

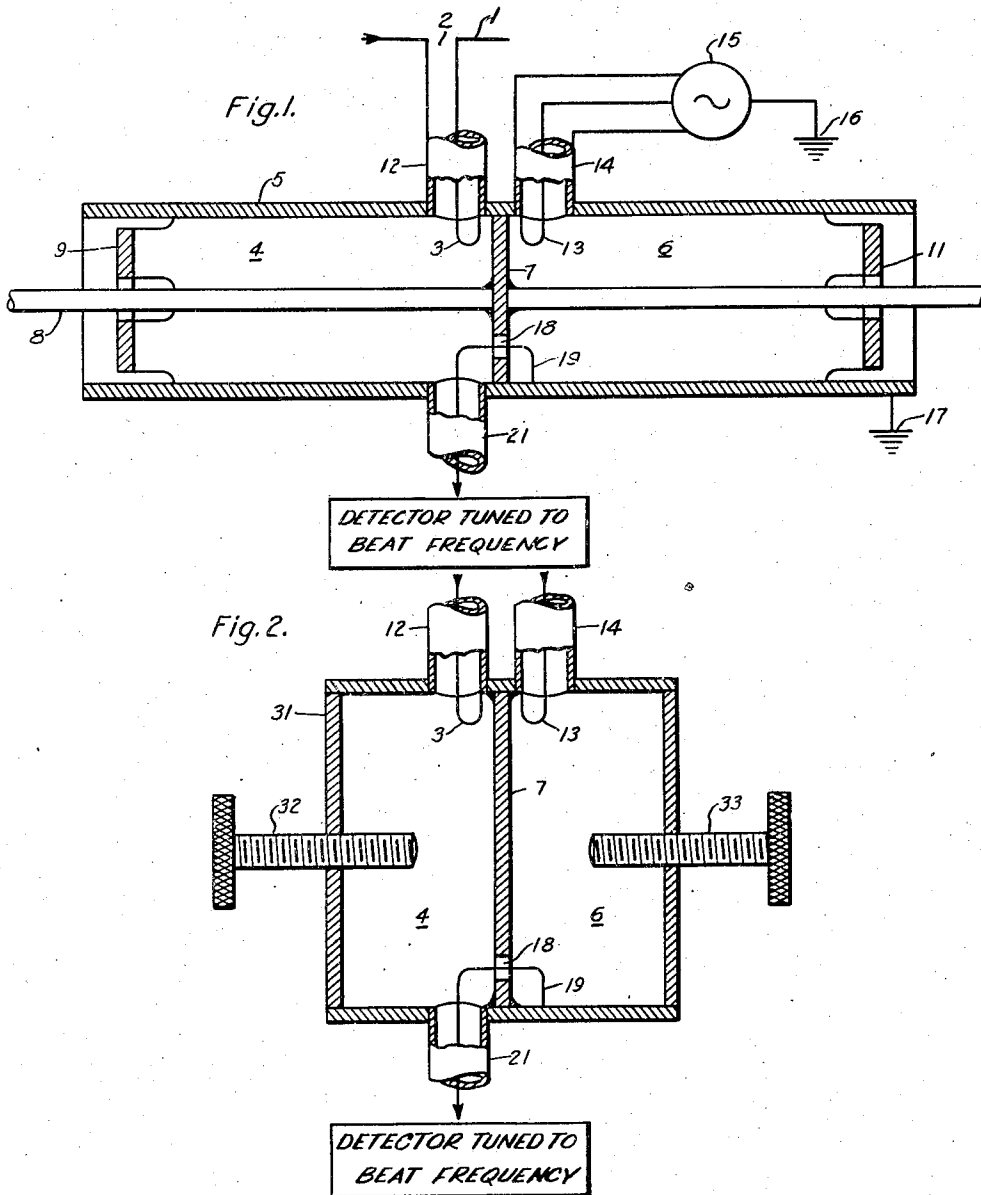
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MIXER FOR MICROWAVE RECEIVERS

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MIXER FOR MICROWAVE RECEIVERS

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My invention relates to ultra high frequency circuit elements and, in particular, relates to arrangements for producing beat frequencies by combining the effects of two higher frequencies for purposes well known in the radio art, such as the demodulation of modulated carrier waves. Arrangements for this purpose are frequently termed "mixers."

As is well known in the radio art, it is frequently desirable to transform the power of a high frequency carrier current to alternating power of a lower frequency; and one expedient for doing this is to provide a local source of alternating currents which differs from the above-mentioned carrier frequency by the frequency to which it is desired to transform the power. Circuit elements are then provided on which both the carrier current and the locally-generated current impress voltages, this step being referred to as "mixing." By now providing a circuit tuned to the desired difference frequencies of the carrier and the locally-generated currents and embodying a detector on which the resultant "mixed" currents impress voltages, power of the desired lower frequency will be derived.

In attempting to apply the foregoing expedient to ultra high frequency carrier waves, the practice has been to provide a single tuned transmission line, acting as a resonant circuit, on which the carrier voltage and local oscillator voltage were impressed; the tuned line being tuned to the carrier frequency. I have found that when this is done the fact that the tuned line is tuned to a frequency other than that of the local oscillator results in an inefficiency in power transfer from the latter. The invention which I herein describe greatly improves the efficiency of this power transfer.

One object of my invention is, accordingly, to provide a "mixer," particularly adapted for ultra high frequency circuits.

Another object of my invention is to provide an arrangement for efficiently transforming the frequency of ultra high frequency power.

Still another object of my invention is to provide an arrangement embodying tuned resonators of the concentric transmission line type in which power of ultra high frequency may be transformed in frequency.

Still another object of my invention is to provide an arrangement embodying electrical resonators of the cavity type which will efficiently transform the frequency of ultra high frequency power.

Other objects of my invention will become ap-

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parent upon reading the following description, taken in connection with the drawings in which:

Figure 1 is a diagrammatic illustration of an arrangement embodying the principles of my invention in a tunable concentric-line type of resonator; and

Fig. 2 is a cross-sectional view of a resonator of the cavity type adapted to be used in place of the tunable concentric line in the Fig. 1 arrangement.

Referring particularly to Fig. 1, there is diagrammatically shown an antenna 1 adapted to receive ultra short radio waves. The antenna 1 is connected through a suitable inleading conductor 2 to a loop 3 disposed within the chamber 4 in the interior of a segment of a transmission line of the concentric type. The transmission line segment may suitably consist of a cylindrical sheath 5 of conducting material having an insulating passage for conductor 2 and divided into two chambers 4 and 6 by a conducting partition 7. In the axis of the sheath 5 is positioned a core 8 of conducting material on which are slidably mounted a pair of pistons 9 and 11 which are capable of moving independently of each other. The pistons 9 and 11 may make contact with either or both the core 8 and the sheath 5 or may be separated from either of these elements by narrow insulating gaps. When the latter construction is used, the pistons should have sufficiently long projecting rims so that the narrow annular space separating these rims from the sheath 5 or core 8 will constitute capacitors having a negligibly small reactance at the frequency of the carrier wave coming in over the antenna 1. The lead from the antenna 1 to the loop 3 constitutes in itself a concentric transmission line, inasmuch as it is centrally positioned inside a conducting sheath 12 which is connected to the sheath 5 at one end. The piston 9 is provided with adjusting means (not shown) by which the chamber 4 may be tuned to the wave length of the incoming carrier wave. On the opposite side of the partition 7 is provided a loop 13 from which a conductor passes through an insulating passage in sheath 5 into a sheath 14 projecting from the sheath 5 and constituting a concentric transmission line leading to a local source of electrical oscillations diagrammatically illustrated at 15. The sheath 5 and one terminal of the oscillator 15 are connected together, for example, by ground connections 16 and 17. The oscillator 15 is preferably arranged so that its frequency can be regulated at will to differ from the frequency of the incoming carrier waves incident

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upon the antenna 2 by the lower beat frequency to which it is desired to transform power. The piston 11 is provided with means by which it can be moved to tune the chamber 6 substantially to the frequency of the oscillator 15.

The partition 7 is provided with an aperture 18 adapted to insulatingly pass a conductor 19 which has one end attached to the sheath 5 within the chamber 6 in such a way as to form a loop therein and which forms another loop within the chamber 4 before it passes through an insulating passage in the sheath 5 to the work-circuit in which it is desired to use the lower or "mixed" frequency output. A conducting sheath 21, forming with the conductor 19 a concentric line leading to the load apparatus, projects from the sheath 5.

The mode of operation of the above-described arrangement is as follows: Carrier waves incident upon the antenna 1 act through the loop 3 to set up resonant vibrations of their own frequency within the chamber 4, the latter being tuned to resonate at that frequency. Oscillations of the frequency of the local oscillator 15 react through the loop 13 to produce resonant vibrations within the chamber 6, the piston 11 being moved so as to tune the chamber 6 to such frequency. The portion of the conductor 19 forming a loop inside the chamber 6 and the portion of that conductor forming a loop within the chamber 4 impress voltages of the combined frequency of the resonant chamber 4 and the resonant chamber 6 on the load apparatus. The latter may conveniently be provided with a detector and circuit tuned to the difference between the carrier frequency and the frequency of the oscillator 15, thereby deriving power of substantial magnitude at such difference frequency.

Referring to Fig. 2, the latter shows a resonator of the cavity type which may be substituted for the concentric transmission line type of resonator described in connection with Fig. 1. Many of the elements of structure in the resonator of Fig. 2 are similar to those of Fig. 1, and in such cases they bear the same reference numeral.

An enclosure 31 of conducting material which may, for example, comprise a rectangular parallelepiped has a central partition 7 which divides it into two chambers 4 and 6 analogous to the chambers 4 and 6 of Fig. 1. An in-leading conductor passing through the conducting sheath 12 of a concentric transmission line leading from the source of carrier frequency forms a loop 3 within the chamber 4, analogous to the loop 3 in Fig. 1. A second loop 13, analogous to the loop 13 in Fig. 1, leads to the central conductor within a sheath 14, forming therewith a concentric transmission line analogous to the transmission line 14 in Fig. 1, and which, like the latter, leads to a source of local oscillations. A conductor 19 having one end connected to the walls of the chamber 31 and passing through an insulating aperture in the partition 7 leads to the central conductor passing through a sheath 21 and forming therewith a concentric transmission line leading to the load circuit. The conductor 19 forms loops within the chambers 6 and 4, analogous to the loops already described in connection with the conductor 19 in Fig. 1.

The resonant chambers 4 and 6 are arranged to be tuned to resonate respectively at the carrier frequency and the local oscillator frequency by two screws 32 and 33 which are threaded in central positions in the end walls of the chamber 31. By inwardly or outwardly displacing these

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screws 32 and 33, the respective chambers 4 and 6 may be tuned to the frequency of the carrier wave and of the local oscillator.

While I have described two specific embodiments of my invention, it will be evident that the principles thereof may be employed in many different ways which will be clear to those skilled in the art.

I claim as my invention:

1. A mixer for deriving beat frequency currents from two sources of alternating current having a frequency difference which comprises an enclosure having conductive walls divided by a conductive partition into two chambers, a transmission line leading from one of said sources and forming a closed loop within one said chamber, a transmission line leading from the other said source and forming a closed loop within the second chamber, a third transmission line forming loops in both said chambers and a detector and circuit tuned to said beat frequency connected to said third transmission line.

2. A mixer for deriving beat frequency currents from two sources of alternating current having a frequency difference which comprises an enclosure having conductive walls divided by a conductive partition into two chambers, a transmission line leading from one said source and forming a closed loop within one said chamber, a transmission line leading from the other said source and forming a closed loop within the second chamber, a third transmission line forming loops in both said chambers, a detector and circuit tuned to said beat frequency connected to said third transmission line, and means in each said chamber for tuning it to resonance at a desired frequency.

3. A mixer for deriving beat frequency currents from two sources of alternating current having a frequency difference which comprises an enclosure having conductive walls divided by a conductive partition into two chambers, a transmission line leading from one said source and forming a closed loop within one said chamber, a transmission line leading from the other said source and forming a closed loop within the second chamber, a conductor having one end connected to the wall of said chamber and passing through an insulating passage through said partition into the other chamber, and from the latter to a third transmission line, and a detector and circuit tuned to said beat frequency connected to said third transmission line.

4. A mixer for deriving beat frequency currents from two sources of alternating current having a frequency difference which comprises an enclosure having conductive walls divided by a conductive partition into two chambers, a transmission line leading from one said source and forming a closed loop within one said chamber, a conductor leading from the other said source and forming a closed loop within the second chamber, a third conductor having one end connected to the wall of said chamber and passing through an insulating passage through said partition into the other chamber, and from the latter to a third transmission line, a detector and circuit tuned to said beat frequency connected to said third transmission line, and means for tuning the first-mentioned chamber to resonate at the frequency of the first-mentioned source and for tuning the second chamber to resonate at the frequency of the second-mentioned source.

5. In combination with an alternating-current input line traversed by a first alternating current,

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a mixer comprising a central conductive core and a conductive outer sheath, a conductive partition interconnecting said sheath and core, a conductive piston movable along said core on one side of said partition, a second piston movable along said core on the other side of said partition, a conductor connected to said input line and insulatingly passing through the wall of said mixer to form a loop on the first-mentioned side of said partition, a second conductor insulatingly passing through said wall and connected to an alternating-current source of frequency different from that of said first alternating current and forming a loop on the second-mentioned side of said partition, and a third conductor having one end connected to said sheath on one side of said partition and insulatingly passing through said partition to form loops on each side thereof, and means for insulatingly passing said third conductor through said sheath to a detector and circuit tuned to the difference of the above-mentioned frequencies.

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