

March 9, 1937.

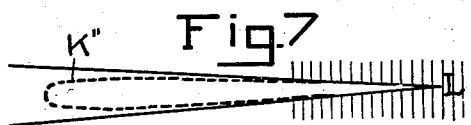
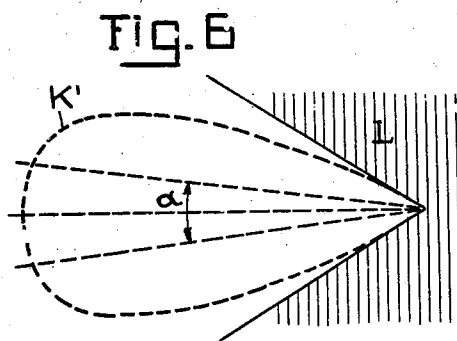
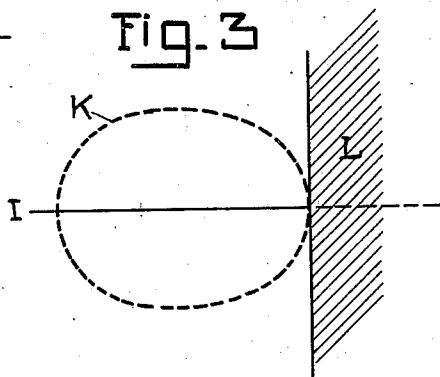
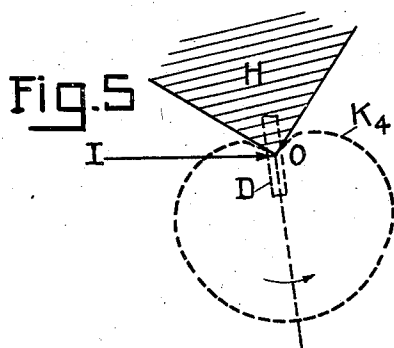
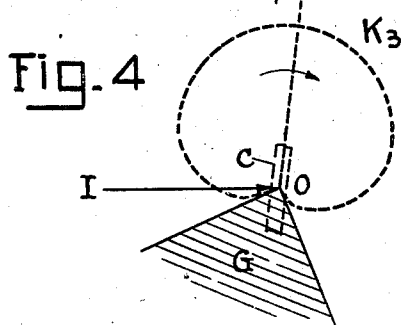
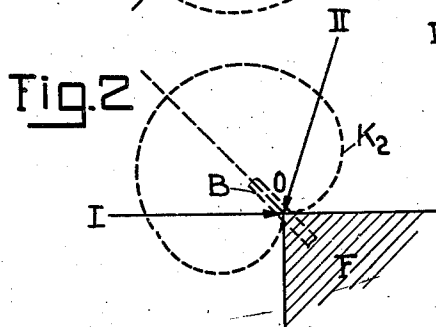
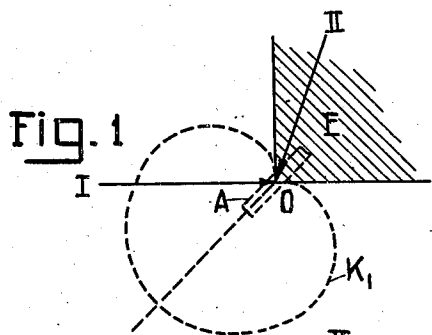
J. PLEBANSKI

2,072,962

RADIO SYSTEM

Filed Sept. 8, 1934

2 Sheets-Sheet 1



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March 9, 1937.

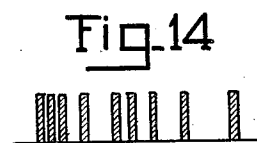
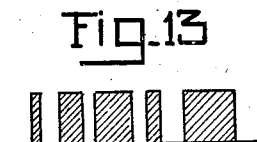
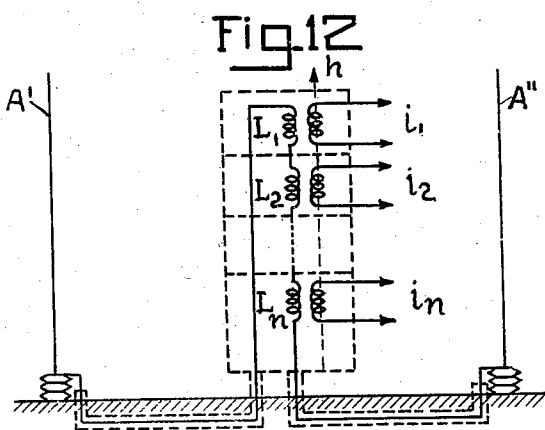
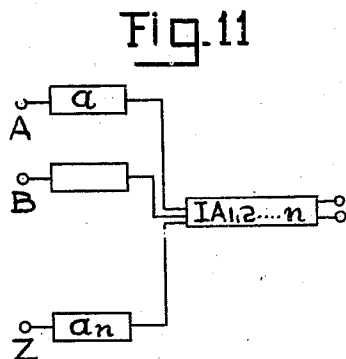
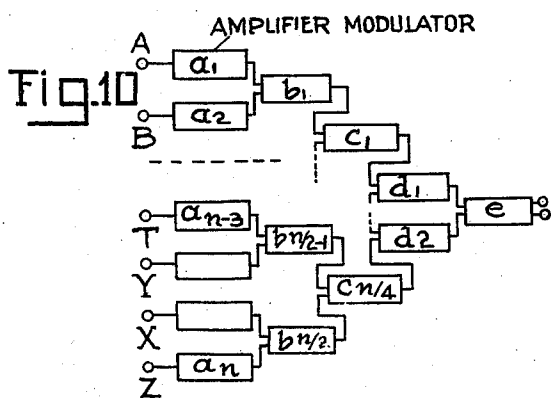
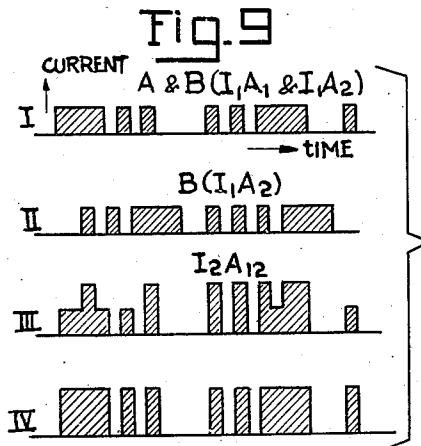
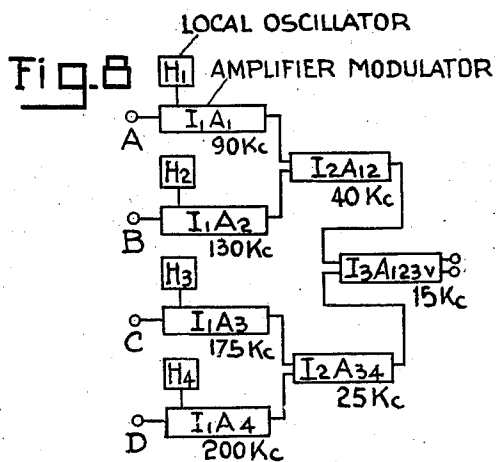
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2,072,962

RADIO SYSTEM

Filed Sept. 8, 1934

2 Sheets-Sheet 2



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2,072,962

RADIO SYSTEM

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16 Claims. (Cl. 250—11)

This invention relates to means and methods of radio communication, more particularly for eliminating interference by directly transmitting and/or receiving wireless signals.

In the known directive systems for transmission and/or reception of wireless signals, usually a plurality of transmitting or receiving aerials are provided arranged in an array and properly spaced from each other for securing a more or less sharply defined directive transmitting and/or receiving characteristic. A disadvantage of these arrangements of the prior art is the fact that the antenna arrangements become very large, sometimes extending over several miles of territory especially for longer wave lengths, resulting in high initial and installation costs.

It is an object of my invention to provide a novel system for directive transmission and/or reception of wireless signals by which a desired sharpness or directive characteristic may be obtained in a simple and easy manner with only little or practically no spacing being required between the aerial systems used.

Another object of the invention consists in the provision of a directive aerial system requiring a single directive antenna with a plurality of associated goniometer arrangements in such a manner that any desired degree of sharpness of the directive transmitting and/or receiving beam in a desired direction may be secured in an easy and simple manner.

Another disadvantage of the known type of directive antenna systems, especially those for longer wave lengths involving large extended aerial arrangements is the fact that it is difficult or impossible to change the transmitting and/or receiving direction of the wireless beam to suit varying conditions of operation.

Accordingly it is a further object of my invention to provide a novel directive transmitting and/or receiving system and method for operating the same whereby the transmitting and/or receiving direction may be varied readily and easily and without the expenditure of excessive apparatus.

Another object of the invention is the provision of a directive antenna arrangement for transmitting and/or receiving wireless signals in which the angle of the directive transmitting and/or receiving beam may be varied at will in an easy and simple manner, thus making it possible for instance to use a wide angle for simultaneous communication with a number of stations and alternatively with a narrow concentrated beam for communication between single stations, thus eliminating interference and securing secrecy of

the communication and increased transmission efficiency.

Still a further object of the invention is to provide a novel directive transmitting and/or receiving aerial system for wireless communication especially adapted for communication by means of "on" and "off" signals such as in the case of telegraphic code transmission, picture transmission, etc., in which disturbances such as signals from an interfering station, atmospheric disturbances, etc. do not affect the spacing characteristics between the signals but merely increase the intensity of the signals in such a manner as to strengthen the signals and, under given circumstances, to improve the volume of reception.

With the above and further objects in view, the invention generally involves the provision of a plurality of differently oriented directive aerial systems all operating at the same signal frequency, and means and methods for combining the signals received by the individual antenna into a common receiving signal. In a preferred form the individual antennae are oriented in such a manner that the non-receiving sectors or angles of the respective polar radiating diagrams are adjoining one another in such a manner as to decrease the resultant receiving angle or sector of the combined antenna system. In an arrangement of this type, as will be described in more detail hereafter, it is seen that a disturbing signal whose direction comes within the non-receiving sector of one antenna and within the receiving sector of another antenna will not destroy the spacing characteristics between the signal impulses especially telegraphic signals or the like, but will merely increase the signal amplitude which may be either compensated, such as by the use of limiting devices, or may be usefully employed to increase the signal strength. As is understood, the invention is applicable to the elimination of both interfering signals of distant stations and to static or other atmospheric or man-made disturbances picked up by the receiving antenna.

As is well known, atmospheric disturbances such as static usually arrive in a preferred direction whereby suppression of such interference is possible by the use of directive antenna systems. However, if both the receiving signals and the disturbance, such as an atmospheric disturbance, arrive in the same direction, no suppression is possible as is obvious. But the latter condition is likely to occur only rarely. Therefore practically the use of directive systems has been found to be the most effective means for eliminating interference preferably of the random character,

such as atmospheric disturbances or similar man-made interference originated from power lines, etc.

The invention has other objects in view which will appear hereinafter in the detailed description thereof in connection with the accompanying drawings in which I have shown several explanatory diagrams and schematic arrangements for carrying out the invention.

In these drawings; Figures 1 to 7 are explanatory diagrams illustrating the directive characteristics in known polar diagram form of the antenna combination used in accordance with the invention.

Figure 8 shows schematically a receiving system according to the invention with an antenna system having characteristics as shown by the previous figures.

Figure 9 illustrates the effect of eliminating interference of telegraphic or similar signals by using a transmitting and/or receiving antenna arrangement of the invention.

Figure 10 shows a general form of receiver in a schematic manner according to the invention.

Figure 11 illustrates a simplification of the receiving organization used in accordance with the invention.

Figure 12 illustrates a preferred type of single directive antenna to be used by the invention in combination with a multiple type goniometer arrangement; and

Figures 13 and 14 illustrate signal forms especially useful in transmission and/or receiving systems and methods according to the invention.

Referring to Figures 1 and 2 of the drawings, I have shown the receiving characteristics k_1 and k_2 in the known polar diagram form of two directional aeriels such as receiving aeriels and having a known cardioid shape with their axis

(A—O and B—O, respectively) oriented as shown to include approximately a right angle. The direction of the desired signals to be received is indicated in both figures by the arrow I—O. From the diagrams it is seen that the antenna of

Figure 1 schematically shown at A, is non-receptive over an angle or sector of approximately 90° as indicated by the cross-hatched area at E while the antenna indicated at B (Fig. 2) has a similar non-receiving sector covering an angle of 90° in a different direction as shown by the cross-hatched portion F.

As is well known, antennae of this type having a cardioid shaped polar transmitting or receiving diagram are well known in the art and for this reason are not shown in detail in the drawings for the sake of simplicity and ease of illustration. Thus for instance, a cardioid shaped polar diagram is obtained by an ordinary loop antenna combined with an open antenna with the loop properly oriented and having its plane coinciding with the desired axis of the cardioid or by a plurality of separately spaced antennae arranged at a proper distance from each other, and/or with the phase of the radiated or receiving waves of the individual antennae properly adjusted, as is well known.

Referring now to Figure 8 of the drawings illustrating schematically a receiving system to be used in combination with a plurality of antennae having receiving diagrams as shown by Figures 1 and 2, it is assumed that the first antenna A (Fig. 1) is connected to a receiver of standard type and construction and that the received wave is changed from the received frequency to an

intermediate frequency I_1A_1 for example being

equal to 90 kilocycles such as by a well known frequency changing system such as by means of a local heterodyne or beating oscillator indicated at H₁. Receiving systems of this nature are well known as super-heterodyne receivers comprising a mixer or frequency changing stage and for this reason have been indicated only schematically as being unnecessary to the understanding of the invention and in order to simplify the illustration in the drawings. It is further assumed that the second antenna B as shown by Figure 2 is similarly connected to a second receiver and that the same receiving signal is changed to another intermediate frequency I_1A_2 such as by means of a second heterodyne or mixer oscillator shown at H₂, this second intermediate frequency being for example equal to 130 kilocycles. As is well known, an incoming frequency may be easily changed into any desired frequency by combination with a local frequency (heterodyne oscillator H₁H₂ etc. . .) in a frequency changing or mixer device such as a mixer tube, the combination frequency being equal to the sum or difference of the mixing frequencies.

The output frequencies from both intermediate frequency stages are then combined in turn in a similar manner to yield a second intermediate frequency I_2A_{12} which in the example given will be 130—90 equal to 40 kilocycles. It is seen that if a disturbing signal arrives in a direction coming within either cross-hatched or non-receiving areas E or F according to Figures 1 and 2, respectively, no intermediate frequency signal shall be produced in I_2A_{12} in both cases since no signal will be received either in the first or in the second case, as is obvious, and accordingly no beating signal will be present in the mixers or frequency changers I_1A_1 and I_1A_2 , respectively.

In the latter case the intermediate frequency amplifier I_2A_{12} shall behave as if the directional characteristic of the entire system combining the aeriels according to Figures 1 and 2 would have a shape K as shown by Fig. 3 from which it is seen that the non-receiving angle has been increased from 90° to 180° (shown by the cross-hatched area L in Fig. 3) with both non-receiving sector areas L and F adjoining and adding each other.

Let it now be assumed that during reception of the desired signals arriving in the direction I—O according to Figs. 1 and 2, an interfering signal arrives in the direction II—O as shown; that is, within the non-receiving angle of the aerial A (Fig. 1) and within the receiving angle of the aerial B (Fig. 2); this disturbing signal will therefore be eliminated by the antenna A (Fig. 1) but will be received by the antenna B (Fig. 2). If in the latter the desired signal is absent, such as during the spacing intervals as in the case of telegraphic code or similar signals, the disturbing signal will be eliminated since there is no second signal present to combine with in the frequency changer or second intermediate stage I_2A_{12} . If the desired signal appears, that is, during the "on periods" of telegraphic code or similar signals, the disturbing signal will also appear in the output of the receiver added to the signal amplitude but without effecting or destroying the characteristic of the spacing intervals between the signalling impulses.

This is seen more clearly from Fig. 9. In this figure, I illustrates the desired receiving signal such as a telegraphic code signal as shown, II represents a similar disturbing signal arriving from an interfering station. Since the inter-

fering signal II cannot produce an effect in the output of a receiver during the spacing intervals of the receiving signal I, as pointed out herein, both signals are added during the "on" or signalling periods and yield a diagram as shown at III in Fig. 9. From this it is clear that the spacing periods and accordingly also the lengths of the signal impulses which in the case of code or similar transmission determines the character of the signals being transmitted, are not destroyed but only the signal amplitudes are strengthened since only during the signalling periods a disturbing signal is beating with the desired signal in the heterodyne or frequency changing stage, as explained before.

The latter effect can however be used to advantage because it increases the desired signal strength as is readily seen and if the output of the receiver is connected to a suitable translating device, for instance such as a sound receiver or a direct current bridge arrangement supplying a recording instrument of any kind, the strengthening effect of the disturbing signal as stated can be useful and advantageous. On the recording tape of the receiver or in the tone reproducer output, the disturbance would not be present due to the usual use of operating or limiting devices employed with such arrangements. The output signals shall therefore have a shape as shown in IV, Figure 9; that is, equal to the desired receiving signal, the effect of the interfering signal having been practically eliminated. The same consideration applies to other disturbing signals of a more random character such as atmospheric disturbances arriving in directions coming within the shaded areas E and F according to Figures 1 and 2. Such disturbances shall also be detected only in the output as long as the desired signal is received; that is during the spacing intervals between the signal current impulses, as is readily understood from the above.

The directive effect and interference elimination by means of arrangements of the type as described can be further increased by providing an increased number of individual antennae with properly oriented directive characteristics such as for instance by combining four antennae having cardioid receiving diagrams k_1, k_2, k_3, k_4 oriented, as shown by Figures 1, 2, 3 and 4, in which case the over-all directional characteristic K' will have a shape as shown in Figure 6 as compared to a characteristic for two antennae shown by Figure 3. It is seen that a characteristic of this type gives substantially equal reception over a definite angle α due to the square top shape of the characteristic shown in the drawings. In order to secure such a characteristic comprising four or more antennae, it is necessary, as shown in Fig. 8, to provide four preliminary frequency changer or heterodyning stages for each antenna $I_1A_1, I_1A_2, I_1A_3, I_1A_4$, in the example shown provided with an individual local oscillator H_1, H_2, H_3, H_4 , respectively, and each beating down the incoming signal to a different first intermediate frequency such as to 90, 130, 175, and 200 kilocycles respectively, as shown in the example. The first two intermediate signals (90 and 130 kilocycles) are then combined in turn, as described above, yielding a second intermediate frequency I_2A_{12} in the example equal to 40 kilocycles while the signals of the antennae C and D in the example shown are combined similarly to produce a second intermediate frequency I_2A_{34} in the example shown equal to 200-175 equal to 25 kilocycles. Then both the second interme-

diate frequency (I_2A_{12} and I_2A_{34}) are combined in their turn in a similar manner to yield a third and final output frequency I_3A_{1234} in the example equal to $40-25=15$ kilocycles which is the final receiving frequency and which serves to operate a suitable translating device (printer, sound receiver) after further amplification and/or detection as is well known in radio receiving systems.

As will be seen, an arrangement of the type according to the invention is easily adapted for varying the directional characteristics by varying the characteristic of either one or more of the individual antennae units. Thus, for instance, if the directional characteristic k_3 of the antenna C as shown by Fig. 4 is rotated in a clockwise direction and the characteristic k_4 of the antenna D shown by Fig. 5 is rotated in an anticlockwise direction as indicated by the arrows in the respective diagrams, the over-all radiating characteristic of the four aerials A, B, C, D (Figures 1 to 4) may be narrowed into a very sharp beam and a characteristic K'' obtained as shown by Fig. 7. The same characteristic may be secured, as is understood, by combining two systems each comprising four aerials and each having a characteristic as shown by Fig. 6. In this case the systems must be displaced so as to leave an angle as desired, say about 10° corresponding to the desired receiving angle as shown by Figure 7.

From the above it is seen that the invention provides easy and simple means for varying the angle or concentration of the transmitting and/or receiving beam to suit various purposes, such as for simultaneous communication to and/or from a plurality of stations coming within the larger sector area of the directive characteristic, or alternatively for communication to and/or from a single station, in which case a very concentrated beam or narrow sector of the directive characteristic may be adjusted.

As is further seen, directive arrangements of the type described are easily adapted for changing the transmitting and/or receiving direction or the opening angle of the directive beam either by turning the loop aerials, if such are used as individual antennae, or if spaced fixed antennae are used, by means of associated goniometer devices well known to those skilled in the art. Due to the reduced dimensions and extension of directive systems of the type according to the invention, the transmitting and/or receiving direction may thus easily be varied without involving the difficulties of extended directive antennae systems heretofore known in the art using spaced antennae and covering extended areas.

As is understood, the system of the invention is not limited to four or eight aerials as described. As many aerials may be used as desired to increase the sharpness or degree of concentration of the directive beam and it is furthermore understood that the directive diagram of the individual aerials may have any desired shape differing from the cardioid diagrams shown for the sake of illustration. It is only essential for the invention that each directive aerial used have a receiving angle or angles and another angle over which the aerial is non-receptive to incoming signals. Figure 10, otherwise being similar to Fig. 8, shows schematically a general receiving arrangement analogously applied to any number n of aerials.

Thus referring to Figure 10, the input terminals of the receivers each to be connected to one of a corresponding number of differently oriented directive aerials are shown at A, B . . . Z. The

received input signals are then changed each to a different first intermediate frequency as by means of frequency changers or mixer stages shown at $a_1, a_2 \dots a_{n-1}$. The thus obtained first intermediate frequencies are then combined in groups of two to secure the second intermediate frequencies in the stages as shown at $b_1, b_2 \dots b_{n/2}$. The thus obtained second intermediate frequencies are then in their turn combined in groups of two to yield third intermediate frequencies $c_1, c_2 \dots c_{n/4}$ which in a similar manner will be combined to secure the fourth intermediate frequencies $d_1, d_2 \dots$ until a single final output frequency e , as shown in the drawings, is obtained.

Instead of using many successive intermediate frequency amplifiers as shown, only one second intermediate amplifier may be used in which n first intermediates are combined. In this case, however, the output of the second intermediate amplifier $I_1 A_{12} \dots n$ (see Fig. 11) must be very selective and chosen so as to be operative only for a combination of all n first intermediates; in other words, it must be inoperative if one of the first intermediates fail. Thus for instance, the separate intermediate frequencies produced by the frequency changers $a_1, a_2 \dots a_n$ in a system as shown by Fig. 11 may be applied to a common mixing circuit such as the grid circuit of a mixer tube with a sharply tuned circuit connected in its anode circuit corresponding to the desired final output frequency. In this manner one intermediate frequency will beat with another to yield a first difference frequency which in turn may beat with another intermediate frequency yielding a second difference frequency, and so forth until a frequency is obtained corresponding to the desired output frequency to which the anode circuit is sharply selective whereby all other frequencies will be filtered out and suppressed.

It is seen that if one of the receiving signals fail, no output signal will be produced or the spacing intervals between the signals will not be effected if a disturbing signal falls at least within one of the non-receiving angles of the individual directive antenna units, as explained herebefore. In case of many first intermediates this is difficult to obtain and therefore it is advisable to use a combination as shown in Fig. 10. The output frequency in any case must be determined by the previous intermediate frequencies in such a manner that if one frequency fails the output is non-responsive.

Since the system according to the invention as described is independent of the spacing of the aeri-als although for mechanical reasons the aeri-als may be spaced if desired, a single aerial may be used for instance in accordance with a further feature of the invention, in the form of a Bellini-Tosi double frame aerial associated with a corresponding number (generally n) of goniometer devices to secure the differently oriented directive characteristics, each goniometer being associated with a separate receiver unit and combined with a vertical antenna if desired. As is well known, goniometer devices as of the Bellini-Tosi type usually comprise a fixed flux carrying member such as an inductance coil connected and definitely oriented in relation to a directive antenna, and a movable flux carrying member such as a movable coil associated therewith whereby the output signal in the movable coil is dependent on its orientation and definitely related to the direction of the incoming signals. In this case a most simplified transmitting and/or receiving arrangement is obtained requiring only a single aerial

and resulting in a substantial saving on the equipment.

According to a preferred embodiment of the invention, a directive antenna system of the known Marconi-Adcock type with associated goniometer arrangements is used, such as illustrated in Fig. 12 in which case only a single pair of aeri-als A' and A'' are required. The movable goniometer coils are shown schematically at $i_1, i_2 \dots i_n$. The movable goniometer coils may be mounted on a common shaft or otherwise coupled mechanically for unitary operation by means of an operating handle as indicated at h . In order to ascertain the relative correct position of movable goniometer coils in respect to the fixed goniometer coils $L_1, L_2 \dots L_n$, the latter may be arranged as to be rotated and shifted in respect to the movable goniometer coils. Using such movable goniometers the operation will be such that the desired signal is tuned on the goniometer equal within 1 to 30° of maximum loudness in accordance with the desired directional characteristic of the system. While in the example shown the goniometers are connected in series with the antennae A' and A'' , they may be connected in any other suitable manner in accordance with the spirit of the invention.

As is understood, it is also possible to associate with the same aerial system a large number of goniometer systems in analogous manner as shown by Fig. 12 in order to receive simultaneously either a plurality of waves on the same frequency arriving in various directions or to receive waves of different frequency coming in from different directions. In this case it is necessary to provide compensation or filtering means of known construction associated with the systems described above to prevent mutual interference of the individual receiving frequencies.

Directive transmitting and/or receiving systems as described above have the curious property to be substantially free from interference arriving from all directions excepting the direction of the desired receiving signal. The greater the intensity of the disturbance, such as static and atmospheric disturbances, the greater the increase of the signal volume. Thus the system according to the invention is both highly directive and at the same time acts as an interference eliminator.

The sharpness of the directional characteristics and the gain in signal to noise level ratio depends to a large extent on the sharpness or definition of the blank receiving angles of the individual antenna units. If it is assumed that the interfering signals or noises arrive simultaneously from all directions and are exactly in synchronism, then the system as disclosed, like any other directive system would give no improvement since the beats between the disturbances would be present in all the intermediate amplifiers (Fig. 8). However, it is well known that disturbances such as static or other shock-like interference of short duration and with random character arrive in most cases from a preferred direction although somewhat indefinite and variable. Thus under practical circumstances the novel systems as described while perhaps not securing the characteristic effects to as high a degree as in the case of the more complicated and extended directive systems known in the prior art, will result in a substantial increase of the signal and noise ratio and considerably improved reception and transmission efficiency. In addition, if the disturbance has not the character of a continuous noise but consists of many shocks

arriving in sequence each from the same or from various directions but not over-lapping each other, then the character of such disturbances may be even useful to the system by increasing the gain and in turn the signal to noise ratio in the receiver. If some of the disturbances overlap each other and if the over-lapping signals fall within the non-receiving angle of any one of the unit antennae, such a disturbance will also be eliminated. If the over-lapping disturbances come from opposite directions which, however, is not very likely to occur except in rare cases, the over-lapping periods may create interference coming within the spacing periods of the transmitting signals. The same applies to more than one disturbing telegraph signal coming for instance both from opposite directions. It is therefore reasonable to assume that the general gain in signal and noise ratio shall be less than exhibited by the directional character but of course substantially higher than the gain for each single unit alone.

The systems described above according to the invention are primarily adapted for reception of telegraph signals where the carrier is interrupted (ICW transmission) and are suited for both long and short waves. However, the invention may also be applied to the transmission and/or reception of telephone or similar transmission, that is, continuous modulation of the carrier wave without the use of current limiting devices in the output stages. Since in transmission of this nature the carrier is always present, the disturbance is not eliminated but the system is also well suited for taking bearings in direction finding with modulated telephone signals.

If it is desired to receive modulated carrier waves with elimination of atmospheric and other disturbances in the manner as described above, a special modulation must be used for the transmission. Thus by using a carrier wave of constant intensity and interrupted periodically according to the modulating frequency such as shown in Fig. 13 (constant amplitude, variable signal length) or as shown in Fig. 8 (constant amplitude and constant signal length but varying frequency), the systems under the invention are suited for reception of modulated carrier waves such as telephony or the like with elimination of atmospheric and other disturbances as is readily understood from the above. Thus the invention is particularly adapted for use in wireless picture transmission in which, on account of atmospheric and other disturbances and difficulties, it is customary to translate the picture signals varying gradually in accordance with varying degrees of light and shade of successive elementary areas of a picture or image to be transmitted, into impulses of substantially equal amplitude but varying duration in accordance with the amplitudes of the original modulating or picture impulses such as shown by Figure 13.

While the invention has been described in connection with the receiving system, it is understood that it equally applies to transmitting arrangements. Thus for instance, by using four directional transmitting aeriels radiating according to characteristics as shown by Figs. 1 to 4 and assuming that by each unit antenna a separate wave length is transmitted, such as for example 90, 130, 175, 200 kilocycles, respectively, as chosen in the example and further assuming that the receiver is provided with four non-directional aeriels A, B, C, D associated with a receiver of the type as shown by Fig. 2 which may be either

of the straight high frequency type or a receiver operated on the super-heterodyne principle and tuned to the respective frequencies 90, 130, 175, 200 kilocycles respectively, it is seen that in this case the whole receiving system shall receive the composite four wave transmission if the receiver is located in the direction of the maximum radiation of the transmitting characteristics which in this case will have a shape similar as shown in Figures 6 and 7.

Systems of the type according to the invention in particular due to the ease and simplicity of adjustment and relation of the directional characteristics, as pointed out hereinbefore, are well suited for use as radio beacons and it is understood that when used as a transmitter a single antenna may be provided with a plurality of associated Bellini-Tosi goniometers similar as described above in connection with the receiver.

The systems of Figures 8, 9, and 10 are also suitable for diversity reception and not only for telegraphy but also for telephone work (modulated carrier). In this case the antennae A, B, C . . . Z (directional or not) must be suitably spaced. The diversity reception is possible because all intermediate frequencies are not dependent from the relative phases in the various antennae.

It can be shown that an intermediate frequency produced by the beats of two modulated carriers shall increase the percentage of modulation and give a distortion (second harmonic of the speech frequency). This distortion can be avoided if the modulation of the received signal is low, or if in the receiving systems of Figures 8, 9, 10 the carrier is increased artificially, or if in one or some amplifiers only the carrier is allowed to pass and the modulation suppressed. In any case, the carrier and the modulation in such diversity system tend to be constant and tend to compensate the fading (not simultaneously occurring in all antennae).

While the invention has been described with specific reference to the accompanying drawings, it is not to be limited, save as defined in the appended claims.

I claim:

1. A directive radio system comprising a plurality of differently oriented directive aeriels each adapted for receiving a common signalling frequency wave; means for changing the individual signalling currents received by said aeriels into secondary currents of different predetermined characteristics; means for combining said secondary currents and deriving a single resultant output current having a predetermined selective characteristic which is a product function of the characteristics of all of said secondary currents; and means for selectively receiving said output current.

2. A directive radio system comprising a plurality of differently oriented loop aeriels adapted for receiving a common signalling frequency wave; means for changing the individual signalling frequency currents received by said aeriels to intermediate currents having different frequencies and combining said intermediate frequency currents to derive a composite output current having a predetermined frequency which is a function of all said intermediate frequencies, and means for selectively translating said output current.

3. A directive radio system comprising a plurality of differently oriented directive aeriels each adapted for receiving a common signalling

frequency wave; frequency changing means connected to said aerials to change the separate signalling currents received by said aerials to intermediate currents of different frequencies; means for combining said intermediate currents to secure a single composite output current having a predetermined frequency which is a product function of all the frequencies of said intermediate frequency currents; and means for selectively receiving said output current.

4. A directive radio system comprising a plurality of differently oriented directive aerials each adapted to receive a common radio signal; frequency changing means for changing the signals received by said aerials into intermediate signals each having a different frequency; means for combining said intermediate frequency signals in groups of two to secure secondary intermediate frequency signals; means for further successively combining said secondary intermediate frequency signals; and means for similarly successively combining the resultant signals to derive a single resultant output signal of predetermined frequency.

5. A directive radio system comprising a plurality of differently oriented directive aerials each having a cardioid shaped directive characteristic and adapted to receive a common radio signal; a plurality of frequency changing means for changing the signals received by said aerials to intermediate signals each having a different frequency; further frequency changing means for deriving second intermediate frequency signals by combination of said first intermediate frequency signals; and means for combining the resultant signals in succession until obtaining a single resultant output signal of predetermined frequency.

6. A directive radio system comprising a plurality of directive aerials each having a cardioid shaped directional characteristic, said aerials being oriented in such a manner that the non-receptive sectors of their characteristics adjoin each other; means for simultaneously receiving a common signal frequency wave by all said aerials; means for differently modifying a characteristic of the current received by said aerials and for deriving a resultant current from all the modified currents which has a predetermined selective characteristic determined by the characteristics of each of said receiving currents; and means for selectively translating said resultant current.

7. A directive radio system comprising a plurality of directive aerials each having a cardioid shaped polar directional characteristic, said aerials being oriented so that the receptive angles of their directional characteristics variably overlap each other; means for simultaneously and separately receiving signals by all said aerials from a single source of radiation; means for differently modifying a characteristic of the signals received by said aerials and for combining the modified signals and deriving therefrom a resultant output current with a predetermined selective characteristic which is determined by the characteristics of each of said modified currents; and means for selectively translating said output current to secure a receiving angle of desired angular spread of the resultant directional characteristic of all said aerials combined plotted with respect to said output current.

8. The method of radio communication by utilization of a plurality of receiving systems having different directional characteristics which

consists in differently modifying a characteristic of the separately received currents and combining the modified currents to derive a resultant current having a selective characteristic which is a function of the characteristics of each of the received currents; and selectively translating said resultant current.

9. A directive radio system comprising a plurality of directional aerials adapted to receive signals from a single source of radiation; means for modifying the signalling currents received by said aerials to have predetermined different characteristics and combining the modified currents into a single composite output current of a predetermined frequency determined by the characteristics of each of said modified currents; means for selectively transplanting said output current; and means for differently orienting said aerials to obtain a desired all-over characteristic by a variable overlap of the individual directional characteristics of said aerials thereby securing a desired angular spread of the resultant directional receiving characteristic of all said aerials plotted with respect to said output current.

10. A directive radio receiving system comprising a directive antenna; a plurality of goniometer devices having primary and secondary coils, said primary coils being connected to said antenna and being differently oriented relative to each other; means for combining the output currents in said secondary coils of said goniometer devices obtained from a common signalling frequency wave received by said antenna to derive a single resultant output current having a predetermined frequency which is a function of all said signalling currents; and means for selectively translating said output current.

11. A radio receiving system comprising a directive receiving antenna; a plurality of goniometer devices each having primary and secondary coils; said primary coils being connected to said antenna for receiving a common signalling frequency wave; means for superimposing the receiving currents in the secondaries of said goniometers to derive a single composite output current of predetermined frequency; means for selectively translating said output current; and means whereby said goniometers produce a cardioid shaped directive characteristic, the primary coils of said goniometers being oriented in such a manner as to secure a resultant all-over directional characteristic of desired shape plotted with respect to said output current.

12. The method of receiving radio signals by utilization of a plurality of receiving antennae having different directional characteristics consisting in changing the received signalling current components to secondary currents of different frequencies, combining said secondary currents into a composite output current having a frequency which is a function of all the frequencies of said secondary currents, and selectively translating said output current.

13. The method of receiving radio signals by utilization of a plurality of receiving antennae having different directional characteristics consisting in modifying the received signal currents to have different predetermined characteristics, combining said modified currents into a resultant current of a predetermined selective characteristic which is a function of all of the characteristics of the modified currents, and selectively translating and receiving said resultant current.

14. The method of receiving radio signals by

utilization of a plurality of receiving antennae having different directional characteristics consisting in heterodyning each of the separately received signalling currents with locally produced oscillations to derive therefrom a plurality of secondary receiving currents of separate predetermined frequencies, and mutually heterodyning said secondary currents to derive therefrom a single resultant current having a frequency which is determined by each of the frequencies of said secondary currents, and selectively translating and receiving said resultant current.

15. The method of radio communication consisting in receiving a plurality of separate electric currents from a single source of electromagnetic waves each of which has a different predetermined relation with the direction of the said electromagnetic waves; differently modifying a

characteristic of the separately received currents and combining the modified currents to generate a resultant current having a selective characteristic determined by the characteristics of all the received currents; and translating said resultant current.

16. The method of radio reception which consists in receiving a plurality of separate electric currents from a source of electromagnetic waves each of which has a different fixed relation with the direction of said waves; changing the separately received currents into secondary currents of different frequencies and combining the secondary currents into a resultant current of predetermined frequency determined by the frequencies of all the secondary currents; and selectively receiving said resultant current.

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