

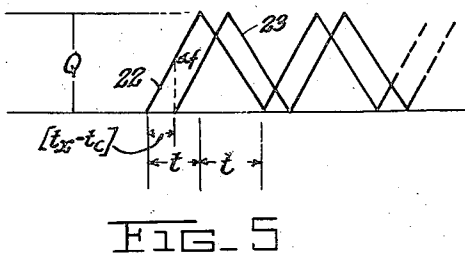
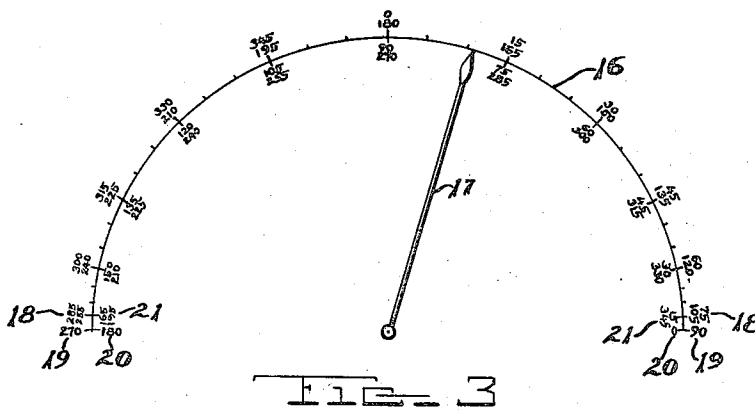
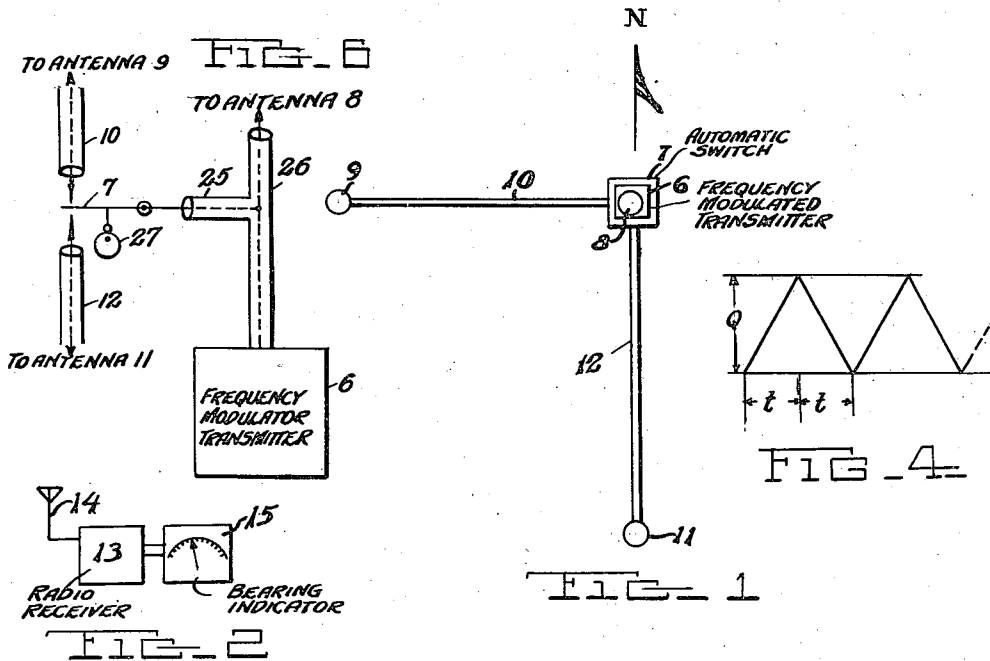
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OMNIDIRECTIONAL RADIO BEACON

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OMNIDIRECTIONAL RADIO BEACON

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My invention relates broadly to radio beacons, systems and means whereby surface vessels and aircraft may obtain continuous indications of their true bearing relative to such beacons.

One object of my invention is to provide a means for radiating an omnidirectional radio signal having a separately distinctive characteristic on all courses departing from it.

Another object of my invention is to provide a means to be carried on board a surface vessel, or on board an aircraft, which is capable of receiving signals radiated from the aforesaid radiating means and which is capable of indicating continuously the true bearing between the receiving means and the radiating means.

Another object of my invention is to provide means capable of providing continuously indicated bearings, in the manner above stated, simultaneously at as many receiving points as may be desired, each of which may have a different bearing from the radiating means.

Another object of my invention is to provide a simple, light weight and inexpensive means for accomplishing the aforesaid purposes which does not involve the use of cathode-ray oscilloscopes nor synchronous motors at the receiving point, and which does not require careful adjustment of phase relationships at the radiator.

Other purposes of my invention will become apparent by reference to the following description of my invention and by reference to the figures, of which:

Fig. 1 is a plan view showing the omnidirectional radio beacon with its radiating system;

Fig. 2 is a block diagram showing a typical receiving and bearing indicating system for the omnidirectional radio beacon;

Fig. 3 is an enlarged view showing the calibrated scale and pointer of the bearing indicator at the receiving station;

Fig. 4 shows graphically the change of transmitter frequency as a function of time; and

Fig. 5 shows graphically the change of frequency of two received waves as a function of time.

Fig. 6 is a more detailed view of a portion of Fig. 1 and shows the manner of connecting the transmitter to the transmission lines and the manner of operation of the automatic switch means.

Referring to the drawing, in Figs. 1 and 6 the output of a frequency modulated transmitter 6 is connected through transmission line 25 to a time controlled automatic switch means 7 and also to a vertical radiator 8 through transmission

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line 26, so as to energize vertical radiator 8 and simultaneously, via the switch 7, to energize either the vertical radiator 9 through transmission line 10 or vertical radiator 11 through transmission line 12. Automatic switch means 7, operated by a motor driven eccentric cam 27, is a conventional time controlled switch well known to the art. The choice between radiator 9 and radiator 11 to be energized simultaneously with radiator 8 is determined by switch means 7. The frequency modulated transmitter 6, the vertical radiators 8, 9 and 11, and the transmission lines 10 and 12 are of conventional types well known to the radio art. Radiator 9 is erected due west of the radiator 8 and radiator 11 is erected due south of radiator 8. Radiators 9 and 11 are preferably equi-distant from radiator 8 and transmission lines 10 and 12 are preferably of the same length.

Referring to Fig. 2, a conventional radio receiver 13 capable of receiving amplitude modulated waves is provided with an antenna 14 located at the receiver, and a bearing indicator 15, responsive to audio frequencies. Bearing indicator 15 is a conventional audio frequency meter such as the one described on page 43 of the Review of Scientific Instruments for February, 1935, but its scale is calibrated in degrees of true bearing.

In Fig. 3, the pivoted pointer 17 and calibrated scale 16 of the bearing indicator 15 (Fig. 2) are shown. Scale 16 comprises four concentric scales 18, 19, 20 and 21, each calibrated to cover 180 degrees of arc. Towards the extremities of scales 18, 19, 20, 21 the calibrated markings are compressed, while toward the center they are expanded. Scales 18 and 19 together comprise what is denominated the outer scale; scales 20 and 21 comprises the inner scale.

In the graph of Fig. 4, the abscissae of which are time units and the ordinates are frequency units, the linear change of frequency of the frequency modulated transmitter 6 (Fig. 1) is shown. As shown in this figure, the transmitter frequency is caused to increase linearly by the amount Q in time t , and then to decrease linearly by the same amount Q in the same time t . Obviously, the period of frequency modulation is $2t$ seconds, and the frequency modulation is continuous at the rate of

$$\frac{1}{2t}$$

cycles per second.

Fig. 5 represents graphically two received waves 22, 23 emanated from transmitter 6, which waves

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arrived at the receiving point at slightly different times. In this figure, as in Fig. 4, time is plotted as abscissae, frequency as ordinates. For the particular situation illustrated, wave 23 lags wave 22 by a time interval $t_x - t_c$ (explained later). The instantaneous frequency difference between waves 22 and 23, also for the particular situation shown, is df , except near the maximum and minimum frequency limits of frequency modulation.

Again returning to Fig. 1, assume that the time required for a wave to travel from the transmitter 6 to the radiator 9 by way of the transmission line 10 is equal to t_x seconds and assume that the time required for a wave to travel from the transmitter 6 to the radiator 11 by way of the transmission line 12 is also t_x seconds. Also assume that the time required for a wave to travel the distance between radiator 8 and radiator 9 or between radiator 8 and radiator 11 by way of radiation in space is t_c seconds. The time t_c may be made any desired value by properly spacing the radiators 9 and 11 from radiator 8. The time t_x may be made any desired value greater than t_c by any well-known method, such as by laying out transmission lines 10 and 12 on indirect routes between the radiators connected thereby.

Now assume that receiver 13 is located at some distance due west of radiator 9. The time required for a wave generated by the transmitter 6 to reach the receiver by way of radiator 8 is $t_c + k$ seconds and the time required for the same wave to reach the receiver by way of radiator 9 is $t_x + k$ seconds where k is the time required for a space wave to travel from radiator 9 to the receiver. The difference in transit time for the two waves will then be $t_x - t_c$ seconds (Fig. 5) and the difference in frequency df between the two waves at any instant will be

$$\frac{Q(t_x - t_c)}{t}$$

cycles, as shown in Fig. 5.

Next assume that the receiver 13 is located some distance due east of radiator 8. The time required for a wave generated by the transmitter 6 to reach the receiver by way of radiator 9 is $t_x + t_c + k$ seconds and the time required for the same wave to reach the receiver by way of radiator 8 is k seconds where k is the time required for a space wave to travel from radiator 8 to the receiver. The difference in transit time for the two waves will then be $t_x + t_c$ seconds and the difference in frequency df between the two waves at any instant will be

$$\frac{Q(t_x + t_c)}{t}$$

For locations of the receiver other than due east or due west of radiator 8 it is obvious that the value of df will vary with change of bearing from radiator 8, and that such values will lie between the minimum value (when the receiver is located due west of radiator 8) and the maximum value (when the receiver is located due east of radiator 8).

In general, the difference in frequency between the two received waves at any instant will be

$$df = Q \frac{(t_x - k + \sqrt{k^2 - 2t_c k \cos \theta + t_c^2})}{t} \quad (1)$$

where

df = instantaneous difference in frequency between the received waves from radiator 9 and radiator 8,

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k = time required for the wave to travel from radiator 8 to the receiver,

and

θ = the bearing angle of the receiver measured clockwise from radiator 9 about radiator 8 as a center.

In normal operation, t_c^2 is negligibly small compared to $k^2 - 2t_c k \cos \theta$, hence the value of the radical in Equation 1 will not be appreciably changed by multiplying the last term thereof by the expression $\cos^2 \theta$ thus completing the square. If this be done, Equation 1 becomes

$$df = Q \frac{(t_x - k + \sqrt{k^2 - 2t_c k \cos \theta + t_c^2 \cos^2 \theta})}{t} \quad (2)$$

or

$$df = Q \frac{[t_x - k + (k - t_c \cos \theta)]}{t} \quad (3)$$

or

$$df = Q \frac{(t_x - t_c \cos \theta)}{t} \quad (4)$$

Let Z = the true bearing of the receiver measured clockwise from true north about radiator 8 as a center. Then

$$Z = 270^\circ + \theta \quad (5)$$

or

$$\theta = Z - 270^\circ \quad (6)$$

and

$$\cos \theta = -\sin Z \quad (7)$$

Substituting Equation 7 in Equation 4, there is obtained

$$df = Q \frac{(t_x + t_c \sin Z)}{t} \quad (8)$$

The above equation will hereinafter be denominated Equation 8.

Assuming that t_c equals 0.573×10^{-6} seconds, that t_x equals 0.70×10^{-6} seconds, that

$$t = 1.273 \times 10^{-2}$$

seconds and that $Q = 10^7$ cycles then, substituting in Equation 8,

$$df = \frac{10^7 (0.70 + 0.573 \sin Z) 10^{-6}}{1.273 \times 10^{-2}}$$

or $df = 785 (0.70 + 0.573 \sin Z)$ cycles per second.

The above assumptions would result in values of df which vary between the limits of 100 and 1000 cycles per second for bearings of the receiver which vary between 270 and 90 degrees true, clockwise or counterclockwise. The time t_c is equivalent to a linear spacing between radiators 1 and 2 of $0.573 \times 10^{-6} \times 3 \times 10^8 = 171.9$ meters = 564 ft. The time t is equivalent to a modulation frequency of

$$\frac{1}{1.273 \times 10^{-2}} = 78.5 \text{ cycles}$$

per second and Q is equivalent to a change in frequency of 10 megacycles during each half cycle. In order not to produce appreciable amplitude modulation in the tuned circuits of the transmitter or receiver, the value Q should not exceed four percent of the unmodulated frequency of the transmitter which in the case cited calculates to be 250 megacycles.

In Fig. 5 it will be noted that there are periods of time near the maximum and minimum frequency limits of the frequency modulation during which one wave continues to increase in frequency after the other has started to decrease in frequency. During these periods the difference

in frequency between the waves is not equal to the aforestated value of df . However, in the case cited the maximum duration of each of these periods is only 1.273×10^{-6} seconds while the duration of the complete half cycle is $12,730 \times 10^{-6}$ seconds, a ratio of 0.0002 to 1. This ratio may be permitted to become as large as 0.02 to 1 without modifying the indications of the type of audio frequency indicating instrument used at the receiver.

The receiver 13 (Fig. 2) should be designed to amplify, with reasonably constant gain, signals which vary in frequency by the amount Q and to attenuate as sharply as possible interfering signals outside of this range. A band width of Q is adequate in the present instance because the number of cycles of frequency modulation per second is small compared to the number of cycles per second frequency deviation of the carrier wave and therefore the spectrum occupied by the signal is substantially that of the deviation itself. When the receiver is so designed, the audio demodulator (final detector) of this receiver takes no cognizance of the fact that the two received waves are varying in frequency, but the fact that these two waves differ in frequency by a constant amount causes the audio de-modulator to produce in its output circuit an audio frequency equal to the difference in frequency between these two waves. A receiver of the type described is so well known to the radio art as to render further description unnecessary.

Frequency meter 15 is calibrated in degrees of true bearing from radiator 8. By substituting different values of true bearing in Equation 3, the corresponding value of df can be obtained (the values of Q , tx , tc and t being constants of the transmitter, transmission lines and radiators), and for such value of df , the corresponding true bearing in degrees is inscribed on the outer scale of scale 16. Except for bearings of 90 degrees and 270 degrees true from radiator 8, there are two possible values of Z for each value of df . The outer scale gives the true bearing, of course, only when radiators 8 and 9 are energized by transmitter 6. Frequency meter 15 is adjusted to produce minimum deflection of pointer 17 (Fig. 3) at a value of df corresponding to $Z=270$ degrees, maximum deflection for a value of $Z=90$ degrees and mid-scale deflection for a value of $Z=0^\circ$ or 180° . Further reference to the outer scale shows that the scale is considerably compressed near the points of maximum and minimum deflection, and expanded near its mid-scale point.

If radiators 8 and 9 alone were continuously energized by transmitter 6, the system would have bilateral ambiguity, and, in addition, the disadvantage of the compressed calibrations and consequent loss of bearing sensitivity at each end of scale 16 would be present.

To overcome the above, at periodic intervals automatic switch means 7 disconnects the output of transmitter 6 from transmission line 10 and connects the transmitter to transmission line 12. This results in radiators 8 and 11 being energized together.

Utilizing radiators 8 and 11 instead of radiators 8 and 9 has the effect of shifting the radiation pattern counterclockwise through an angle of 90 degrees. At any given receiving point, this would result in causing the bearing indicator to read 90° more than the true bearing on the outer scale. To obviate the necessity of solving a problem in mental arithmetic after each shift of the

radiation pattern, the inner scale, comprising scales 20 and 21, is added to the scale 16. As on the outer scale, each point on the inner scale except the maximum and minimum points represents two bearings. The inner scale is exactly similar to the outer scale, in that for each calibration mark on the outer scale there is a corresponding mark on the inner scale, but the corresponding calibration marks on the inner scale are denominated 90 degrees less than the corresponding mark on the outer scale.

It will be noted that when radiators 8 and 9 are energized the outer scale should be employed; when radiators 8 and 11 are energized the inner scale should be employed.

In order that the operator at the receiver may know which scale to read and which of the two supplementary bearings is the correct one, the following keying cycle may be followed at the transmitter:

(1) The identification letters of the station are keyed using only the central radiator and using amplitude modulation of a frequency equal to that required to produce half-scale deflection of the frequency meter at the receiver. In addition to station identification, this provides a calibration signal for the frequency meter.

(2) The transmitter is "off" for two seconds.

(3) Radiators 8 and 9 are supplied with frequency modulated energy for 30 seconds.

The receiving operator reads two possible bearings on the outer scale.

(4) The transmitter is "off" for 2 seconds.

(5) Radiators 8 and 11 are supplied with frequency modulated energy for 30 seconds. The needle of the bearing indicator will now generally shift its position. The receiving operator reads two possible bearings on the inner scale. Of these latter two bearings, only one will be identical to either one of the two bearings previously indicated on the outer scale. This bearing which is regularly repeated on the inner and outer scales is the correct bearing.

(6) The transmitter is "off" for 2 seconds.

(7) The cycle is repeated.

Reference to Figure 3 indicates that any bearing lying in the compressed area of the outer scale, say between 60 and 120 degrees true, will be repeated on the expanded portion of the inner scale, and vice versa.

In the cycle of operation above described, the receiving operator is informed as to which bearing scale to read by the order in which transmission is made following the identification and calibrating signal. Another method of conveying the same information at more frequent intervals consists of causing the modulating frequency

$$\left(\frac{1}{2f}\right)$$

of the transmitter to be increased by a small percentage for approximately one-tenth of a second during each second of operation when energizing, for example, radiators 8 and 9 (Fig. 1) simultaneously. This mode of operation causes the pointer of the bearing indicator 15 to pulsatingly increase its deflection by a small percentage for time intervals which are short in comparison to the time during which the correct bearing is indicated. These upward pulsations indicate that the outer scale is to be read. Similarly, when simultaneously operating radiators 8 and 11, the modulating frequency of the transmitter may be pulsatingly decreased by a corresponding small percentage which will cause the pointer of the

bearing indicator 15 to pulsatingly decrease its deflection and thus indicate that the inner scale is to be read. The means for periodically increasing or decreasing the modulating frequency may be by a motor driven rotating capacitor, or such may be accomplished electronically.

The above are only two of many cycles or methods of operations that could be successfully employed utilizing the system herein described. Variations in the cycle or method may require slightly modified transmitters and switching means, but such are so well known to the art as to require no further description here.

In the foregoing, the vertical planes containing radiators 8, 9 and radiators 2, 11 were specified as being located at right angles to each other. This particular configuration is chosen in order that any bearing which may be indicated in the most compressed portion of the scale of the bearing indicator 15 during transmission by radiators 8 and 9 will be indicated again in the most expanded portion of the scale during transmission by radiators 2 and 11. It is obvious that the vertical planes containing the radiators may be located at any desired angle provided that the inner and outer scales of the bearing indicator 15 are calibrated accordingly.

The type of beacon described herein is a true omnidirectional beacon in that the energy radiated during any one radio frequency cycle is equal in all directions. It provides continuous indications of bearing to as many receivers as may be located in all directions from the transmitter. The transmitting equipment is simple, inexpensive, and easily maintained in adjustment, particularly in the respect that careful phasing of the radiating system is not required. The receiving equipment is simple, compact, inexpensive, and easily maintained in adjustment. If the suggested cycle of operation is followed a calibrating signal is received at the receiver at approximately one minute intervals. This type of beacon appears to possess certain desirable features which may recommend its use to replace existing types of 4-course runway localizers and radio range beacons.

Other modifications and changes in the number and arrangement of the parts may be made by those skilled in the art without departing from the nature of this invention, within the scope of what is hereinafter claimed.

The invention described herein may be manufactured and/or used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

Having thus set forth and disclosed the nature of this invention, what is claimed is:

1. In combination, a frequency modulated radio transmitter, a first vertical radiator positioned at said transmitter, a second vertical radiator and a third vertical radiator located in the vicinity of said transmitter, equidistant therefrom, and each positioned on a different radius from said transmitter, said radii being ninety degrees apart, a transmission line for energizing said second vertical radiator, a transmission line for energizing said third vertical radiator, an automatic switch means located at said transmitter, the output of said transmitter being connected to said switch means and to said first vertical radiator, said transmission lines being connected to said switch means, said switch means being operable to connect said transmission lines to said transmitter alternately, whereby said first

vertical radiator is energized continuously and said second and said third vertical radiators are energized alternately, substantially equal energy being radiated in all directions by said radiators, a radio receiver with an audio demodulator, an indicating means responsive to audio frequency being connected to the output of said receiver, said indicating means being calibrated in degrees of true bearing from said first vertical radiator, the output audio frequency of said receiver being a function of its true bearing from said first vertical radiator when energy emitted from said radiators is applied to the input of said receiver.

2. In combination, a frequency modulated radio transmitter, a first vertical radiator positioned at said transmitter, a second vertical radiator and a third vertical radiator located in the vicinity of said transmitter, substantially equidistant therefrom, and each positioned on a different radius from said transmitter, said radii being substantially ninety degrees apart, a transmission line for energizing said second vertical radiator, a transmission line for energizing said third vertical radiator, an automatic switch means located at said transmitter, the output of said transmitter being connected to said switch means and to said first vertical radiator, said transmission lines being connected to said switch means, said switch means being operable to connect said transmission lines to said transmitter alternately, whereby said first vertical radiator is energized continuously and said second and third vertical radiators are energized alternately, substantially equal energy being radiated in all directions by said radiators, a radio receiver with an audio demodulator, an indicating means responsive to audio frequency being connected to the output of said receiver, said indicating means being calibrated in degrees of true bearing from said first vertical radiator, the output audio frequency of said receiver being a function of its true bearing from said first vertical radiator when energy emitted from said radiators is applied to the input of said receiver.

3. In combination, a frequency modulated radio transmitter, a first vertical radiator positioned at said transmitter, a second vertical radiator and a third vertical radiator located in the vicinity of said transmitter, equidistant therefrom, and each positioned on a different radius from said transmitter, said radii being ninety degrees apart, a transmission line for energizing said second vertical radiator, a transmission line for energizing said third vertical radiator, an automatic switch means located at said transmitter, the output of said transmitter being connected to said switch means and to said first vertical radiator, said transmission lines being connected to said switch means, said switch means being operable to connect said transmission lines to said transmitter alternately, whereby said first vertical radiator is energized continuously and said second and said third vertical radiators are energized alternately, substantially equal energy being radiated in all directions by said radiators, a radio receiver, an indicating means responsive to audio frequency being connected to the output of said receiver, said indicating means being calibrated in degrees of bearing from said first vertical radiator.

4. In combination, a frequency modulated radio transmitter, a first vertical radiator positioned at said transmitter, a second vertical radiator and a third vertical radiator located in the vicinity of said transmitter, said second vertical

radiator being located due west of said vertical radiator, said third vertical radiator being located due south of said vertical radiator, said second vertical radiator and said third vertical radiator being equidistant from said transmitter, a transmission line for energizing said second vertical radiator, a transmission line for energizing said third vertical radiator, an automatic switch means located at said transmitter, the output of said transmitter being connected to said switch means and to said first vertical radiator, said transmission lines being connected to said switch means, said switch means being operable to connect said transmission lines to said transmitter alternately, whereby said first vertical radiator is energized continuously and said second and said third vertical radiators are energized alternately, substantially equal energy being radiated in all directions by said radiators, a radio receiver with an audio demodulator, an indicating means responsive to audio frequency being connected to the output of said receiver, said indicating means being calibrated in degrees of true bearing from said first vertical radiator, the output audio frequency of said receiver being a function of its true bearing from said first vertical radiator when energy emitted from said radiators is applied to the input of said receiver.

5. In combination, a frequency modulated radio transmitter, a first vertical radiator positioned at said transmitter, a second vertical radiator and a third vertical radiator located in the vicinity of said transmitter, equidistant therefrom, and each positioned on a different radius from said transmitter, said radii being ninety degrees apart, a transmission line for energizing said second vertical radiator, a transmission line for energizing said third vertical radiator, an automatic switch means located at said transmitter, the output of said transmitter being connected to said switch means and to said first vertical radiator, said transmission lines being connected to said switch means, said switch means being operable to connect said transmission lines to said transmitter alternately, whereby said first vertical radiator is energized continuously and said second and said third vertical radiators are energized alternately, substantially equal energy being radiated in all directions by said radiators, a radio receiver with an audio demodulator, an indicating means responsive to audio frequency being connected to the output of said receiver, said indicating means having an outer scale and an inner scale calibrated in degrees of true bearing from said first vertical radiator, said outer scale being calibrated for use when said first vertical radiator and said second vertical radiator are energized together, said inner scale being calibrated for use when said first vertical radiator and said third vertical radiator are energized together, the output audio frequency of said receiver being a function of its true bearing from said first vertical radiator when energy emitted from said radiators is applied to the input of said receiver.

6. An omnidirectional radio beacon, comprising a frequency modulated radio transmitter, a first radiator positioned at said transmitter, a second radiator and a third radiator located in the vicinity of said transmitter, substantially equidistant therefrom, and each positioned on a different radius from said transmitter, said radii being substantially ninety degrees apart, a transmission line for energizing said second radiator, a transmission line for energizing said third radiator, an automatic switch means located at said transmit-

ter, the output of said transmitter being connected to said first radiator and to said switch means, both said transmission lines being connected to said switch means, said switch means being operable to connect said transmission lines alternately to the output of said transmitter, whereby said first radiator is energized continuously and said second radiator and said third radiator are energized alternately by said transmitter, whereby substantially equal energy is radiated from said beacon in all directions.

7. An omnidirectional radio beacon, comprising a frequency modulated radio transmitter, a first radiator positioned at said transmitter and connected to the output thereof, a second radiator and a third radiator positioned in the vicinity of said transmitter, substantially equidistant therefrom, and each positioned on a separate radius from said transmitter, said radii being substantially ninety degrees apart, means for alternately connecting said second radiator and said third radiator to the output of said transmitter, whereby said first radiator is energized continuously and said second radiator and said third radiator are energized alternately by said transmitter, whereby substantially equal energy is radiated in all directions from said beacon.

8. In combination, a frequency modulated radio transmitter, a first radiator positioned near said transmitter and connected to the output thereof, a second radiator and a third radiator positioned in the vicinity of said first radiator, substantially equidistant therefrom, and each positioned on a separate radius from said first radiator, said radii being substantially at right angles, means including a switch means for alternately connecting said second radiator and said third radiator to the output of said transmitter, whereby said first radiator is energized continuously and said second radiator and said third radiator are energized alternately by said transmitter, whereby said radiators in combination are caused to radiate an omnidirectional pattern of radio frequency having a distinctive and distinguishable characteristic on each separate bearing from said first radiator, a radio receiver responsive to the energy emitted by said radiators, said receiver having an audio demodulator, an indicating means calibrated in degrees of bearing from said first radiator being connected to the output of said receiver, said indicating means being responsive to audio frequency, the output audio frequency of said receiver being a function of its bearing from said radiators.

9. In combination, a frequency modulated radio transmitter, a first radiator positioned near said transmitter and connected to the output thereof, a second radiator and a third radiator positioned in the vicinity of said first radiator and each positioned on a separate radius from said first radiator, means including a switch means for alternately connecting said second radiator and said third radiator to the output of said transmitter, whereby said first radiator is energized continuously and said second radiator and said third radiator are energized alternately by said transmitter, whereby said radiators in combination are caused to radiate an omnidirectional pattern of radio frequency having a distinctive and distinguishable characteristic on each separate bearing from said first radiator, a radio receiver responsive to the energy emitted by said radiators, an indicating means calibrated in degrees of bearing from said first radiator being connected to the output of said receiver,

the output of said receiver being a function of its bearing from said radiators.

10. In combination, a frequency modulated radio transmitter, three radiators disposed on two lines at right angles to each other, one said radiator being common to both lines, means continuously connecting to said transmitter the radiator at the vertex of the angle, means including an automatic switch alternately and cyclically connecting the other said radiators to said transmitter, whereby said radiators in combination are caused to radiate an omnidirectional pattern of radio frequency energy having a distinctive and distinguishable characteristic on each separate bearing from said radiators, a signal receiving means responsive to the energy radiated from said radiators, said receiving means including an audio demodulator, and an indicating means actuated by the audio demodulated output of said receiving means proportionately to a function of the true bearing of said receiving means from said radiators, whereby the said distinguishing characteristic of said omnidirectional pattern may be identified in terms of the true bearing of the said signal receiving means from the said radiators.

11. A frequency modulated radio transmitter, a reference radiator and a plurality of other radiators, means for supplying energy to said other radiators one at a time and for simultaneously supplying energy to said reference radiator, whereby said radiators in combination are caused to radiate an omnidirectional pattern of radio frequency having a distinctive and distinguishable characteristic on each separate bearing from said reference radiator, a signal receiving means responsive to the energy radiated from said radiators, said receiving means including an audio demodulator, and an indicating means actuated by the audio demodulated output of said receiving means proportionately to a function of the true bearing of said receiving means from said reference radiator, whereby the said distinguishing characteristic of said omnidirectional pattern may be identified in terms of the true bearing of the said signal receiving means from said reference radiator.

12. In combination, a frequency modulated radio transmitter, a plurality of radiators located in the vicinity of said transmitter, a transmission line connected to each of said radiators, a switch means operable to connect simultaneously at least two of said transmission lines to said transmitter, whereby said radiators in combination are caused to radiate an omnidirectional pattern of radio frequency energy having a distinctive and distinguishable characteristic on each separate bearing from said radiators, a signal receiving and indicating means, whereby the said distinguishing characteristic of said omnidirectional pattern may be identified in terms of the true bearing of the said signal receiving means from the said radiators.

13. A method of directional signalling by radio which comprises generating frequency modulated oscillations of a high frequency, impressing said oscillations continuously on a first radiator and alternately on a second radiator and a third radiator, said second radiator and said third radiator being positioned in the vicinity of said first radiator, equidistant therefrom and each positioned on a separate radius from said first radiator, said radii being substantially ninety degrees apart, whereby a frequency modulated wave

is emitted continuously from said first radiator and alternately from said second radiator and said third radiator, simultaneously receiving two of said frequency modulated waves in a radio receiver having an audio demodulator, heterodyning said waves in said receiver to produce an audio frequency output wave, the frequency of said output wave being a function of the true bearing of said receiver from said first radiator, and impressing said audio frequency wave on an indicating means responsive to audio frequency, said indicating means being calibrated in degrees of true bearing.

14. A method of directional signalling by radio which comprises generating frequency modulated oscillations of a high frequency, impressing said oscillations continuously on a first radiator and alternately on a second radiator and a third radiator, said second radiator and said third radiator being positioned in the vicinity of said first radiator, equidistant therefrom and each positioned on a separate radius from said first radiator, said radii being substantially ninety degrees apart, whereby a frequency modulated wave is emitted continuously from said first radiator and alternately from said second radiator and said third radiator, simultaneously receiving two of said frequency modulated waves in a radio receiver, heterodyning said waves in said receiver to produce an audio frequency output wave, the frequency of said output wave being a function of the true bearing of said receiver from said first radiator, and impressing said audio frequency wave on an indicating means responsive to audio frequency.

15. A method of directional signalling by radio which comprises impressing frequency modulated oscillations continuously on a first radiator and alternately on a second radiator and a third radiator, said second radiator and said third radiator being positioned in the vicinity of said first radiator, equidistant therefrom and each positioned on a separate radius from said first radiator, said radii being substantially ninety degrees apart, whereby a frequency modulated wave is emitted continuously from said first radiator and alternately from said second radiator and said third radiator, simultaneously receiving two of said frequency modulated waves in a radio receiver, heterodyning said waves in said receiver to produce an audio frequency output wave, the frequency of said output wave being a function of the true bearing of said receiver from said first radiator, and impressing said audio frequency wave on an indicating means responsive to audio frequency.

16. In a radio direction finding arrangement comprising a pair of transmitting systems arranged in predetermined spaced relation to a first point, each of said transmitting systems comprising means to transmit radio waves to a second point over at least two paths the difference between which varies according to the directional angle between the line connecting said first and second point and a fixed reference line, means for equally periodically varying the frequency of the waves radiated according to a predetermined schedule, a receiver located at said second point adapted to produce beat signals from the waves received over the separate paths from each transmitting system, and means for utilizing the beat frequencies to determine said directional angle.