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Sonic picture system

INVENTOR: HARVEY RINES ROBERT

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SUMMARY:

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

At the receiving station, the sound Waves thus reflected and scattered from the object I may be focused by a sound lens 3 upon a bank or array 5, comprising a plurality of sound-receiving pick-up unit elements vibratory in response to the sound energy impinging thereon. The sound lens 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 f on the bank or array 5 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 5 are shown as a plurality of vibrator receiver elements, sound insulated from one another as shown at 43, 45, 47, 49 and 51, to prevent vibrational interference. These elements may, for example, be of the transversely-vibrating diaphragrtttype disclosed in Letters Patent 2,063.,944, granted to G. W. Pierce, on December 15, 1936. The outer vibrator elements may be supported by clamps as described in Letters Patent 2,063,945, issued on the said December 15, 1936, to the said G. W. Pierce. The inner vibrator elements are shown mounted within frames bounded by the sound-insulating members 43, 45, 47, 49 and 51.

If the lens 3 has a large focal length, the waves focused on any diaphragm of the bank will enclose a small solid angle. The waves within that small solid angle will arrive at the diaphragm with their wave fronts almost parallel. Let it be assumed that these wave fronts, at the time that the waves converge upon the diaphragm, are parallel to the line 7 - 7. A maximum vibratory response will then be obtained if the diaphragm be oriented parallel to the line 9 - 9 making the Pierce angle with the line 7 - 7.

The Pierce angle e is given by the formula where Vo is the velocity of propagation in the medium, which here may be water, and V is the corresponding velocity, at the critical frequency of the propagation, of the transverse sound or other elastic waves in the diaphragm. The Pierce angle may not be necessary for operation, how- .30 ever, where the focused vibrations are of sufficient magnitude to transfer elastic vibrations to the diaphragm.

The diaphragm pick-up units are shown arranged in the form of rows and columns, in the proximity of the focal plane of the lens 3. The first or uppermost row of the bank is illustrated as comprising the vibrators 2, 4, 6, 8, and id, shown as equally spaced horizontally. The second row from the top is shown constituted of similarly disposed vibrators, respectively disposed directly below the corresponding vibrators of the first row; several of these are illustrated at 22, 24, 26, etc. The third or next-lower row is similarly constituted, several of the vibrators being illustrated at 42 and 44-. Though only a small number of pick-up units is shown in each row, and though only eleven 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 vibrator elements 2, 22, 42, etc., are shown arranged vertically in the first or left-hand column. The vibrator elements 4,. 24, 44, etc., are disposed in the second column from the left.

The vibrator elements 6, 26, 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 effective. A visual likeness of the object will thus be produced on the screen of the oscilloscope.

With proper predetermination or adjustment of the lengths of the conductors, the loss of column is shown as comprising only a few pick5 vibrational intensity in the various conductors 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 3 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 i. Vibrations will thus be produced across the pickup elements corresponding to the different field strengths of sound-wave energy thus received by them, and proportional to the intensity of the will be equalized, in order to maintain in a fixed magnetostrictive core !5 the relative vibrational intensities of the diaphragms.

When the commutator II is in contact with the sound contactor 120, as shown, sound waves, focused by the lens 3 from a corresponding component part or area of the object I on the vibrator ID, are transmitted along the sound conductor to the sound-contact member 128 as described in Letters Patent 2,063,947, granted to the said G. W. Pierce on the said Dec. 15, 1936. From the contact member 120, sound is conducted by the sound conductor (i to the magnetostrictive core 15. The fixed core makes contact continuously sound-wave energy reflected or scattered or otherwise emanating from the various component with the shaft of the motor IS at a point near parts of the object I and converged upon the the end thereof as the shaft rotates, thus to array 5 of pick-up elements by the lens 3. The maintain it in elastic contact with the commutasound lens 3 or its equivalent will thus focus tor conductor II. The vibrations of the core upon the array 5 the sound waves reflected or will result in magnetostrictive interaction in the scattered from the various parts of the object I coil 17. The voltage signal thus produced in the coil 17 in response to the sound signal on the vibrator will be.fed through an amplifier and a rectifier 23.

As the motor 13 revolves, the sound commutain. approximately the focal plane of the lens 3. tor H connects successive diaphragm vibrators It has heretofore been proposed to convert a of first, the top row to the core I S, arid then the diaphragm vibrators of the next successively lower rows of the array 5. All the elements of the bank 5 will thus be successively connected in various energy strengths dependent on the reflecting properties of the component parts of the object I, thus to produce a faithful sound image of this distribution of the sound waves sound-energy picture of this character into a visible-picture likeness 39 of the object I upon the fluorescent viewing screen 41 of a display cathode-ray oscilloscope tube 37 The tube 31 35 to the ampiifler 21 during one revolution of the is shown 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 diaphragm pick-up elements through the use of the Pierce angle 6, as has been more fully described.

motor (3 As will presently appear, this results in effectively scanning the diaphragm pick-up elements and the cathode 47 of the oscilloscope 37.

Electrons emitted from the cathode 47 of the tube 37 will become accelerated, in response to Each transversely vibrating vibrator is con45 PrPer stimulation of the grid 45, so as to pass nected by a sound conductor to a fixed soundcontact member. The sound conductors may, for example, be of the nature described by S. Sokoloff on pages 542 to 544, vol. 2, of Technical Physics of the U. S. S. R., 1935. The vibrators 2, 4, 6, 8, and of the top row of vibrators, for example, are respectively connected by sound conductors 12, 14, 16, 18 and to sound-contact or transfer members 112, 114, 116, 118 and 120. The vibrator by the grid to the anode S3 of the oscilloscope 37. The electrons will continue to travel in a stream from the anode .43, between a pair of vertically disposed deflector plates .29 and 31, of which the plate 31 is shown grounded, and between a pair of horizontally disposed deflector plates 33 and 35, of which the plate is shown grounded, to impinge finally on the screen 41. A horizontal-sweep-time base, applied to the vertiof the second row is connected by a sound 55 cally disposed deflector plates 28 and 31, will conductor 32 to a contact member 132, the vibrator 42 of the third row is connected by a sound conductor 52 to a contact member 152, and so on. The stationary sound-contact members are arcause the electron stream from the cathode to become deflected horizontally in a period corresponding to the time in which the motor causes the sound commutator 11 successively to ranged in a circle in order successively to make 60 connect all the vibrators of a complete row to contact or engage elastically with a sound-conducting commutator or distributor 11, rotated by a motor 13. The invention thus provides a sound-distributthe ampiifler 21. After each horizontal sweep of the oscilloscope 37 has been completed, a successively larger voltage will be applied to the horizontally disposed deflector plates 33 and ing means associated with the

normally ineffec65 of the oscilloscope 37, by a vertical-sweep-time tive receiving diaphragm pick-up elements together with a plurality of sound conductors for successively connecting the diaphragms to the distributor. The distributor, moreover, is acbase, 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 41 corresponding tuated to connect it with the sound conductors 70 to successively lower vertically disposed levels in succession. Connection is also made synchronously with the actuation of the distributor to connect the cathode-ray oscilloscope and the of the rows of vibrators. After the last such horizontal sweep, the hori-

-----zontally disposed plates of the oscilloscope will elements, thus, as will be more fully explained become restored to their starting voltage. The hereinafter, to render the elements successively T5 next horizontal sweep, therefore, will start again at the first or top row. The period of a complete vertical scan of the oscilloscope 37 will correspond to the period of one revolution, of the motor 13, during which period all the rows and columns of vibrators are successively connected to the core !5. Sweep generators and may be employed to produce the horizontal-timebase sweep and the vertical sweep, respectively, 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 29 and 31 of the cathode-ray tube 37, travels along any particular horizontal line on the screen SI, the voltages fed from the rectifier 23 between the grid and the cathode 47 cause more or less electrons to pass to the screen 41, thereby intensity modulating this horizontal line of the electron stream impinging on the screen 4!. This affords successive indications of the intensity of the sound energy impinged upon the diaphragm receiving elements of the particular row of diaphragm elements at the time that they are connected into the vacuum-tube circuit.

Since the output of the amplifier 21 and the rectifier 23 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 I, during the scanning of the elements in response to the operation of the member 11 under the control of the motor 13, it constitutes a measure of the strength of the sound energy received by the respective pick-up elements from their corresponding component parts or areas of the object I. Successive energizing voltages are thus produced from the rectifier 23 on the control electrode of the cathode-ray tube 37, 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 41 will be such that the intensity of illumination of parts or regions of the screen 41 corresponding to particular diaphragm units of the vibrator bank 5 will correspond to the intensity of the parts of the soundwave image on the rows and columns of the bank 5; these parts of this sound-wave image and these particular diaphragm units, in turn, corresponding to correspondingly disposed component parts of the object I.

The vibrators of the bank 5 for receiving the distribution of sound waves from the object I may be thin transversely vibratory diaphragm plates of small dimensions, say, a few wave lengths, in order to-make possible the use of a sufficiently large number of them in the array to provide for good definition. The frequency of the sound waves employed may be reasonably high.

Although the invention has been described in connection with pick-up elements arranged in g 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 claim

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