Nov. 2, 1948. I. C. CLEMENT 2,452,571

SOUND SIGNALING APPARATUS

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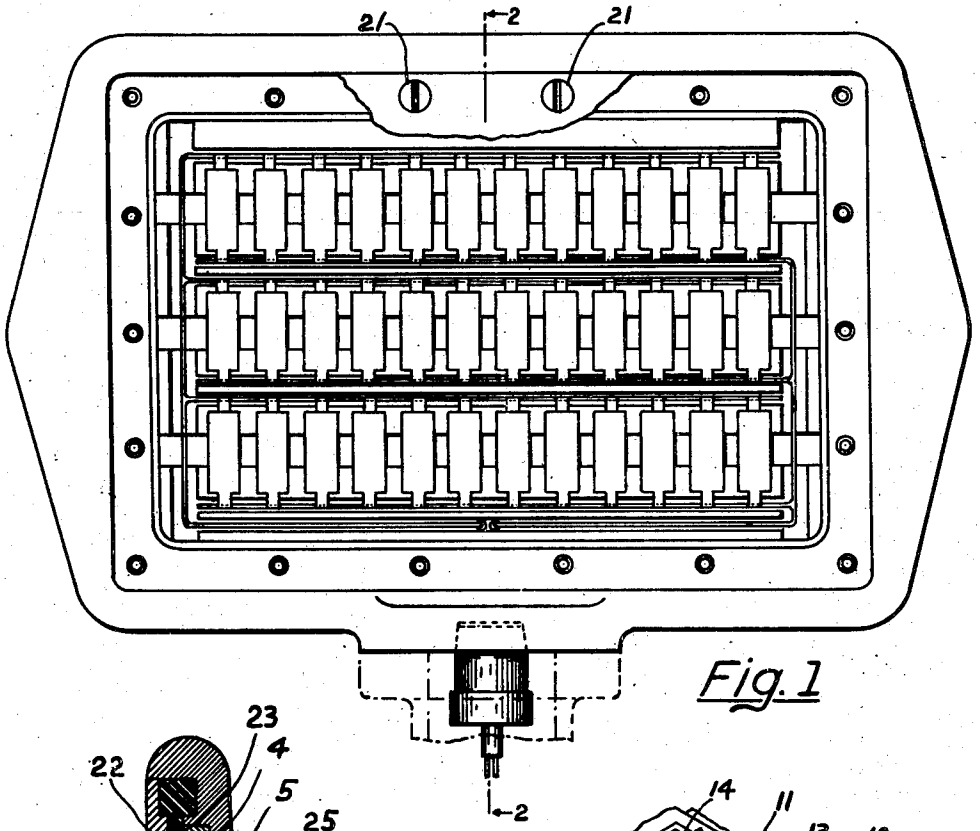


Fig. 1

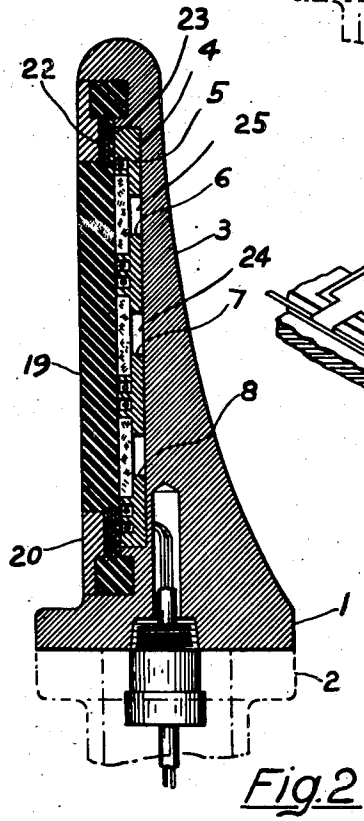


Fig. 2

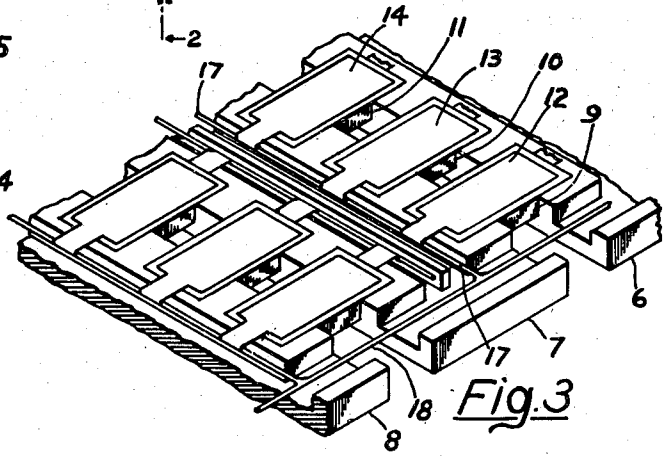


Fig. 3

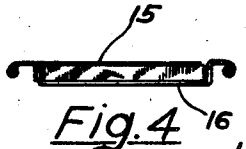


Fig. 4

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SOUND SIGNALING APPARATUS

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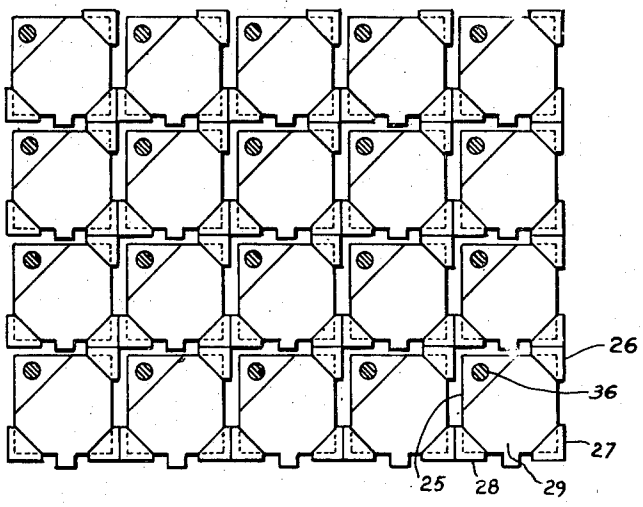


Fig. 5

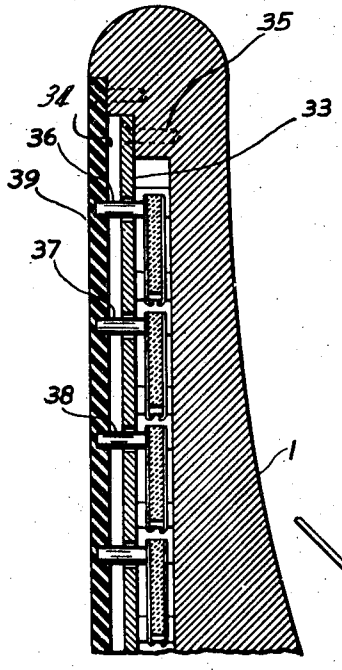


Fig. 6

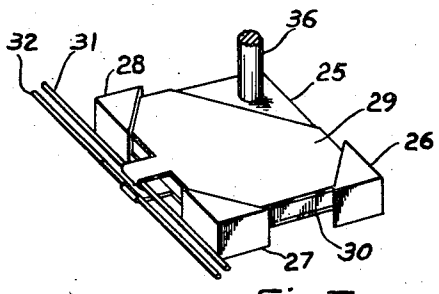


Fig. 7

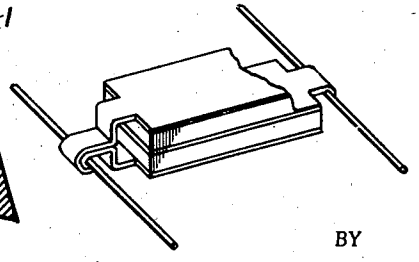


Fig. 8

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SOUND SIGNALING APPARATUS

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Application June 14, 1933, Serial No. 675,700

9 Claims. (Cl. 177—386)

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The present invention relates to an apparatus for transmitting and receiving submarine or subaqueous signals, and more particularly to the use of compressional waves in a frequency range above or near the upper limit of audibility of the human ear.

The invention further relates to the transmission of a directive beam of compressional waves with the use of piezo-electric crystals which may be quartz but preferably are Rochelle-salt crystals or crystals having similar piezo-electric properties.

In the present invention crystals of the Rochelle-salt type are not used purely as a so-called compressional crystal in which a compression between two faces of the crystal sets up an electrical potential in a direction parallel to the faces and normal to the opposite faces but the crystals are used as bending crystals, and in this connection the method of support and the method of applying the vibratory energy to the crystal are substantially different. The crystals as indicated may be used individually or they may be mounted in groups in face-to-face relation, the outer electrodes being connected together and serving as one pair of electrodes while the inner face-to-face electrodes serve as the common electrode.

The device of the present application may in particular be used to receive supersonic waves within a broad range of frequencies by the use of a plurality of crystals substantially aligned in the same plane covering a large surface as compared with the wave length of the wave which is being transmitted or received. A directional beam may be transmitted when the device is used as a transmitter or the device may act as a directional receiver, in which case it receives waves from substantially one direction.

The apparatus will be more fully described in connection with the description of the embodiment illustrated in the drawings annexed to the specification in which Fig. 1 shows a vertical view of the apparatus with the diaphragm removed; Fig. 2 shows a sectional view along the line 2—2 of Fig. 1; Fig. 3 shows a perspective view of the arrangement of the crystals; Fig. 4 shows a detail view of the application of the electrodes to the crystals; Fig. 5 shows a plan view of the modification of the system shown in Fig. 1; Fig. 6 shows a part sectional view of the same modification corresponding to Fig. 2; Fig. 7 shows a detail of the method of the support of the crystals as used in Fig. 5; and Fig. 8 shows

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a modification of the detail of the crystal as shown in Fig. 4.

In Figs. 1 and 2 the apparatus is contained in a casing 1 which is supported preferably by the center piece 2 at the bottom of the middle of the casing. As illustrated in Figs. 1 and 2 the support may be circular so that the whole device may be mounted in a bearing and rotated about a vertical axis. The casing 1, which may be of metal, is provided with a heavy back plate 3 which tapers somewhat to the top of the apparatus as shown more particularly in Fig. 2. Within the back plate 3 is a recessed portion 4 in which the elements 5, 6, 7 and 8 are positioned. These elements, as illustrated in Fig. 3, may be molded or formed to have recessed portions 9, 10, 11, etc., in which the crystals may be positioned. The molded elements 5, 6, 7 and 8 are spaced apart in parallel relation and form pockets in which the ends of the crystals 12, 13, 14, etc., rest. This is shown quite clearly in Fig. 3 where one end of the crystal 12 rests in the pocket 9 formed in the support 6 while the other end of the crystal rests in a corresponding pocket in the support 7.

Each crystal is provided with electrodes at both sides thereof. These electrodes are indicated in Fig. 4 by numerals 15 and 16, and, as shown in Fig. 3, each electrode is conductively connected to a conductor 17 connecting to a main conductor 18, the conductor 17 resting in a groove parallel to the supporting element while the conductor 18 connects all the conductors 17 in the cross grooves together. The crystals may all be connected in parallel with the top electrodes all connected together to the same conductor and the lower electrodes connected together to a different conductor or any parallel series combination may be employed.

The supporting elements 5, 6, 7 and 8 may be of any yielding material such as rubber but I prefer to use the substance which is known as "glyptal" and which is a synthetic rubber but possesses the desirable quality that it is yielding but has slight elasticity. At the front of the crystals there is positioned a rubber diaphragm 19 the surface of which preferably comes in contact with the crystal itself. While the diaphragm 19 may have a substantial thickness it is preferable to have it of such a material and thickness that the compressional waves are transmitted through it as part of the propagating medium so that it does not act in effect like a diaphragm and produce reflections at its surfaces. For this purpose soft rubber is preferably used which has

about the same sound hardness as water and on account of which the compressional waves are transmitted through it as though it were a part of the propagating medium itself.

The diaphragm 19 may be held in place by the clamping ring 20 suitably bolted to the back casing through the bolts 21, 21 arranged around the periphery of the casing. The diaphragm 19 may have a thick central portion and be provided with a thin neck portion 22 in which a hard fiber ring 23 may be inserted for the purpose of furnishing a firm clamping surface and preventing yielding in the clamping joint.

In the operation of the device shown in Figs. 1 to 4, inclusive, the sound impressed upon the diaphragm 19 is transmitted directly to the crystals causing a bending of the crystals between the two supporting ends. This bending creates a potential difference between the faces of the crystals which is detected in the receiver or receiving circuit. When the device is used as a transmitter, electrical energy is applied to the electrodes of the crystal and the crystals are made to bend in the same manner that they are bent when excited by compressional waves.

The open spaces 24 and 25 between the crystal supports may, if desirable, be partially or substantially filled with some fluid or liquid in which the crystals will not dissolve. Substances like castor oil or other suitable oils may be used for this purpose.

In the modifications shown in Figs. 5, 6, 7 and 8 the crystal 25 is supported by rubber corners 26, 27 and 28 in which the corners of the crystals fit with the attached electrodes 29 and 30. The electrode 29, as indicated, may be connected to conductor 31, the electrode 30 to the conductor 32.

The corners 26, 27 and 28, supporting three corners of the crystal, may be made of molded rubber or of the substance of the nature previously described. The crystals with the molded corners attached are held in position in the casing 1 by means of the plate 33 which is supported on a shoulder 34 in the casing by means of the bolts 35. The plate 33 is perforated at points corresponding to the free corners of the crystals, and through these perforations the rods 36, 37, 38, etc., operate, transmitting acoustic vibrations to the free corners of the crystals. The rods themselves may be of rubber or other similar molded material or they may be metallic and the diaphragm 39 itself rubber. In the modification illustrated in these figures the same type of bending action is obtained as that described in connection with the operation of the first modification of the invention. It will be noted that in both modifications the crystals are substantially placed in the same plane, and the front surface or face of the crystals substantially lies in this plane. With this arrangement the sound energy approaching normal to the surface of the diaphragm excites all of the crystals in the same phase while the sound energy approaching from any but the normal direction excites the crystals out of phase. In this way it will be readily observed that the device is highly directional in a direction normal to the surface of the diaphragm.

In Fig. 8 a slightly different form of crystal structure is shown. In this figure it will be noted that two similar crystals are mounted in face-to-face contact. The crystals in this figure are mounted so that the same polarity is produced on the top and bottom electrodes of the combination, with the other polarity on the adjacent or common electrode between the two crystals.

The crystal structure illustrated in Fig. 8 may be substituted for that shown in Figs. 2 and 5 and the crystals will substantially operate and act in the same way.

Having now described my invention, I claim:

1. A submarine transceiver including a plurality of individual piezo-electric crystals of the Rochelle salt type formed as flat plates, means positioning said crystals with similar surfaces in the same plane and supporting the crystals only near their end portions, a diaphragm covering the front of the crystals and in acoustic relation thereto, said crystals being provided with electrodes and means conductively connecting said electrodes together.

2. A submarine transceiver including a piezo-electric crystal of the Rochelle salt type formed as a flat plate, means supporting the plate near its end positions on one side, a diaphragm covering the plate on the other side and in acoustic relation thereto, said crystal being provided with electrodes and means conductively connected to said electrodes.

3. A submarine transceiver including a casing having a heavy back frame, a plurality of supports which permit limited flexure mounted within the casing at the back, a plurality of piezo-electric crystals of the Rochelle salt type positioned with their end portions only on said supports and a yielding diaphragm covering the front of said crystals and in acoustic relation thereto.

4. A submarine transceiver including a casing having a rigid back element, a flat plate of "glyptal" mounted on said back element, said plate being formed with regularly spaced pockets, piezo-electric crystals of the Rochelle salt type positioned with their ends in said pockets and means for acoustically independently connecting said crystals with the compressional wave propagating medium.

5. A submarine transceiver including a casing having a rigid back element, a plurality of piezo-electric crystals of the Rochelle salt type, means for mounting said crystals individually in said casing and supporting said crystals at their back faces only near their end portions, and means in contact with said crystals on their front faces at the front of said casing for acoustically independently connecting said crystals with the compressional wave propagating medium.

6. A submarine transceiver including a casing having a rigid back element, a plurality of piezo-electric crystals of the Rochelle salt type adapted to be operated through the bending of the same, means mounting said crystals and supporting the same at their back faces near their end portions, means connecting said crystals acoustically at their front faces with the propagating medium for exerting individual pressure on the unsupported part of each of said crystals.

7. A submarine transceiver including a casing having a rigid back element, a plurality of piezo-electric crystals of the Rochelle salt type, means for mounting said crystals in said casing with similar surfaces in substantially the same plane and supporting the same at least at two places thereon on their back faces, means acoustically connecting said crystals at their front faces individually with the propagating medium, exerting pressure at places on the crystals other than the supporting places.

8. A submarine transceiver comprising a casing having a rigid back element, a plurality of piezo-electric crystals, means for mounting said crystals on the back of the said casing in substan-

tially the same or parallel planes, supporting the same at some of the corners thereof symmetrically with a center line across the face of the crystal and means acoustically connecting said crystals to the propagating medium to exert acoustic vibrations on said symmetrical line normal to the face of the crystals.

9. A submarine transceiver comprising a casing having a rigid back element, a plurality of piezo-electric crystals, means for mounting said crystals on the back of the said casing in substantially the same or parallel planes, said means including corner elements placed symmetrical with a center line across the face of the crystals for holding said crystals and means holding said corner elements in place, and means acoustically connecting said crystals to the propagating medium to exert acoustic vibrations on said crystals normal to the face of the crystals on the unsupported corners thereof on a point on said center line.

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