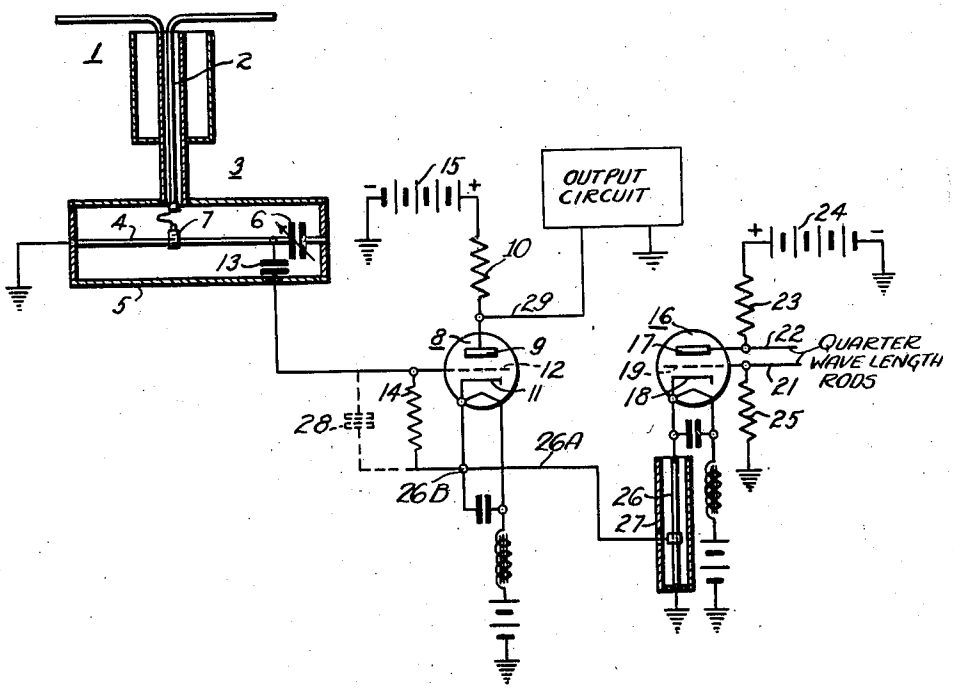
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HIGH STABILITY RECEIVER CIRCUIT

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WITNESSES:

Alice L. Howell

Mrs. C. Groome

INVENTOR

James D. Booth.

BY

F. W. Lyle

ATTORNEY

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HIGH STABILITY RECEIVER CIRCUIT

James D. Booth, Catonsville, Md., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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My invention relates to radio circuits, and, in particular, relates to circuits for heterodyning radio frequency currents. One especially important field of application being to currents of extremely high frequencies such as 500 megacycles per second.

At higher frequencies it is especially important that circuits be designed for the best possible stability. In such circuits it is particularly difficult to prevent reaction of one circuit on another in an objectionable degree. Similar reasons make it difficult to provide circuit arrangements which shall be sharply resonant to but a single frequency. One situation in which difficulties of the foregoing nature are noticeable is in converter tube circuits such as those of a radio receiver, in which an incoming signal is heterodyned or mixed with the output of a local oscillator. I have found great difficulty with prior art arrangements for coupling local oscillator and converter tubes in reducing the coupling between the oscillator and the input circuit to the converter sufficiently to prevent the oscillator from locking into step with the frequency of the incoming signal instead of maintaining its own frequency and heterodyning the latter.

One object of my invention is accordingly to provide a method of coupling an input circuit with an amplifier tube by means of a coupling which shall be sharply resonant at only single frequencies and integral multiples thereof.

Another object of my invention is to provide for coupling an input circuit to a tube by a resonant coupling in the form of a segment of a concentric line in which the entire arrangement is sharply resonant to but a single frequency and integral multiples thereof.

Another object of my invention is to provide a coupling between an input circuit and a tube in the form of a concentric line so arranged that the internal reactance of the tube is so connected as not to interfere with the sharpness of resonance of the concentric line segment to a single frequency or exact integral of harmonic thereof.

Still another object of my invention is to provide a coupling between an input circuit and a tube in the form of a segment of a concentric transmission line in which the impedance of the input circuit and of the tube leave undisturbed the sharpness of resonance of the segment to a single frequency or integral multiples thereof.

Still another object of my invention is to provide an arrangement for connecting the input circuit through the agency of a resonant segment of a transmission line and a capacitor to the

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control electrode of a grid controlled tube in such a way that the said capacitor and the capacitance between the grid electrode and other electrodes of the tube form an effective voltage and impedance divider between the input circuit and the tube.

Still another object of my invention is to provide an arrangement for coupling an input circuit, a converter tube and a local oscillator tube in such a way as to produce a very low degree of coupling between the resonant circuit of the local oscillator tube and the input circuit.

A still further object of my invention is to provide an arrangement for coupling a local oscillator tube to a converter tube in such a way as to minimize the coupling between the resonant circuit of the oscillator tube and the converter tube.

A still further object of my invention is to provide a method of connecting an input circuit, a converter tube and an oscillator tube in such a way as to insure that the local oscillator tube produces currents determined substantially solely by the constants of its own resonant circuit.

A still further object of my invention is to provide a method of connecting a receiving antenna through a converter tube to an oscillation generator in such a way as to prevent the oscillation generator energy from being radiated by the receiving antenna.

Other objects of my invention will become apparent upon reading the following description taken in connection with the drawing in which the single figure is a diagrammatic showing of circuits embodying the principles of my invention.

Referring in detail to the drawing, an input antenna 1 which may be of a type adapted to receive ultra high frequency currents is connected through a concentric line 2 to a resonator 3 comprising a conducting core 4 located in the axis of a cylindrical surrounding conducting sheath 5. The sheath 5 is made of approximately an integral number of quarter wave lengths of the frequency which it is expected to receive and is closed at each end by conducting walls. One end of the core 4 is connected to one said end wall and to ground while the other end is connected to the other said end wall through a variable capacitor 6. The core of the transmission line 2 is connected to a tap point 7, the position of which may, if desired, be varied by suitable arrangements along the core 4, thereby producing an impedance match between the input line

2 and the input circuit of an amplifier or other tube to which it is expected to transmit energy.

A tube 8 provided with an anode 9 and a cathode 11 and a control electrode 12 receives energy from the resonator 3. For this purpose a point on the core 4 closely adjacent the capacitor 6 is connected through a capacitor 13 to the control electrode 12. The control electrode 12 is likewise connected through a leak resistor 14 to its cathode 11 which is preferably of the unipotential type. The anode 9 is connected through a resistor 10 to the positive terminal of a source of direct current 15, the negative terminal of which is grounded.

The tube 8 is shown arranged to convert or mix the incoming signals with the output of a local oscillator tube 16 which may be of any suitable type but is preferably in the form of a tube having an anode 17, a cathode 18 and a control electrode 19. The anode 17 and the control electrode 19 are coupled to each other by some convenient resonant circuit, for example, a pair of rods 21, 22 having a length substantially equal to one quarter wave length of the current to be generated by the oscillation generator 16. The anode 17 is connected through a resistor 23 to the positive terminal of a source of direct current 24, the negative terminal of which is grounded. The control electrode 21 is connected through a resistor 25 to ground.

The cathode 18 is connected to the core 26 of a second segment of concentric transmission line which preferably has a length different from an integral of one quarter wave length of the oscillation generator 16. The sheath 27 of the last-mentioned transmission line segment is connected to the core at the end remote from the cathode 18 and is likewise grounded. As a result of the above-described arrangement the transmission line 26, 27 is not resonant to the frequency of the oscillation generator 16. The core 26 is likewise connected by conductor 26A to the cathode 11 of the tube 8 at point 26B.

Between the electrode 12 and the other electrodes of the tube 8, notably the cathode, there is an inherent capacitance which is represented in the drawing by the capacitor 28. This capacitor 28 in series with the coupling capacitor 13 is, in effect, connected between one end of the core 4 and ground; and the capacitor 6 is, in effect, likewise so connected. This network of capacitances connected between said end of the core 4 and its grounded sheath 5 will alter the frequency to which the resonator 3 is resonant from exact correspondence to the length between its end faces. However, they will not in any way disturb the sharpness of its resonance to one particular frequency and integral multiples thereof. The particular value of this frequency can be varied through a range by adjustment of the variable capacitor 6. The situation just outlined is in contrast to that which would exist were the capacitor 13 connected to the core 4 at some point substantially displaced along the core 4 from its said end. In the last-mentioned situation the capacitances determining the mode of electrical oscillation of the resonator 3 would be made unsymmetrical and the chamber would not resonate to a single frequency. The connection of the capacitor 13 to a point near the end of the core 4 which is remote from that connected to the sheath 5 is, accordingly, a valuable feature of my invention. It may be noted that the transmission line 2 and tap 7 connect the antenna 1 to the input circuit generally to a point on the core 4 which is remote from each end of that core. However, where, as is conventional in the case, the input circuit has negligible reactance due to the fact that it is resonantly tuned, the position of the tap 7 at a point remote from either end of the core 4 does not prevent the sharp tuning of the resonator 3 to a single frequency or integral harmonics thereof.

The capacitor 13 is preferably made about equal in value, or at least of the same order of magnitude, as the capacitance 28. If this is done the capacitances 13 and 28 form an effective voltage and impedance divider between the resonator 3 and the other electrode of the tube 8. By properly varying the value of the capacitor 13, the ratio of this voltage division may be controlled at will and the arrangement thus provides a device for impedance matching the output of the resonator 3 to the input of the tube 8. The variable tap 7, together with the resonator 3 and the capacitances 13 and 28, thus likewise provide an arrangement for effectively matching the impedance of the input circuit 2 to the input circuit of the tube 8.

Turning to the oscillation generator 16, its frequency is substantially determined by the resonant circuit comprising the rods 21, 22, this frequency being such as to constitute the length of these rods an integral number of quarter wave lengths. Such being the case, the concentric line 26, 27 in the cathode lead from the tube 16 has substantially no effect on the oscillation frequency of the generator 16. However, the segment of the core 26 between the point of connection thereto of the cathode 11 and the ground forms a common path in the particular circuits of the tubes 8 and 16 and constitutes a coupling between them which is sufficient to mix the frequency generated by the tube 16 with the frequency impressed on the control electrode 12 by the input from antenna 1. As a result, currents of the mixed frequencies may be derived from the output circuit between the lead 29 and ground. The value of the voltage of the frequency of the oscillator 16 thus impressed on the tube 8 can, of course, be varied by altering the position of the tap point of the lead connecting cathode 11 to the core 26.

Since the tube 8 is connected only indirectly to the network comprising oscillation generator 16 and is separated from the resonant circuit 21, 22 thereof, there is very little tendency for the currents of the frequency incident upon the antenna 1 to alter the frequency of oscillation of the tube 16. In short, the coupling between the antenna 1 and the resonant circuit of the oscillator generator 16 is extremely weak. Similarly, the coupling between the oscillation generator 16 and the antenna 1 is reduced to a very low value by the network comprising the capacitance 28, capacitor 13, resonator 3 and tap point 7. In consequence of this extremely low value of coupling between the oscillator generator 16 and antenna 1, substantially no energy of the frequency oscillation generator 16 is fed back and radiated from antenna 1.

I have described a specific embodiment of my invention but the principles thereof are of broader application in ways which should be evident to those skilled in the art.

I claim as my invention:

1. In combination with an input line, a resonator comprising a central conducting core surrounded by a conducting sheath, means for con-

necting one end of said sheath to one end of said core directly and for connecting the other end of said sheath to the other end of said core through a capacitor, a tube provided with an anode, a cathode and a control electrode, means for connecting said control electrode through a second capacitor to the end of said core adjacent said first capacitor, and a connection from said cathode to said sheath, means for connecting said input line to an intermediate point on said core, an oscillation generator comprising an anode, a control electrode and a cathode, a resonant circuit interconnecting said anode and said control electrode, a lead connecting said cathode and said anode comprising a central conductive core and a surrounding conducting sheath, a connection between an intermediate point on said central conducting core and the first-mentioned cathode and a connection between said surrounding sheath, the end of said conducting core remote from the cathode of said oscillation generator and the first-mentioned sheath.

2. In combination with an input line, a resonator comprising a central conducting core surrounded by a conducting sheath, means for connecting one end of said sheath to one end of said core directly and for connecting the other end of said sheath to the other end of said core through a capacitor, a tube provided with an anode, a cathode and a control electrode, means for connecting said control electrode through a second capacitor to the end of said core adjacent said first capacitor, and a connection from said cathode to said sheath, means for connecting said input line to an intermediate point on said core, an oscillation generator comprising an anode, a control electrode and a cathode, a resonant circuit interconnecting said anode and said control electrode, comprising two quarter wave conductors in inductive relation with each other, a lead connecting said cathode and said anode comprising a central conductive core and a surrounding conducting sheath, a connection between an intermediate point on said central conducting core and the first-mentioned cathode and a connection between said surrounding sheath, the end of said conducting core remote from the cathode of said oscillation generator and the first-mentioned sheath.

3. In combination with an input line, a resonator comprising a central conducting core surrounded by a conducting sheath, means for connecting one end of said sheath to one end of said core directly and for connecting the other end of said sheath to the other end of said core through a capacitor, a tube provided with an anode, a cathode and a cathode electrode, means for connecting said control electrode through a second capacitor to the end of said core adjacent said

first capacitor, and a connection from said cathode to said sheath, said input line being connected to an intermediate point on said core, said second capacitor having a capacitance of the order of magnitude of the capacitance between said control electrode and said cathode, an oscillation generator comprising an anode, a control electrode and a cathode, a resonant circuit interconnecting said anode and said control electrode, a lead connecting said cathode and said anode comprising a central conductive core and a surrounding conducting sheath, a connection between an intermediate point on said central conducting core and the first-mentioned cathode and a connection between said surrounding sheath, the end of said conducting core remote from the cathode of said oscillation generator and the first-mentioned sheath.

4. In combination, a first tube comprising an anode, a control electrode and a cathode, a second tube comprising an anode, a control electrode and a cathode, a resonant circuit interconnecting the control electrode and cathode of said first tube, a connection between the cathode and anode of said second tube comprising a central conductive core surrounded by a conducting sheath connected to said core at its end remote from the cathode of said second tube, a resonant circuit positioned outside said sheath and interlinking the control electrode and anode of said second tube, a connection between the cathode of said first tube and a point intermediate the ends of said core, means for causing current flow from the end of said core remote from the cathode of said second tube to the anode thereof and means for causing current flow from the end of said core remote from the cathode of said second tube to the anode of said first tube.

JAMES D. BOOTH.

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