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Time of Request: Wednesday, August 01, 2007 11:59:22 EST
Client ID/Project Name:
Number of Lines: 189
Job Number: 1841:40504151

Research Information

Service: Terms and Connectors Search
Print Request: Current Document: 59
Source: Utility, Design and Plant Patents
Search Terms: inventor(robert /2 rines)

59 of 81 DOCUMENTS

UNITED STATES PATENT AND TRADEMARK OFFICE GRANTED PATENT

2553606

Link to Claims Section

May 22, 1951

Plural image radio locator system

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APPL-NO: 557807 (02)

FILED-DATE: October 9, 1944

GRANTED-DATE: May 22, 1951

PRIORITY: October 9, 1944 - 19440557807, United States (US)

PUB-TYPE: May 22, 1951 - Utility Patent having no previously published pre-grant publication (A)

PUB-COUNTRY: United States (US)

US-MAIN-CL: 342#179

US-ADDL-CL: 315#5, 348#36

CL: 342, 315, 348

SUMMARY:

The present invention relates to electric systerns, and more particularly to radio-receiving systems that, while having more general fields of usefulness, are especially adapted for use in television.

An object of the invention is to provide a new and improved radio-receiving system.

Another object is to provide a novel combined radio-and-television system.

Another object of the present invention is to provide a new and improved radio-locator system for both detecting the presence of a body and rendering it visible.

A further object is to provide a new and improvided system of the above-described character is the arrow B; but not in synchronism with the for obtaining a panoramic view.

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

The invention will now be more fully explained in connection with the accompanying drawings, in which Pig. 1 is

a diagram showing an airplane object from which radio waves are reflected and scattered to a receiving system in accordance with the present invention; Fig. 2 is a diagrammatic view of circuits and apparatus arranged and constructed in accordance with a preferred embodiment of the invention; and Pigs. 3, 4 and 5 are views of modifications.

An electromagnetic wave generator 4 is shown go therefore, a horizontal element of the airplane exciting a dipole 21 to produce ultra-high-frequency pulsed-radio energy, say, of 3 or 1.5 centimeters wave-length. A continuous-wave or any other type of modulated-wave generator may be lsed energy, at present, has the gg energy losses through the opening advantage of economical and easy high-power ultra-high-frequency generation.

The waves emitted by the dipole 2 may be employed.

directed by a reflector 3 upon a parabolic reflector 6. The parabolic reflector 6 is shown directing the waves in any desired direction, for example, toward an object, say, an airplane 8, from which they are reflected and scattered toward a receiving station.

At the receiving station, the radio waves thus reflected and scattered from the object 8 may be focused by an electromagnetic dielectric lens 5, such as polystyrene, upon a closed-ended resonant-cavity cylinder circular wave-guide 7. The dielectric lens 5 may be replaced by any other type of well-known lens, mirror or other directive system for focusing the electromagnetic energy scattered or reflected from the object 3 on the cavity cylinder 7.

The resonant-cavity cylinder 7 is provided with a longitudinally extending slot 10. The cylinder 7 is disposed to rotate axially on bearings within a concentrically arranged outer cylinder 12. The outer cylinder 12 may be supported upon semi-circular roller bearings, not shown in order to simplify the drawings. The cylinder 12 is provided with a plurality of sets of slots 14, 16, 18, and 22, the slots of each set, being helically disposed along the cylinder 12. The rotation of the cylinder 7 is effected in the direction of the arrow A by means of a synchronous motor 24, driving a shaft fixed to one of the ends of the cylinder 7. A motor 26 similarly rotates the cylinder 12 in the same direction, indicated by rotation of the cylinder 7.

Assuming, for the moment, the cylinder 7 to be stationary, and the cylinder 12 to be rotating, the radio waves reflected from the airplane 8 will enter the resonant chamber 7 at successively spaced positions along the slot 10, through the slots 14, 16, 18, 20 and 22.

As a result of this construction, therefore, during the rotation of the cylinder 12 through an ans!e such that the slots 14, 16, i8, 20 and 22 become successively aligned with the slot 10, radio waves reflected or scattered from the object 8 will be focused by the lens 5 at succesive positions along the slot from right to left. In effect, object 8 will become scanned along the slot during this part rotation of the cylinder t2.

Preferably, the cylinder 7 may fit more or less snugly within the cylinder l, to prevent To the same end, the slot 10 may be made quite narrow, consistent with the dimensions and frequencies The slots 14, 16, 18, and 22, of course, will all directly receive the reflected or scattered radio waves through the lens simultaneously. Only that one of these slots at a time, however, that is aligned with the slot 10 will permit focused radio waves to enter the resonant chamber 7 through the slot 10. The respective slots 14, 16, 18, and 22 will each thus permit the entry into the resonant wave-guide chamber 7 through the slot 10 of a radio-frequency voltage corresponding to the scattering from a corresponding region of the object 8. The slots 14, 16, 18, and 22 will thus receive different field strengths of radio energy, corresponding to the amount of energy reflected or scattered from the various parts of the elemental regions of the object 8 and converged upon them by the lens 5.

The energy thus received in the resonant chamber 7 is picked up by a probe or other antenna 30, which constitutes an extension into the chamber 7, through the other end thereof, of the inner conductor 34 of a coaxial line, the outer conductor of which is shown at 32. This coaxial line is bent at right angles to provide a right-angularly extending coaxial-line leg, the outer conductor of which is shown at 36 and the inner conductor at 38. The coaxial line 32, is fixed to the cylinder 7 so as to rotate axially therewith. The coaxial-leg extension 36, 38, therefore, rotates in a plane at right

angles to the axis of the cylinder 1. The inner conductor 38 of the coaxial-leg extension projects beyond the outer conductor 38 to engage, during its rotation, a plurality of circularly arranged contact members, one of which is shown at 40. The contact member is connected, by an inner conductor 42 of a further coaxial line, to an amplifier 46, to which is connected also the outer conductor 44 of the further coaxial line. The amplifier 46 feeds to a rectifier 48. The rectifier 48 is connected by a conductor 85 to the control electrode 92, and by a conductor 87 to the cathode 94, of the electron-gun part 88 of a display oscilloscope 90. It will be understood that all the outer conductors of the before-mentioned coaxial cables have a common connection to ground (not shown).

Electrons emitted from the cathode 94 will become enabled in response to the action of the amplifier48 and the rectifier 48,to pass by the control grid 92 toward the anode 86 of the tube electrongun 88 of the oscilloscope 99. The electrons will continue to travel in a stream from the anode 96, between a pair of vertically disposed deflector plates 98 and (00, and between a pair of horizontally disposed deflector plates 102 and 104, to impinge finally on the fluorescent viewing screen 108 of the oscilloscope 90. A horizontal-sweeptime base applied to the horizontally disposed de-

Sector plates 98 and I OB will cause the electron stream from the cathode 94 to become deflected horizontally. The horizontal sweep will become brightened by the energy fed from the amplifier 46 and the rectifier 48 to the control grid 92 of the oscilloscope. Successive energizing voltages are thus produced from the amplifier 46 and the rectifier 48 on the control electrode 92 of the no electron-gun part 88 of the cathode-ray-tube 90, of magnitude proportional to the radio-frequency energy received by the corresponding aligned slots. This will permit the passage of the electrons, in quantities dependent upon the radiofrequency energy in the corresponding aligned slots to the anode 9S, and between the pairs of deflecting plates 98, and 102, 104, to the viewing screen I OS. A visible picture 123 will thus be produced upon the fluorescent viewing oscill scope screen 106 of the horizontal scanned line of the airplane.

The above description has proceeded upon the assumption that the cylinder 7 is stationary during the rotation of cylinder 12. As the cylinder 7 also rotates in the direction of the arrow A, however, though at a much slower speed, the-slot will assume successively lowered positions, thus effecting a scanning of successively lower horizontal elements of the airplane 8.

The vertical-sweep-time base applied to the horizontally disposed deflector plates 102 and 104 will cause the electron stream to become defleeted vertically as the slot 10 becomes gradually lowered. Successively lowered horizontal IK

sweeps, graded in intensity corresponding to horizontal elements of the airplane 8, will thus be produced on the oscilloscope screen. The radioenergy picture of the airplane 8, focused by the lens 5 upon the cylinders 7 and I2, therefore, will thus become converted into a visible picture or likeness 123 of the airplane upon the screen Though only five slots 14, (6, !8, and 22 are shown in each set of slots on the cylinder 12, and though only two sets of these slots are illustrated, it will be understood that this is in order to simplify the drawing, and that, in practice, there will be many sets of these slots; say, as many as fifty sets, more or less; and that there will be many more than five slots in each set; say, as many as. two hundred, more or less; all depending upon the dimensions of the cylinders and the frequencies of the radio waves employed. In order properly to excite the cavity 7, the frequency of the radio waves should preferably correspond to the resonant frequency of the cavity.

Preferably, moreover, the length of each of these siots may be one-quarter of the wave-length corresponding to the frequency employed. Another probe like the probe 30 may then similarly be employed at the other end of the cylinder 7, so that if there are the proper number of slots in each set, the probes will receive the radiation,allowed in the resonant chamber 7, in phase, and the two signals may be added into the amplifier & lt;jg as shown in Fig. 3.

This additional probe SO may be connected by means of a coaxial cable comprising an outer conductor 52 and an inner conductor 54, to join with the coaxial line 38, 3?, so that the additive energy is fed through the contact member by coaxial line 42, 44 to the amplifier 46.

A pulse generator 65may be employed to trigger the horizontal time-base-sweep circuit S3 and a further pulse generator 64 may be employed to trigger the vertical-sweep circuit 69, according to conventional and well known television technique.

For example, the pulse generators may be peak oscillators or, more specifically, free-running unbalanced multivibrators. The frequency of the generator should be adjusted to correspond to the period in which a set of slots Ifl, !B, 18, a a and 22 completely scans the longitudinal slot A horizontal, time-base sweep will thereby be produced between the vertically disposed defleeter plates 98 and 108, corresponding to each horizontal scan of the slot by the sets of slots 14, (6, 18, and 22:

The period of the vertical sweep between the horizontally disposed deflector plates 102 and 104 should correspond to the period in which the slot itself scans, in a vertical sense, the radioenergy picture focused upon it by the lens 5.

flo This may be accomplished by adjusting the frequency of the pulse generator 64 to correspond to the period in which the slot 10 scans the field converged by the lens 5.

The visible picture 123 of the airplane object 8 on the fluorescent screen (06 will accordingly correspond to the radio-frequency picture on the cylinders 7 and 12 which, in turn, corresponds to the actual object 8.

The above description has proceeded upon the assumption that the airplane object 8 is in a position such that the radio waves reflected or seattered therefrom will pass through the lens 5, rigidly fixed in space. It will now be explained how to obtain a panoramic view.

If it be assumed that the airplane object is in a widely different elevation in space, so that the radio waves reflected or scattered therefrom would travel to the receiving station through a different lens, say, the lens 105, the operation escribed would be precisely the same, pro- g connected by conductors vided that the coaxial-line leg extensions 36, 38 were to make contact with another contact member connected, through the same amplifier 46 or a different amplifier (not shown, for simplicity), and the same rectifier 48 or a different rectifier (not shown), to another oscilloscope !90, in a manner similar to the connection to the oscilloscope 90. Similarly, if the object 8 were in still a widely different direction in space, such that the radio waves reflected or scattered therefrom were to reach the receiver through another lens 205, the operation would still be the same, provided that the coaxial-line leg 36, 38 were to be connected to a contact member connected, in turn, to still another oscilloscope 290. The receiver 7, 12 is effective along the direction of the lens 5 when the slot ! 0 occupies angular positions corresponding to that general direction; and it is effective along the direction of the lens !0 when the slot 10 is scanning the waves focused upon Z5 circuits for the separate oscilloscopes. Where a it through that lens !Q5, and so on from, for example, the horizon through the zenith to the oppositely disposed horizon. Eight lenses are illustrated in the drawings, supported by an insulating frame 35, and eight contact members, eonnected similarly to eight oscilloscopes. The more lenses that are used in this manner, and the more contact members and oscilloscopes, the finer the detail of the images viewed on the screens of the se considerations, however, B5 connected to the same inner conductor must be balanced against the fact that the dimensions of the dielectric lenses should not be too small compared to the wave-lengths employed.

The same receiver is shown employed with all the dielectric lenses, and all the contact members and oscilloscopes. As the slot 10, during the rotation of the cylinder 7, scans, in a vertical direction, the fields of the successive lenses 5, i05, 205, etc the wave energy received through those lenses, as the cavity cylinder 7 is horizontally scanned by the slots 14, 16, 18, and 22, is fed through the respective contact members 40, 140, 240, etc to the respective oscilloscopes. Through the medium of these contact members, the respective oscilloscopes are selectively connected to the receiver 7, 12, when the slot 10 occupies corresponding angular positions. The resonantcavity receiver 7, therefore, during each revolution thereof, is adapted to receive radio waves from objects in widely different directions, to produce simultaneously likenesses of the objects J a flange in these different directions, and simultaneously to display these likenesses on the screens of the respective oscilloscopes.

When the airplane objects 8 occupy widely dif- to fall within the spirit and scope of the invenferent elevations in space, however, it may be that the waves transmitted from the dipole 2 that might reach one of the airplanes, might not reach another. It is desirable therefore, that the dipole 2, and the reflector 6 in which it is co tained, be rotated in synchronism with the cavity resonator 7. In this manner, the direction of the waves propogated from the reflector 6 will correspond instantaneously to the momentary angular position of the slot 10. This may readily be effected by driving the dipole 2 and its reflector 6 from the same motor 24 that drives the cavity resonator 7 or, as shown, by means of a separate synchronous motor 25, operating in synchronism with the motor 24.

In that event, it may be desirable to connect the dipole 2 to the generator fl by means of slip rings 27, to which the generator 4 is connected by conductors 29, and to which the dipole 2 is in a horizontally disposed hollow insulating shaft, rotated by the motor 25, and on which the reflector ft is mounted for rotation in a vertical plane.

It may be desirable that the inner cavity 7 rotate at a high rate of speed, so that the complete field converged by the system of lenses be scanned rapidly. The outer cylinder 12 must then rotate at an even more rapid rate, to effect horizontal scans of the slot (0. In this manner the slot may, for all practical purposes, be regarded as relatively stationary during a horizontal scanning operation.

For simplicity, only a single oscilloscope is shown in Fig. 2. It will be understood, however, that the pulse generators 64 and and the sweep circuits 63 and 69 will preferably be connected to the remaining oscilloscopes in parallel with the oscilloscope 90. Obviously, it is not necessary to employ separate pulse generators and sweep single set of sweep circuits is employed, the bias on the control electrodes of all the oscilloscopes, except one at a time, will prevent the sweeps from appearing except on that one oscilloscope at that time.

According to the modification of Fig. 5, all the likenesses of all the airplane objects may be shown upon a single oscilloscope 106. The contact members 40, 140, 240, etc. are shown all of the coaxial line 42, 44 that is connected to the amplifier 46. The only further change necessary is to readjust the period of the pulse generator 64 and the vertical-sweep circuit 69 to correspond to the period in which the slot 10 scans the fields converged by the complete system of lenses. Different vertically-positioned areas of the screen will therefore correspond to the scanning of the fields converged by the different lenses The different areas correspond to the different screens of the other figures.

It is desirable to have the panoramic view in all widely different directions of azimuth. To the attainment of this end, the system of lenses, the receiver 7, 12, the dipole 2 and its reflector 6 are shown in Fig. 4 mounted upon a large platform 37, rotatable about a vertical axis through the receiver. The platform 37 may be manually or motor rotated in any desired manner. To facilitate this, rollers 39 are shown mounted on beneath the platform 37, and resting upon a circular rail 43.

Further modifications will occur to persons skilled in the art, and all such are considered tion, as defined in the appended claims.

LOAD-DATE: November 14, 2005

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Time of Request: Wednesday, August 01, 2007 11:59:22 EST

Print Number: 1841:40504151
Number of Lines: 189
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