prevent passage therethrough of received radio frequency energy and to by-pass low frequency energy from said grid.

15. A radio receiving system comprising the combination with an absorption structure, of a receiving set comprising a plurality of three-electrode thermionic devices in cascade and at least one of which amplifies the radio frequency energy, condensers associated with said thermionic devices for tuning to the same wave lengths throughout a range of wave lengths, each of said condensers comprising rotor and stator elements of such character that the increments of capacity are equal for equal increments of adjustment of the rotor with respect to the stator, and means for insuring that the rotors of said condensers shall partake of equal extent of movement in adjusting from resonance for one wave length to resonance for another wave length comprising a three-electrode thermionic amplifier whose output circuit is coupled to the input circuit of the first of said thermionic devices and whose input is operatively related to said absorption structure, the input of said last named thermionic device and said absorption structure constituting an input system the magnitudes of whose inductance and capacity are substantially constant.

16. A radio receiving system comprising the combination with an absorption structure, of a receiving set comprising a plurality of three-electrode thermionic devices in cascade and at least one of which amplifies the radio frequency energy, condensers associated with said thermionic devices for tuning to the same wave lengths throughout a range of wave lengths, each of said condensers comprising rotor and stator elements of such character that the increments of capacity are equal for equal increments of adjustment of the rotor with respect to the stator, means mechanically coupling the rotors of said condensers for effecting their adjustment in unison to equal extents, and means for insuring that the circuits tunable by said condensers shall be simultaneously resonant to the same wave length comprising a three-electrode thermionic amplifier interposed between the first tuned circuit and said absorption structure for reactively isolating them from each other, the input of said last named thermionic device and said absorption structure constituting an input system the magnitudes of whose inductance and capacity are substantially constant.

17. The method of tuning cascaded circuits throughout a frequency range of energy received upon an absorption structure, which comprises reactively isolating said absorption structure from the first of said tuned circuits while permitting the transfer of received energy from said absorption structure thereto, maintaining said absorption structure non-resonant to the received energy throughout said frequency range, and moving the adjustable tuning elements of said circuits to equal extents in tuning said circuits from resonance for one frequency to resonance for another frequency of said received energy.

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Certificate of Correction.

Patent No. 1,639,414. Granted August 16, 1927, to

JOHN M. MILLER.

It is hereby certified that error appears in the printed specification of the above-numbered patent requiring correction as follows: Page 3, after the numeral "2" in line 25 and the word "rotor" in line 91 insert a comma, and in line 102, for the word "pulley" read *pulleys;* page 6, line 27, claim 7, for the word "movements" read *movement;* same page, lines 64, 77, and 81, claims 9 and 10, respectively, for the word "adjustments" read *adjustment;* page 7, line 55, for the word "extent" read *extents;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of December, A. D. 1927.

[SEAL.]

M. J. MOORE,
Acting Commissioner of Patents.

Certificate of Correction.

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