



## UNITED STATES PATENT OFFICE

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## ULTRA SHORT WAVE RECEIVER

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This invention relates to ultra short radio wave systems.

One of the objects of the present invention is to provide an ultra short wave receiver capable of receiving an extremely wide modulation band, such as might be used in the transmission of television programs. Such a modulation band may be of the order of about three million cycles.

A further object is to provide a band pass transformer having balanced primary and secondary circuits of the coaxial line type.

For achieving the foregoing object, there is employed a novel type of band pass transformer, for passing the energy received by the antenna to a balanced detector circuit, to which are fed locally generated high frequency oscillations from a resonant line controlled oscillator. The output of the detector is designed to feed into a cascaded intermediate frequency amplifier which, in turn, may be coupled to a second detector circuit from which the output is amplified and arranged to pass into a suitable utilization circuit.

Various features of the present invention relate to a novel coaxial or concentric line type of band pass transformer, and to the concentric frequency control line for the local oscillator, which, although described with particular reference to the receiver circuit, are not of themselves limited thereto, since they are capable of being used in other systems.

Other objects and features, and their advantages will appear more fully hereinafter in connection with the accompanying drawing, wherein Fig. 1 shows a preferred embodiment of the invention in connection with a receiving circuit for receiving ultra short waves of the order of 1.7 meters, although it is to be understood that the invention is not limited to this particular wavelength. Fig. 1a is a cross-sectional view of the coaxial line transformer of Fig. 1 along the lines 1a-1a.

Referring to the drawing in detail, there is shown in Fig. 1 a band pass transformer comprising a plurality of pairs of coaxial or concentric lines 1, 2; 1, 3; 4, 5; and 4, 6. It will be noted that there are two pairs of lines oppositely and symmetrically located with respect to a central metallic plate 7, and that the conductors on one side of plate 7 are extensions, or on the same straight line with the conductors on the other side of the plate. Since the coaxial lines on each side of the central metallic plate 7 are located next to one another, it is proposed, for purposes of convenience and design, to employ

a common outer conductor for both pairs of lines on the same side of the center plate and to accomplish this result the outer conductors are made to have a square form, as shown in Fig. 1a, which is a cross sectional view of the band pass transformer along the line 1a-1a. The outer conductors 1 and 4 are made of seamless, square, brass or copper tubing and are arranged to be symmetrically positioned with respect to their associated inner conductors. These square tubings are designed to extend beyond the ends of the inner conductors and to be closed at such ends in order to completely shield the entire system. The inner conductors 2, 3; and 5, 6, are joined together at their ends by means of variably balanced condensers C<sub>2</sub>, C<sub>2</sub>. Each half of the band pass transformer, looked upon from the center toward the ends, is a resonant circuit completely balanced with respect to ground. Both resonant circuits comprising halves 1, 2; 1, 3; and 4, 5; 4, 6 are coupled together at their inner conductors by means of connections 8 and 9 which couple together the inner conductors extending on the same straight line, preferably substantially symmetrically with respect to the center plate 7, as shown. It will thus be seen that we have the equivalent of a transformer comprising two balanced resonant circuits coupled together, each resonant circuit being equivalent, electrically, to a parallel tuned circuit. A damping resistance R, of the correct value, is shown connected across the adjacent ends of the inner conductors of one of the balanced tuned circuits in order to assist in obtaining the desired flat top characteristic of the transformer; that is, so that both balanced halves 4, 5; 4, 6; and 1, 2; 1, 3; may effect a band pass transformer. In certain instances it may be desirable to provide an additional damping resistance across the opposite adjacent ends of the inner conductors of the other tuned resonant circuit, although this is not necessary in the present case. The band pass transformer, just described, is coupled to a suitable input circuit, herein designated the antenna, through a pair of connections 10 which are conductively joined to the inner conductors 2, 3 of one-half of the band pass transformer. This last balanced circuit comprising 1, 2; 1, 3 will thus be designated the primary of the transformer, and the other balanced tuned circuit to which the output leads 11 are connected, the secondary of the transformer.

The energy received from the antenna over connections 10, and passed on to connections 11

through the band pass transformer, is fed into the grids of a pair of push-pull connected detector tubes 12, 13 to whose cathode is coupled a line controlled high frequency oscillator 14. It will thus be observed that the received signal waves are applied to the grids of tubes 12, 13 in push-pull (i. e., the signal waves are applied to the grids out of phase with respect to each other), while the local oscillations generated by oscillator 14 are applied to the cathodes of the tubes 12, 13 in push-push (i. e., in parallel relationship). In the output of the detector tubes 12, 13 there is a transformer  $L_3L_4$  whose primary winding  $L_3$  is balanced with respect to ground but whose secondary winding  $L_4$  is unbalanced with respect to ground and coupled to the intermediate frequency amplifier. A balanced condition of the primary winding  $L_3$  is maintained by the electrostatic shield 15 which symmetrically surrounds the coil. A portion of this shield is positioned between  $L_3$  and  $L_4$ . It should be noted that windings  $L_3$  and  $L_4$  comprise a band pass transformer for passing the desired wide modulation band on to the intermediate frequency amplifier.

The local oscillator 14 is stabilized as to frequency by a concentric line comprising an outer conductor 16 and an inner conductor 17, which are conductively coupled together at one of their adjacent ends and capacitively coupled together by capacitor  $C_1$  at their other adjacent ends. The control electrode of oscillator 14 is connected to the outer conductor 16 through the parallel combination of a condenser 18 and a resistor 19.

The anode of oscillator 14, it should be noted, extends through a pipe 20 to the inside of inner conductor 17, near its end and extends, by means of a connection 21, through the entire length of the inner conductor and then to the source of power supply +250 volts. It is preferred that the anode be by-passed to the pipe 20, as shown. The cathode of the oscillator 14 connects with the inner conductor 17 near its middle, while the heater element extends through a pipe 20', also to the inside of the inner conductor 17 near the middle, and then to the heater source of supply. The reasons for this manner of connection may perhaps be more readily explained by comparing the oscillator tube 14 and the line circuit 16, 17 to the well known three point Hartley oscillator circuit as described in United States Patent No. 1,356,763, granted October 26, 1920. Such circuit comprises an inductance whose extreme terminals are coupled to the anode and control electrode and whose cathode is connected to a point intermediate the ends of the inductance. In the present case, the inner conductor 17 acts as the inductance of the Hartley circuit, and it is to the lower end of this inductance 16 that the anode of oscillator 14 extends. The control electrode of oscillator 14, it should be noted, is connected to the outer conductor which is at ground potential. Since this outer conductor 16 is conductively connected to the inner conductor, or inductance 17, at its other end, we thus have a connection from the control electrode to the end of inductance 17 which is opposite the end of the inner conductor connected to the anode. The cathode of oscillator 14, however, extends and is effectively joined for all purposes, to the middle of the inductance 17, since it enters the inside of inductance 17 near its middle, as previously described and as shown in the drawing. In order to maintain both the cathode and the

heater element of oscillator 14 at the same radio frequency potential, so that they fluctuate simultaneously and in the same phase with respect to one another, the heater leads are brought to the middle of the line at substantially the same location to which the cathode element is brought, and extends through the inside of inner conductor 17 to the heater supply. In order to maintain the cathode and heater elements of the detector tubes 12 and 13 at the same radio frequency potential, the connections to these elements are also brought to substantially a single location on the inner conductor for the same reasons hereinabove mentioned with respect to the identical elements of the oscillator tube. It will be noted, however, that the connections to the heater and cathode elements of the detector tubes 12 and 13 are brought to a point on the inner conductor 17 near the conductively connected ends of conductors 16 and 17. This is because the cathodes of detectors 12 and 13 present an appreciable resistance load to the line circuit 16, 17, and the circuit arrangement must be such that this resistance load does not destroy, to a great extent, the oscillator stability of the tube 14 produced by the concentric line 16, 17. It is desired that the cathodes of the detector tubes be coupled to the inner conductor as near the low potential end of the line 16, 17, in this case the conductively joined end, as possible, but this point of connection cannot be too close to the low potential end for the reason that the detectors require an appreciable exciting voltage to enable them to function as such, and the closer this point of connection is placed toward the low potential end, the less this exciting voltage for the detector will be. It will thus be seen that for efficient operation of the detectors, there will be a point of entrance to the inner conductor from the cathodes of the detector tubes 12 and 13, which will not be too near the low potential end of the resonant line 16, 17 to interfere with the efficiency of the detectors, nor too near the high potential end of the line 16, 17 to interfere with the frequency stability of the control line circuit. The cathodes of the detector tubes, it will be noted, are in circuit with ground through a suitable bias resistor  $R'$ . Metal pipes 20, 20', 20'' serve the useful purpose of preventing undesired capacity effects between the outer conductor 16 and the leads which extend within the pipes, and for this reason the pipes extend slightly beyond the outer surface of the conductor 16.

Coupled to the output of detectors 12, 13 is a cascaded intermediate frequency amplifier system, not shown.

In setting up and making test runs on the receiver, it may be desirable to supply a local signal generator which is arranged to feed locally generated oscillations over a concentric cable to a point near the receiving antenna. In this way the signal generator can be made to radiate energy into the receiving antenna which allows band width and sensitivity checks to be made on the antenna receiver combination. This set-up is provided mainly as a help in properly tuning the receiver.

It will be appreciated that the invention is not limited to the precise arrangement of parts shown and described, since various modifications may be made in the circuit elements without departing from the spirit and scope of the appended claims.

It will also be understood that the term "ground" used in the specification and appended

claims is not limited to an actual earthed connection but includes any point of zero or relatively fixed radio frequency potential.

What is claimed is:

1. A band pass transformer having a primary comprising a pair of resonator circuits, each resonator circuit including an inner and an outer conductor, said inner and outer conductors of said pair being conductively coupled together at one end, said inner conductors being capacitively coupled together and said outer conductors conductively coupled together at their other ends, a secondary for said transformer having a similar arrangement of a pair of resonator circuits arranged in such manner that the inner conductors and outer conductors of both said primary and secondary are extensions of one another, the conductively coupled ends of both said primary and secondary being placed end to end, an input circuit coupled to the inner conductors of said primary, an output circuit coupled to the inner conductors of said secondary, and a connection coupling together each inner conductor of said primary with the inner conductor of said secondary which extends on the same straight line.

2. A band pass transformer in accordance with claim 1, including a resistance connected across said inner conductors of said secondary.

3. A band pass transformer having a primary comprising a pair of resonator circuits, each resonator circuit including an inner and an outer conductor, said inner and outer conductors of said pair being conductively coupled together at one end, said inner conductors being capacitively coupled together and said outer conductors conductively coupled together at their other ends, a secondary for said transformer having a similar arrangement of a pair of resonator circuits arranged in such manner that the inner conductors and outer conductors of both said primary and secondary are extensions of one another, the conductively coupled ends of both said primary and secondary being placed end to end, an input circuit coupled to the inner conductors of said primary at points substantially near and symmetrically located from the conductively coupled ends, an output circuit coupled to points on the inner conductors of said secondary near the capacitively coupled ends thereof, and a connection coupling together each inner conductor of said primary with the inner conductor of said secondary which extends on the same straight line.

4. A balanced resonant circuit comprising a pair of adjacent resonator circuits, each having an inner and a parallel outer conductor, means for conductively coupling together all of said conductors at one end, a pair of variable condensers coupling together the other ends of said inner conductors, a damping resistor directly connected across said last ends of said inner conductors for providing a desired frequency characteristic for said balanced resonant circuit, means for grounding said outer conductors, and input and output circuits coupled to said inner conductors.

5. A balanced resonant circuit comprising a rectangular metallic container, an electrically conductive partition separating said container longitudinally into two halves to form square tubular conductors, an inner conductor coaxially positioned in each half, a metal plate conductively coupling together all of said inner and outer conductors, and means for variably coupling together capacitively the free ends of said inner

conductor, said square tubular conductors extending beyond the capacitively coupled ends of said inner conductors.

6. A balanced resonant circuit comprising a pair of adjacent resonator circuits, each having an inner and a parallel outer conductor, means for conductively coupling together all of said conductors at one end, means for capacitively coupling together the inner conductors of said pair at a location removed from said one end, and a resistor connected across said inner conductors near said last location.

7. A transformer comprising a first balanced resonant circuit comprising a pair of adjacent resonator circuits, each having an inner and a parallel outer conductor, means for conductively coupling together all of said conductors at one end, and means for capacitively coupling together the inner conductors of said pair at a location removed from said one end, a second balanced circuit having a similar arrangement of a pair of resonator circuits, and connections from the inner conductors of said first balanced circuit to the inner conductors of said second balanced circuit, an input circuit coupled to said inner conductors of said first balanced circuit, and an output circuit coupled to said inner conductors of said second balanced circuit.

8. A resonant circuit arrangement comprising a rectangular metallic container, an electrically conductive partition separating said container longitudinally into two portions to form substantially square tubular conductors, an inner conductor coaxially positioned in each portion, means for conductively coupling together all of said inner and outer conductors at one location, whereby each of said square conductors with its associated inner conductor forms a tuned circuit, and means for capacitively coupling together the inner conductors of both portions at another location removed from said first location.

9. A resonant circuit arrangement comprising a rectangular metallic container, a metal sheet separating said container into two portions each having the form of substantially square tubular conductors, an inner conductor coaxially positioned in each portion, means for conductively coupling together said inner and outer conductors at one location, and means for capacitively coupling together the inner conductors of both portions at another location removed from said first location, a second similar resonant circuit arrangement, a connection from each inner conductor of one resonant circuit arrangement to the correspondingly located inner conductor of the second resonant circuit arrangement, an input circuit coupled to the inner conductors of one resonant circuit arrangement, and an output circuit coupled to the inner conductors of the other resonant circuit arrangement.

10. In combination, a tuned circuit comprising an inner and an outer conductor conductively coupled together at one end, another tuned circuit also comprising an inner and an outer conductor coupled together at one end, a direct connection from a point on one inner conductor intermediate its ends to a point on the other inner conductor intermediate its ends, an input circuit coupled to one of said inner conductors at another point intermediate its ends, and an output circuit coupled to the other of said inner conductors also at another point intermediate its ends.

11. A resonant circuit arrangement comprising a pair of coaxial lines each having an inner and

an outer conductor, means for conductively coupling together said inner and outer conductors at one location, and means for capacitively coupling together the inner conductors of both lines at another location removed from said first location, a second similar resonant circuit arrangement, a connection from each inner conductor of one resonant circuit arrangement to the correspondingly located inner conductor of the second resonant circuit arrangement, an input circuit coupled to the inner conductors of one resonant circuit arrangement, and an output circuit coupled to the inner conductors of the other resonant circuit arrangement.

12. A balanced resonant circuit comprising a pair of adjacent resonator circuits, each having an inner and a parallel outer conductor, means for directly coupling together all of said conductors at one end, a pair of variable condensers coupling together the other ends of said inner conductors, a damping resistor connected across said last ends of said inner conductors for providing a desired frequency characteristic for said balanced resonant circuit, means for connecting said outer conductors to a point of relatively fixed radio frequency potential, and input and output circuits coupled to said inner conductors.

13. A balanced resonant circuit comprising a pair of adjacent resonator circuits, each having

an inner and a parallel outer conductor, means for conductively coupling together all of said conductors at one end, and means for capacitively coupling together the inner conductors of said pair at a location removed from said one end, a resistor connected across said inner conductors near their other ends, an input circuit coupled to said inner conductors of said pair at points substantially symmetrically located from one end, and an output circuit coupled to said inner conductors of said pair at differently located points which are intermediate the ends of said inner conductors and also substantially symmetrical with respect to said same last end.

14. In combination, first and second tuned circuits each comprising a pair of conductors disposed one within the other, means coupling together the conductors of each tuned circuit at one end, means coupling the outer conductors of said tuned circuits together and to ground, whereby the inner conductors of said tuned circuits are coupled together near said same end, a connection including a reactance between the inner conductors of said tuned circuits at a location removed from said last ends, and a resistive connection also between said inner conductors at a location removed from said last ends.

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