

Aug. 19, 1969

W. L. ANGELOFF
 TRANSDUCER OF ACOUSTICAL ENERGY EXHIBITING THE
 CHARACTERISTICS OF A PULSATING SPHERE
 Filed March 11, 1968

3,462,730

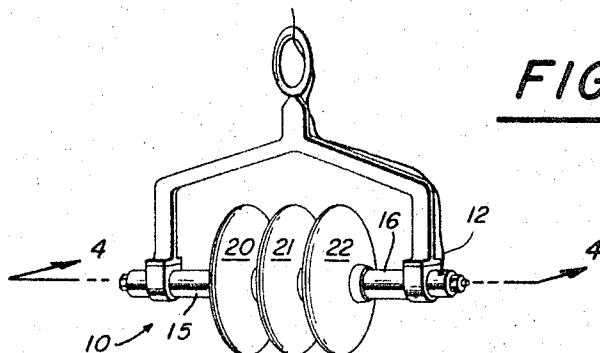


FIG. 1

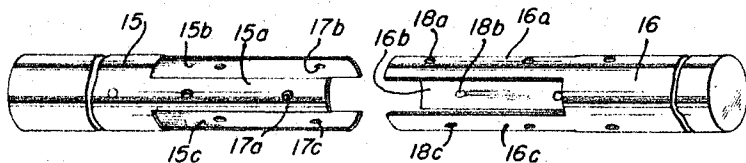


FIG. 2

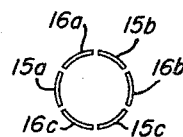


FIG. 3

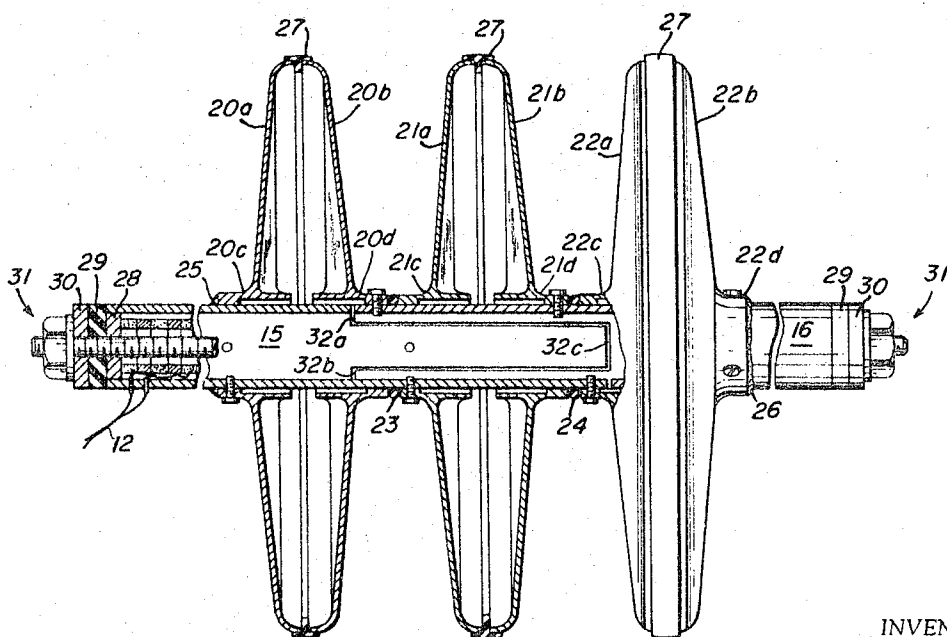


FIG. 4

INVENTOR.
 WESLEY L. ANGELOFF
 BY *Thomas Glen Keith*
James A. G. Keith
 ATTORNEYS

1

3,462,730

TRANSDUCER OF ACOUSTICAL ENERGY EXHIBITING THE CHARACTERISTICS OF A PULSATING SPHERE

Wesley L. Angeloff, San Diego, Calif., assignor to the United States of America as represented by the Secretary of the Navy

Filed Mar. 11, 1968, Ser. No. 711,968

Int. Cl. H04b 13/00

U.S. Cl. 340—8

5 Claims

ABSTRACT OF THE DISCLOSURE

The present invention relates to a transducer of acoustic energy capable of operating in a transmitting or receiving mode. An elongate electromechanical means, preferably a stack of piezoelectric cylinders, provides a mechanical deformation when an electric field is impressed thereacross or, when mechanically compressed, yields an electrical signal proportional to the mechanical deformation. A housing is provided with two interlocking splined portions enclosing the piezoelectric stack. The housing carries a plurality of piston surfaces resiliently separated in opposed pairs with the opposing surfaces of the pairs each secured to different ones of the two splined portions. Thusly constructed, with a large radiating and receiving surface in contact with the surrounding medium, the transducer tends to exhibit the operating characteristics of a nominal sphere having the attendant advantages of a greater broad-band-linear operation and lower frequency response than possible with a nominal piston transducer.

Statement of Government interest

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

Background of the invention

The field of the instant invention primarily deals with low frequency acoustic transducers having a broad band of operation. Inherently, existing transducers designed for such operation are large and cumbersome because of conventional design requirements. By enclosing the electromechanical drive element within an elongate tubular housing having mutually interlocking splined portions and mounting several radially extending piston surfaces on respective ones of the splined portions, the present invention overcomes the size limitation and presents a compact rugged transducer capable of broad band, linear operation.

Summary of the invention

The present invention is directed to providing a compact transmitter-receiver transducer responsive to signals representative of acoustic energy. An elongate electromechanical means, preferably in the form of a stack of piezoelectric cylinders alternating with parallel connected conductors, extends to opposite sides of a lightweight tubular housing. The housing is formed of two identical housing members each having a splined portion shaped for mutual mechanical cooperation that permits a reciprocal movement. Opposed pairs of radially extending piston surfaces are carried on the housing with one of each of the opposed pairs being carried on one member and the other being carried on the other member. Suitable seals between the opposed pairs and between adjacent opposed pairs seal the interior of the transducer from the surrounding medium and also permit reciprocal displacement of the piston surfaces. This reciprocal displacement between the opposed pairs is simultaneous in

2

opposite directions in accordance with an electric potential impressed across the stack.

It is an object of the present invention to provide a transducer capable of transmitting and receiving acoustic energy.

It is another object of the invention to provide a transducer which is compact and easily transportable.

A further object is to provide a transducer capable of broadband linear operation.

These and other objects of the invention will become more readily apparent from the ensuing description, drawing, and claims.

Brief description of the drawings

FIG. 1 is a perspective view of the transducer suspended in water.

FIG. 2 is a perspective exploded view of the two housing members showing the relative orientation of the splined portions.

FIG. 3 is a cross sectional end view of the splined portions illustrating the mutual mechanical cooperation therebetween.

FIG. 4 is a side view partially in section taken along lines 4—4 in FIG. 1.

Preferred embodiment of the invention

Referring now to the drawings, a preferred form of the transducer 10 is suspended by a yoke 11 in a water transmitting medium. A pair of leads 12 extend from the transducer to distant driving or monitoring electronic circuitry. While serving in a transmit or a receive mode, the transducer must be free to axially vibrate to enable projection or absorption of acoustic energy. Therefore, the manner of attachment of the yoke to the transducer must be such as to permit the aforementioned axial vibration.

The transducer housing is formed of two cylindrically shaped housing members 15 and 16, each provided with a splined portion consisting of three equally, circumferentially spaced fingers 15a, 15b, 15c, and 16a, 16b, and 16c. In the preferred form, the machining of the fingers and the relative dispositions of the fingers when both housing members are brought together and interlocked present the appearance as shown in FIG. 3. Thusly configured, the housing members are restricted to only an axial displacement with respect to one another.

Each housing member is provided with a like number of sets of three tapped holes. The tapped holes of each set are disposed in a coplanar relationship with one hole on each of the fingers. For example, note the coplanar disposition of the set of tapped holes 17a, 17b, 17c and the set of 18a, 18b, and 18c.

A plurality of transmit-receive pistons 20, 21, and 22 are formed from disc shaped piston surfaces and arranged in pairs 20a and 20b, 21a and 21b, and 22a and 22b. The innermost portions of the piston surfaces terminate in axial collars 20c, 20d, 21c, 21d, 22c, or 22d. The collars are sized to snugly fit around the outermost surface of both the housing member and each are provided with a plurality of bores spaced to coincide with the circumferential spacing of the tapped holes on the fingers.

The piston surfaces are positioned on the housing members to align the bores provided in the collars 20c, 21c, and 22c with respective sets of tapped holes provided in the fingers 15a, 15b, and 15c. Similarly, the piston surfaces 20b, 21b, and 22b are mounted on the housing member 16 to align their bores provided in collars 20d, 21d, and 22d with respective tapped holes in the fingers 16a, 16b, and 16c. Suitably sized bolts or metal screws extending through the aligned bores and holes secure the piston surfaces in opposed pairs onto the housing members.

Since the operational environment of the present invention is underwater, seals must be provided to isolate the inside of the housing from the surroundings. A pair of annular seals rings 23 and 24 are interposed between adjacent collars, 20d and 21c, 21d and 22c, while a resin like sealer 25 or 26 is preferred to seal the end collars 20c and 22d. On the peripheral extremes of the piston surfaces an annular piston ring 27, having a T-shaped cross sectional area, separates the opposed pairs of surfaces to ensure transmission of acoustic energy and to isolate the interior of the housing. As an expedient to operation and maintenance of the transducer, the opposite ends of housing members 15 and 16 are left open and an inner washer 28, washer seal 29, and outer washer 30 enclose the stack when a rod and bolt assembly 31 exerts a compressive force on the piezoelectric stack.

It can be seen that the resiliency of the seal ring and the piston ring permits axial displacement of the piston surfaces in accordance with impinging acoustic energy or an impressed electric field causing an axial deformation of the ceramic stack. In FIG. 4, for purposes of clarity, most of piezoelectric stack has been removed from the housing to allow a better showing of the spaces 32a, 32b, and 32c. These spaces must be provided between the ends of the fingers of housing member 15 and housing member 16 to permit the axial motion.

In operation the transducer is suspended in a water transmitting medium as shown in FIG. 1. The increased surface area of the correspondingly oriented vibrating surface simultaneously compresses the water medium in a manner similar to a pulsating sphere. However, this invention presents marked advantages over a pulsating sphere.

A pulsating sphere cannot be used in actual practice since an elastic spherical structure capable of pulsating in accordance with an impressed potential could not stand up to the environmental and operational demands made of it.

By providing a transducer having an infinite baffle, or node, at the center of the piezoelectric drive element driving several parallel connected opposed pairs of piston surfaces, the operational characteristics of a pulsating sphere are realized, e.g. creation of a source of harmonic spherical waves of constant intensity.

Obviously many modifications and variations of the present invention are possible. In light of the above teachings, it is therefore to be understood that within the scope of the disclosed inventive concept, the invention may be practiced otherwise than as specifically described.

I claim:

1. A transducer of signals representative of acoustic energy comprising:

means for electromechanically responding to said sig-

nals to insure reciprocal displacement in accordance thereto;

a plurality of piston surfaces disposed in opposed pairs spaced in an adjacent relationship;

first means for resiliently separating said pairs and being interposed between the peripheral extremes of each of said pairs;

two housing members configured to enclose and secure the electromechanically responding means therein and each provided with at least one mutually mechanically cooperating splined portion, correspondingly oriented ones of said surfaces being secured onto one said splined portion and correspondingly oriented opposed ones of said services being secured onto the other said splined portion; and second means for resiliently separating said pairs and being interposed between the adjacently spaced pairs, said first means and second means cooperating to isolate the transducer interior from the surrounding medium and permitting a transfer of said signals between said piston surfaces and said electromechanically responding means.

2. A transducer according to claim 1 further including:

means for maintaining said electromechanically responding means in a compressed relationship extending between said two housing members.

3. A transducer according to claim 2 in which said two housing members are formed as aligned cylinders having opposite ends abutting opposite ends of said electromechanically responding means and both of the splined portions being in circumferential alignment.

4. A transducer according to claim 3 in which said piston surfaces are disc shaped each having an inner collar provided with a transverse bore sized to positionably fit on said cylinders.

5. A transducer according to claim 4 in which said first means is an annular rubber ring having a T shaped cross sectional area and said second means is an O ring.

References Cited

UNITED STATES PATENTS

3,215,977	11/1965	Williams et al.	340—10
3,266,011	8/1966	Massa	340—10 X
3,320,581	5/1967	Sims	340—10
3,320,582	5/1967	Sykes	340—10

RODNEY D. BENNETT, Jr., Primary Examiner

BRIAN L. RIBANDO, Assistant Examiner

U.S. Cl. X.R.

340—10