

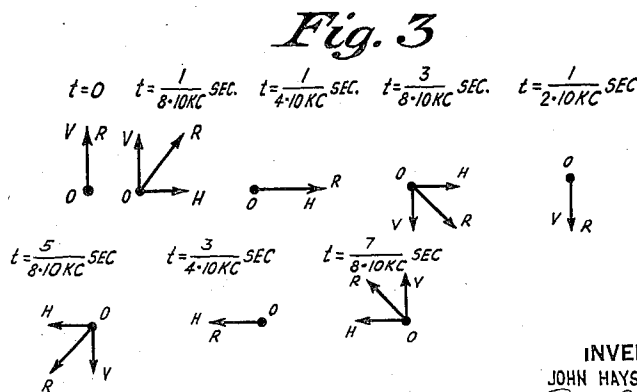
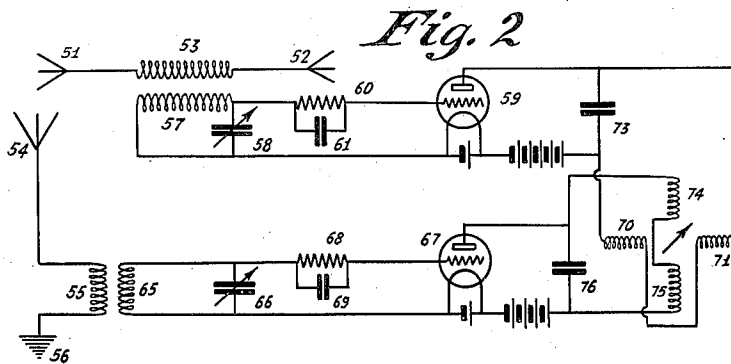
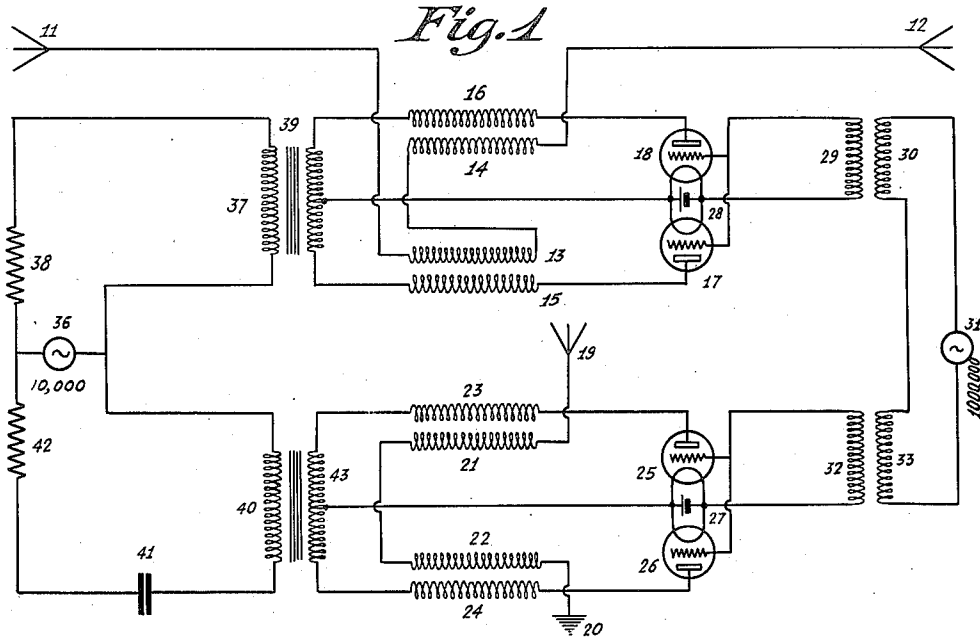
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J. H. HAMMOND, JR

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SYSTEM OF TRANSMISSION OF RADIANT ENERGY

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INVENTOR
JOHN HAYS HAMMOND JR.
BY *Sha J. Adams*
ATTORNEY

UNITED STATES PATENT OFFICE

JOHN HAYS HAMMOND, JR., OF GLOUCESTER, MASSACHUSETTS

SYSTEM OF TRANSMISSION OF RADIANT ENERGY

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The radiation of electromagnetic waves from various antennæ will have a polarized effect in accordance with the direction of the length of the antenna being used. Thus a vertical antenna will transmit vertically polarized waves; whereas a horizontal antenna will transmit horizontally polarized waves. In other words, the transmission from vertical and horizontal antennæ will be such that it is best adapted to be received by similar antennæ, depending upon the distance and character of the intervening territory. This effect is termed polarization.

For certain distances the effect of polarization of ether waves is very pronounced and transmission from a vertically polarized antenna, for instance, cannot be received at all by a horizontal antenna, and vice versa. As the distance increases this effect may become modified, so that it may be that at a given distance the waves transmitted by horizontally arranged antenna may be best received by an antenna in the vertical position or vice versa.

It has been observed, however, that regardless of the distance of transmission, a wave polarized in a given direction may be best received on an antenna having a certain direction which need not necessarily be the same as that of the transmitter. Conversely, it has also been observed that a given receiving antenna will receive waves which have been polarized in a given direction better than waves which have not been polarized, although as previously stated, the direction of polarization of the transmitter need not necessarily be the same as the direction of the extent of the receiving antenna.

It is an object of the present invention to utilize the polarization characteristics of horizontal and vertical antennæ to produce a rotating field at the receiver.

It is a further object of this invention to provide a system for rotating a field at the receiver at a low but supersonic frequency.

It is a still further object of this invention to provide means whereby synchronism may be maintained between rotating mechanisms located at a transmitting station and at a receiving station.

Other objects of this invention will become apparent upon reading the following specification taken in connection with the accompanying drawing.

The apparatus involved in this invention comprises, at each of the transmitting and receiving stations, a horizontal and a vertical antenna and at the transmitting station means for exciting the horizontal and vertical antenna in a given relationship so as to cause the energy received at the receiver on the two antennæ to have the same relationship and thus provide a rotating field at the said receiving station.

Having thus briefly described my invention, attention is invited to the accompanying drawing wherein:

Fig. 1 represents a transmitting station for carrying out the object of my invention;

Fig. 2 represents a receiving station for cooperation with the transmitting station as shown in Fig. 1;

Fig. 3 is a series of vector diagrams showing the signal strength existing in the horizontal and vertical antennæ of the receiver and transmitter as well as the resultant field.

Having thus briefly described the drawing accompanying this specification, attention is particularly invited to Fig. 1 which shows a horizontal antenna having the two sections 11 and 12 coupled through the inductances 13 and 14 to the inductances 15 and 16 of the plate circuits of the plate modulated radio amplifier tubes 17 and 18 respectively. The vertical antenna 19 is similarly connected to the ground 20 through the inductances 21 and 22 which are coupled to the inductances 23 and 24 in the plate circuits of the plate modulated radio amplifier tubes 25 and 26 respectively.

The plate modulated radio amplifier tubes 17 and 18 as well as the plate modulated radio amplifier tubes 25 and 26 are connected in push-pull. The filaments of the thermionic devices are supplied in the usual and well known manner, by the low potential sources 27 and 28.

For supplying the high frequency to be radiated the grids and filaments of the devices 17 and 18 are connected in parallel to

the inductance 29 inductively coupled to the inductance 30 in the output of the high frequency source 31. Similarly the grids and filaments of the devices 25 and 26 are connected in parallel to the inductance 32 which is inductively related to the inductance 33, also included in series with the inductance 30 in the output circuit of the high frequency source 31.

For supplying the low or modulation frequency and alternately causing the high frequency produced in the oscillator 31 to be radiated by the horizontal and the vertical antenna, there is provided a low frequency source 36 the output of which comprises two circuits in parallel. The first circuit includes in addition to the oscillator 36, the inductance 37 and the resistance 38, the former of which is inductively coupled to the inductance 39 in the plate circuits of the device 17 and 18 and is for the purpose of supplying the high potential to the two circuits. The second circuit is composed of the inductance 40, the condenser 41 and the resistance 42, the former of which comprises the primary of the transformer 40—43, and the latter winding 43 of which is included in the plate circuits of the devices 25 and 26 and is for the purpose of supplying a high potential to these two thermionic devices. The condenser 41 is for the purpose of causing a lead of the current in the circuit which includes it, of approximately 90° with respect to the current in the parallel circuit including the inductance 37. Thus the devices 25 and 26 will be supplied with full amplitude current or voltage 90 electric degrees before the devices 17 and 18.

Also, due to the push-pull arrangement of the plate circuits, the plate of the device 25 will be positively charged at one portion of the cycle, whereas, the plate of the device 26 will be negatively charged. On the opposite cycle the reverse will occur. The same is true with respect to the high potentials on the plates of the devices 17 and 18.

Fig. 2 shows the receiving device comprising the horizontal antenna composed of the horizontal elements 51 and 52 connected by the inductance 53 and the vertical antenna circuit comprising the vertical antenna 54, the input inductance 55 and the ground connection 56. The inductance 53 is inductively related to the inductance 57 of the closed oscillatory circuit comprising, in addition, the condenser 58. The closed oscillatory circuit thus composed is adapted to supply the grid of the rectifier 59 through the grid leak 60 and grid leak condenser 61 in the usual and well-known manner.

The inductance 55 is inductively related to the inductance 65 included in the closed oscillatory circuit which includes also the tuning condenser 66. The closed oscillatory circuit thus composed is adapted to supply

the grid of the device 67 through the grid leak 68 and the grid leak condenser 69 in the usual and well-known manner. The filament of the devices 59 and 67 are supplied by the low potential source, as indicated, in the usual and well known manner.

The plate circuit of the device 59 includes the inductances 70 and 71 and the condenser 73 which latter is for the purpose of tuning the output to the modulation frequency of the transmitter. The plate circuit is completed through the high potential source as shown in the usual manner. The plate circuit of the device 67 includes the inductances 74 and 75 and the condenser 76. The condenser 76 is for the purpose of tuning the output of the device 67 to the modulation frequency of the transmitter shown in Fig. 1.

The coils 74 and 75 are arranged at right angles to the coils 70 and 71 and are for the purpose of producing a rotating field in accordance with the variations in energy received on the respective antenna.

In Fig. 3 there are shown a series of vector diagrams representing the current intensity existing in the vertical and horizontal antennae either of the receiver or the transmitter and also the resultant electric field produced covering the complete cycle. The energy in the vertical antenna is represented by the line OV while the energy in the horizontal is represented by the line OH. The resultant or direction of polarization of transmission is represented as the line OR and in case there is a single component present by the single existing component OV or OH. The diagrams of Fig. 3 will be more clearly explained later in connection with the description of the operation of my device.

Having thus described my invention I will now describe its operation.

The oscillator 31 is adapted to supply the high or carrier frequency of any given frequency as, say, one million cycles per second. This high frequency energy is adapted to be amplified in the devices 17 and 18, 25 and 26. The amount of such amplification in each device is dependent upon the plate potential of said device. For supplying the plate potential to these devices a generator 36 is provided which is adapted to supply alternating current voltage at a frequency, say, of 10,000 cycles per second. It is to be understood however, that this frequency may be either audible or supersonic. The primary plate current existing in the circuit for supplying the devices 25 and 26 is so adjusted by means of the condenser 41 that it will have a lead of approximately 90° over the plate current for the devices 17 and 18. Thus referring more particularly to Fig. 3 when the current in the winding 40 is maximum in one direction the plate voltage and therefore the amplification of the thermionic device 25 will be maximum and the high frequency gener-

ated at 31 will be transmitted through the amplifying device 25 and the vertical antenna. This is represented by the first diagram of Fig. 3 where the line OV represents maximum transmission on the vertical antenna and the time is indicated as zero. 45 electric degrees later or in $\frac{1}{8}$ of $1/10,000$ of a second the current in the winding 37 will be on the increase in a given direction and say the device 17 will have an increasing plate voltage and the high frequency produced by 31 will be increasingly radiated through said device by the horizontal antenna 11 and 12. At this same instant the current in the winding 40 will be on the decrease and the charge on the plate of the device 25 will be decreasing and consequently the high frequency being transmitted through said devices through the vertical antenna will be decreasing. This is shown diagrammatically in the second diagram of Fig. 3 which represents the amount of transmission from the vertical and horizontal antenna and the vector sum of said radio transmission. It is obvious that the line OR will also represent the actual direction of polarization of the combined field of radiation of the two antennae.

After 90 electric degrees or $\frac{1}{8}$ of $1/10,000$ of a second later the current in the coil 37 will be maximum and the current in the coil 40 will be zero. Therefore, the only radiation of the carrier frequency is through the device 17 upon the plate of which the maximum voltage is impressed. The transmission will then be polarized in a horizontal direction.

Similarly, the remaining diagrams of Fig. 3 show the relationship of the antenna radiations of the two antennae throughout the complete cycle.

It can thus be seen that for every cycle of the oscillator a modulation pulse is caused by each of the two modulators and therefore the modulation frequency would be twice the frequency of oscillator 36 or 20,000 cycles.

When the transmission is polarized in a given direction the amount of energy pick-up by the two antennae 51—52 and 54 of the receiver of the Fig. 2 is proportional to the amount of energy transmitted by the corresponding antennae of the transmitter of Fig. 1 so that the vector diagrams of Fig. 3 also represent the energy in the horizontal and vertical antennae. This energy is detected and supplied to the coil systems arranged at right angles. Since the detected currents are of double the frequency used in modulation at the transmitter, it follows that the phase difference of detected grid currents in devices 59 and 67 will be twice the phase difference of the original modulating currents, namely 180 electrical degrees. The phase of the currents in the output coils 70—71 and 74—75 may be adjusted to 90 electrical degrees difference by having one circuit tuned to a slightly

higher frequency and the other circuit tuned to a slightly lower frequency than for exact resonance, producing phase shifts in the plate circuit of 45 degrees in opposite senses.

Thus it is seen that at the receiver a rotating field is provided, caused and determined by the rate of modulation used at the transmitter of Fig. 1.

In the case that the frequency of modulation at the transmitter is supersonic, as in the case taken for the purpose of illustration, where the oscillator 36 has a frequency of 10 kilocycles and the frequency of modulation is therefore 20 kilocycles, the secondary or supersonic frequency may be modulated by an audio or signal frequency. In this case it would be possible to transmit two audio messages, one over the horizontal antenna and one over the vertical antenna, by causing the two audio frequency circuits to operate upon the modulator plate circuits of the respective systems, as by using a magnetic modulator in the place of transformers 37—39 and 40—43. To receive this type of transmission, it would be necessary to provide a double detection receiver for use with each of the horizontal and vertical antenna at the receiver. This could be easily done by adding a second detector coupled to the inductances 70 and 74 of Fig. 2. The output of the additional detector would, of course, consist of an audio frequency utilization circuit.

It is to be understood that a great many modifications of my invention may be made without departing from its spirit and that, therefore, I am not to be limited by the specific embodiment shown for the purpose of illustration only, but rather by the scope of the invention as indicated in the appended claims.

Having now described my invention, what I claim is:

1. Means for the transmission and reception of radiant energy which comprises a transmitter including, a source of high frequency energy, a source of low frequency energy, a horizontal antenna, a vertical antenna, means for amplifying and supplying said high frequency energy to said horizontal antenna, means for amplifying and supplying said high frequency energy to said vertical antenna, means for modulating the energy supplied to said horizontal antenna at said low frequency, and means for modulating the energy supplied to said vertical antenna at the same low frequency but at 90° phase quadrature, said amplifying means for each of said antennae comprising two thermionic devices the grid circuits of which are coupled in parallel with respect to said high frequency source and whose plate circuits are arranged in push-pull with respect to said low frequency source, and a receiver including a horizontal antenna, a vertical antenna, a thermionic detector associated

with said horizontal antenna, a thermionic detector associated with said vertical antenna, a tuned circuit in the input of said second mentioned detector, a tuned output circuit for each of said detectors, and field coils connected to each of said output circuits arranged at right angles whereby a rotating field is produced, the frequency of rotation of which will correspond to the frequency of the low frequency source of the said transmitter.

2. Means for the transmission of radiant energy which comprises a source of high frequency energy, a horizontal antenna, a vertical antenna, means for amplifying and supplying said high frequency energy to said horizontal antenna, means for amplifying and supplying said high frequency energy to said vertical antenna, a source of low frequency energy, means for modulating the energy supplied to said horizontal antenna at said low frequency, and means for modulating the energy supplied to said vertical antenna at the same low frequency but at 90° phase quadrature, said amplifying means for each of said antennae comprising two thermionic devices the grid circuits of which are coupled in parallel with respect to said high frequency source and whose plate circuits are arranged in push-pull with respect to said low frequency source.

3. Means for the transmission of radiant energy which comprises, a source of high frequency energy, a horizontal antenna, a vertical antenna, means for amplifying and supplying said high frequency energy to said horizontal antenna, means for amplifying and supplying said high frequency energy to said vertical antenna, a source of low frequency energy, means for modulating the energy supplied to said horizontal antenna at said low frequency, means for modulating the energy supplied to said vertical antenna at the same low frequency but at 90° phase quadrature.

4. Means for the transmission and reception of radiant energy which comprises a transmitter including, a source of high frequency energy, a horizontal antenna, a vertical antenna, means for amplifying and supplying said high frequency energy to said horizontal antenna, means for amplifying and supplying said high frequency energy to said vertical antenna, a source of low supersonic energy, means for modulating the energy supplied to said horizontal antenna at said low supersonic frequency, means for modulating said last mentioned frequency at an audio frequency, means for modulating the energy supplied to said vertical antenna at the same low supersonic frequency but at 90° phase quadrature, means for modulating said last mentioned supersonic frequency at a second audio frequency, said amplifying means for each of said antennae comprising

two thermionic devices the grid circuits of which are coupled in parallel with respect to said high frequency source and whose plate circuits are connected in push-pull with respect to said low audio modulated supersonic frequency source and a receiver including a horizontal antenna, a vertical antenna, a thermionic detector associated with said horizontal antenna, a thermionic detector associated with said vertical antenna, a tuned circuit in the input of said first mentioned antenna, a tuned circuit in the input of said second mentioned antenna, a tuned output circuit for each of said detectors, and utilization circuits for utilizing the energy supplied by each of said last mentioned tuned circuits.

5. Means for production of a rotating field which comprises a transmitting station and a receiving station, said transmitting station comprising a vertical and a horizontal antenna, means for exciting each of said antennae with energy of the same frequency alternately modulated at quadrature phase relationship, means at the said receiver for independently receiving the horizontal and vertical components of said transmission and means for rectifying and reproducing the currents thus received and means for producing from said currents a rotating electromagnetic field.

6. Means for the transmission of radiant energy which comprises, a source of high frequency energy, a horizontal antenna, a vertical antenna, means for amplifying and supplying said high frequency energy to said horizontal antenna, means for amplifying and supplying said high frequency energy to said vertical antenna, a source of low supersonic frequency energy, means for modulating the energy supplied to said horizontal antenna at said low supersonic frequency, means for modulating the energy supplied to said vertical antenna at the same low frequency but at 90° phase quadrature, means for modulating the low supersonic frequency supplied to modulate the energy supplied to each of said vertical and horizontal antenna at different audio frequencies to send messages, said amplifying means for each of said antenna comprising two thermionic devices the grid circuits of which are coupled in parallel with respect to said high frequency source and whose plate circuits are arranged in push-pull with respect to said supersonic low frequency source.

7. Means for the transmission of radiant energy which comprises, a source of high frequency energy, a horizontal antenna, a vertical antenna, means for amplifying and supplying said high frequency energy to said horizontal antenna, means for amplifying and supplying said high frequency energy to said vertical antenna, a source of low supersonic frequency energy, means for modulating the

energy supplied to said horizontal antenna at said low supersonic frequency, means for modulating the energy supplied to said vertical antenna at the same low frequency but at 90° phase quadrature, means for modulating the low supersonic frequency supplied to modulate the energy supplied to each of said vertical and horizontal antenna at different audio frequencies to send messages.

8. Means for the transmission and reception of radiant energy which comprises; a transmitting station and a receiving station; said transmitting station comprising a vertical and horizontal antenna, means for alternately exciting each of said antennae with energy of the same frequency modulated at quadrature phase relationship, means for modulating the current modulating the exciting frequency supplied to each of said antennae at a different audio frequency to send two messages, and said receiver comprising means for independently receiving horizontal and vertical components of the transmission of said transmitter, means for rectifying and reproducing the currents thus produced and utilizing means for each of said audio frequency components.

9. A receiver for the reception of radiant energy which comprises, a horizontal antenna, a vertical antenna, a thermionic detector associated with said horizontal antenna, a thermionic detector associated with said vertical antenna, a tuned circuit in the input of said first mentioned detector, a tuned circuit in the input of said second mentioned detector, a tuned output circuit for each of said detectors and field coils connected to each of said output circuits arranged at right angles whereby a rotating field is produced.

10. A receiver for the reception of radiant energy comprising, a horizontal antenna, a vertical antenna, a detector associated with said horizontal antenna, a detector associated with said vertical antenna, tuned input and output circuits for each of said detectors, field coils connected to each of said output circuits and second detection means associated with said field coils.

11. Method of producing a rotating field which comprises transmitting vertically and horizontally polarized high frequency waves modulated at a low frequency at quadrature phase relationship, receiving the horizontal and vertical component of said transmission and independently rectifying and reproducing the low frequency components of the currents thus received and producing therefrom a rotating electromagnetic field.

12. The method of transmission and reception of radiant energy which comprises transmitting high frequency energy polarized at right angles, modulating each of said polarization components by the same low supersonic frequency but at phase quadrature, modulating the low supersonic frequency energy

used to modulate each of said high frequency components by an audio frequency to send two messages, independently receiving and detecting the polarized components of said polarized transmission and utilizing the resulting frequencies.

13. In a system for the reception of radiant energy, means for independently receiving and detecting the horizontal and vertical polarization components of a radio transmission and means for independently utilizing the detected components of said transmission.

14. The steps in the method of producing and transmitting signalling energy having a rotating field which comprise, generating carrier frequency energy, generating modulating frequency energy, transmitting said carrier frequency energy in the form of vertically polarized waves and horizontally polarized waves and modulating the horizontally polarized waves and the vertically polarized waves by the modulating frequency energy at quadrature phase relationship.

15. The steps in a method of signalling which comprise, generating carrier frequency energy, producing modulating frequency energy, producing modulating frequency energy having the same frequency as said first-named modulating frequency energy but being at quadrature phase relationship therewith, modulating a portion of said generated carrier frequency energy with said first-named modulating frequency energy, transmitting the side-bands resulting from said modulation in the form of horizontally polarized waves, modulating another portion of said carrier frequency energy with said second-named modulating frequency energy and transmitting the side-bands resulting from said second-named modulation in the form of horizontally polarized waves.

16. The steps in the method of signalling by means of energy having a rotating field which comprises, generating a carrier frequency energy, generating modulating frequency energy, transmitting said carrier frequency energy in the form of vertically polarized waves and horizontally polarized waves and alternately modulating the horizontally polarized waves and the vertically polarized waves by the modulating frequency energy at quadrature phase relationship, receiving said transmitted energy and producing therefrom a rotating electro-magnetic field and utilizing said rotating field.

17. The steps in a method of signalling which comprise, generating carrier frequency energy, producing modulating frequency energy, producing modulating frequency energy having the same frequency as said first-named modulating frequency energy but being at quadrature phase relationship therewith, modulating a portion of

said generated carrier frequency energy with said first-named modulating frequency energy, transmitting the side-bands resulting from said modulation in the form of
5 horizontally polarized waves, modulating another portion of said carrier frequency energy with said second-named modulating frequency energy and transmitting the side-bands resulting from said second-named
10 modulation in the form of horizontally polarized waves, receiving both said vertically and horizontally polarized waves producing therefrom a rotating field and utilizing said rotating field for obtaining the signals therefrom.

18. In a transmission system, a pair of space discharge devices having a common input circuit and parallel connected output circuits, a horizontal antenna system coupled to both said output circuits, a second
20 pair of space discharge devices having a common input circuit and parallel connected output circuits, a vertical antenna system coupled to both said last-named parallel
25 connected output circuits, a source of carrier frequency energy coupled to both said input circuits, a source of modulating frequency energy coupled to said first-named parallel connected output circuits and a source of
30 modulating frequency energy having a different phase than said first-named source of modulating frequency energy coupled to said second-named parallel connected output circuits.

35 19. In a transmission system, a pair of space discharge devices having a common input circuit and parallel connected output circuits, an antenna system adapted to transmit horizontally polarized waves coupled to both
40 said output circuits, a second pair of space

discharge devices having a common input circuit and parallel connected output circuits, an antenna system adapted to transmit vertically polarized waves coupled to both
70 said last-named parallel connected output circuits, a source of carrier frequency energy coupled to both said input circuits, a source of modulating frequency energy, means for coupling said source to one of said parallel
75 connected output circuits arrangement, and means connected with said modulating frequency energy source for supplying said other parallel connected output circuits arrangement with modulating frequency
80 energy out of phase with respect to the energy supplied to said first-mentioned arrangement.

20. The steps in a method of producing and transmitting a rotating electric field representative of signal energy desired to be
85 transmitted which comprise producing high frequency energy, producing lower frequency energy having the desired signal characteristics impressed thereon, modulating a portion of the high frequency energy by a portion
90 of the low frequency energy and transmitting at least the side bands resulting therefrom in the form of energy having certain definite polarization characteristics, modulating another portion of said high frequency
95 energy by another portion of said low frequency energy but at phase quadrature as compared with said first mentioned portion of said low frequency energy, and transmitting at least the side bands resulting
100 therefrom in the form of energy having certain definite polarization characteristics differing from said first mentioned transmitted energy.

JOHN HAYS HAMMOND, JR. 105

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