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UNITED STATES PATENT AND TRADEMARK OFFICE GRANTED PATENT

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Link to Claims Section

November 7, 1950

Electric system

INVENTOR: HARVEY RINES ROBERT

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SUMMARY:

The present invention relates to electric systerns; and more particularly to receiving systems using: sound waves as the agency of eommunication: 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 vibrationsv This present application is a division of application, Serial Number 597,281, JQ filed: June 2, 1945:

An: object of -the invention is to provide a new and improved sound -receiving system embodying a. novel cathode-ray-tube member.

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 drawing, the single figure of which is a diagrammatic view of circuits: and apparatus arranged and: constructed in! accordance with a preferred embodiment thereof.

A directive ultrasonic transmitter is shown comprising an ultrasonic oscillator !05 for exciting a piezo-electric

crystal 10! and an auxiliary " reflector 103 for reflecting ther energy emitted by the piezo-electric crystal 10 1 upon a parabolic sound: reflector (. Ultrasonic waves are thus propagated toward: an object 3, illustrated as an , underwater submarine. The sound waves are refleeted and scattered from the surface of the object 3 toward a sound-receiving station. The invention is operable also with objects 3" that emit, as well as reflect or scatter, sound waves. gg At the receiving station, the sound waves thus reflected and scattered from the object 3 may be focused, converged or directed by a sound lens 5 upon a bank or array 26, comprising a plurality of sound-receiving pick-up unit eiements, mechanically vibratory in response to the sound energy impinged thereon. The sound lens 5 may be replaced by any other type of wellknown lens, mirror or other directive system for focusing the sound waves scattered and reflected from the: object 3 on the bank or array 28 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. 59 The vibratile pick-up elements of the bank or array 26:are illustratively shown as piezo-electriccrystal receiver elements embedded in the insulating screen, face or wall 7 of a cathode-rayoscilloscope-like member 9: They may, forexample, be constituted of Rochelle salt, dihydrogen potassium phosphate, or any other suitablesub - stance, including quartz. The front surface of each crystal element projects forward beyond the screen, face or wall 7 of the member 9 outside the cathode-ray member, exposed in the direction of the incoming sound waves, but the/rear surface of each crystal element is exposed within the evacuated cathode-ray-tube member 9 along ne inside surface of the screen, face or wall 7.

The crystal 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 group of crystals 25, 23, 27, 21, 19, 17, 15, 1 3 and 1 1 , shown as equally spaced horizontally. The second row from the top is shown constituted of a group of similarly disposed crystals, respectively disposed directly below e corresponding crystals of the first row; several of these are illustrated at 29, 31, and 33. The third or next-lower row is similarly constituted, several of the crystals being illustrated: at and 37. Though only a small number of pickunits 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 crystal elements 25, 29, 35, etc., are shown equally spaced vertically in the first or righthand column. The crystal elements 23, 31, 37, etc., are disposed in the second column from the right. The crystal elements 27, 33, etc., are disposed in the third column from the right, 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.

Upon: the successive short-circuiting of each ccY-stal-condenser element by the electron stream, as:disc.ussed:aboye, the alternating voltage across the impedance 4 is diminished by the small voltage from the particular crystal element representative of the intensity of the sound wave impinged on that element. The amplified positive pulses o.ccuring in the output of the amplifier 24, during the scanning of a crystal, therefore, will have a, peak amplitude that is less than before by an amount equal to the amplification of the tube multiplied by the voltage appearing across the particular crystal element. The output of the amplifier 24 will thus obviously vary, at successive instants, in accordance with the discharge or short-circuiting of the successive crystals, which discharge, as before stated, is ameasure of the strength of the sound energy received by the corresponding pick-up elements:

Means is provided, controlled by the discharge or short-circuiting of the crystal electrodes, for producing, upon the screen of the display oscilloscope 90, images 1.23 corresponding to the sound: energy received by the corresponding pick-up elements. Successively disposed parts, portions, regions or areas of the screen 30, that correspond to the similarly disposed pick-up elements, are energized by an electron stream in the oscilloscope to illuminate them. This electron stream is synchronized to travel with the electron stream of the cathode-ray-like member 9. The horizontal sweep circuit is shown connected to the horizontal-deflector plate 116 of the oscilloscope 90, and to the horizontal deflector plate IS of the oscilloscope-like member 9: The vertical-sweep circuit 22 is shown connected to the vertical-deflector plate H2 of the oscilloscope SB and to the vertical-deflector plate 12 of the oscilloscope-like member 9. The other horizontal-deflector plate 118 and the other vertical-deflector plate of the oscilloscope are shown grounded.

Since the cathode-ray tubes 9 and are subjected to the same scanning voltages, the electron stream in the tube will impinge on the fluorescent screen in synchronism with the electron stream impinging on the crystals on the face T of the oscilloscope-like member 9 during the voltage-discharging or scanning, process. The signals amplified by the amplifier 24, and fed between the cathode and the control electrode 80, will produce intensity modulation of the beam impinging on the screen 30.

Prior to the discharging process, the positive swings or pulse outputs of the amplifier 24 would make the cathode 6D periodically positive with respect to the grid 80. In conjunction with the bias of a battery 38 disposed between the cathode and the grid 80, this would permit the passage of but few of the electrons of the electron stream beyond the grid 80. Since, during the discharge of a crystal element, however, the positive swings or pulses in the output of the amplifier 24 are of a peak amplitude less than the original pulses by an amount proportional to the voltage produced by the sound waves across the particular crystal element, the cathode is periodically driven less positive with respect to the grid 80. A larger quantity of electrons are thus permitted to travel periodically past the anode 100, during the train of pulses produced by a crystal-condenser discharge, to impinge finally on the fluorescent screen 30. The quantity of electrons that reach the screen to produce intensity modulation during the scanning of a particular crystal, therefore, depends on the decrease in the output of the amplifier 24, and this, in turn, depends upon the voltage produced across the crystal by the sound-wave intensity impinged thereon. The illumination resulting from the intensity modulation on the screen will be such that the intensity of illumination of parts of the screen 3fl corresponding to parts of the crystal bank will-correspond to the sound-wave image on the rows and columns of the bank 26; this soundwaveimage, in turn, corresponding to correspondingly disposed parts of the object 3.

The sound waves received successively by the crystal units along the successive rows and columns as the units are rendered successively effective in the display circuit, will thus become con2o verted into successive portions of the visual likeness; along correspondingly disposed rows and columns thereof, along the successive time bases. The visual picture i 23 of the object 3 on the oscilloscope screen will accordingly correspond to the sound-energy-frequency picture on the array 2-6 of pick-up elements which, in turn, corresponds to the actual object 3. A visual image of the object. 3r is thus produced on the screen 30. The crystals of the bank 26 may be wafer thin in order to make possible the use of a sufficiently large number of them in the array 26 to provide for good definition. The frequency of the sound waves, for example, may be megacycles, corresponding to a wavelength of approximately x 105 feet, in water, and produced, for example;, by an oscillating quartz crystal, as described, for example, in an article by W. P. Mason and i; E. Fair, entitled "A New Direct CrystalControlled Oscillator for Ultra-Short-Wave Frequencies," Proceedings of the Institute of Radio Engineers, October, 1942, vol. 30, No. 11, pages 464 to 472. Lower-frequencied crystal oscillators may also be used, as described, for example, in an article by G. W. Pierce, entitled "Piezoelectric 15 Crystal Oscillators Applied to the Precision Measurement of the Velocity of Sound in Air and CO at High Frequencies," Proceedings of the American Academy of Arts and Sciences, October, 1925, vol. 60, No. 5, pages to 295. Reference may be made also to W. G. Cady, Piezoelectricity, McGraw-Hill, 1946, pages 501 to 506 and 682, and Kamayachi and Watanabe, Electrotechnical Journal of Japan, vol. 5, No. 1, 1941, pages and 20.

i& gt;r& gt; 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.

ENGLISH-CLAIMS:
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What is claimed is:

1. In an evacuated cathode-ray apparatus provided with means for producing an electron stream, a mosaic upon

which the electron stream may impinge provided with a plurality of groups of piezo-electric elements having front and rear surfaces and substantially equally spaced along a predetermined dimension, with the piezo-electrie elements of each group substantially equally spaced along a second predetermined dimension, the front surfaces of the elements being exposed through the front surface of the screen to receive sound waves and the rear surfaces of the elements g being exposed through the rear surface of the screen within the evacuated cathode-ray apparatus, and means for directing the electron stream upon the rear surfaces of the elements.

2. An electric system having, in combination, 1 an evacuated cathode-ray member having means for producing electrons, a plurality of soundwave receiving elements mounted along a wall of the cathode-ray member and capable of responding electrically when mechanically vibrated by is sound waves impinged thereupon, one surface of each sound-wave receiving element being exposed at the surface of the said wall outside the cathode-ray member to receive sound waves and another surface of each element being exposed at the surface of the said wall within the evacuated cathode-ray member to the electrons, and means for directing the electrons upon the said other surfaces of the elements.

6. An electric system having, in combination, an evacuated cathode-ray member having means for producing electrons, a plurality of series-connected sound-wave receiving elements mounted along a wall of the cathode-ray member and capable of responding electrically when mechanically vibrated by sound waves impinged thereupon, one surface of each sound-wave receiving element being exposed at the surface of the said wall outside the cathode-ray member to receive sound waves and another surface of each element being exposed at the surface of the said wall within the evacuated cathode-ray member to the electrons, and means for directing the electrons upon the said other surfaces of the elements.

ROBERT HARVEY RINES.

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