

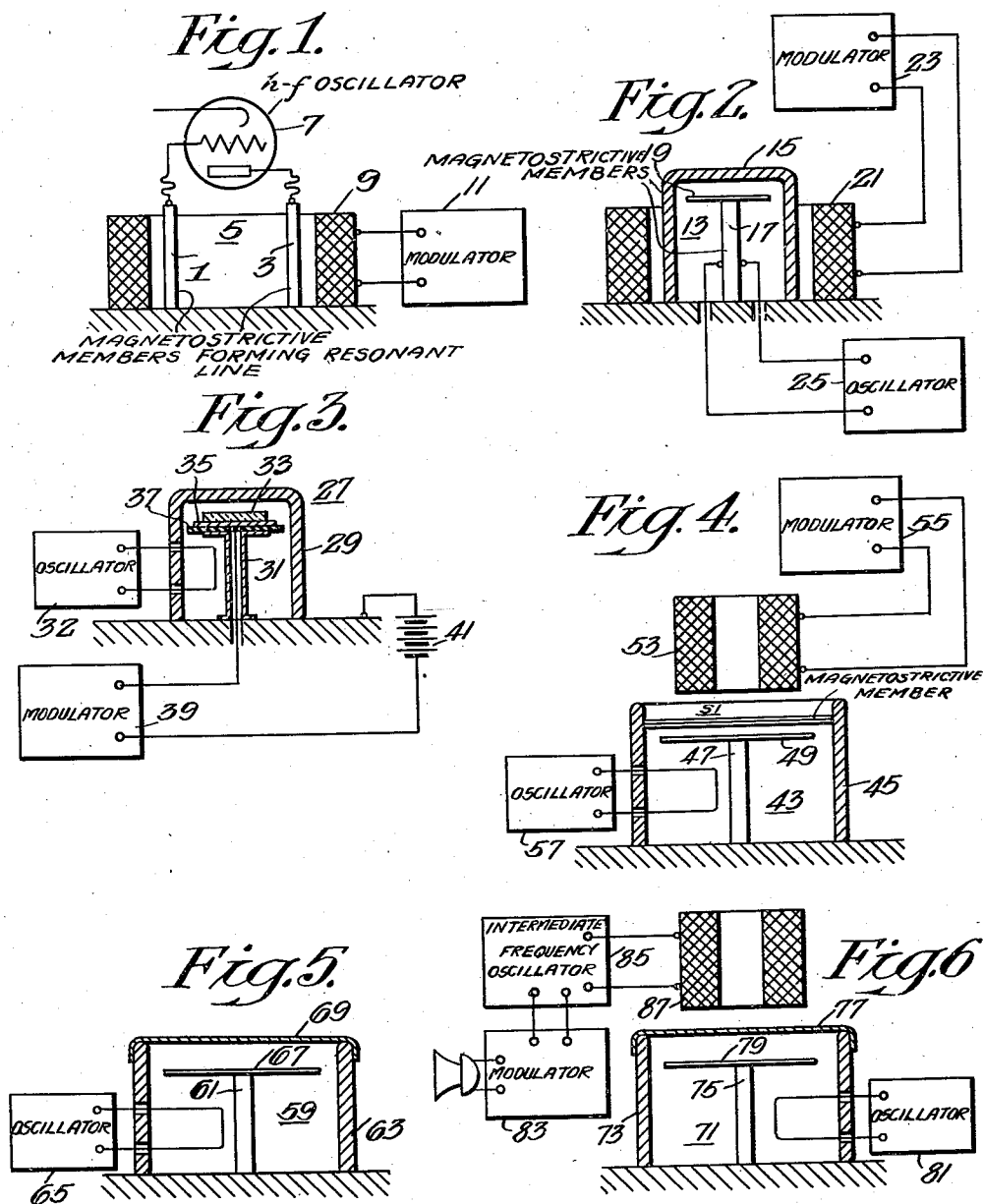
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ULTRA HIGH FREQUENCY MODULATOR

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ULTRA HIGH FREQUENCY MODULATOR

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My invention relates to ultra high frequency modulators, and particularly to means for frequency modulating an ultra high frequency resonant line circuit.

It has been found that generators of currents of 50 megacycles per second and upwards may be better stabilized by resonant transmission lines than by piezo-electric crystal controls with their attendant difficulties. In one aspect, my invention contemplates varying the characteristic of such stabilizing ultra high frequency resonant line circuits to thereby frequency modulate the ultra high frequency currents impressed on said resonant lines. Thus employed, the resonant line series the dual purpose of frequency modulation and stabilization.

One of the objects of my invention is to provide an improved means for modulating an ultra high frequency current.

Another object is to provide an improved means for frequency or amplitude modulating an ultra high frequency carrier.

Another object is to provide means for modulating the frequency of a high frequency oscillator by means of amplitude modulated currents of a lower frequency.

Another object is to provide means for varying the effective stabilizing frequency of a resonant line.

An additional object is to provide a stabilizing resonant line including magnetostrictive material and means for modulating the output of the line by modulations of said magnetostrictive material.

A still further object of my invention is to provide means for modulating an ultra high frequency carrier without the application of electrical power.

My invention may be best understood by reference to the accompanying drawing, in which

Figure 1 is a schematic circuit diagram of a resonant line and means for modulating said line,

Figure 2 is a modification of Fig. 1 and illustrates one embodiment of my invention applied to a concentric resonant line,

Figure 3 is a circuit diagram showing a concentric line and a crystal modulator applied thereto,

Figure 4 is a circuit diagram illustrating a modified form of magnetostrictive modulator and concentric line,

Figure 5 is a schematic illustration of a concentric line which is modulated by sound waves, and

Figure 6 is a schematic diagram of a circuit

which produces frequency modulated waves through the use of amplitude modulated waves.

Referring to Fig. 1, a pair of magnetostrictive members 1, 3 form a resonant transmission line 5 which is connected to a thermionic oscillator 7. The oscillator may be of the Barkhausen-Kurz, magnetron, or any suitable type of ultra high frequency current generator. The transmission line 5 is surrounded by a solenoid 9 which is energized by currents from a modulator 11.

If no modulation currents are impressed on the resonant line 5, the frequency of the oscillator will be determined by the characteristics of the line, and in particular by its length. The line will stabilize the frequency of the oscillator. When modulation currents are impressed on the solenoid, these currents will exert forces on the magnetostrictive material of the members of the line, alter its length, and hence the resonant frequency of the line. Thus, the line both stabilizes the frequency and modulates the frequency of the currents generated by the oscillator.

Referring to Fig. 2, a concentric resonant line 13 is made up of an outer member 15, an inner member 17, and an armature member 19 mounted on the top of the inner member. The outer member 15 and the inner member 17 are made of magnetostrictive material. A solenoid 21, surrounding the concentric line 13, is connected to a modulator 23. The line 13 is energized by an oscillator 25.

The foregoing construction shortens the length of the line because of the increased capacity between the armature 19 and the end of the outer member 15. When the modulation currents are passed through the solenoid 21, the length of the magnetostrictive member of the concentric line will be varied to thereby modulate the frequency of the currents stabilized by the line 13. The undesirable effects of eddy currents in the outer member 15 may be avoided by one or more slits in the outer member. The stabilizing effects of the line on the carrier currents of the oscillator will be retained and the modulation characteristics described above added thereto.

In Fig. 3 the modulation is effected, not by magnetostrictive forces, but by piezo-electric effects. A concentric line 27, comprising an outer member 29 and an inner member 31, is coupled to an oscillator 32. The inner member is made hollow to thereby accommodate a connecting wire. A piezo-electric member 33 is mounted on a conductor 35 or electrode which is insulated from the inner member by an insulated plate 37.

The conductor 35 is connected to a modulator 39 and a biasing battery 41.

In the operation of the circuit of Fig. 3, the oscillator currents are stabilized by the concentric line to thereby maintain the carrier frequency substantially constant. When modulation potentials are applied to the piezo-electric crystal 33, the crystal will undergo changes in its thickness which will vary the capacity between the conductor 37 and the outer member 29. This variation in capacity will, in effect, modulate the concentric line 27 and hence the frequency of the carrier currents.

In the circuit of Fig. 4, a concentric line 43 is used. The line consists of an outer member 45, an inner member 47, an armature 49 which is fastened to the inner member and a diaphragm 51 which is attached to the outer member 45. The diaphragm is made of bimetal; one of the metals is magnetostrictive. The diaphragm may be slotted to eliminate eddy current losses. A solenoid 53, energized by a modulator 55, actuates the magnetostrictive portion of the diaphragm.

Because one portion of the diaphragm is responsive to magnetostrictive forces, and the other is not, the diaphragm will bulge toward or away from the armature 49. The diaphragm movements will vary the capacity of the resonant concentric line and hence the period of carrier currents from the oscillator 57 which is coupled to the line 43.

The device illustrated in Fig. 5 can be used to modulate ultra high frequency oscillations without the application of electrical energy. A concentric line 59, having an inner member 61 and an outer member 63, is suitably coupled to a generator 65 of ultra high frequency oscillations. The upper portion of the inner member 61 includes an armature 67. An acoustic diaphragm 69 is mounted on the end of the outer conductor 63 in spaced relation to the armature 67. Sound waves may be impressed directly on the diaphragm 69. The diaphragm actuated by such waves will vary the capacity of the concentric line and hence its resonant frequency. The variation in capacity will frequency modulate the line 59 and the output from the oscillator 65. This arrangement is particularly adapted to an ultra high frequency portable transmitter because of the absence of apparatus and the power supply usually required for modulation. In installations where weight and power supplies are not important factors, the diaphragm 69 may be driven by a loudspeaker motor or the like.

A schematic circuit diagram of the application of the invention to an ultra high frequency transmitter and frequency modulator is shown in Fig. 6. In this circuit, a concentric line 71 is arranged with an outer member 73 and an inner member 75. A diaphragm 77 is mounted on the top of the outer conductor 73. An armature 79 is mounted on top of the inner member 75 and adjacent the diaphragm 77. An oscillator 81, supplying ultra high frequency currents, is coupled to the concentric line 71. A modulator 83 and an intermediate frequency oscillator 85 are arranged to supply a solenoid 87 with amplitude modulated intermediate frequency currents which actuate the diaphragm 77 through the reaction between the magnetic field set up by the currents in coil 87 and the field due to the eddy currents in the diaphragm. The in-

termediate frequency is chosen so that the diaphragm will have too large an inertia to follow the individual intermediate frequency waves. The diaphragm will, however, follow the average amplitude or modulation wave. Thus operated, the carrier currents from the oscillator 81 are stabilized by the concentric line and modulated as described. The greater the current through coil 87, the greater will be the eddy current induced in the diaphragm, and the greater will be the depressing of the diaphragm, resulting in a greater decrease in frequency of oscillator 81.

I have described several modifications of my invention which provide means for applying modulating signals to a resonant line which is used to stabilize an ultra high frequency oscillator. The resonant line serves the dual purpose of modulation and stabilization, and permits an efficient application of wide range frequency modulation to an ultra high frequency carrier. In this type of modulation, the anode voltage on the oscillator may be continuous, thereby maintaining high grid impedance and low grid circuit power losses.

While I have specifically described the invention as applied to frequency modulation of the direct or double modulation type, it should be understood that my invention may be applied to vary the coupling between the oscillator and an antenna to modulate amplitude. It is also possible to apply the invention as shown to the automatic control of the frequency of the heterodyne oscillator of a superheterodyne receiver. In such cases, changes in the intermediate frequency currents are applied to the resonant line circuit to thereby change the frequency of the heterodyne oscillator to maintain constant intermediate frequency currents.

I claim as my invention:

1. An ultra high frequency device including a line resonant to ultra high frequency currents, said line being made in part at least of a magnetostrictive material, and means for applying magnetostrictive forces to said material to thereby vary the physical proportions and thus the resonant characteristics of said line.

2. A resonant line for ultra high frequency oscillations, said line being made of magnetostrictive material, and means for applying magnetostrictive forces to said material.

3. A concentric line for ultra high frequency currents comprised of an inner member and an outer member, one of said members being made of magnetostrictive material, and means for applying magnetostrictive forces to said one member.

4. In a device of the character of claim 3, an armature attached to said inner member for increasing the capacity of said line.

5. A device of the character of claim 3 in which said means for applying magnetostrictive forces includes a solenoid surrounding the element made of magnetostrictive material.

6. An ultra high frequency oscillator coupled to a concentric line including an inner member, outer member, a bimetallic diaphragm secured to said outer member, and an armature secured to said inner member; one of said bimetallic elements being responsive to magnetostrictive forces; and means for varying the length of said concentric line by applying magnetostrictive forces to said diaphragm, whereby said oscillator is modulated.

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