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System and method of communication

INVENTOR: HARVEY RINES ROBERT

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SUMMARY:

The present invention relates to systems and methods of communication, and more partic- duce radio waves, emitting the radio waves into ularly to the generation, transmission and reception in radio.

An object of the invention is to provide a new and improved system and method for the mod- mounted with its conducting electrode elements ulation and demodulation of radio waves.

A further object is to provide a novel system and method for mechanically modulating radio Dielectric or insulating members Another object Is to provide a new and im- shown spacing the crystal electrode members tO

proved system and method for modulating refleeted radio waves.

Other and further objects will be explained hereinafter and will be particularly pointed out in the appended claims.

The invention will now be more fully explained in connection with the accompanying drawings, irr which Fig. 1 is a diagrammatic view of circults and apparatus illustrating the transmission and reception of waves modulated piezoelectrically in accordance with the present invention; Pig. 2 is a similar diagram illustrating magnetostrictive modulation; Pig. 3 is a similar diagram illustrating modulation effected with the aid of a tuning fork; Pig. 4 is a similar

diagram illustrating modulation produced with the aid of a resonating air column; Pig. 5 is a similar diagram illustrating the modulation of a reflected radio wave; and Pig. 6 is a similar diagram illustrating the modulation of high-frequency waves.

Referring; first to Pig. 1, the two elements of a lineardlpole antenna are shown at 2 and 4. The . of the antenna, have been found to produce -

antenna 14 Is of the type that emits radio responding variations in the radio& gt;-frequency-enwaves Into space in response to electrical excltatiorr by radio-frequency energy drawn by the antenna from a radlo-frequency-energy-generattag electric system prior to the emission of the-radio-frequency energy as radio waves. Antennas of this type need not take the specific form of a diplole, but may have other forms ineluding, for example, the single elements of Pigs.

and 3. The particular antenna t4 is shown 43 excited by and to support the radio waves reoriented1 vertically to emit a bundle of rays of radio- waves in widely separated directions, being omni-dlrectionar In the horizontal plane and1 directional in the vertical plane, there being no endVon radiation-. A radio-frequency generator BQ

8 may constitute the radio-frequency-energygenerating- electric system or source of radiofrequency energy connected to the antenna 2-4 by a transmission line in order that the antenna may- become- enabled to draw radio-frequency energy from the electric system, thereby to prospace as above described.

A mechanically vibratory member comprising, for example, a piezoelectric crystal 8, is shown and 17 spaced from, but close tor the adjacent ends of the dipole elements 2 and 4 to which they are therefore electromagnetlcally coupled.

and 18 are and 12" from the adjacent ends of the respective antenna elements 2 and 4. The crystal 8 may be vibrated by connecting its electrodes (0 and to a source of vibrational energy such as a beat-frequency or a signal audio oscillator 18.

The vibrations thus produced in the piezoelectric crystal 8 will be transmitted through the electrodes 10 and 1.2 and the insulating elements f4 and 16 to the dipole elements 2 and in a directlon at an angle to all the directions in which radio waves are emitted and at right angle to the horizontal radio-wave field pattern. This resuits in varying the dimensions of the dipole antenna elements at frequencies dependent upon the frequency of the vibrations of the piezoelectrie crystal . As the crystal 8 vibrates, moreover, the spacing and coupling between the electrodes 10 and 12 and the respective dipole elements 2 and 4 are periodically varied in response to the vibration of the crystal 8. These dlmensional variations in the physical, and hence in the effective electrical dimensions or impedance ergjr drawn from the generating electric systern 6, thereby to effect modulation of the elenstromagnetic- radio waves emitted by the antenna 24.

The modulated electric waves will be received at a receiving, station in any desired way; as by means of a similar dipole the two elements of which are shown: at 29 and 22, adapted to be ceived from the transmitting station. The received waves may be demodulated; by a& lt; desmodulator 24 of any suitable and well-known form, to make evident the signal in a loud-speaker 26.

The-modulation-controlling piezo-electrie crystal 9 needj not necessarily be disposed, as shown, between the adjcent ends of the dipole elements s? and 4. It may be positioned at any desired predetermined portion of either one of the elements" 2 and . The radio waves produced by that one element only would, of course, then become modulated. The degree of the modulation will depend upon the position of the piezo-electrie crystal with respect to the dipole element 2 or 4. It was found, for the case of a hollow half -wave dipole, that the best results were obtained with the crystal at either end of the corresponding dipole element, but in all cases the before-described modulation effects were discern!ble, the mechanical vibration of the high-frequency-current-supportlng elements producing current alternations therein of the same periodicity as the mechanical vibrations.

The dimensional variations of the antenna may be produced by other means than by vibrating wlth a piezoelectric crystal. According, for example, to the modification of Pig. 2, an antenna 28, shown excited or fed through a transformer from the generator n, is constituted of mag-

netostrictive material. It is shown enclosed in magnetostrictive windings 32 and 34 of a magnetostrictive oscillator of the Pierce type, the vacuum tube of which is shown at 36. The length and other dimensions of the antenna 28, therefore, are varied during the generation of the radlo waves, In order to modulate the waves.

As illustrated in Fig. 3, the dimensions of the antenna 38, excited to produce radio waves as in .Fig. 2, may be varied by means of a tuning fork to effect the modulation of the radio waves.

The dimensions of the antenna 38 are varied as .the conducting tuning fork element, coupled thereto, vibrates towards and away from the end of the antenna 38 The tuning fork may be replaced by a vibrating beU or other mechanically A T rf g,H dia raBm; w According to the modlflcation shown in Pig.

4, the antenna 42, excited to produce radio waves from a generator 48, is constituted of the outer 0 g a - ency to modulate the electromagnetic system having, in comadapted for use in directive antenn. arrays comprising interacting antenna elements, such as, for example, those illustrated in ,?lgs. 5 and 6. The radio waves produced by a driven dipole 50, 52, Fig. 5, as It draws radio-frequency energy from a generator 64 may SO

excite and thus be reflected by a parasitic antenna element 56, as it intercepts at least part of the radio waves emitted by the dipole antenna 60-52 and re-radiates the waves. The electric system prior to the production from dimensions of the element 56 may be varied the electromagnetic energy of electromagnetic in any desired way, as by means of a piezoelectric crystal 68. excited from an audio oscillator 60. The radio waves received and re-radiated by the parasitic element 56 will be found to have become modulated as a result emitted by an electromagnetic-wave antenna in of the length and other dimensional variations of the element 56. A similar linear director parasitic antenna 62, excited by and supporting radio-frequency radiation from the driven elements . 50, 62 may also be subjected to similar dime sional variations, as by means of a crystal 59, to modulate the forward radiation of the driven elements 50, 62, and to reenforce the modulation of the reflection off the reflector element 56.

Fig. 6 illustrates the dimensional variation of a dipole the elements of which are shown at 81, 63, excited electromagnetically by a generator 76 from which it draws radio-frequency energy to emit the energy as radio waves, and of a parasitic reflecting element 68, by means of crystals and 69, respectively. The crystals 67 and 69 are synchronously excited by an audio-oscillator 7 1 to modulate the electromagnetic radiation refleeted in a directional beam into space by r parabollc reflector 73.

The invention may be applied to other uses also. The production of a supersonically modulated radio wave may, for example, prove to be useful for conveying hidden information.

Further modifications will occur to persons skilled in the art and all such are considered to fall within the spirit and scope of the invention as defined in the appended claims.

ENGLISH-CLAIMS:
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What is claimed is:

1. An electromagnetic system having, In combinatlon, an antenna, means for exciting the antenna to produce electromagnetic waves, and means for varying the length of the antenna to modulate the waves.

2. An electromagnetic system having, in combination. an antenna, means for exciting the antenna to produce electromagnetic waves, and piezo-electric means for mechanically varying the length of the antenna to modulate the

waves.

3. An electromagnetic system having, in combination, an antenna, means for exciting the antenna to produce electromagnetic waves and magnetostrictive means for mechanically varylng tne length of the antenna to modulate the waves.

4. electromagnetic system having, in combination, an antenna having conducting outer and i r surf aces, means for exciting the outer surface of the antenna to produce electromagnetic Wave8 and means for mechanically resonating the antenna to modulate the waves.

5. electromagnetic system having, in combinati ante ltjng th an_

tenn& electrically to produce electromagnetic wave. an means for varying a dimension of the waves- and means f antenna at supersonic frequency to modulate the waves.

7. A me no / modulating electromagnetic wav s Produced from an electromagnetic-wave emitter of the type that draws electromagnetic energy from an electromagnetic-energy-generatwaves. that comprises varying a dimension of the emitter during the production of the electromagnetio waves and reflecting the modulated waves.

8. A method of modulating the radio waves widely separated directions in response to electrical excitation by the electromagnetic energy drawn by the antenna from an electromagnetlcenergy-generating electric system prior to the as emission of the electromagnetic energy as electromagnetic waves, that comprises mechanically vibrating the antenna during the emission of the waves.

9. A method of modulating the radio waves emitted by a radio-wave antenna in a predetermined direction in response to electrical excitation by radio-frequency energy drawn by the antenna from a radio-frequency-energy-generating electric system prior to the emission of the radiofrequency energy as radio waves, that comprises mechanically-1 vibrating th antemwafc an& gt; angle tcrthe said direction.

10. A method of modulating the radhr waves response to electrical excitation by radio-f reemitted by a radio-wave antenna; in, a predetermined direction- in response to e ctrical-excit tion by radio-frequency energy drawtt.by.the; an& gt;

fcennsvfrom a radio-frequency-energy generating electric- system prior to& gt; the emissibmoir the1 radios frequency energy as radio waves; that comprises mechanically vibrating the antennai at right ia antenna may draw radio-frequency energy from angles to the saitfdirection.

11. A radio transmitter having, in. combinav tlon; an antenna of the type- that emits radio waves into space in response to electrical excita-

Won by radio-frequency energy drawn- by-- the w waves emitted by the antenna.

antenna from a-radib-frequenoy-energy-generating electric1 systeim prior to the1 emission of the radio-frequency energy as; radio- wavesi an1 electric& lt; system for generating radio-frequency energy; means electrically connecting the antenna to- the electric- system- in order that- the antenna mar draw radio-frequency- energy from the electrib system, thereby to caus tlie; antenna to-emit radio waves into space, anff mean for varying a dimension of the; antenna uring the emission of the-Tadio- waves by the antenna. thereby effect modulation of the radio waves emitted by the na- . . _. , . dimension of the antenna n JtiJit rJS?; n dgnal during the emlssion of the radio waves by an antenna- of the type that emits radio 30 the antenna in order, to effect the signal modulawaves into space in response to electrical- excltatlon by radio-frequency energy drawn bythe antenna from a radio-frcquency-energy eneratihg system, thereby to cause the antenna to emit radio waves into space, a mechanically vibratory member, means for mechanically connecting the antenna to the mechanically vibratory member to vary a- dimension of the antenna mechanically in response to the

mechanical vibrations of the mechanicallyvibratorymember, thereby to effect modulation of the radio waves emitted by the anduce corresponding variations in the energy 13. In a radio transmitter having an antenna of the type that emits radio waves into space in response to electrical excitation by radlo-frequency energy drawn by the antenna from- a radio-frequency-energy-generating electric system prior to the emission of the radio-frequency energy as radio waves, a method of the character described that comprises feeding radio-frequency energy from the electric system in order thaf the antenna may draw radio-frequency energy from the electric system, thereby to cause the- antenna to emit-radio waves into space, and- varying a d mension of the antenna during the emission of the radio waves by the antenna in order to effect modulation of the radio waves- emitted- by the antenna.

4. An electromagnetic system having; in combinatlon, an electromagnetic-wave-reflector for reflecting a bundle of rays of electromagnetic waves, a mechanically vibratory member, means for vibrating the mechanically vibratory member, and means mechanically connectlnjrthe reflector to the mechanically vibratory member to- transmit the mechanical vibrations from the mechanically vibratory member to and within the1 re fleeter, thereby to effect modulation of the1 refleeted waves.

15. in a radio transmitter having an antenna of the type that emits -radio waves into space- in quency energy drawn by the antenna from a radio-frequency-energy-generating electric systern prior to the emission of the radio-frequency energy as radio waves, a method of the character described that comprises feeding radio-frequency energy from the electric system in order that the the electric system, thereby to emit radio waves into space, and varying the length of the antenna during the emission of the radio waves by the antenna in order to effect modulation of the radio is. in a- radio transmitter having an antenna Of the type that emits radio waves into- space in response to electrical excitation by radlo-frequency energy drawn by the antenna from a radlo-frequency-energy-generating electric systern prior to the emission of the radio-frequency energy as radio waves, a method of the character described that comprises feeding radio -frequency energy from toe eiectrlc tem ln order that tne antenna may draw radio-frequency energy from the electrlc syst thereb to emlt rad,0 eg lnto space& gt; producing a slgnajt and varymg a accordance with the tlon of the . wayes emitted by thStenna.

17 TT, _ v_j.- f__r.-_,4.1._v, 1nfnnvpSC refat cxmpr ses feeding radio-frequency energy from the electric system ln rder that the an fnna: may draw radio-freif from ef electric sys fm thf reby emit radio waves into space, and varying a dimension of the antenna under the control, of e Piezoelectric means during the emission of "ie radio waves by the antenna in order to prodrawn from the electric system by the antenna, thereby to effect modulation of the emitted radio waves.

18. In a, radio transmitter having an antenna of t16 t e that emits radio: waves: into space m response to electrical excitation by radio-frequency energy drawn by the antenna from a radio-frequency-energy-generating electric systarn prior to the emission of the radio-frequency energy as radio waves- and magnetostrlctlve means, a method of the character described that 00 comprises feeding radio-frequency energy from the electric system in order that the antenna may draw radio-frequency energy from the electric system, thereby to emit radio waves Into space, and varying a dimension of the antenna under the control of the magnetostrictive means during the emission of the radio waves by the antenna in order to produce corresponding variations In the energy drawn, from the electric system by the antenna, thereby to effect modulation of the emitted radio waves.

19. In a radio system having an antenna that receives radio waves from space, a method of the character described that comprises exciting- the antenna to receive radio waves, and& gt; varying?- the length of the antenna during the reosptlon of the radio waves by the antenna in order to effect modulation of the received radio waves.

20. In a radio system having an antenna of the type that emits radio waves into space in response to electrical excitation by radio-frequency energy 0 of the antenna during the emission of the radio drawn by the antenna from a radio-frequencyenergy-generating electric system prior to the emission of the radio-frequency energy as radio waves, a method of the character described that comprises exciting the antenna to emit radio waves, and .varying the effective impedance of the antenna during the emission of the radio waves by the antenna in order to effect modulation of the

emitted radio waves.

21. In a radio transmitter having a driven antenna and a parasitic antenna, the driven antenna being of the type that emits radio waves into space in response to electrical excitation by radio-frequency energy drawn by the driven antenna from a radio-frequency-energy-generating electric system, a method of the character described that comprises feeding radio-frequency energy from the electric system in order that the driven antenna may draw radio-frequency energy from the electric system, thereby to emit radio waves into space, positioning the parasitic antenna to intercept and re-radiate at least part of the radio waves emitted by the driven antenna and varying a dimension of the parasitic antenna during the re-radiation of the radio waves by the parasitic antenna in order to effect modulation of the radio waves.

22. In a radio transmitter having an antenna and a conducting element spaced from but close to one end of the antenna to which it is el-sctromagnetically coupled, the antenna being of the type that emits radio waves into space in response to electrical excitation by radio-frequency energy drawn by the antenna from a radio-frequency-energy-generating electric system prior to the emission of the radio-frequency energy as radio waves, a method of the character describsd that comprises feeding radio-frequency energy from the electric system in order that the antenna may draw radio-frequency energy from the electric system, thereby to emit radio waves into space, and varying the spacing and hence the degree of electromagnetic coupling between the conducting element and the said one end of the antenna during the emission of the radio waves by the antenna in order to effect modulation of the radio waves emitted by the antenna.

23. In a radio transmitter having an antenna and a conducting element electromagnetically coupled to a predetermined portion of the antenna, the antenna being of the type that emits radio waves into space In response to electrical excitation by radio-frequency energy drawn by the antenna from a radio-frequency-energy-generating electric system prior to the emission of the radio-frequency energy as radio waves, a method of the character described that comprises feeding radio-frequency energy from the electric systern in order that the antenna may draw radiofrequency energy from the electric system, ther by to emit radio waves into space, producing a signal, and varying the degree of electromagnetic coupling between the conducting element and the said predetermined portion of the antenna in accordance with the signal during the emission of the radio waves by the antenna in order to effect signal modulation of the radio waves emitted by the antenna.

24. A radio transmitter having, in combination, an electric system for generating radio-frequency energy,, an antenna electrically connected to the electric system in order that the antenna may draw radio-frequency energy therefrom to emit radio waves, and means for varying the length waves to modulate the radio waves.

5. A radio system having, in combination, a generator of radio-frequency energy, a dipole element excited by the generator to emit radio waves, and means for varying a dimension of the dipole element during the emission of the radio waves to modulate the radio waves.

6. A radio system having, in combination, an antenna of the type that may produce radio waves in space in response to electrical excitation by radio-frequency energy drawn by the antenna from a radio-frequency-energy-generating electrie system prior to the production of the radiofrequency energy as radio waves, means for producing a signal, and means responsive to the signal-producing means for varying a dimension of the antenna In accordance with the signal during the production of the radio waves to signal modulate the radio waves.

27. A radio system having, in combination, an electric system for generating radio-frequency energy, an antenna of the type that emits radio waves into space in response to electrical excitation by radio-frequency energy drawn by the antenna from the radio-frequency-energy-generating electric system, means for enabling the antenna to draw radio-frequency energy from the electric system in order to emit radio waves into space, means for modulating the radio waves prior to their emission, a parasitic antenna positioned to intercept and re-radiate at least part of the emitted modulated radio waves, and means for varying a dimension of the parasitic antenna during the re-radiation of the radio waves, thereby further to modulate the re-radiated radio waves.

28. A radio system having. In combination, a linear antenna, means for exciting the antenna with radio-frequency energy, a conducting element spaced from but close to a predetermined portion near an end of ihe antenna to which it is electromagnetically coupled, and means for varying the spacing and hence the degree of electromagnetic coupling between the conducting element and the said predetermined portion of the antenna during the exciting of the antenna in order to effect modulation of the radio frequency energy.

29. A radio transmitter having, In combination, a source of radio-frequency energy, an antenna excited from the source to draw radio-frequency energy therefrom In order to emit radio waves, and means for vibrating the antenna mechanically during the emission of the radio waves to cause the antenna to effect modulation of the emitted radio waves as an inherent response to its mechanical vibrations.

30. In a transmitter having an antenna for emitting a bundle of rays of radio waves, each 06 ray along a predetermined direction, a method of modulating the radio waves that comprises varying a dimension of the antenna during the emission of the radio waves to vary a property of the radio waves, and retaining for each ray its predetermined direction.

31. A radio transmitter having, in combination, a source of radio-frequency energy, an omni-directional antenna excited from the source to emit radio waves In all directions, and a vibratory member to which the antenna is mechanically connected, vibrations of the member being adapted to modulate the radio waves.

32. A radio system having, in combination, a parasitic antenna for intercepting and re-radlating radio waves, a conducting element electromagnetlcally coupled to a predetermined portion of the antenna, means for producing a signal, and means controlled by the signal-produc-

Ing means for varying the degree of electromagnetlo coupling between -the conducting element and the parasitic antenna in accordance with the signal to signal modulate the re-radiated radio waves.

33. A radio system having, In combination, a linear parasitic antenna element for Intercepting and re-radiating radio waves, means for producing a signal, and means controlled by the signalproducing means for varying the length of the parasitic element In accordance with the signal to signal modulate the re-radiated radio waves. 20 2,287,881 34. In a radio system, a conducting element adapted to be disposed In an electromagnetic field In which there Is an electromagnetic wave and of sufficient dimensions to permit of continuous electromagnetic Interaction with the electro-
25 2,432,984 magnetic wave, and means for varying a dimenslon of the conducting element in accordance with a signal during the electromagnetic interaction with the electromagnetic wave in order to signalmodulate the electromagnetic wave.

35. An electric system having, in combination, a conducting element adapted continuously to support high-frequency current, and means for varying a dimension of the conducting element by subjecting it to mechanical vibrations to produce alternations of the supported current in the conducting element of the same periodicity as the mechanical vibrations.

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