April 26, 1938. M. L. THOMPSON 2,115,655

ANTENNA COUPLING CIRCUIT

Filed Feb. 27, 1935

Fig. 1.

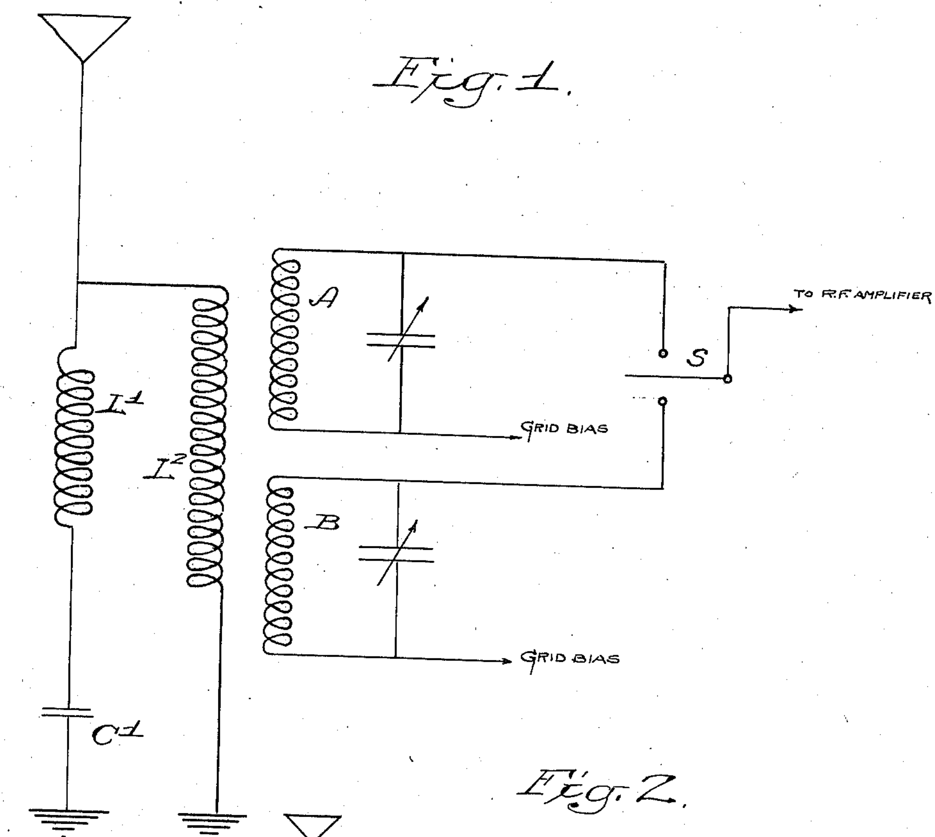
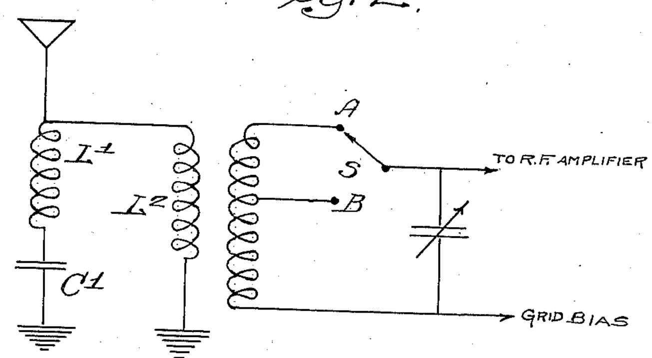


Fig. 2.



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UNITED STATES PATENT OFFICE

2,115,655

ANTENNA COUPLING CIRCUIT

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Application February 27, 1935, Serial No. 8,537

6 Claims. (Cl. 250—20)

This invention relates to antenna coupling devices for radio receivers, particularly those of the superheterodyne type. One of the principal features of this invention is an antenna coupling circuit which may be used for the reception of wave signals in two or more frequency bands and which eliminates the necessity of providing wave band switching means in the antenna circuit.

A further feature of the invention is the provision of a circuit having substantially uniform gain over two or more frequency bands.

A still further feature of the invention is the provision of means whereby wave signals having a frequency the same as or close to the intermediate frequency may be prevented from being transferred from the antenna to the first radio frequency amplifier tube.

Other features and objects will appear hereinafter. In the drawing, Fig. 1 is a schematic diagram of a portion of a superheterodyne multiband radio receiving system embodying the invention; and

Fig. 2 is a similar diagram of a modification.

The device of Fig. 1 comprises a series resonant circuit having an inductance L_1 and a capacitance C_1 connected between the antenna and ground. This series circuit is shunted by a second inductance L_2, said second inductance being loosely coupled inductively to a plurality of tuned circuits A and B, although, of course, there may be more than two such circuits. Each circuit A or B comprises an inductance and parallel variable capacitance and may be tuned by means of the variable condenser to the frequency of a wave signal which it is desired to receive. Circuit A may be tuned to any frequency in one wave band and circuit B to any frequency within a second different wave band.

One side of circuit A and one side of circuit B are connected to a conventional wave band switch S so that the control grid of the first R. F. amplifier tube may be connected to circuit A or circuit B in the manner well known in the art. Proper grid bias, which may be a fixed bias or the conventional automatic volume control bias, may be applied to the grid of this tube by connecting the second sides of circuits A and B to the supply means of the grid bias. A circuit of the type A or B is supplied for each wave band that it is desired to receive. It is, of course, understood that if desired, only one variable condenser may be used in which case the change in wave band is accomplished by switching over the inductance, as shown in Fig. 2. In the latter case, circuit A includes the variable condenser and the entire inductance, whereas circuit B includes the same variable condenser and only part of the inductance.

Thus when it is desired to receive signals in one wave band only one tuned circuit, for example, circuit A, is connected to the amplifier. And when it is desired to receive a signal in another wave band, another tuned circuit, for example, B, is used instead of A.

It has been found desirable to select a value of L_2 such that its resonant frequency with the minimum expected capacitance of the antenna is slightly below the lowest frequency in the particular frequency band that it is desired to receive. By doing so, the gain throughout the band range may be made more uniform. Ordinarily, the gain tends to increase with frequency. However, by selecting a parallel resonant frequency for the antenna circuit just below the lowest frequency of the band, in the lower part of the range the coupling circuit will be operating near resonance with a subsequent increase in gain in that region which will make the gain more uniform throughout the entire region. Consequently, in a multi-band receiver, it is necessary to vary the value of L_2 for each wave band in order that its resonant frequency with the antenna capacitance may be properly adjusted for each set of conditions. By this invention, means are provided whereby it is unnecessary to change the value of L_2.

The series circuit L_1, C_1 may conveniently be tuned to the intermediate frequency and, as the impedance of this unit to wave signals of or near that frequency will approach zero, no signal energy of that frequency will be transferred to the following stage.

Above the intermediate frequency, the series unit will act as an inductive reactance in parallel with the inductance L_2. The unit, therefore, may be designed so that the resonant frequency of the combined inductance and distributed capacitance of the antenna will be slightly below the lowest frequency of the range B which it is desired to receive. Below the intermediate frequency, the series unit will act as a capacitance and thus provide a second resonant frequency for the unit comprising the distributed capacitance of the antenna, the parallel capacitance of the series circuit, and the inductance L_2 and, by proper design, this resonant frequency may be located slightly below the lowest frequency which it is desired to receive in range A. Thus, it will be seen that uniform gain may be obtained in both ranges A and B by having the resonant frequencies of the antenna unit slightly below the lowest frequency of each range. It is, of course, necessary that the series resonant frequency of the series or trap circuit be located in the region between range B and range A.

Considering the impedance function of the shunt related elements $L_1C_1L_2$ and the antenna, it will be seen that the impedance will be the maximum at two different frequencies, the lower frequency being that frequency at which the capacitance of the series unit L_1C_1 in shunt with the antenna capacity resonates with the inductance L_2 and the higher frequency being that frequency at which the series unit acts as an inductance in shunt with L_2 and resonates it with the distributed capacitance of the antenna. At the frequency at which the series circuit L_1C_1 is resonant, the impedance of the entire unit will be a minimum.

A further advantage of this circuit is that it will minimize the effect of variations in the antenna capacity which may be caused, for example, by the swaying of the antenna with the wind. The antenna capacitance is important principally in determining the resonant frequency of the antenna circuit as a unit. Above the series resonant frequency of the circuit L_1C_1, said circuit will act as an inductive reactance which will increase with frequency. Thus the combined inductive reactance of this circuit and L_2 will increase with frequency until the effect of C_1 becomes negligible. Consequently for one value of antenna capacitance, the unit will have one resonant frequency, but if the antenna capacitance is halved, the new resonant frequency will not be much higher for with a slight increase in frequency, the combined inductance of L_1C_1 and L_2 will increase enough to make up for the change in antenna capacitance. Thus by means of this circuit the effect of variations in antenna capacitance may be minimized.

Thus, it will be seen that by this invention, means have been provided whereby the transfer of wave signals of the intermediate frequency or thereabouts may be prevented, high and uniform gain may be provided in two or more bands, and the necessity for providing switching means to change the value of the conventional antenna inductance coil has been eliminated. It will be understood that the invention is susceptible to modifications such as will occur to persons skilled in the art.

I claim:

1. In a multi-band radio receiving system, the combination of a single primary winding, tunable means including at least one secondary winding associated with said primary winding, means for adapting said tunable means for reception of signals in a plurality of wave bands, an element having capacitance connected to said primary winding, and a series circuit comprising an inductance and a capacitance in shunt relation with said primary winding, the impedance function of said shunt related elements being characterized by having a plurality of points of maximum impedance, said points occurring at frequencies in the lower portions of the respective wave bands, and a point of minimum impedance occurring at a frequency between said bands, said inductance and said capacitance being serially resonant at said last named frequency.

2. In a multi-band superheterodyne radio receiving system, the combination of a single primary winding, tunable means including at least one secondary winding associated with said primary winding, means for adapting said tunable means for reception of signals in a plurality of wave bands, an element having capacitance connected to said primary winding, and a series circuit comprising an inductance and a capacitance in shunt relation with said primary winding, the impedance function of said shunt related elements being characterized by having a plurality of points of maximum impedance, said points occurring at frequencies in the lower portions of the respective wave bands, and a point of minimum impedance occurring at the superheterodyne intermediate frequency, said inductance and said capacitance being serially resonant at the superheterodyne intermediate frequency, said frequency being located between said wave bands.

3. In a multi-band radio receiving system, the combination of a single primary winding, a secondary winding associated with said primary winding, a tuning condenser associated with said secondary winding, means for selectively including different portions of said secondary winding in circuit with said condenser, whereby signals in a plurality of wave bands may be received, an element having capacitance connected to said primary winding, and a series circuit comprising an inductance and a capacitance in shunt relation with said primary winding, the impedance function of said shunt related elements being characterized by having a plurality of points of maximum impedance, said points occurring at frequencies in the lower portions of the respective wave bands, and a point of minimum impedance occurring at a frequency between said bands, said inductance and said capacitance being serially resonant at said last named frequency.

4. In a multi-band superheterodyne radio receiving system, the combination of a single primary winding, a secondary winding associated with said primary winding, a tuning condenser associated with said secondary winding, means for selectively including different portions of said secondary winding in circuit with said condenser, whereby signals in a plurality of wave bands may be received, an element having capacitance connected to said primary winding, and a series circuit comprising an inductance and a capacitance in shunt relation with said primary winding, the impedance function of said shunt related elements being characterized by having a plurality of points of maximum impedance, said points occurring at frequencies in the lower portions of the respective wave bands, and a point of minimum impedance occurring at the superheterodyne intermediate frequency, said inductance and said capacitance being serially resonant at the superheterodyne intermediate frequency, said frequency being located between said wave bands.

5. In a multi-band radio receiving system, the combination of an antenna, a single primary winding in series with said antenna, tunable means including at least one secondary winding associated with said primary winding, means for adapting said tunable means for reception of signals in a plurality of wave bands, an element having capacitance connected to said primary winding, and a series circuit comprising an inductance and a capacitance in shunt relation with said primary winding, the impedance function of said antenna and said shunt related elements being characterized by having a plurality of points

of maximum impedance, said points occurring at frequencies in the lower portions of the respective wave bands, and a point of minimum impedance occurring at a frequency between said bands, said antenna, said inductance, and said capacitance being serially resonant at said last named frequency.

6. In a multi-band superheterodyne radio receiving system, the combination of an antenna, a single primary winding in series with said antenna, tunable means including at least one secondary winding associated with said primary winding, means for adapting said tunable means for reception of signals in a plurality of wave bands, an element having capacitance connected to said primary winding, and a series circuit comprising an inductance and a capacitance in shunt relation with said primary winding, the impedance function of said antenna and said shunt related elements being characterized by having a plurality of points of maximum impedance, said points occurring at frequencies in the lower portions of the respective wave bands, and a point of minimum impedance occurring at the superheterodyne intermediate frequency, said antenna, said inductance, and said capacitance being serially resonant at the superheterodyne intermediate frequency, said frequency being located between said wave bands.

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