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# Radio picture system and apparatus

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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.

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 is to provide a novel combined radioand-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 apparatus arranged 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 Fig. 1; and Fig. 4 is a view of a 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 advantages of economy 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 refleeted and scattered toward a receiving station.

At the receiving station, the radio waves reflected and scattered from the object 8 may be focused by an electromagnetic dielectric lens 5, such as of polystyrene, upon a receiving mosaic, bank or array 7 comprising a plurality of normally ineffective insulated radio-wave absorbingand-rectifying pick-up unit antenna elements. These may be constituted of small beads or globules of silicon, uranium oxide or other similar crystal pick-up-unit detecting elements. Small crystal beads or globules of uranium oxide or other such pick-up unit elements may, for example, be set into an insulating supporting disc 9 in the face at the screen end of an oscilloscope-like memilar mosaic of radio-wave ab- - and so on, in two-dimensional order.

sorbing-and-rectifying crystals may be employed. The dielectric lens 5 may be replaced by any other t-ype of well known radio lens, mirror or other directive system for focusing an image of the electromagnetic energy scattered and reflected from the object 8 on the bank or array 7 of the pick-up antenna elements.

The pick-up elements of the bank or array 7 are shown 12> 14> 16> etc-> shown as equally The second row from the top is 20, 22, etc.

The third or next-lower row is shown comprising the elementg. and SQ Qn fof remaining rows of pick-up elements. Though only a small number merely for illustrative purposes, and in order not to practice, a large number of pick-up units will be employed The pick-up antenna units 10, 18, 24, etc? are arranged in. the first or right-hand column. The units 12, 20, 26, etc are disposed in the second column from the right.

Tne elements 14, 22, etc are disposed in the third column from the right; and so on for the remaining columns of elements. There may be as many columns as there are pick-up units in each row. Though each column ls shown as comprising only a few units, this is again in order not to complicate the drawings.

The pick-up units will, of course, all receive the refleeted or scattered radio waves through the lens simultaneously. There will be focused on each pick-up unit a radio-frequency field strength corresponding to the scattering from a corresponding area of the object 8.

The bank of silicon, uranium-oxide or other similar " detecting crystals will act to absorb and rectify the energy incident on the array 7 of antenna units. Silicon and uranium-oxide detectors and similar crystals are known to absorb radio-frequency energy, and to exhibit high negative-temperature coefficients of resistance. Because of this high negative-temperature coefficient of resistance, the resistance of the uranium-oxide or other crystal beads will change with the intensity of the impinging radio-frequency energy. The pick-up elements wi l mus absorb different field strengths of radio energy, corresponding to the amount of energy reflected or scattered fr m tne various parts of the object 8 and converged as a radio-wave image upon the array 7 of pick-up elements by the lens 5. In accordance with the present invention, as will presently be explained, a radiowave-energy distribution becomes thus focused upon the arrav 7 to produce a radio-energy image or picture of the obiect 8> specific elemental areas of which will correspond to specific elemental areas of the object 8.

According to the preferred embodiment of the invention at is herein illustrated and described, this radioenergy image or picture of the object 8 thus received bv the Pick-up units may be converted into a visible lmaSe> Picture or likeness 123 of the object 8 upon the fluorescent viewing screen or face 106 of a display electr static cathode-ray receiving or presentation oscilloscope 90.

The invention provides means for first rendering the normally ineffective pick-up units 10, 12, IS, 16, etc of the first row successively effective momentarily in 6 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; This result may be attained by scanning the pick-up elements with an electron stream, as will hereinafter be more fully explained.

The beads 10, 12, 14, 16, etc of the first row are all connected to a conducting strip 43, grounded through a common conductor 78. The beads 18, 20, 22, etc of the second row are similarly shown all connected to a similarly grounded strip 51. The beads 24, 26, etc

of the third row are similarly shown all connected to a third similarly grounded strip 57, and so on.

The cathode-ray-oscilloscope-like member 89 is shown provided with a grounded cathode 95, a control-grid electrode 93 and an anode 97. Electrons emitted from the cathode will become enabled, in response to proper stimulation of the grid 93, to travel past the grid 93 to the anode 97. The electrons will continue to travel in a stream past the anode 97, between a pair of vertically disposed horizontal-deflector plates of which the plate 99 is shown grounded, and between a pair of horizontally disposed vertical-deflector plates 103 and 105, of which the-plate is shown grounded, to impinge finally on the insulating supporting disc 9 of the member 89.

A horizontal-sweep time-base voltage, applied, as here-

inafter more fully; explained, to the vertically disposed horizontal-deflector plate 99 and the vertically disposed -

horizontal-deflector plate 101, will cause the electron stream.from the cathode 95 to become deflected horizontally for each horizontal sweep, and a vertical-sweeptime base, applied to the horizontally disposed deflector plates 103 and 105, will cause the electron stream from the cathode to become deflected vertically.

The rows of pick-up units may be positioned along the successive paths of the electron stream in order to enable the electron stream to impinge on them as the electron stream successively sweeps over the successive rows of crystal beads of the array 7. Horizontally disposed lines of crystal elements will thus be scanned by the electron stream.

One of the surfaces of each crystal pick-up element is thus exposed to the incoming radio waves, and the other surface is exposed, within the cathode-ray tube member 89, to the electron stream.

The bank 7 of crystal 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 each crystal pick-up unit of the bank the moment that the electron stream impinges upon it.

This provides a measure of the resistance across each crystal, indicative of the intensity of the radio-frequency energy impinged upon that particular crystal and absorted thereby directly from the radio field.

the high negative-temperature coefficient of resistance of the crystals, their resistance will change with the intensity of the impinging radio-frequency energy. The radio-frequency energy will also become rectified to produce direct-current potential differences across the resistance of the crystals. This results from the rectifying or detecting properties of the crystals in the above-described radio-receiving circuits traceable from the crystal electrodes through the crystals to the grounded conductor 78. These variations of resistance and potential are representative of the radio-frequency energy impinged on the crystals by the lens and impressed on these circuits.

The resulting resistance and potential variations on the crystals will become manifest in corresponding circuits, ly, during the 00 rows of pick-up antennae; The pulse generator scanning process, by the electron stream from the cathode

of the member 89 According to the second principle, advantage is taken of the direct-current voltage impressed across each crystal. This voltage is proportional to the intensity of the Go radio-frequency energy received by the corresponding crystal, as communicated to the said receiving circuits.

With the aid of this principle, it becomes possible to measure the change of current along the electron stream as the electron stream traverses areas of different directcurrent potential. As the electron stream, during the scanning, travels across and impinges upon the successively disposed crystals, the change in the electron-stream current resulting from the different potentials across the variably resistive crystals upon which the electron stream impinges manifests itself first in the above-described crystal circuits to ground and, through these circuits, in the input circuit of the grounded preferably linear amplifier 79.

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 and 101, 10 in the input circuit of the amplifier 79.

Mosaics of silicon, as shown in Fig. 1, alternate sections of silicon and metal, as shown in Fig. 4, or dielectrie 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 Erequency 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-iike member 89, travels across the pick-up elements in the disc 9, they wiM successively discharge into the amplifier 79, by way of the conductor 78. If desired, the amplifier 79 may at 40 be replaced by a bank of linear amplifiers, one correspending to each cf 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 Because of 45 Pick-up elements.

A Pulse generator 40 may be employed to trigger a horizontal-time-base-sweep circuit 63 and a verticalsweeP Clrcmt 69> according to conventional and wellknown television technique. The pulse generator may feed> through an attenuator and rectifier 1, to an oscillator r any_similar or equivalent television circuit. One sucf. CUIt ls shown as a pulse-recurrence-frequency multiplier 65, for applying many p.ulses corresponding to ead? radio-frequency pulse for the period between successive radio pulses, to trigger the horizontal-sweep "rcmt f ,T1?e horizontal-time-base sweep will thereby bf produced between the vertically disposed deflector Plates 9.9 and 101, occurring as many tunes, say, between successive radio-frequency transmissions, as there are also eed> th.r ush the attenuator and rectifier 1, to trigger e vertical-sweep circuit 69, once corresponding to every radio-frequency transmission. One vertical sweep ccu.r between the horizontally disposed plates 10S du.rmg the penod between successive radiopulse transmissions, corresponding to as many horizontal s eef as there are rows of antennae, causing each of the horizontal sweeps to appear at successively lower levels on the oscilloscope-sweep faces.

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

The period of the oscillations which, as previously explained, is much less than the duration of each radio pulse, 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 pick-up mosaic antenna elements. The screen illuminated by an electron stream in the oscilloscope 90.

This electron stream is synchronized to travel with the electron stream of the cathode-ray-tubelike member 89.

The horizontal-sweep circuit 63 is connected to the horizontal-deflector plate 100 of the oscilloscope 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 90 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 conductors 84 and 86, to a phase-inverter stage or stages 81 which, in turn, is connected, by conductors and 87, 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 will cause the electron stream from the cathode 94 to become defleeted horizontally, and the vertical-sweep-time base, applied to the horizontally disposed deflector plates and 104, will cause the electron stream to become defleeted 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 circuit. After the last such horizontal sweep, the vol age between the horizontally disposed plates 103, 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 106 of the oscilloscope 90 will therefore correspond to the similarly disposed mosaic-antenna sections in the disc 9 of the oscilloscope-like member 89. Each spot along a particular horizontal sweep, therefore, will become brightened on the screen 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-inverting-and-amplifying 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 the bank of beads 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.

is 10 Though the tubes 90 and 89 have been described as operating upon the electrostatic principle, it will be understood that magnetic-deflection means or a combination of magnetic and electrostatic means may equally well be employed.

by a 15 Although the invention has been described in connection with mosaic-antennae arranged in rows and columns, it will be understood that this is not essential, for other arrangements are also possible. Antennae arranged along concentric circles covering the field, or a continuous spiral, will also serve, though the oscilloscope arrangement would, of course, be correspondingly modified.

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. An electric system having in combination, an oscilloscope-like member having a mosaic of absorbingand-rectifying radio-receiving elements and means for producing an electron stream for impinging on the mosaic, means for focusing radio energy on the mosaic, means for causing the electron stream to scan the mosaic, ar> d means controlled by the electron stream, as it scans tne mosaic, for indicating variations in resistance or potential of the elements in response to the action of the focused radio waves.

2. An electric system having, in combination, an oscilloscppe-like member having a mosaic of absorbing-andrectifying radio-receiving elements and means for producing an electron stream for impinging on the elements, means for focusing radio energy on the mosaic, means for causing the electron stream to scan the elements, means controlled by the radio waves focused on the mosaic for producing varying potentials on the elements of me mosaic, and means controlled by the electron stream, as it scans the elements, for indicating variations in the current of the electron stream.

3. An_electric system having, in combination, an oscilloscppe-like member having a mosaic of absorbing-andrectifying radio-receiving elements and means for producing an electron stream for impinging on the mosaic, means for focusing radio energy on the mosaic, means for causing the electron stream to scan the mosaic, and means controlled by the electron stream, as it scans the 55. m saic,_ for indicating variations in resistance of the elements in response to the action of the focused radio waves> the last-aiamed means comprising a balanced bridge.

4. An e ectnc system having, in combination, an oscilloscPe having a screen and means for producing an electron stream impinging on the screen, an oscilloscopellke mem er having an insulating support and means for producing an electron stream impinging on the support, the suPPrt having a plurality of radio-receiving elements, means for focusm radw energy on the radio-receiving elements, and means operable m response to the energy received by the radio-receiving elements for causing the first-named electron stream to produce upon the screen a h keness_ corresponding to the energy received by the radio-receiving elements.

5. An electric system having, in combination, an oscilloscope having a first screen, a control electrode and means for producing an electron stream impinging on the screen, an oscilloscope-like member having a second screen and means for producing an electron stream impinging on the second screen, the .second screen having a plurality o.f radio-receiving .elements, means for focusing radio .energy on the radio-receiving elements, means for causing .the elements ; to he scanned by the secondnamed electron stream, .and means controlled by the change in resistance of the elements, in response to the action of the focused radio waves, for controlling the control electrode, thereby to cause the electron stream to produce upon the first screen a likeness corresponding to the energy focused upon .the radio-receiving elements.

6. An electric system having, in combination, an oscilloscope having a first .screen, a ; control electrode and means for producing an electron stream impinging on the screen, an oscilloscope-like member having .a second screen and means for producing an electron stream impinging on the second screen, the second screen having a plurality of radio-receiving elements, means for focusing radio energy on the radio-receiving elements, means for causing the elements to be scanned by the secondnamed electron stream, means controlled by radio waves focused -on the radio-receiving elements for producing varying potentials on the radio-receiving elements, means controlle.d by the second-named electron stream, as it scans the second screen, for producing variations in the current of the second-named electron stream, and means controlled by the variations in the said current for producing upon the first screen a likeness corresponding to the energy focused upon the radio-receiving elements.

7. A bridge having arms one of which comprises a mosaic of radio-receiving elements exhibiting a negative temperature coefficient of resistance on exposure to radio waves, and indicating means controlled by the radioreceiving elements.

8. An electric system having, in combination, a mosaic of insulated radio-receiving elements, means for producing an electron stream impinging on the elements, means for focusing radio energy on the mosaic, an oscilloscope having a screen and means for producing an electron stream impinging on the screen, and means operabk in response to the energy received by the radio-receiving 4Q

elements for causing the second-named electron stream to produce upon the screen a likeness corresponding to the energy received by the radio-receiving elements.

9. A bridge having arms one of which comprises a plurality of radio-receiving and absorbing elements and means for indicating variations m the balance of the bridge in response to radio waves received by the ele-

To8 A bridge having a plurality of arms connected together to fonl apluralit A pair! oi: veijces, one, the K Sf c ectrdTof thl and an output circuit connected to another pair of A bridge having four arms connected together to form two pairs of oppositely disposed vertices, one of the arms having radio-receiving and absorbing means, an input circuit connected to one of the pairs of vertices, and an output circuit connected to the other pair of ertices A bridge having four arms connected together to form two pairs of oppositely disposed vertices, one of the arms having a plurality of radio-receiving and absorbing elements, an input circuit connected to one of ths pairs of vertices, and an output circuit connected to the other pair of. vertices.

13. A bridge having four arms connected together to form two pairs of oppositely disposed vertices, one of the arms having a plurality of series-connected radioreceiving elements, an input circuit connected to one of the pairs of vertices, and an output circuit connected to if AS hlvingfour arms connected together to form two pairs of oppositely disposed vertices, one of the arms comprising a plurality of normally ineffective radio-receiving elements, an input circuit connected to one of the pairs of vertices, an .output circuit connected to the other pair of vertices, and-means .for rendering ths elements successively effective.

15. An electric system having, in combination, a plurality of insulated radio-receiving elements each having a terminal, means for producing an electron stream impinging .on the elements, a bridge circuit to which the terminals are connected to connect the elements into an arm of the bridge, and means for causing the electron stream to scan the elements, thereby to vary the balance of the bridge circuit.

16. An electric system having, in combination, a bridge having a plurality of arms connected together to form a plurality of pairs of vertices, one of the arms having radio-receiving-and-rectifying means, means for producing an electron stream for impinging on the radio-receiving-and-rectifying means, and means for causing the electron stream to scan the radio-receiving-and-rectifying means.

17. An electric system having, in combination, radioreceiving-and-rectifying means, means for producing an electron stream for impinging on the radio-receiving-andrectifying means, means for causing the electron stream to scan

the radio-receiving-and-rectifying means, and means controlled by the electron stream, as it scans the radio-receiving-and-rectifying means, for detecting variations in potential of the radio-reeeiving-and-rectifying means.

18. An eiectric system having, in combination, radioreceiving-and-rectifying means, means for producing an electron stream for impinging on the radio-receiving-andrectifying means, means for causing the electron stream to scan the radio-receiving-and-rectifying means, means controlled by the radio waves received by the radio-receiving-and-rectifying means for producing varying pptentials on the radio-receiving-and-rectifying means, and means controlied by the electron stream, as it scans the radio-receiving-and-rectifying means, for detecting variations in the current of the eiectron stream.

19 An electric system having; in combination; a flrst electron tube having a screen and means for producing a fcst electron stream impinging on the screen a second electron tube hayi an luralit of insulated radio.re.

cdving elements and means for producing a second elec.

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ceiying elements and cooperative with the second electron stream for causing the first electron stream to produce O. An electric system having, in combination, radioreceiving means the resistance of which varies in respouse to the received radio waves, means for producing an electron stream impinging on the radio-receiving means means for causing the electron stream to scan the radio-receiving means, an electric circuit in which the radio-receiving means is connected, and means for direeling radio energy on the radio-receiving means to produce resistance changes m the radio-receiving means, thereby to vary the current in the circuit as the electron stream scans the radio-receiving means.

21. An electric system having, in combination, radioreceiving means the potential of which varies in response to the received radio waves, means for producing an electron stream impinging on the radio-receiving means, means for causing the electron stream to scan the radioreceiving means, an electric circuit in which the radioreceiving means is connected, and means for directing rad.Q g Qn radio.receiving means to produce potential changes radio.receiving meanS; thereby to vary the current in the circuit as the electron stream scans the radio-receiving means 22. An electron tube having for employment with the electrons therein a crystal element of silicon and the like electrically connected with at least one conductor to provide rectifying characteristics by such connection.

23. An electric system having, in combination, a mosaic comprising a two-dimensional array of radio-receiving elements for receiving radio waves from an object, means for producing an electron stream impinging on the mosaic, means for causing the stream to scan the mosaic in twodimensional order, a normally ineffective electric circuit in which the elements are connected for producing a likeness corresponding to the radio energy received by the elements from the object, and means controlled in synchronism with the scanning means for rendering the circuit successively effective to produce successive portipns of a likeness of the object in two-dimensional order synchronously with the reception of the radio energy from the object by the receiving elements.

24. In combination, means for imaging radio waves from a scene to be recorded, a radio wave pick-up device comprising a crystal detector, means for scanning the said radio wave image by said pick-up device and converting the energy thus picked up into an electrical signal, an image reproducing means, means for operating said image reproducing means in synchronism with said scanning, and means for supplying said signal to said reproducing means whereby a picture of said scene is obtained.

25. In combination, means for imaging radio waves from a scene to be reproduced, a radio-wave pick-up device comprising crystal detector means, means for scanning an area successive portions of which correspond to successive portions of the radio-wave image, means controlled in accordance with the scanning for converting the energy picked up by the pick-up device from the different portions of the image into corresponding electrical signals, a display

cathode-ray tube, means for operating the tube in synchronism with the scanning, and means for supplying the signals to the tube, whereby a picture pf the scene is obtained. .

26. In combination, means for imaging radio waves from a scene to be reproduced, a two-dimensional array of radio-wave pick-up devices upon which the radio image may be formed, means for scanning an area successive portions of which correspond to successive pick-up devices in the array, means controlled in accordance with the scanning for converting the energy picked up by the successive pick-up devices into corresponding electrical ments, thereby accumulating an electric charge on one signals, a display cathode-ray tube, means for operating the tube in synchronism with the scanning, and means for supplying the signals to the tube, whereby a picture of the scene is obtained.

27. In combination, means for imaging radio waves gQ in accordance with the magnitude of the accumulated from a scene to be reproduced, a radio-wave pick-up device comprising crystal-detector means, means for scanning an area successive portions of which correspond to successive portions of the radio-wave image, means conccordance with the scanning for converting the g5 by radio waves into energy picked up by the pick-up device from the different portions of the image into corresponding electrical signals, an image-reproducing means, means for operating the image-reproducing means in synchronism with the scanning, and means for supplying the signals to the eo wayes of the primary image upon the receiving-and-rectiimage-reproducing means, whereby a picture of the scene K 28.ta combination, means for imaging radio waves from a scene, a radio-wave pick-up device comprising crystal detector means, means connected to the pick-up Rf. Pnary image, whereby the electric field vanatwns at device for scanning the said radio-wave image and co verting the energy picked up by the pick-up device during the scanning into electrical signals, a display cathoderay tube, means for operating the tube in synchronism with the scanning, and means for supplying the signals to the tube, whereby a picture of the scene is obtained.

29. In combination, means for imaging radio waves from a scene to be reproduced, a radio-wave pick-up device, crystal detector means for rectifying the radio waves picked up by the pick-up device, means for scanning an area successive portions of which correspond to successive portions of the radio-wave image, means controlled in accordance with the scanning for converting the energy picked up by the pick-up device from the different portions of the image into corresponding electrical signals, an image-reproducing means, means for operating the image-reproducing means in synchronism with the scanning, and means for supplying the signals to the imagereproducing means, whereby a picture of the scene is obtained.

30. A system comprising means for propagating ultra high-frequency electromagnetic energy modulated with a high-frequency wave of electro-magnetic energy, a receiving antenna array including a plurality of closely spaced conductors, an antenna array load impedance connected to said conductors, means for focusing the point of emanation of the propagated energy on a small portion of said antenna array, means for projecting a narrow beam of electrons against said antenna array, means for causing said beam of electrons to scan said antenna array, means for rectifying the electro-magnetic energy received by said antenna array, circuit means forming a closed circiut including said beam of electrons, said antenna conductors, said load impedance and said rectifier means in which electron current flows, amplifier means, means for feeding the rectified component of said electromagnetic energy to said amplifier, and means for utilizing the amplified output of said amplifier.

31. A system for transforming a primary image formed by electromagnetic waves into a secondary image formed by other electromagnetic waves, said system comprising a plurality of spaced rectifying elements each having a conductive surface divided into two portions separated by a rectifying boundary region, means supporting said rectifying elements in the form of a mosaic lying substantially in the plane of the primary image, each said rectifying element being arranged to have its direction of best conduction substantially parallel to the plane of the primary image and said elements being poled with the conductive direction of each element the same as any other with respect to the said plane, whereby the electricfield variations at any given point in the primary image give rise to alternating currents on the conductive-surface portions of a particular one of said rectifying eleside of the corresponding rectifying boundary in proportion to the electric-field intensity at the given point, means periodically discharging said rectifying elements in succession, thereby producing a fluctuating current varying charge from element to element, and means producing a

secondary image from the information carried by the fluctuations in said current.

32. A system for transforming a primary image formed visible secondary image, said systern comprising a plurality of spaced radio-wave receiving-and-rectifying elements each having a conductive surface divided into two antenna portions separated by a rectifying boundary region, means for impinging the radio fyjng elementS; each said receiving.and-rectifying element eing poled with the conductive direction of each element the same as & W other with respect to the plane of the Ot) any Slven Pmt ln th.e primary image give rise to. alternatmg currents on the antenna portions of a particular one of said receiving-and-rectifying elements, thereby accumulating an electric charge on one side of the corresponding rectifying boundary in proportion to the electric field intensity at the given point, means periodically discharging said receiving-and-rectifying elements in succession, thereby producing a fluctuating current varying in accordance with the magnitude of the accumulated charge from element to element, and means producing a visible secondary image from the information carried by the fluctuations in said current.

33. A system for transforming a primary image formed by electromagnetic waves into a secondary image formed by other electromagnetic waves, said system comprising a plurality of spaced electromagnetic-wave receiving-andrectifying elements each having a conductive surface divided into two portions separated by a crystal rectifier, means for impinging the electromagnetic waves of the primary image upon the receivirig-and-rectifying elements, each said receiving-and-rectifying element being poied with the conductive direction of each element the same as any other with respect to the plane of the primary image, whereby the electric-field variations at any given point in the primary image give rise to alternating currents on the conductive-surface portions of a particular one of said receiving-and-rectifying elements, thereby accumulating an electric charge on one side of the corresponding crystal rectifier in proportion to the electricfield intensity at the given point, means periodically discharging said receiving-and-rectifying-elements in succession, thereby producing a fluctuating current varying in accordance with the magnitude of the accumulated charge from element to element, and means producing a secondary image from the information carried by the fluctuations in said current.

34. A system for transforming a primary image formed by electromagnetic waves into a secondary image formed by other electromagnetic waves, said system comprising an insulating support, a plurality of spaced electromagn etic-wave receiving-and-rectifying elements supported by the support each having a conductive .surface divided into two portions separated by a rectifying boundary region, .means for impinging the electromagnetic waves of the primary image upon the receiving-and-rectifying elements, each said receivin g-and-rectifying element being poled with the conductive direction of each element the same as any other with respect to the plane of the primary image, whereby the electric-field variations at any given point in the primary image give rise to alternating currents on the conductive-surface portions of a particular oiie of said receiving-and-rectifying elements, thereby accumulating an electric charge on one side of the correspending rectifying boundary in proportion to the electrie-field intensity at the given point, means periodically discharging said receivirig-and-rectifying elements in suecession, thereby producing a fluctuating current varying in accordance with the magnitude of the accumulated charge from element to element, and means producing a secondary image from the information: carried by the fluctuations in said current.

35. Apparatus of the character described having, in combination, an insulating support an area of which is provided with discreet elements, means for producing ari electromagnetic image on the elements, means supported by the support for producing an electrostatic charge on each of the elements varying in accordance with the intensity of the portion1 of the electromagnetic image produced thereon, means for scanning the elements in order successively to release the charges in accordance with a go high-frequency wave of electromagnetic energy, a receivpredetermined scanning pattern, and mean s responsive to the released charges for forming a visual image.

36. Apparatus of the character described having, in combination, an insulating support an area of which is ments, mean s for producing an antenna array, means for projecting electromagnetic image on the elements, means supported by the support for producing an electrostatic charge on each of the elements varying in accordance with the intensity of the portion of the electromagnetic image produced thereon, means for impinging an electron stream successively on the elements to scan the elements in order successively to release the charges, and means responsive to the released charges

for forming a visual image.

37. In combination, means for imaging radio waves from a scene to be reproduced, a radio wave pick-up device comprising crystal detector means, means for scanning the said radio wave image by said pick-up device and converting the energy thus picked up into an electrical signal, a facsimile reproducer, means for operating said reproducer in synchronism with said scanning, and means for supplying said signal to said reproducer whereby a picture of said scene is reproduced.

38. In combination, means for imaging radio waves from a scene to be reproduced, a radio wave pick-up device comprising crystal detector mean s, means for scanning the said radio wave image by said pick-up device and converting the energy thus picked up into an electrical signal, an image reproducing means, means for operating said image reproducing mean s in synchronism with said scanning, and means for supplying said signal to said reproducing means whereby a picture of said scene is obtained.

39. A system comprising means for propagating ultrahigh-frequency electromagnetic energy modulated with a high-frequency wave of electromagnetic energy, a receivmg antenna array including a plurality of closely spaced antenna elements each provided with a conducting circuit, an1 antenna array load impedance connected to the antenna element conducting circuits, means for focusing the point of emanation of the propagated energy on the antenna elements of the said antenna array, means for projecting a narrow beam of electrons against predetermined portion s of the antenna element conducting circuits, means for causing said beam of electrons to scan the said predetermined portions of the antenna element conductm circuits thereby to scan the said antenna array, means for rectifying the electromagnetic energy received by the antenna elements, circuit means forming a closed circuit including said beam of electron s, a portion of said antenna element conducting circuits and said load impedance m which electron current flows, amplifier means, means for feeding electric energy representative of the rectified component of said electromagnetic energy to said amplifier, and means for utilizing the amplified output of said amplifier.

40- A electric system having, in combination, an oscilloscope-like member having means for producing an electron_stream, a mosaic of radio-receiving elements each provided with and connected to a corresponding electric circuit comprising a radio-wave absorbing-and-rectifying element, means for impinging the electron stream on predetermined portions of the radio-receiving element electric circuits, means for focusing radio energy on the mosaic, means for causing the electron stream to scan the said predetermined portions of the radio-receiving element electric circuits, means controlled by the radio waves focused on the mosaic for producing varying potentials on the said predetermined portions of the radio-receiving element electric circuits, and means controlled by the electron stream, as it scans the said predetermined portions of the radio-receiving element electric circuits, for indicating variations in the current of the electron stream.

41. A system comprising means for propagating ultra high-frequency electromagnetic energy modulated with a ing antenna array including a plurality of closely spaced conductors, an antenna array load impedance connected to said conductors, means for focusing the point of emanation of the propagated energy on a small portion of said narrow beam of electrons against said antenna array, means for causing said beam of electrons to scan said antenna array, means for rectifying the electromagnetic energy received by said antenna array, circuit means forming a closed circuit ineluding said beam of electrons, said antenna conductors, said load impedance and said rectifier means in which electron current flows, amplifier means, means for feeding the rectified component of said electromagnetic energy to said amplifier, a cathode ray tube having a fluorescent screen, means for projecting a beam of electrons against said screen, means for causing said last mentioned beam of electrons to scan said screen in synchronism with the scanning action of said first beam of electrons, a control grid in said cathode ray tube, means normally biasing said control grid to block the flow of electrons in said cathode ray tube, a load circuit including a load impedance coupled to the output of said amplifier means, and means coupled to said load circuit for changing the biasing potential on said control grid to establish a flow of electrons in said cathode ray tube whenever rectified received electromagnetic energy flows from said amplifier through said load circuit.

42. In a radio-current electric system, alternately disposed elements of metal and silicon and the like concted to provide a first element of silicon and the like 15 i794730 having electrical connections at opposite ends to the metal elements, the first element being provided with an electrical connection to an intermediate point thereof, and at least one of the said electrical connections providing rectifying characteristics with the said first element, 20 2155471 and means for impinging an electron stream upon at least one of the elements.

43. In a radio-current electric system, alternately disposed elements of metal and silicon and the like coned to provide a first element of silicon and the like 25 219ll3 having electrical connections at opposite ends to the metal elements, the first element being provided with an , . .

electrical connection to an intermediate point thereof, n ii j i t , and at least one of the said electrical connections providing for rectifying characteristics with the said first element.

44. Apparatus as claimed in claim 43 and in which the said electrical connection to the said intermediate point is connected to a grounded electric circuit.

45. In a current-translating electric system, alternately disposed elements of conductive material and silicon and the like constructed to provide a first element of silicon and the like having electrical connections at opposite ends to the conductive elements, the first element being provided with an electrical connection to an intermediate point thereof, and at least one of the said electrical connections providing for rectifying characteristics with the said first element.

46. Apparatus as claimed in claim 45 and in which voltage is applied to the conductive elements and the said electrical connection to the said intermediate point is connected to a grounded electric circuit.

47. Apparatus as claimed in claim and in which a further electrical connection is made to the first element at the surface opposite the said connection to the said intermediate point.

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