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December 9, 1958

Electric system

INVENTOR: HARVEY RINES ROBERT

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SUMMARY:

The present invention relates to electric systems, and more particularly to radio-receiving systems that, while having more general fields of usefulness, are especially adapted for use in television. The present application is a division of application, Serial- Number 527,375, filed March- 18, 1944.

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

Another object is to provide a new and improved 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.

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 Fig. 1 is a diagrammatic view of circuits and apparatusarranged and constructed in accordance with a preferred embodiment thereof; Fig. 2 is a view of a modification; Fig.- 3 is a diagram showing an airplane object from which radio waves are reflected and scattered to the receiving system of Fig1. 1; and Fig. 4. is a view of further modification.

An electromagnetic-wave generator 4 is shown exciting a dipole 2 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 employed, but pulsed energy, at present, has the advantage of economical and easy high-power ultra-high-frequency generation.

The waves emitted by the dipole 2 may be directed by a reflector 3 upon a parabolic reflector 6. The parabolic reflector 6 is shown directing the waves toward an object, say, an airplane 8, from which they are r fleeted 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 bank or array 7 comprising a plurality of radioreceiving pick-up unit antenna elements. The dielectric lens 5 may be replaced by any other type of well-known lens,, mirror or other directive system for focusing the electro-magnetic energy scattered and reflected from- the object 8 on the bank or array 7 of pick-up elements.

The pick-up elements of the bank or array 7 are shown arranged in two dimensions in the form of rows and columns, in the proximity of the focal plane of the lens 5; The first or uppermost row of the bank is illustrated as comprising the sections 10, 12, 14, 16, etc shown, as equally spaced horizontally. The second row from- the top is shown comprising the sections 18, 20, 22, etc. The third or next-lower row is shown comprising the sections 24 26; etc and so on for the remaining rows of pickup elements. Though only a small; number of pick-up units isi shown in each row,,this is. merely for illustrative purposes, in order not to confuse the disclosure. It will patented Dec. 9, less 18i 24> etc-> are arranged in the first The sections 12, 20, 26, etc are disposed in the second column from the right. The sections I4-, 11, etc are disposed in the third column ftoml the-right. and so on_ There may be as many- col.

umns as there are pick-up units in each row. Though each column is shown as comprising only a few pick-up units; this is again in order not to complicate the drawings.

Tfie pick.up. units willi of C0urse> all receive fhe re_

simulradio-frequency energy of a voltage corresponding to the scattering from a corresponding view of the object 8.

The pick-up elements will thus receive different field strengths of radio energy, corresponding to the amount of energy reflected or scattered from the various parts of the object 8 and converged upon the array 7 of pickup elements by the lens 5. A radio-energy picture of the object 8, as will presently be explained, is thus recorded upon the array, specific elemental areas of which will correspond to specific elemental areas of the object 8. By means of the present invention, this radio-energy picture may be converted into a visible picture 123. According to the preferred embodiment of the invention, the visible picture 123 is caused to appear upon the fluorescent viewing screen 106 of a display cathode-ray oscilloscope tube 90. Though the tube 90, and also the herematter described cathode-ray oscilloscope-like member 89, are shown operating on the electrostatic principle, magnetic deflection or a combination of magnetic and electrostatic forces may be employed. The invention provides; a means for producing upon the screen 106 images corresponding to the radio frequency energy received by the pick-up elements.

Provision is made for first rendering the normally ineffective pick-up units 10, 12, 14, 16, etc of the first row successively effective momentarily in the display circuits; for then rendering the pick-up units 18, 20, 22, etc of the second row successively effective momentarily; for then rendering the pick-up units 24, 26, etc of the third row successively effective momentarily; and so on, the pick-up units thus being rendered effective in two-dimensional order.

The pick-up units are shown arranged in an insulating disc, bank or array 9, at the screen end of the oscilloscopelike member 89, and the pick-up units may be consti0 tuted of small crystal beads of uranium oxide insulatingly set into the support disc 9. Any similar mosaic of radiowave absorbing and rectifying crystals such as silicon, for example, may be employed. The beads 10, 12, 14, 16, etc. of the first row are all connected to a grounded strip 43. The beads 18, 28, 22,

etc of the second row are similarly shown all connected to another grounded strip 51. The beads 24, 26, etc of the third row are similarly shown all connected to a third grounded strip 57, and so on.

The cathode-ray-oscilloscope-like member 89 is shown provided with a cathode 95, a control-grid electrode 93 and an anode 97. Electrons emitted from the cathode 951 will become enabled, in response to proper stimulatiori of the grid 93, to pass by the grid 93 to the anode 97 of the member 89. The electrons will continue to travel in a stream from the anode 97 between a pair of vertically disposed deflector plates 99 and 101, of which the plate 99 is shown grounded, and between a pair of horizontally disposed deflector plates 103 and 105, of which the plate is shown grounded, to impinge finally on the disc 9 of the member 89: A- horizontal-sweeptime base, applied, as hereinafter more fully explained, -3 .

to the vertically disposed deflector plates 99 and 101, will cause the electron stream from the cathode to become deflected horizontally, and a vertical-sweep-time base, applied to the horizontally disposed deflector plates 103 and 105, will cause the electron stream to become de- 6 . fleeted vertically. The rows of pick-up -units may be positioned along the successive paths of the electron stream so that the stream can impinge on them as the electron stream successively sweeps out the successive rows of the array 7. The front surface of each crystal pick-up element is exposed in the direction of the incoming radio waves, and the rear surface of each element is exposed within the cathode-ray-tube member 89 to the electron stream.

If, accordingly, the lens 5 is caused to focus the radioenergy picture on the oscilloscope-like member 89, the bank of uranium-oxide globules will act to absorb the incident energy. Silicon and uranium oxide detectors and similar crystals are known to absorb radio-frequency energy, and to exhibit negative temperature coefficients of resistance. Because of its high temperature coefficient of resistance, the resistance of the uranium oxide will change with the intensity of the impinging radio-frequency energy.

The radio-frequency energy will become rectified to produce direct-current potential differences across the resistance of the uranium oxide. This results from the detecting properties of the uranium oxide in the radioreceiving circuits traceable from the crystal electrodes through the crystals to the grounded conductor 78. These potential differences are representative of the radiofrequency energy impressed on the uranium oxide in the radio-receiving circuits comprising the uranium oxide units and the ground conductor 78. The variations of resistance and potential along the bank of globule beads are thus a measure of the radio-frequency energy impinged on the array by the lens 5. The resistance of the uranium oxide, since its temperature coefficient is negalive, changes with the intensity of the impinging radiofrequency energy. The resistance variation thus also produced along the bank of uranium-oxide beads is representative of the radio-frequency energy received by the respective beads.

A radio-energy image of the object 8 becomes thus recorded upon the array of uranium-oxide beads.

The bank of uranium-oxide globules may be scanned according to either of two principles or according to a combination of the same. One principle involves measuring the variation in the resistance of the bank at the moment that the electron stream impinges upon the suecessively disposed beads to short-circuit them. This provides a measure of the resistance across the uraniumoxide beads, indicative of the radio-frequency energy impinged on the particular bead upon which the electron stream has impinged. The other principle involves measuring in the amplifier 79 the current along the electron stream as it impinges upon areas of different potential of the variably resistive beads, completing the circuit to the ground through the successive crystals by way of the conductor 78.

Each uranium-oxide bead will absorb and rectify the radio-frequency energy. Dependent upon the magnitude of this energy, it will change the resistance of the uranium oxide. This change will result as a consequence of the absorption and the rectifying action by the uranium gg The period of the oscillations which, as previously exoxide of the radio-frequency energy received by it. As the electron stream successively impinges upon the suecessively disposed uranium-oxide beads, during the scanning, it successively measures the resistance of the successive crystals. This produces a corresponding change in the input voltage to a grounded preferably linear amplifier 79, indicative of the

radio-frequency energy impinged on the respective uranium-oxide beads.

The scanning of these crystals may obviously also operate on the principle of change in electron-beam current upon impinging on surfaces of various potentials. As the stream hits these crystals of different potentials, a change in beam current occurs, which manifests itself in the input circuit of the amplifier 79.

Mosaics of silicon, as shown in Fig. 1, or alternate sections of silicon and metal, as shown in Fig. 4, or dielectric and silicon, may be mounted in the disc 9 of the oscilloscope 89, and may similarly be used as a scanning mosaic.

Radio-frequency energy impinged on the metal sections 200, 202, etc will produce rectified voltages across the adjacently-disposed silicon sections 201, 203, etc in the radio-receiving circuits traceable from the metal sections through the adjacently disposed silicon sections by way of the common lead 78. The rectifying sections of silicon may follow the square law in their response, but this can be compensated for by proper design of the amplifier 79 (page 492 of "Ultra High Frequency Techniques," by Brainerd, Koehler, Reich and Woodruff, 1942 edition).

The exposed silicon sections will also absorb radio energy and exhibit a negative-resistance effect. The electron scanning of the successive silicon sections will thus operate, as before described, to measure the resistance variation of the sections, or the change in beam current upon impinging on sections of different potential, or according to a combination of the two principles.

As the electron stream produced from the cathode 95, in response to appropriate horizontal sweep-time-base voltages applied to the vertically disposed deflector plates 99 and 101 of the cathode-ray-tube-like member 89, travels across the pick-up elements in the disc 9, they will successively discharge into the amplifier 79, by way of a conductor 78. If desired, the amplifier 79 may be replaced by a bank of linear amplifiers, one corresponding to each of the pick-up elements.

The output of the amplifier 79 will obviously vary, at successive instants, in accordance with the radio-frequency energy received by the successive corresponding pick-up elements.

A pulse generator 40 may be employed to trigger a horizontal-time-base-sweep circuit 63 and a verticalsweep circuit 69, according to conventional and wellknown television technique. The pulse generator may feed, through an attenuator and rectifier 1, to an oscillator or any similar or equivalent television circuit. One such circuit is shown as a pulse-recurrence-frequency multiplier 65, for applying many pulses corresponding to each radio-frequency pulse for the period between successive radio pulses, to trigger the horizontal-sweep circuit 63. The horizontal-time-base sweep will thereby be produced between the vertically disposed deflector plates 99 and 101, occurring as many times, say, between successive radio-frequency transmissions, as there are rows of pick-up antennas. The pulse generator may also feed, through the attenuator and rectifier 1, to trigger the vertical-sweep circuit 69, once corresponding to every radio-frequency transmission. One vertical sweep will then occur between the horizontally disposed plates 103, 105 during the period between successive radio-pulse transmissions, corresponding to as many horizontal sweeps as there are rows of antennas, causing each of the horizontal sweeps to appear at successively lower levels on the oscilloscope-sweep face.

If the circuit 65 comprises an oscillator, the oscillations may be employed to trigger the horizontal sweep.

plained, is much less than the duration of each radiopulse, corresponds to the time of sweep across one row of the pick-up units in the disc 9. If, as previously mentioned, continuous-wave radio transmission is employed, the vertical sweep circuit 69 may be triggered to produce one vertical sweep corresponding to as many horizontal sweeps from the horizontal-sweep circuit 63 as there are rows of receiving units.

Means is provided for producing upon the screen 106 of the display oscilloscope 90, images corresponding to.

the radio-frequency energy received by the corresponding p?ck-up mosaic antenna elements. The screen 106 is

illuminated by an electron stream in the oscilloscope 90.

This electron stream is synchronized to travel with the electron stream of the cathode-ray-like member 89. The horizontal-sweep circuit 63 is connected to the horizontaldeflector plate of the oscilloscope 90, by a conductor 67, and to the horizontal-deflector plate 101 of the oscilloscope-like member 89 by the conductor 67 and a conductor 124. The vertical-sweep- circuit 69 is connected to the vertical-deflector plate 102 of the oscilloscope by a conductor 71, and to the vertical-deflector plate 103 of the oscilloscope-like member 89 by the conductor 71 and a conductor 146.

The amplifier 79 is connected, by eonductdrs 84 and 86, to a phase-inverter stage or stages 81 which, in turn, are connected, by conductors 83 and87, to the controlgrid electrode 92 and the cathode 94 of the oscilloscope 90. The mosaic beads become thus successively connected, through the amplifier 79 and the phase inverter 81, to the control electrode 92. Electrons emitted from the cathode 94 will become enabled, in response to the action of the amplifier 79 and the phase-inverter 81, to pass by the grid 92, to the anode 96 of the oscilloscope tube 90. The electrons will continue to travel in a stream from the anode 96, between the pair of vertically disposed oscilloscope deflector plates 98 and 100, of which the plate 98 is shown grounded, and between the pair of horizontally disposed oscilloscope deflector plates 102 and 104;. of which the plate 104 is shown grounded, to impinge finally on the fluorescent viewing screen 106 of the oscilloscope 90; The horizontal-sweep-time base applied to the vertically disposed deflector plates 98 and 100 will cause the electron stream from the cathode 94 to become deflected horizontally, and the vertical-sweeptime base, applied to the horizontally disposed deflector plates 102 and 104, will cause the electron streanr to become deflected vertically, in synchronism with the horizontal and vertical sweeps scanning the mosaic 7 of the oscilloscope-like member 89.

After each simultaneous horizontal sweep of both the oscilloscope and the oscilloscope-like member 89 has been completed, a successively larger voltage will be applied to the horizontally disposed deflector plates 103, 105 and 102, 104, respectively, by the vertical sweep ci cuit. After the last such horizontal sweep, the voltage between the horizontally disposed plates 103, 105 and 102, 104 will become restored to zero. The next horizontal sweep, therefore, will start again at the first or top row.

Successively disposed areas of the screen 1G6 of the oscilloscope will therefore correspond to the similarly disposed mosaic-antenna sections in the disc 9 of the member 89. Each spot along a particular horizontal sweep, therefore, will become brightened on the_ screen gg perature coefficients of resistance when exposed to radio 106 according to the amount of radio energy received by the corresponding pick-up elements, and fed, by way _ of the amplifier 79 and the phase-mverting-and-amphfying circuit 81, to the control electrode 92 of the cathode-ray oscilloscope 90.

A more sensitive video signal device might be _any well-known resistance-measuring circuit, such as a bridge detector of, say, the Wheatstone construction. If the uranium-oxide or other crystal globules have their resistances connected in a direct-current series circuit, then 6g the bank of crystals may serve as an extremely sensitive radio-detecting element of a Wheatstone bridge, in which they may be balanced against fixed elements 212, 214 and 216, as shown in Fig. 2. The short-circuiting of each successive globule or resistance by the electron stream, diagrammatically shown as short-circuiting switches 205, 207, 209, 211, in parallel with the globules 204, 206, 208, 210, would thus be markedly indicated in the amplifier 79 and fed to the control electrode 92 of the display oscilloscope 90.

Although the invention has been described in connectipn: with mosaic-antennas arranged in rows and columns, it will be understood that this is not essential, for other arrangements are also possible. Antennas arranged along concentric circles covering the field, or a continuous spiral, will also serve, though the oscilloscope arrangement would, of course, be correspondingly modified, as is well-known in the art, to render successive circles of the receiving units successively effective, in twd-dimensional order.

Further modifications will occur to persons skilled in the art, and all such are considered to fall within the spirit and

scope of the invention, as defined in the appended- claims.

ENGLISH-CLAIMS:
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What is claimed is:

1. A mosaic of absorbing and rectifying radio-receiving elements having negative temperature coefficients of resistance, the resistance of the elements varying in accordance with the radio waves received thereby.

2. A mosaic comprising a two-dimensional array of uranium-oxide radio-receiving elements for detecting a two-dimensional distributions of radio waves.

3. A mosaic comprising a two-dimensional array of alternately disposed silicon and metal radio-receiving elements for detecting a two-dimensional distribution of radio waves.

4. An electric system having, in combination, a mosaic of radio-wave absorbing and rectifying elements having negative temperature coefficients of resistance, the resistance of the elements varying in accordance with the racjio waves absorbed and rectified thereby, and means for focusing radio- waves upon the mosaic of elements in order to cause tne resistance of the elements to vary ja accordance with the focused waves.

5. An electric system having, in combination, a plurality of sets of, radio-rectifying elements exhibiting neaative temperature coefficients of resistance when- exposed to radio waveS; & & elements of each set being connected together to a common terminal, a load, and means for 4U connecting the common terminals to the load.

6 An electric system having, in combination, a pluraity of sets of: normally ineffective radio-receiving: elements exhibiting negative temperature coefficients of restance when exposed to radio waves, the elements of each set being connected together to a common terminal, a load; means for connecting the common terminals to the loadj and means for renciering the elements of successive sets successively effective.

7 A mosaic having an insulating support and a phigQ rality of radio-receiving elements supported by the support the elements operating inherently to rectify the radio waves, as they are received by the elements.

g An electric system having, in combination, radioreceiving-and-rectifying means exhibiting negative ternwaveS; and means for focusing radio waves upon the radio-receiving-and-rectifying means in order to vary the resistance thereof in accordance with the focused radio waves.

9. A mosaic of unitary radio-receiving elements capa-

We of receiving radio waves directly from space and inherently rectifying the received waves exhibiting a nega-

ive temperature coefficient of resistance in response to t e recejved waves.

10_ A mosaic of combined radio-receivina-and-rectifying singie-element devices exhibiting negative temperature coefficients of resistance when exposed to radio waves, the resistance of the devices varying in accordance with received radio waves.

1L A mosaic having an insulating support and a plurality of uranium-oxide radio-receiving elements supported by the support.

12. A mosaic of uranium-oxide radio-receiving elements disposed in two-dimensions for detecting a twodimensional distribution of radio waves.

13. A mosaic having an insulating support and a plurality of silicon radio-receiving elements supported by the support.

14. A mosac of silicon radio-receiving elements disposed in two-dimensions for detecting a two-dimensional distribution of radio waves.

15. An electric system having, in combination, a plurality of normally ineffective radio-receiving elements disposed in two-dimensions, means for converging radio waves upon the plurality of elements, and means for rendering the elements successively effective in two-dimensional order.

6. A mosaic having an insulating support and a plurality of radio-receiving-and-rectifying. elements insulatingly set into the support in order independently to receive and rectify radio waves.

7. A mosaic of mutually insulated radio-receiving antenna elements each provided with means capable of absorbing and rectifying the radio waves received thereby.

8. A mosaic having an insulating support and a plurality of antennas for independently receiving radio waves insulatingly set into the support.

19. An electric system having, in combination, a mosaic comprising a plurality of antenna elements for receiving radio waves each provided with a radio-wave absorbing and rectifying element having a negative temperature coefficient of resistance, the resistance of each absorbing and rectifying element varying in accordance with the radio waves received by the corresponding antenna element, and means for focusing a distribution of radio waves upon the mosaic in order to produce a corresponding resistance distribution upon the absorbing and rectifying elements.

20. An electric system having, in combination, a mosaic comprising a plurality of antenna elements for receiving radio waves each provided with a rectifying element for producing a rectified voltage in response to the radio waves received by the corresponding element, and means for focusing a distribution of radio waves upon the mosaic in order to produce a corresponding rectifie voltage distribution upon the rectifying elements.

21. An electric system having, in combination, a mosaic comprising a plurality of antenna elements for receiving radio waves each provided with a rectifying elent for producing a rectified voltage in response to the 4& 1936514 radio waves received_ by the corresponding element, means for preventing interference between adjacent antenna elements, and means for focusing a distribution of radio waves upon the mosaic in order to produce a correing rectified-voltage distribution upon the rectifying 50 2s73s96 elements without interference between adjacent elements.

22. A mosaic having an insulating support and an antenna array comprising a plurality of closely spaced conductors of dimensions appropriate to receive radio waves of a predetermined frequency insulatingly supported by the support in order independently to receive the radio waves 23. A mosaic having an antenna array comprising a plurality of closely spaced conductors of dimensions appropriate to receive radio waves of a predetermined frequency, each conductor being provided with a rectifying element for rectifying the radio waves received by the corresponding antenna conductor.

24. A mosaic having an antenna array comprising a plurality of closely spaced conductors of dimensions appropriate to receive radio waves of a predetermined frequency, each conductor being provided with a crystal detector for rectifying the radio waves received by the corresponding antenna conductor.

25. A mosaic having an insulating support and an antenna array comprising a plurality of closely spaced conductors of dimensions appropriate to receive radio waves of a predetermined frequency insulatingly supported by the support in order independently to receive the radio waves, each conductor being provided with a rectifying element for rectifying the radio waves received by the corresponding antenna conductor.

26. A plurality of spaced rectifying elements each having a conductor divided into two portions separated by a rectifying boundary region, means for supporting the rectifying elements in the form of a mosaic, each rectifying element being poled with its conductive direction the same as the other elements in order that radio waves received by the elements may give rise to alternating currents that are rectified at the rectifying boundaries to produce corresponding electric charges thereon.

27. A plurality of spaced rectifying elements each having a conductor divided into two portions separated by a rectifying boundary region, means for supporting the rectifying elements in the form of a substantially plane mosaic, each rectifying element being arranged to have its direction of best conduction substantially parallel to the plane of the mosaic and each element being poled with its conductive direction the same as the other elements in order that radio waves received by the elements may give rise to alternating currents that are rectified at the rectifying boundaries to produce corresponding electrie charges thereon.

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