

May 25, 1943.

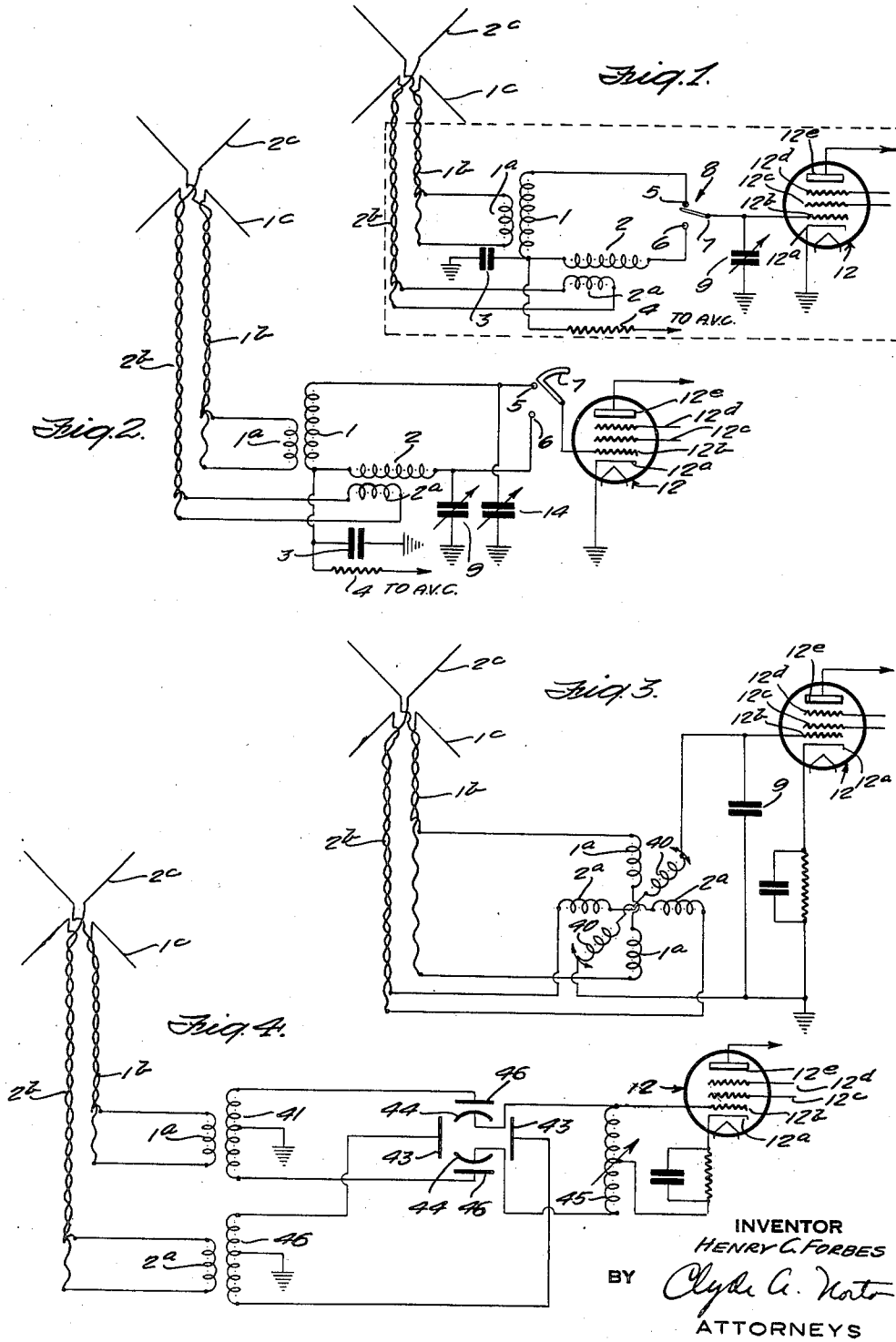
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2,320,124

RADIO RECEIVER FOR HORIZONTALLY POLARIZED WAVES

Filed Jan. 18, 1941

2 Sheets-Sheet 1



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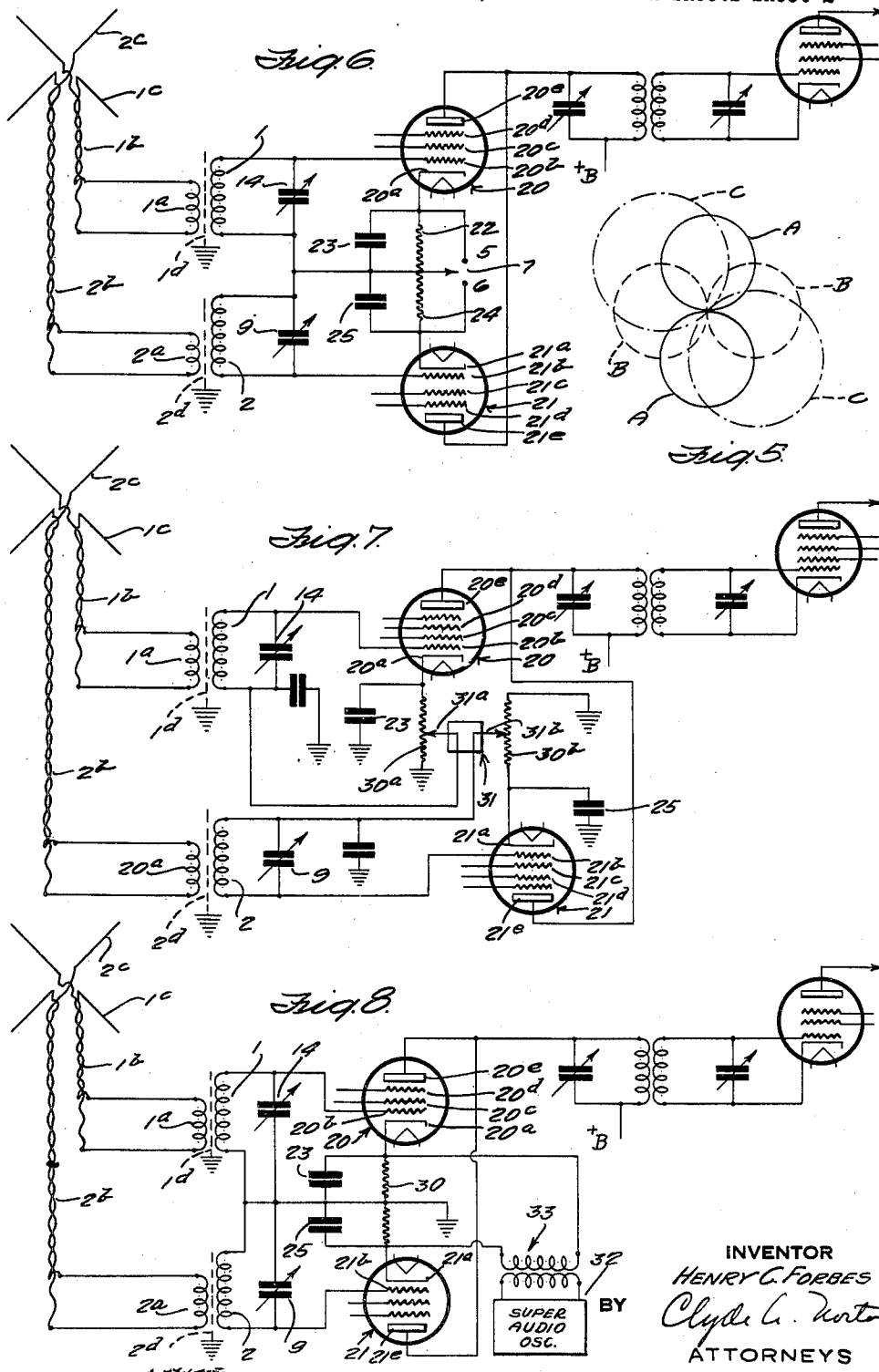
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2 Sheets-Sheet 2



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2,320,124

RADIO RECEIVER FOR HORIZONTALLY
POLARIZED WAVESHenry C. Forbes, Eggertsville, N. Y., assignor to
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Application January 18, 1941, Serial No. 374,966

10 Claims. (Cl. 250—20)

This invention relates to radio receiving apparatus, and more particularly to radio receiving apparatus arranged to receive horizontally polarized waves, and is a continuation in part of my earlier application, Ser. No. 354,539, filed August 28, 1940, now Patent No. 2,266,630, issued December 16, 1941.

Some types of transmitters now radiate horizontally polarized waves; for example, television and other so-called short wave transmitters. These transmitters do not permit of directional reception with a loop antenna. For this and other reasons it has been suggested that such transmitters be re-arranged to transmit vertically polarized instead of horizontally polarized waves, in order to permit the use of loop antennas with their known advantages of directional receptivity enabling the user to set the loop for maximum signal pick-up, minimum interference pick-up, or at some intermediate setting.

Alternatively, it has been suggested that directional receptivity may be obtained with horizontally polarized waves by the use of rotatable doublet positioned upon the roof. This is clearly impracticable for the broadcast listener because of the complexity and expense of the apparatus required even when the listener lives in a house.

I have discovered that it is not necessary to resort to vertical polarization at the transmitter to enable the listener to have the advantage of directional receptivity, nor is it necessary to resort to complicated and expensive mechanism such as that referred to above.

Among the objects of my invention may be mentioned:

To provide an antenna system for receiving horizontally polarized waves which will permit the user to utilize directional antenna characteristics for the purpose of getting maximum signal pick-up, or minimum interference or static pick-up, or the optimum signal-noise ratio, or to have non-directional reception characteristics as he may desire at the moment.

To provide such a system which may be easily and quickly installed in any location and which does not require complicated and expensive mechanism for rotating an antenna at a distance from the receiver.

To provide such a system which may be easily and inexpensively incorporated in receivers intended to be operated by persons without technical or operating skill and having an antenna system which may be easily and simply installed

and connected to the receiver without involving special problems.

Still other objects and advantages of my invention will be apparent from the specification.

In this application I have particularly pointed out and distinctly claimed, the part, improvement or combination which I claim as my invention or discovery and I have explained the principles thereof and the best mode in which I have contemplated applying those principles so as to distinguish my invention from other inventions.

In the drawings:

Fig. 1 is a circuit diagram of a simple form of apparatus embodying my invention;

Fig. 2 is a circuit diagram of another form of apparatus according to my invention;

Figs. 3 and 4 are circuit diagrams of still other forms of apparatus according to my invention, Fig. 3 employing magnetic coupling and Fig. 4 capacitive coupling;

Fig. 5 is a chart of the response which may be obtained from my system;

Figs. 6, 7 and 8 are circuit diagrams of still other modified forms of apparatus according to my invention.

In accordance with my invention, I prefer to employ two pairs of similar horizontal doublet antennas arranged preferably but not necessarily at right angles to each other. With such an arrangement one of the doublets will produce a response characteristic of figure eight shape, such for instance as indicated as solid line curve A of Fig. 5. If the other doublet of the pair is set at 90° to the first doublet and has the same electrical characteristics, then its response may be represented by the dotted figure eight curve B in Fig. 5. If the output of the two doublets is combined, they add vectorially with the resultant characteristic still another figure eight of greater magnitude and at an angle to the axis of the component doublet responses such as shown by dot and dash curve C of Fig. 5. Reversing the phase of the output of either doublet in the example given will not change the magnitude of the response but merely shifts the axis of the combined response figure by 90°.

Referring now more particularly to Fig. 1, I have shown a relatively simple circuit for selectively providing either the response curve A or the response curve B. The two horizontal doublets 1c and 2c may be mounted in the desired position, for example, upon the roof and are preferably, but not necessarily, at 90° to each other. From each doublet there may be

run a transmission line, such as in the form of twisted pair, and each transmission line may terminate within or at the receiver housing in a coil 1a at the end of transmission line 1b and a coil 2a at the end of transmission line 2b respectively. Within the receiver there may be provided a pair of coils 1 and 2 arranged with zero coupling to each other and the coil 1a may be coupled to the coil 1 and the coil 2a to the coil 2. These coils 1 and 2 may have a common terminal connected to ground through condenser 3 and their free terminals may be respectively connected to contacts 5 and 6 with switch contact 7 of switch 8 arranged to make contact with terminal 5 or 6 selectively. Contact 7 may be connected to the control electrode 12b of tube 12 which may have a cathode 12a and suppressor and screen grid 12c and 12d and anode 12e.

The switching mechanism embodying contacts 5, 6 and 7 is preferably, but not necessarily, a push button type of switch which takes alternate positions with successive pushes. For example, it may have a push button extending from the front face of the receiver and when first pushed in may connect contact 6 to grid 12b and such connection may remain until further actuation of the push button, at which further actuation, contact 7 is disconnected from contact 6 and connected to contact 5.

Tuning condenser 9 may be provided connected to grid 12b so that it is in circuit at all times and the constants of coils 1 and 2 are preferably alike so that on switching from one contact to the other, the tuning is not substantially affected. As will be observed, when the contact 7 is closed against contact 5, the input to the tube 12 is from the doublet 1c only, feeding through transmission line 1b to coil 1a which in turn is coupled to the coil 1 which is then connected between grid and effective ground and shunted by the tuning condenser 9.

When the switch is connected to contact 6 the input of the receiver is from the doublet 2c only, feeding through transmission line 2b to coil 2a coupled to coil 2 which is then connected to the grid 12b and to ground. The placing of the two coil systems 1a and 1 and 2a and 2 at right angles to each other, prevents any coupling between them, but it will be understood that this same result may be obtained by placing the two coil systems in separate shielding boxes if desired.

Tube 12 may be the input tube of a superheterodyne receiver and may be a pentode as shown or other type of tube, the same being well known to those skilled in the art. If desired, the receiver may be a tuned radio frequency amplifier type instead of a superheterodyne, my invention not being concerned with the type of circuit employed other than as herein described and claimed.

In operation, after the receiver has been turned on, the operator may tune in the desired station in the usual manner, and after it has been tuned in, may operate the switch 8 a few times to be sure that the antenna is used which affords either the best reception, or the minimum interference as the case may be.

It will be noted by reference to Fig. 5 that if the doublets are at right angles to each other, it is always possible to get a response which is between the response which would be obtained if the doublet pointed directly toward the desired station, and a minimum of 0.707 of that value because it is always possible by operating the

switch 8 to select the doublet which is no more than 45° out of line with the desired signal.

Referring now to Fig. 2, I have shown an arrangement in which the doublets may be used together so as to obtain the pick-up of both doublets. In this instance, I have indicated another variable condenser 14, which may be ganged with the variable condenser 9, the condenser 14 having one terminal connected to the high potential end of coil 1 and condenser 9 having one terminal connected to the high potential end of coil 2, the other terminals of both condensers being grounded. In this instance, the common point of condenser 14 and coil 1 may be connected to switch point 5, the common point of condenser 9 and coil 2 to the switch point 6 and the contact plate 7 may have an intermediate position in which it makes contact with both terminals 5 and 6 connecting the tuned circuits in parallel.

Operation of the push button 8 may then connect the grid 12b in sequence, first to switch point 5 only, then to switch points 5 and 6 and then to switch point 6 only. In the first position the input circuit is made up of doublet 1c only, feeding through transmission line 1b to coil 1, the coil 1 being tuned by condenser 14. In the second position it is made up of both doublets 1c and 2c feeding through transmission lines 1b and 2b to coils 1a and 2a and in turn to coils 1 and 2 and condensers 9 and 14, the tuned circuits being in parallel. In the third position, the input is from the doublet 2 only.

Since in switching from either of the single tuned circuits to both the tuned circuits in parallel, the inductance is halved and the capacity nearly doubled, the circuits will remain nearly in tune to the same frequency when changing the switch positions. Such minor differences in capacity which may result from the minimum capacity of the tube and the switching circuits may be compensated for, so that no disturbance of tuning is caused in making the change. The effect of the switching operation is to enable the user to select any one of the three operating characteristics indicated by Fig. 5.

Referring now more particularly to Fig. 3, I have shown an arrangement by means of which it is possible to produce exactly the same characteristic as if the doublet on the roof were rotated. In this instance, the coil 1a fed by doublet 1c may be split into two parts and likewise coil 2a may be split into two parts. Coils 1 and 2 shown in Figs. 1 and 2 may be replaced by a single coil 40 mounted for rotation in such a manner that coil 40 is in the position of maximum coupling to coil 1a when it has zero coupling to coil 2a and vice versa, so that by rotation of the coil 40 the user may obtain exactly the same effect which he would obtain by rotation of one of the doublets if only a single rotatable doublet were used.

The same effect can be obtained with the apparatus shown in Fig. 4 in which the coupling from the doublets to the input circuit is electrostatic instead of electromagnetic. In this instance coil 1a may be coupled to coil 41 grounded at its midpoint. The opposite end of coil 41 may be connected to condenser plates 46 arranged opposite to each other. Similarly, coil 2a may be coupled to coil 42 grounded at its midpoint and its terminal being connected to condenser plates 43 arranged opposite to each other and at 90° to the plate 46. Rotary condenser plates 44 may be connected to opposite terminals of coil 45, a portion of which may be included in the input

circuit of tube 12. Condenser plates 44 may be arranged for rotation on a common shaft not shown. It will be understood that when the movable plates 44 are adjacent the fixed plate 46, the output of doublet 1c only will be fed to tube 12 and when the plates 44 are placed adjacent to plates 43 only the output of doublet 2c will be used. Intermediate position of the plates 44 produces a result similar to intermediate position of coil 40 of Fig. 3 and is a result which would be that given by a single doublet in some intermediate position corresponding to the position of the plates 44.

Instead of using both tuned circuits or a single tuned circuit in the input circuit of one tube, the tuned circuits may be employed in the input of separate tubes, the output of which is combined in a subsequent tube as in Figs. 6, 7 and 8.

For example, referring to Fig. 6 the doublets 2c and 1c may as before feed coils 1a and 2a, and these coils may be again coupled to coils 1 and 2 respectively. In this instance I have shown electrostatic grounded shields 1d and 2d interposed between coils 1a and 1 and 2a and 2 respectively, which shields may be used with the arrangements shown in Figs. 1 and 2 if desired.

In this instance condenser 14 may be connected across coil 1 and condenser 9 across coil 2, the common point of these two circuits being led to a midpoint between resistances 22 and 24 connected between the cathodes 20a and 21a of tubes 20 and 21, the output circuits of which are connected together and feed a common coupling circuit and subsequent tube as shown. Control electrode 20b of tube 20 may be connected to the common point of coil 1 and condenser 14 and the control electrode 21b to the common point of coil 2 and condenser 9.

Resistances 22 and 24 may be shunted by suitable bypass condensers 23 and 25. The switch points 5, 6, and 7 may be connected as indicated. The switch point 7 to the midpoint between resistances 22 and 24, switch point 5 to the cathode 20a and switch point 6 to cathode 21a. The biases upon these tubes which may be derived through or impressed across resistances 22 and 24 may be made such that when switch blade 7 is on switch point 5, tube 21 is biased to cut-off whereas tube 20 operates with its normal bias and similarly when switch blade 7 is on switch point 6, tube 20 is biased to cut-off and tube 21 operates with its normal bias. Thus it will be seen that by turning switch blade 7 to switch point 5 only the response of the doublet 1c will be obtained whereas by turning it to switch point 6 only the response of doublet 2c will be obtained.

In case it is desired to provide for a smooth and gradual change of the characteristic of doublet 1c to the characteristic of doublet 2c, the arrangement of Fig. 7 may be utilized, in which switch point 5 and switch blade 7 have been replaced by resistors 30a and 30b, slider 31 having two arms 31a and 31b and making contact with resistors 30a and 30b respectively. Slider 31 may be continuously varied from one end of resistors 30a and 30b to the other.

Cathode 20a may be connected to one end of resistor 30a for instance the top end, the other end of which may be grounded and cathode 21a may be connected to the lower end of resistor 30b, the upper end of which may be grounded. The biases are so chosen on tubes 20 and 21 that when the slider is at the top end of resistor 30a, the tube 21 is biased to cut-off whereas tube 20 has its normal operating bias. By moving the

slider 31 to the bottom extremity of resistor 30a the tube 21 has its normal operating bias and tube 20 is biased to cut-off. For intermediate position, an intermediate effect is obtained which is similar to what would be obtained if doublet 1c were rotated. That is to say, the directional pattern gradually and smoothly changes from that of doublet 1c to that of doublet 2c and vice versa.

It may now be seen that if it were possible to continuously operate the slider 31 from one extremity of its travel to the other and back again at a rate above audibility, such as 20,000 times per second there would be no observable maximum or minimum directional characteristic in the doublet. The effect would be substantially the same as if the doublet 1c or 2c were rotated at a rate above audibility. In other words the system while having the convenience of doublet reception would have a directionless characteristic.

It is of course impractical to attempt to swing the slider 31 at such a rate, but a similar result may be obtained by varying the bias on tubes 20 and 21 at a super-audible rate as shown in Fig. 8. For example, across the terminals of resistor 30 I may connect the secondary of transformer 33, the primary of which may be connected to the output of a super-audio frequency oscillator 32. This oscillator may operate at a super-audible frequency such as 20,000 cycles per second and the magnitude of its output is so chosen that the bias alternately impressed upon tubes 20 and 21 is sufficient to cut off one or the other. The effect of this is that during a portion of each cycle the tube 20 only operates at its normal bias and during another portion of the oscillator cycle the tube 21 only operates at its normal bias and the effect is as though doublets 1c or 2c were rotated at superaudible frequency thereby eliminating the directional characteristic.

While I have shown and described certain preferred embodiments of my invention, it will be understood that modifications and changes may be made without departing from the spirit and scope of my invention as will be clear to those skilled in the art.

I claim:

1. A radio receiver comprising, in combination, at least one vacuum tube, a pair of coils having similar constants selectively connectable in the input circuit of said vacuum tube means for tuning said coils alike and in unison to the desired signal frequency, a pair of doublet antennas arranged at angles to each other and tuned alike, a transmission line extending from each doublet to said receiver, each transmission line terminating in a coil, said coils being coupled to said first mentioned coils respectively, and selectively operable means for connecting one or the other of said first mentioned coils in the input circuit of said tube.

2. A radio receiver comprising, in combination, at least one vacuum tube, a pair of coils having similar constants selectively connectable in the input circuit of said vacuum tube, a pair of horizontal doublet antennas arranged at angles to each other, a transmission line extending from each doublet to said receiver, each transmission line terminating in a coil, said coils being coupled to said first mentioned coils respectively, and means for selectively connecting one or the other or both of said first mentioned coils in the input circuit of said tube.

3. A radio receiver comprising, in combination, at least one vacuum tube, said vacuum tube having a cathode and a control electrode, a pair of coils having a common terminal, a connection between said common terminal and one of said tube electrodes, a pair of tuning elements, each of said tuning elements being connected to the free terminal of each of said coils respectively, selective means for connecting the other of said tube electrodes to either of said free terminals of said coils, a pair of horizontal doublet antennas arranged at angles to each other, and a transmission line from each doublet to said receiver, each transmission line terminating in a coil coupled to one of said first mentioned coils.
4. A radio receiver comprising, in combination, a pair of vacuum tubes, each of said tubes having a cathode and a control electrode, said tubes having a common output circuit, a pair of coils having a common terminal, a pair of adjustable impedances connected between said cathodes and said common terminal respectively, a connection from the free terminal of one of said coils to the control electrode of one of said tubes, a connection from the free terminal of the other coil to the control electrode of the other tube and means for connecting the grid return side of said coils to said impedances respectively, said means serving to vary the said impedances between coils and said common terminal in an inverse manner, a pair of horizontal doublet antennas at angles to each other, a transmission line from each doublet to said receiver, said lines being arranged to feed signals to said coils respectively.
5. A radio receiver comprising, in combination, a pair of vacuum tubes, each of said tubes having a cathode and a control electrode, said tubes having a common output circuit, a pair of coils having a common terminal, a pair of impedances connected between said cathodes and said common terminal respectively, a connection from the free terminal of one of said coils to the control electrode of one of said tubes, a connection from the free terminal of the other of said coils to the control electrode of the other tube, and connections from the other terminal of said coils to said impedances respectively, said connections being simultaneously variable in opposite senses, a pair of horizontal doublet antennas arranged at angles to each other, and a transmission line from each of said doublets to said receiver, said transmission lines being arranged to feed signals to said coils respectively.
6. Radio receiving apparatus comprising, in combination, at least one vacuum tube, said vacuum tube having a cathode and a control electrode, a pair of coils having substantially zero coupling to each other and having substantially the same values of inductance and capacity, a pair of horizontal doublet antennas arranged at angles to each other, and a transmission line from each of said doublets, said transmission lines being coupled at their inner ends to said coils respectively, and means for impressing upon said tube electrode signals picked up by either of said doublets while maintaining the tuning substantially constant.
7. Radio receiving apparatus comprising, in combination, at least one vacuum tube, said vacuum tube having a cathode and a control electrode, a pair of coils having substantially zero coupling to each other and having substantially identical tuning characteristics, a pair of horizontal doublet antennas arranged at angles to each other, a transmission line from each doublet, each transmission line being coupled at the receiver end to one of said coils and means for selectively impressing upon said tube electrode signals picked up by either of said doublets while maintaining the tuning substantially constant.
8. Radio receiving apparatus comprising, in combination, at least one vacuum tube, said vacuum tube having a cathode and a control electrode, a pair of coils having substantially zero coupling to each other and having substantially identical tuning characteristics, a pair of horizontal doublet antennas arranged at angles to each other, a transmission line from each of said doublets to said receiver, said transmission lines being coupled to said coils respectively, and means for selectively connecting one or the other of said doublets in the input circuit of said tube while maintaining the tuning substantially constant, said means comprising a push button sequence switch mounted on said receiving apparatus.
9. In radio receiving apparatus, in combination, at least one vacuum tube, said vacuum tube having a cathode and a control electrode, a coil connected in the input circuit of said tube, a pair of horizontal doublet antennas disposed at angles to each other, a transmission line from each doublet, each transmission line terminating in a coil, said transmission line coils being located at right angles to each other, and said first named coil being rotatable in the field of said transmission line coils to selectively couple said first coil to either of said transmission line coils.
10. Radio receiving apparatus comprising, in combination, at least one vacuum tube, said vacuum tube having a cathode and a control electrode, an inductance coil connected in the input circuit of said tube, and a pair of condenser plates mounted for rotation and connected to said coil, a pair of horizontal doublet antennas arranged at angles to each other, a transmission line extending from each of said doublets to said receiver, a second set of condenser plates positioned for selective coupling with said first pair of condenser plates, said second set comprising two pairs of condenser plates, the plates of each pair being spaced apart and at an angle of 90° with the other pair, and opposite plates being operatively connected to said transmission lines respectively, and means for supporting said first pair of condenser plates so as to be relatively rotatable with respect to said second set to provide maximum or minimum coupling to either of said doublet systems.

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