Nov. 7, 1950 R. H. RINES 2,528,727

SONIC PICTURE SYSTEM

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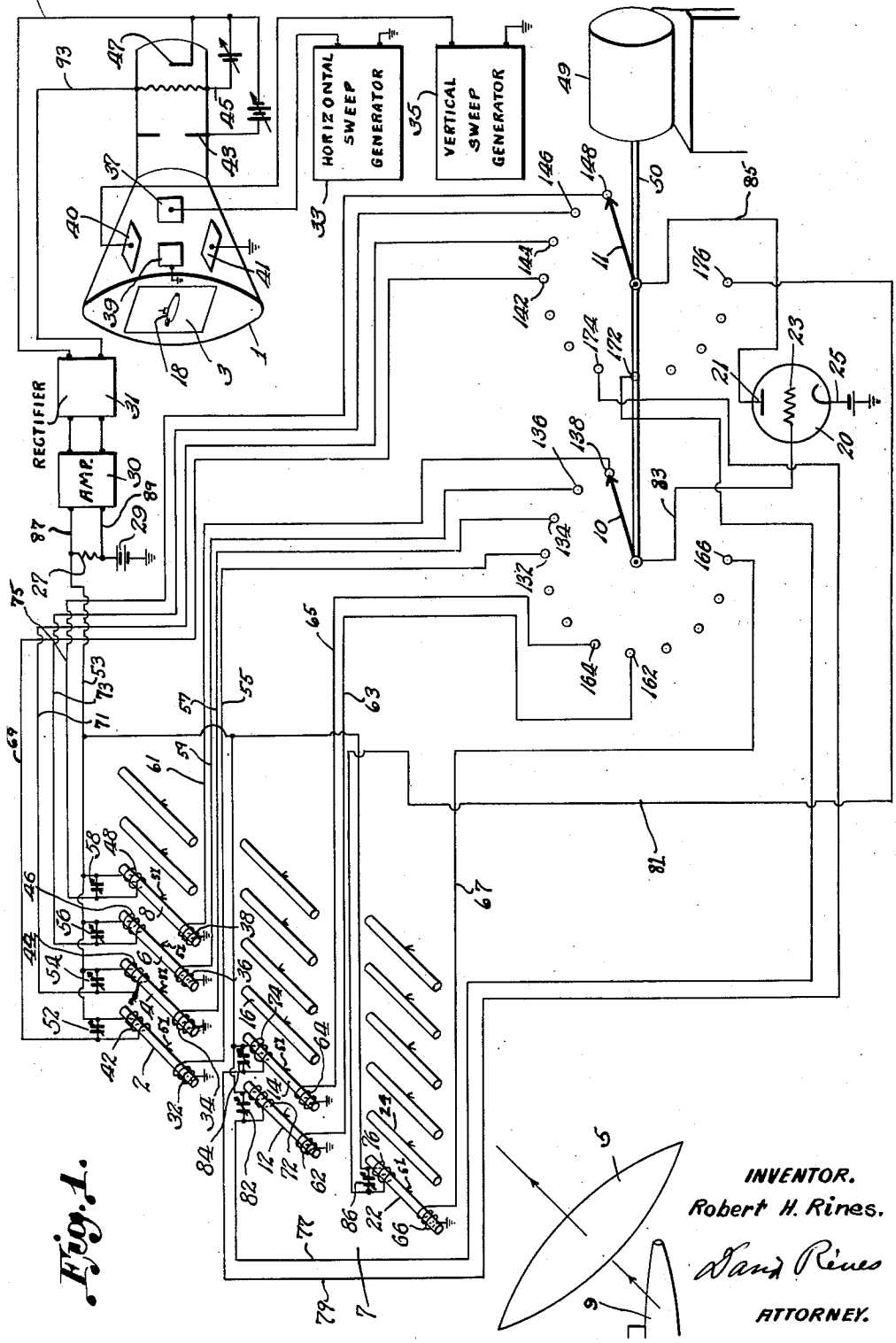

Fig. 1.

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Fig. 2.

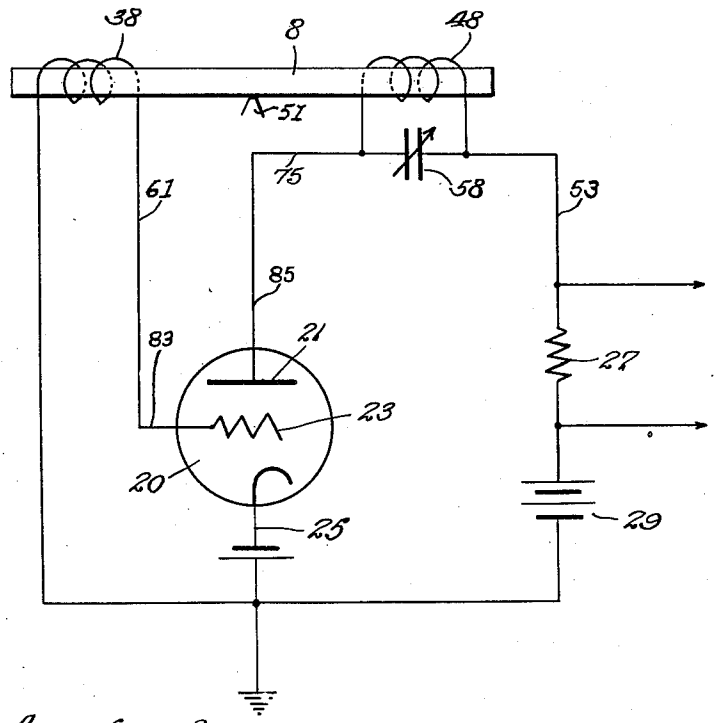
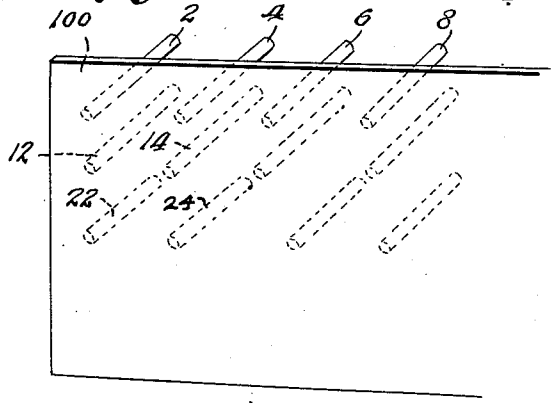


Fig. 3.



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SONIC PICTURE SYSTEM

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Application August 3, 1945, Serial No. 608,782

23 Claims. (Cl. 178—6.8)

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The present invention relates to electric systems, and more particularly to receiving systems using sound waves as the agency of communication. The term "sound" will be employed hereinafter, in the specification and the claims, to include not only the audible part of the sound spectrum, but also, and more particularly, the ultrasonic spectrum, and to include also all kinds of elastic vibrations.

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

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

Another object of the present invention is to provide a new sound-locator system for both detecting the presence of a body and producing a visible likeness thereof.

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 simplified circuit diagram; and Fig. 3 is a fragmentary view of a detail of a modification.

A directive ultrasonic transmitter (not shown) may be employed to direct ultrasonic waves toward an object 9, illustrated as an underwater submarine. The sound waves are reflected and scattered from the surface of the object 9 toward a sound-receiving station. The invention is operable also with objects 9 that emit, as well as reflect or scatter, sound waves.

At the receiving station, the sound waves thus reflected and scattered from the object 9 may be focused by a sound lens 5 upon a bank or array 7, comprising a plurality of sound-receiving pick-up unit elements vibratory in response to the sound energy impinging thereon. The sound lens 5 may be replaced by any other type of well-known lens, mirror or other directive system for focusing the sound waves scattered and reflected from the object 9 on the bank or array 7 of pick-up elements. The sound lens may, for example, be constituted of a collodion balloon filled with carbon dioxide or sulphur dioxide; or any other substance for refracting the sound waves.

The vibratory pick-up elements of the bank or array 7 are shown as magnetostrictive receiver elements which may be in the form of rods. The rods may each be supported to vibrate about a central support 51, as illustrated in Figs. 1 and 2,

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or they may be rigidly secured at their rear ends to a supporting plate 100, as illustrated in Fig. 3. The front surface of each magnetostrictive element projects forward, in the direction of the incoming sound waves.

The magnetostrictive pick-up units are shown arranged 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 magnetostrictive rods 2, 4, 6, 8, etc., shown as equally spaced horizontally. The second row from the top is shown constituted of similarly disposed magnetostrictive rods, respectively disposed directly below the corresponding magnetostrictive rods of the first row; several of these are illustrated at 12, 14, and 16. The third or next-lower row is similarly constituted, several of the magnetostrictive rods being illustrated at 22 and 24. Though only a small number of pick-up units is shown in each row, and though only three rows are shown, this is merely for illustrative purposes, in order not to confuse the disclosure. It will be understood that, in practice, a large number of pick-up units will be employed in each row.

The magnetostrictive elements 2, 12, 22, etc., are shown arranged vertically in the first or left-hand column. The pick-up elements 4, 14, 24, etc., are disposed in the second column from the left. The pick-up elements 6, 16, etc., are disposed in the third column from the left, and so on. There may, or may not, be as many columns 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 drawing.

The pick-up units will, of course, all receive the reflected or scattered sound waves through the lens 5 simultaneously. There will be focused on each pick-up unit a sound wave intensity corresponding to the intensity of the sound energy reflected or scattered from a corresponding component part or area of the object 9. Sound-wave pressures will thus be impressed upon the front ends of the pick-up elements corresponding to the different field strengths of sound-wave energy thus received by them, and proportional to the intensity of the sound-wave energy reflected or scattered or otherwise emanating from the various component parts of the object 9 and converged upon the array 7 of pick-up elements by the lens 5. The sound lens 5 or its equivalent will thus focus upon the array 7 the sound waves reflected or scattered from the various component parts of the object 9 in various energy strengths de-

pendent on the reflecting properties of the component parts of the object 9, thus to produce a faithful sound image of this distribution of the sound waves in approximately the focal plane of the lens 5.

It has heretofore been proposed to convert a sound-energy picture of this character into a visible-picture likeness 18 of the object 9 upon the fluorescent viewing screen 3 of a display cathode-ray oscilloscope tube 1. The tube 1 is shown in Fig. 1 operating on the electrostatic principle, but, of course, a magnetic deflector, or a combination of magnetic and electrostatic forces, may equally well be employed.

According to a feature of the present invention, however, improved results are obtained by suitably enhancing the vibrations of the vibratory pick-up elements. One method of attaining this end is illustrated in Fig. 1, which will now be more fully described.

The magnetrostrictive rods are each preferably provided with a pair of coils, one at each end. The rod 2 is provided with the pair of coils 32 and 42, the rod 4 with the pair of coils 34 and 44, the rod 6 with the pair of coils 36 and 46, the rod 8 with coils 38 and 48, the rod 12 with the pair of coils 62 and 72, the rod 14 with the pair of coils 64 and 74, the rod 22 with the pair of coils 66 and 76, etc. One end of the one coil of each pair of coils is connected to a corresponding stationary contact member of a switching device. The other ends of these coils are grounded. The ungrounded ends of the coils 32, 34, 36 and 38, for example, are shown respectively connected by conductors 55, 57, 59 and 61 to stationary contact members 132, 134, 136 and 138; the ungrounded ends of the coils 62 and 64 are similarly connected by conductors 63 and 65 to the respective contact members 162 and 164; the ungrounded end of the coil 66 is connected by a conductor 67 to a stationary contact member 166; and so on. These contact members are adapted to be successively engaged by a switch or contact member 10 that is mounted upon a shaft 50 of a continuously operating motor 49.

One end of the other coil of each pair of coils is connected to a stationary contact member of a similar switching device, the cooperating movable switch or contact member 11 of which is also mounted upon the shaft 50, so as to be rotated in synchronism with the switching member 10. The other ends of these last-named coils are grounded by way of a conductor 53 through a plate resistor 27 and a plate supply battery 29. The ungrounded ends of the coils 42, 44, 46 and 48, for example, are respectively connected by conductors 69, 71, 73 and 75 to stationary contact members 142, 144, 146 and 148; the coils 72 and 74 are respectively connected by conductors 77 and 79 to stationary contact members 172 and 174; the coil 76 is connected by a conductor 81 to a stationary contact member 176; and so on.

The coils 42, 44, 46, and 48 are shown respectively connected in parallel with tuning condensers 52, 54, 56 and 58; the coils 72 and 74 are similarly shown connected in parallel with tuning condensers 82 and 84, respectively, and the coil 76 is similarly shown connected in parallel with the tuning condenser 86.

By means of the contact members 10 and 11, under the control of the motor 49, the coils of each pair of coils of the respective magnetostrictive elements are respectively adapted to be connected successively into the input, or grid, and the output, or plate, circuits of a normally ineffective vacuum tube 20 shown provided with a cathode 25, a control electrode 23, and a plate or anode 21. As will presently appear, this results in effectively scanning the magnetostrictive pick-up elements.

With the contact members 10 and 11 respectively engaging the contact members 138 and 148, as shown, for example, the input circuit embodies the coil 38, and the output circuit the other coil 48 of the pair of coils of the magnetostrictive element 8. The input circuit may be traced from the cathode 25 by way of the ground to the coil 38 and from the coil 38 by way of the conductor 61 to the contact member 138. The input circuit continues through the switch member 10 by way of a conductor 83 to the control electrode 23. The output circuit may be traced from the cathode 25 by way of the ground to the plate battery 29, then through the impedance 27 and by way of the conductor 53 to the coil 48 and the condenser 58 in parallel. The output circuit continues by way of the conductor 75 to the contact member 148 and the switch member 11 in contact therewith and by way of a conductor 85 to the plate or anode 21. A simplified diagram of this circuit is illustrated in Fig. 2.

The two coils of the other magnetostrictive elements will similarly become respectively connected successively into the input and output circuits of the vacuum tube 20 in substitution for the coils 38 and 48 of the magnetostrictive element 8 as the switch members 10 and 11 are successively rotated in unison by the motor 49.

When the magnetostrictive rod 8 receives a signal sound through the lens 5, it is set into vibratory operation. Assuming that the contact members 10 and 11 respectively engage the contact members 138 and 148, as illustrated, at this time, the circuit diagrammatically shown in Fig. 2 will thereupon be caused to oscillate, in the manner first described by George W. Pierce as a magnetostrictive oscillator. It will be understood, of course, as stated, for example, in Pierce Letters Patent 1,750,124 of March 11, 1930, that the tuning condenser may be disposed in parallel with the coil 38 instead of the coil 48 or between the control electrode 23 and the anode 21.

As is also described in the said Letters Patent, the sound energy received by the forward end of the magnetostrictive element 8 will be converted by magnetostriction into electric energy, whereupon the oscillator 20 being set into oscillation, the vibrations of the magnetostrictive vibrators will become greatly enhanced, with correspondingly increased alternating-current electric energy in the output circuit of the oscillator 20. This enhancement of the vibrations of the magnetostrictive vibrators, and the correspondingly increased oscillations of the magnetostrictive oscillator, are effected irrespective of the frequency of the received sound, depending only upon the natural frequency of mechanical vibration of the magnetostrictive vibrators.

The increased electric energy may be taken across the impedance 27 out of the output circuit of the oscillator 20, by way of conductors 87 and 89, to an amplifier 30 for further amplifying the increased alternating-current electric energy. The amplified alternating-current oscillations may be rectified by a rectifier 31 and the rectified energy conducted by way of conductors 91 and 93 to the cathode 47 and the control electrode 45, respectively, of the cathode-ray tube 1.

As the output of the amplifier 30 and the rectifier 31 will obviously vary, at successive instants, in accordance with the strength of the oscillations

in the plate circuit, it constitutes a measure of the strength of the sound energy received by the corresponding pick-up elements from the corresponding component parts or areas of the object 9.

Electrons emitted from the cathode 47 of the tube 1 will become accelerated, in response to proper stimulation of the control-grid electrode 45, so as pass by the grid 45 to the anode 43 of the oscilloscope 1. The electrons will continue to travel in a stream from the anode 43, between a pair of vertically disposed deflector plates 37 and 39, of which the plate 39 is shown grounded, and between a pair of horizontally disposed deflector plates 40 and 41, of which the plate 41 is shown grounded, to impinge finally on the screen 3 of the member 1. A horizontal-sweep-time base, applied to the vertically disposed deflector plates 37 and 39, will cause the electron stream from the cathode 47 to become deflected horizontally in a period of time corresponding to the time in which the motor 49 drives the contact members 10 and 11 successively to connect the magnetostrictive elements of one complete row into the vacuum-tube circuit as before described. After each horizontal sweep of the oscilloscope 1 has been completed, a successively larger voltage will be applied to the horizontally disposed deflector plates 40 and 41 of the oscilloscope 1, by a vertical-sweep-time base, causing the electron stream to become deflected vertically, and causing each of the horizontal sweeps to appear at successively lower levels on the oscilloscope face 3 corresponding to successively lower vertically disposed levels of the rows of magnetostrictive elements. The vertical-sweep circuit has a period corresponding to the time in which the motor 49 carries the contact members 10 and 11 into successive engagement with all their cooperating contact members, thus successively connecting all the rows of magnetostrictive elements into the vacuum-tube circuit. After the last such horizontal sweep, the horizontally disposed plates of the oscilloscope will become restored to their starting voltage. The next horizontal sweep, therefore, will start again at the first or top row. Sweep generators 33 and 35 may be employed to produce the horizontal-time-base sweep and the vertical sweep, according to conventional and well-known television technique.

As the electron stream produced from the cathode 47, in response to appropriate horizontal sweep-time-base voltages applied to the vertically disposed deflector plates 37 and 39 of the cathode-ray tube 1, travels along any particular horizontal line on the screen 3, the voltages fed from the rectifier 31 between the grid 45 and the cathode 47 causes more or less electrons to pass to the screen 3, thereby intensity modulating this horizontal line of the electron stream impinging on the screen 3. This affords successive indications of the intensity of the sound energy impinged upon the magnetostrictive receiving elements of the particular row of magnetostrictive elements at the time that they are connected into the vacuum-tube circuit.

Since the output of the amplifier 30 and the rectifier 31 will therefore obviously vary, at successive instants, in accordance with the strength of the sound energy impinging upon the successive receiving pick-up elements from the corresponding component parts or areas of the object 9 during the scanning of these elements in response to the operation of the contact members 10 and 11 under the control of the motor 49, it constitutes a measure of the strength of the sound energy received by the respective pick-up elements from the corresponding component parts or areas of the object 9. Successive energizing voltages are thus produced from the rectifier 31 on the control electrode 45 of the cathode-ray tube 1, of magnitude proportional to the sound-wave energy received by the corresponding pick-up elements. The illumination resulting from the intensity modulation on the screen 3 will be such that the intensity of illumination of parts or regions of the screen 3 corresponding to particular magnetostrictive units of the magnetostrictive bank 7 will correspond to the intensity of the parts of the sound-wave image on the rows and columns of the bank 7; these parts of this sound-wave image and these particular magnetostrictive units, in turn, corresponding to correspondingly disposed component parts of the object 9.

The sound waves received by the magnetostrictive units along the successive rows and columns will thus become converted into successive portions of the visual likeness, along correspondingly disposed rows and columns thereof, along the successive time bases. The visual picture likeness 18 of the object 9 thus produced on the oscilloscope screen 3 will accordingly correspond to the sound energy picture on the array 7 of pick-up elements which, in turn, corresponds to the actual object 9, but it will be very much sharper and clearer than if the sound vibrations of the magnetostrictive pick-up units had not been enhanced through the oscillations of the oscillator 20.

The magnetostrictive rods of the bank 7 for receiving the distribution of sound waves from the object 9 may be small in diameter in order to make possible the use of a sufficiently large number of them in the array 7 to provide for good definition. The frequency of the sound waves employed may be reasonably high; especially if, as is also described in the said Letters Patent, the higher modes of vibration of the magnetostrictive elements be utilized.

Instead of employing a common circuit for all the elements, the magnetostrictive elements may, if desired, be connected into independent vacuum-tube circuits, which would successively be connected to the amplifier 30. As is further described in the said Letters Patent, the magnetostrictive elements may also be provided with a single coil each, connected, say, in the input circuit of the oscillator. The operation of the output circuit of the oscillator 20 connected to the oscilloscope will still be the same as above described.

Although the invention has been described in connection with pick-up elements arranged in rows and columns, it will be understood that this is not essential, for other arrangements are also possible. Pick-up elements arranged along concentric circles covering the field, or along 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.

What is claimed is:

1. An electric system having, in combination, a plurality of normally ineffective magnetostrictive sound-receiving elements for receiving sound waves from an object, a plurality of tuned circuits respectively associated with the plurality of re-

ceiving elements, means for selectively rendering the receiving elements successively effective, and means cooperative with the last-named means and operating through the respective circuits for producing a likeness of the object.

2. An electric system having, in combination, a plurality of magnetostrictive sound-receiving elements for receiving sound waves from an object, means for supporting each element at its center so as to vibrate mechanically thereabout in response to the received sound energy, means for enhancing the mechanical vibrations of the elements, means for detecting the sound energy received by the respective elements, and means cooperative with the last-named means for producing a likeness of the object.

3. An electric system having, in combination, a plurality of magnetostrictive sound-receiving elements for receiving sound waves from an object, means for supporting each element at one of its ends so as to vibrate mechanically therefrom in response to the received sound energy, means for enhancing the mechanical vibrations of the elements, means for detecting the sound energy received by the respective elements, and means cooperative with the last-named means for producing a likeness of the object.

4. An electric system having, in combination, a two-dimensional array of normally ineffective magnetostrictive sound-receiving elements for receiving sound waves from an object, the elements respectively corresponding to respective portions of the object from which they respectively receive the sound waves when rendered effective, means for rendering the elements successively effective in two-dimensional order to convert the sound waves received by the elements from the corresponding portions of the object into corresponding voltage signals in two-dimensional order, a normally ineffective electric circuit for producing a likeness corresponding to the sound energy received by the elements from the corresponding portions of the object, and means controlled in synchronism with the operation of the rendering means for rendering the circuit successively effective in response to the respective voltage signals to produce successive portions of a likeness of the object in two-dimensional order synchronously with the reception of the sound energy from the corresponding portions of the object by the elements.

5. An electric system having, in combination, a plurality of sound-receiving elements for receiving sound waves from an object, each element having an input and an output circuit, a normally non-conducting electric circuit for interconverting sound-wave and electric energy, means for simultaneously connecting the input and output circuits of the successive sound-receiving elements to the electric circuit to render the circuit conductive causing alternating currents to flow in the electric circuit in response to the sound waves received by the successive elements, display means, means cooperative with the connecting means and responsive to the currents flowing in the electric circuit for controlling the display means in order to produce a likeness of the object thereupon.

6. An electric system having, in combination, a plurality of sound-receiving elements for receiving sound waves from an object each element having an input and an output circuit, a normally non-conducting electron-tube circuit for interconverting sound-wave and electric energy, means for simultaneously connecting the input and output circuits of the successive sound-receiving elements to the electron-tube circuit to render the circuit conductive causing alternating currents to flow in the electron-tube circuit in response to the sound-waves received by the successive elements, display means, means cooperative with the connecting means and responsive to the currents flowing in the electron-tube circuit for controlling the display means in order to produce a likeness of the object thereupon.

7. An electric system having, in combination, a plurality of sound-receiving elements for receiving sound waves from an object, each element having an input and an output circuit, a normally non-conducting electric circuit for interconverting sound-wave and electric energy, two sets of switch terminals each having one switch terminal corresponding to each of the elements, means for connecting the input circuit of each element to its corresponding switch terminal of one set and the output circuit of the element to the corresponding switch terminal of the other set, means for simultaneously connecting corresponding switch terminals of the two sets of switch terminals successively to the electric circuit thereby simultaneously to connect the input and output circuits of the corresponding successive elements to the electric circuit, and display means controlled in accordance with the connecting means and responsive to the interconverted energy of the electric circuit for producing a likeness of the object.

8. An electric system having, in combination, a plurality of magnetostrictive sound-receiving elements, means for converging sound energy emanating from an object upon the magnetostrictive elements to set the magnetostrictive elements into mechanical vibration, electric-circuit means, means for connecting the magnetostrictive elements to the electric-circuit means to produce magnetostrictive-oscillator means for enhancing the mechanical vibrations set up in the magnetostrictive elements, and means connected to the magnetostrictive-oscillator means for producing a likeness of the object.

9. An electric system having, in combination, magnetostrictive means, means for converging sound energy emanating from an object upon the magnetostrictive means to set the magnetostrictive means into mechanical vibration, means for enhancing the mechanical vibrations set up in the magnetostrictive means, and means controlled in accordance with the enhanced mechanical vibrations of the magnetostrictive means for producing a likeness of the object.

10. An electric system having, in combination, magnetostrictive means, means for converging sound energy emanating from an object upon the magnetostrictive means to set the magnetostrictive means into mechanical vibration, magnetostrictive-oscillator means comprising the magnetostrictive means for enhancing the mechanical vibrations set up in the magnetostrictive means, and means connected to the magnetostrictive-oscillator means for producing a likeness of the object.

11. An electric system having, in combination, a plurality of magnetostrictive sound-receiving elements, means for converging sound energy emanating from an object upon the magnetostrictive elements to set the magnetostrictive elements into mechanical vibration, means for enhancing the mechanical vibrations set up in the magnetostrictive elements, and means controlled in accordance with the enhanced mechanical vi-

brations of the magnetostrictive elements for producing a likeness of the object.

12. An electric system having, in combination, a plurality of magnetostrictive sound-receiving elements, means for converging sound energy emanating from an object upon the magnetostrictive elements to set the magnetostrictive elements into mechanical vibration, electric-circuit means, means for connecting the magnetostrictive elements to the electric-circuit means to produce a magnetostrictive oscillator with an input circuit and an output circuit for enhancing the mechanical vibrations set up in the magnetostrictive elements, means controlled by the magnetostrictive elements for controlling the input circuit, and means connected to the output circuit for producing a likeness of the object.

13. An electric system having, in combination, mechanically vibratory means adapted to be set into mechanical vibration in response to sound energy impinging thereon, means for converging sound energy emanating from an object upon the mechanically vibratory means to set the mechanically vibratory means into mechanical vibration, means operable irrespective of the frequency of the sound energy impinging upon the mechanically vibratory means for enhancing the mechanical vibrations set up in the mechanically vibratory means, and means controlled in accordance with the enhanced mechanical vibrations of the mechanically vibratory means for producing a likeness of the object.

14. An electric system having, in combination, mechanically vibratory means adapted to be set into mechanical vibration in response to sound energy impinging thereon, means for converging sound energy emanating from an object upon the mechanically vibratory means to set the mechanically vibratory means into mechanical vibration, means for converting the energy of the mechanical vibration of the mechanically vibratory means into electric energy, means for enhancing the mechanical vibrations set up in the mechanically vibratory means to enhance the electric energy into which the energy of the mechanical vibration of the mechanically vibratory means is converted, and means controlled in accordance with the enhanced electric energy for producing a likeness of the object.

15. An electric system having, in combination, a plurality of magnetostrictive sound-receiving elements, means for converging sound emanating from an object upon the magnetostrictive elements to set the magnetostrictive elements into mechanical vibration, the magnetostrictive elements respectively corresponding to respective component parts of the object the sound emanating from which impinges upon them, electric-circuit means, means for connecting the magnetostrictive elements to the electric-circuit means to produce magnetostrictive-oscillator means for enhancing the mechanical vibrations set up in the magnetostrictive elements, and means connected to the magnetostrictive-oscillator means and operable when the magnetostrictive elements are connected to the electric-circuit means to produce portions of a likeness of the object corresponding to the sound energy impinging upon the respective magnetostrictive elements.

16. An electric system having, in combination, a plurality of mechanically vibratory sound-receiving elements each adapted to be set into mechanical vibration in response to sound energy impinging thereon, means for converging sound energy emanating from an object upon the mechanically vibratory elements to set the mechanically vibratory elements into mechanical vibration, means operable irrespective of the frequency of the sound energy impinging upon the mechanically vibratory elements for enhancing the mechanical vibration set up in the mechanically vibratory elements, and means controlled in accordance with the enhanced mechanical vibrations of the mechanically vibratory elements for producing a likeness of the object.

17. An electric system having, in combination, a plurality of mechanically vibratory sound-receiving elements each adapted to be set into mechanical vibration in response to sound energy impinging thereon, means for converging sound energy emanating from an object upon the mechanically vibratory elements to set the mechanically vibratory elements into mechanical vibration, means for scanning the vibratory elements, means for enhancing the mechanical vibration set up in each mechanically vibratory element as it is scanned and for converting the enhanced mechanical vibration of each mechanically vibratory element into electric energy, and means controlled in accordance with the electric energy for producing a likeness of the object.

18. An electric system having, in combination, a plurality of magnetostrictive sound-receiving elements, means for converging sound energy emanating from an object upon the magnetostrictive elements to set the magnetostrictive elements into mechanical vibration, means for scanning the magnetostrictive elements, electric-circuit means, means operable as the magnetostrictive elements are scanned for connecting them to the electric-circuit means to produce magnetostrictive-oscillator means for enhancing the mechanical vibrations set up in the magnetostrictive elements, and means connected to the magnetostrictive-oscillator means for producing a likeness of the object.

19. An electric system having, in combination, a plurality of mechanically vibratory sound-receiving elements each adapted to be set into mechanical vibration in response to sound energy impinging thereon with an intensity corresponding to the intensity of such impinging sound energy, means for converging sound energy emanating from an object upon the mechanically vibratory elements to set the mechanically vibratory elements into mechanical vibration each with an intensity corresponding to the intensity of the sound energy emanating from the component part of the object from which the sound energy impinging thereon emanates, means operable irrespective of the frequency of the sound energy impinging upon the mechanically vibratory elements for enhancing the mechanical vibration set up in the mechanically vibratory elements, means for scanning the mechanically vibratory elements, and means operable as each mechanically vibratory element is scanned for producing, in a region corresponding to the component part of the object from which the sound energy impinging on such mechanically vibratory element emanates, an illumination of intensity corresponding to the intensity of the sound energy emanating from such component part of the object, thereby to produce a likeness of the object.

20. An electric system having, in combination, a plurality of mechanically vibratory sound-receiving elements each adapted to be set into mechanical vibration in response to sound energy impinging thereon, means for converging sound energy emanating from an object upon the me-

chanically vibratory elements to set the mechanically vibratory elements into mechanical vibration, means for enhancing the mechanical vibration set up in the mechanically vibratory elements, display means, electric-circuit means normally disconnected from the mechanically vibratory elements and the display means, means operable when the electric-circuit means is connected to the mechanically vibratory elements and the display means to convert the energy of mechanical vibration of the mechanically vibratory elements into electric energy and to control the display means in accordance with the electric energy, means for connecting the mechanically vibratory elements to the electric-circuit means, and means operable synchronously with the connecting means for connecting the electric-circuit means to the display means at times when a mechanically vibratory element is connected to the electric-circuit means.

21. An electric system having, in combination, a plurality of mechanically vibratory sound-receiving elements each adapted to be set into mechanical vibration in response to sound energy impinging thereon with an intensity corresponding to the intensity of such impinging sound energy, means for converging sound energy emanating from an object upon the mechanically vibratory elements to set the mechanically vibratory elements into mechanical vibration each with an intensity corresponding to the intensity of the sound energy emanating from the component part of the object from which the sound energy impinging thereon emanates, means for enhancing the mechanical vibration set up in the mechanically vibratory elements, means for scanning the mechanically vibratory elements, a cathode-ray oscilloscope having a screen regions of which correspond to component parts of the object and to the respective mechanically vibratory elements upon which the sound energy emanating from the respective component parts of the object impinge, and means operable as each mechanically vibratory element is scanned for illuminating the region of the screen corresponding to such mechanically vibratory element with an intensity corresponding to the intensity of the sound energy emanating from the corresponding component part of the object, thereby to produce a likeness of the object.

22. An electric system having, in combination, a plurality of magnetostrictive sound-receiving elements, means for converging sound energy emanating from an object upon the magnetostrictive elements to set the magnetostrictive elements into mechanical vibration each with an intensity corresponding to the intensity of the sound energy emanating from the component part of the object from which the sound energy impinging thereon emanates, means for enhancing the mechanical vibration set up in the magnetostrictive elements, means for scanning the magnetostrictive elements, and means operable as each magnetostrictive element is scanned for producing, in a region corresponding to the component part of the object from which the sound-energy impinging on such magnetostrictive element emanates, an illumination of intensity corresponding to the intensity of the sound energy emanating from such component part of the object, thereby to produce a likeness of the object.

23. An electric system having, in combination, a plurality of magnetostrictive sound-receiving elements, means for converging sound energy emanating from an object upon the magnetostrictive elements to set the magnetostrictive elements into mechanical vibration each with an intensity corresponding to the intensity of the sound energy emanating from the component part of the object from which the sound energy impinging thereon emanates, means for enhancing the mechanical vibration set up in the mechanically vibratory elements, a cathode-ray oscilloscope having a screen regions of which correspond to component parts of the object and to the respective magnetostrictive elements upon which the sound energy emanating from the respective component parts of the object impinge, and means operable as each magnetostrictive element is scanned for illuminating the region of the screen corresponding to such magnetostrictive element with an intensity corresponding to the intensity of the sound energy emanating from the corresponding component part of the object, thereby to produce a likeness of the object.

ROBERT HARVEY RINES.

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