

Dec. 2, 1958

F. J. FRY

2,863,075

ULTRASONIC TRANSDUCER

Filed Dec. 15, 1953

FIG. 1

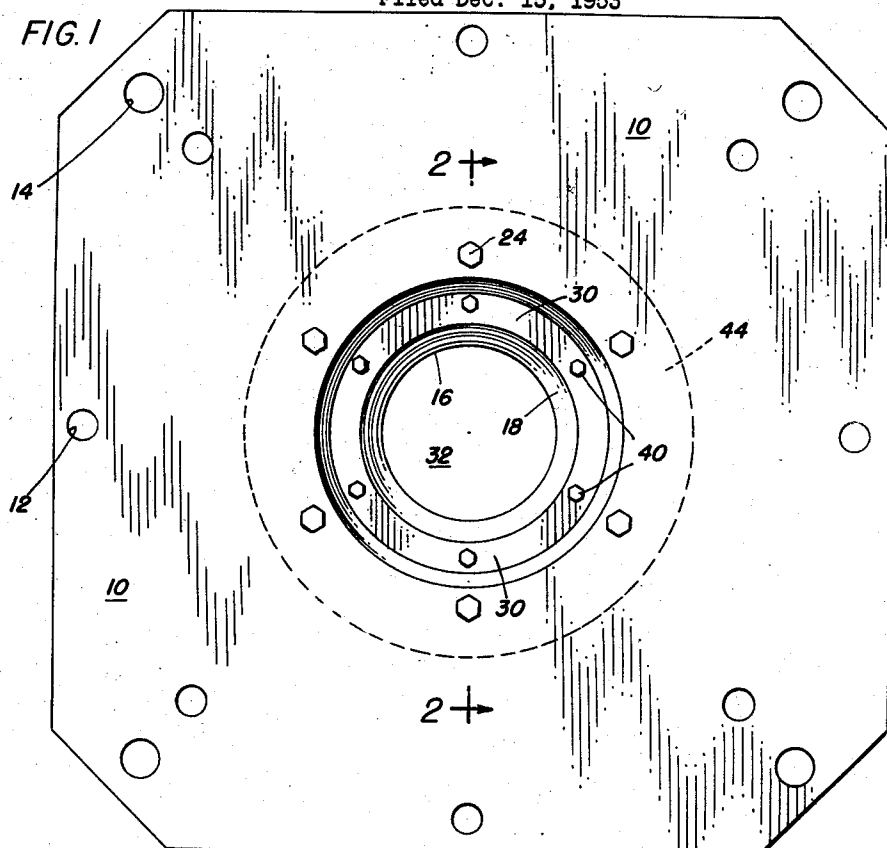


FIG. 2

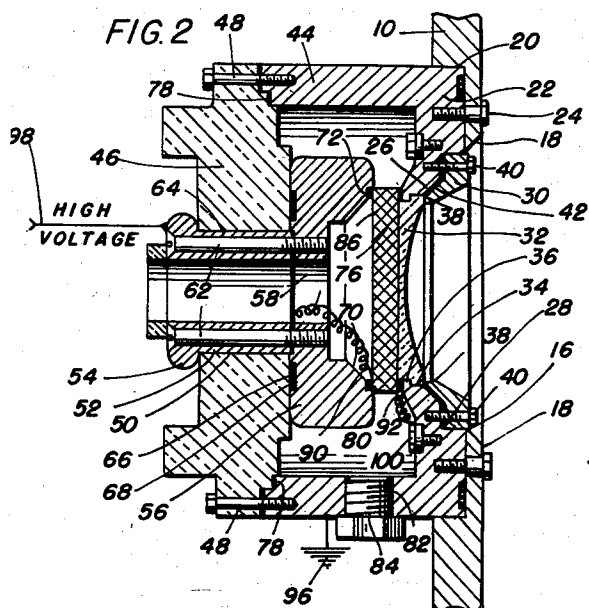
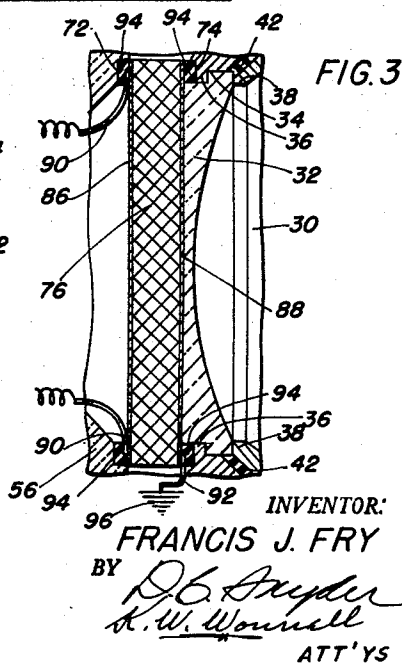


FIG. 3



INVENTOR:
FRANCIS J. FRY
BY *R. B. Snyder*
H. W. Wonnell
ATT'YS

1

2,863,075

ULTRASONIC TRANSDUCER

Francis J. Fry, Champaign, Ill., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

Application December 15, 1953, Serial No. 398,441

5 Claims. (Cl. 310—8.1)

This invention relates to an ultrasonic transducer of the crystal type for transmitting and receiving supersonic waves of variable frequencies.

An important object of the invention is to provide an improved electromechanical, ultrasonic transducer for converting electrical energy at high frequencies in the supersonic range into mechanical energy.

A further object of the invention is to provide an improved construction using a piezoelectric crystal such as barium titanate as a means for converting electrical energy with increased efficiency.

A still further object of the invention is to provide an ultrasonic transducer having a lens for focusing the sound beam in the chamber in which the liquid or other substance is subjected to mechanical vibration by the high-frequency energy produced.

A still further object of the invention is to provide a new and improved closure for separating the liquid enclosing the crystal from the chamber in which liquid is contained in which mechanical vibrations are produced.

A still further object of the invention is in providing a removable lens at one side of the vibratory crystal for focusing sound in a liquid or chamber at the side of the crystal where the lens is mounted.

Other objects of the invention will appear in the specification and will be more apparent from the accompanying drawings in which:

Fig. 1 is an elevation of the structure shown in section in Fig. 2 as applied to a mounting plate and viewed from the right side of said figure;

Fig. 2 is a sectional view of an ultrasonic transducer constructed in accordance with the principles of the invention and as taken on the line 2—2 of Fig. 1; and

Fig. 3 is an enlarged cross section of the lens and crystal portions as shown in Fig. 2.

This single-beam type of transducer may be used as a focusing irradiator in a laboratory for producing lesions of small diameter but rather long. A multibeam transducer of this type is used as an essential part of a neurosurgical apparatus for laboratory use. With this apparatus, the effects of ultrasound on the tissues of a central nerve system of an animal or of a human being may be produced and studied.

Referring now more particularly to the drawings, a transducer in accordance with this invention is secured by means of a mounting plate 10 to one side of a receptacle to which the transducer is applied. This plate is of solid conducting material and has sets of peripheral openings 12 and 14 by means of which it is secured to a container.

At the center of the plate 10 is an opening 16 with an inner beveled edge 18 and extending from the opposite face is an angular shoulder groove 20 extending around the opening. In this groove, a transducer ring support 22 is seated having a plurality of shouldered machine screws 24 inserted through the plate 10 from the inner

2

side thereof and extending into the adjacent portion of the supporting ring which projects inwardly around the edge of the opening 16. The inner edge of the mounting ring within the opening 16 has a beveled face 26 which corresponds to the beveled edge 18, and in which is a rectangular groove 28 for seating a ring retainer 30 for a lens 32. The lens has a shoulder marginal projection 34, and the inner edge of the supporting ring 22 has a shouldered projection 36 for receiving the lens therein with the shouldered portion 34 abutting the projection 36. At the inner edge of the ring retainer 30 is a contact rim 38 for engaging the outer periphery of the lens 32 and, by means of the screws 40 which extend through the periphery of the ring 30 into the holding ring support 22, the lens is clamped tightly in position. A compressible washer 42 may be interposed between the adjacent surfaces of the rings 30 and 22 so that the lens may be clamped tightly in place making a fluid-tight joint and also permitting a compression of the ring 30 against the edge of the lens. The lens is concave at its inner face and may be of polystyrene or other suitable material.

The collar or mounting ring 22 has a cylindrical flange 44 to which an outer insulator 46 (Hysol 6020) is secured by machine screws 48, a gasket 49 being clamped between the ring and the insulator. The insulator 46 has a bore 50 in which is closely fitted a cylindrical metallic conductor sleeve 52 having an outer flange 53 abutting the insulator. The inner end of the sleeve 52 is countersunk at 54 to accommodate a gasket 55. At the inner faces of the insulator 46 and sleeve 52 is a metallic contact member 56 having a bore 58 of the same diameter as and coaxial with the sleeve bore and having about the bore 58 a series of threaded holes receiving screws 62 extending from the sleeve. A gasket 66 is seated in a groove 68 in the outer face of the contact member 56. Thus the contact member 56 is clamped against the insulator 46, sleeve 52, and sleeve gasket 55, and the gasket 66 is clamped against the inner face of the insulator.

The inner side of the contact member 56 diverges at 70 to a groove 72 containing a ring gasket 74. The mounting ring 22 has a complementary groove 76 containing a ring gasket 78. A barium titanate or other suitable piezoelectric crystal 80, whose outer and inner faces are designed to provide minimum electrical stresses and are respectively plated with film electrodes 82 and 84, is clamped marginally between the gaskets 74 and 78 when the screws 48 are tightened. There is thus formed an annular chamber 86 adapted to contain an insulating liquid, such as oil, which may be supplied or removed through an opening 88 for which a threaded closure 90 is provided.

A conductor 92 extends from the outer end of the sleeve 52 for connection to a high frequency high voltage. An outer conductor 94 is arranged with one terminal clamped between the sleeve 52 and the gasket 55 and with the other terminal clamped between the outer electrode 82 and the outer gasket 74 and extending radially outward to a point about midway of the radial contact distance between the electrode and the gasket 74. An inner conductor 96 is arranged with one terminal grounded to the collar 22 by a screw 100 and the other terminal clamped between the inner electrode 84 and the inner gasket 78 and extending radially inward to a point about midway of the radial contact distance between the electrode and the gasket. The conductor terminals engaging the gaskets 74 and 78 are thus held in good electrical contact with the respective electrodes 82 and 84 without interfering with the ability of the gaskets to seal off the oil chamber 86.

The distance between the detachably mounted lens 30

and the electrode 84 is about 0.010", and this space is filled with a good-sound-transmitting liquid, such as degassed water.

The crystal generates an ultrasonic beam at the high frequency of the applied high voltage. In the absence of the lens 30, the beam is transmitted unfocused to a liquid medium (not shown) at the right. If a focused beam is desired, the lens 30 is used.

This transducer will operate either in a vertical or horizontal position as well as in any intermediate position. The transducer is therefore particularly designed for a flexible fixed-frequency, ultrasonic instrument for a wide range of research applications.

While a preferred embodiment has been described in some detail, it should be regarded as an example or embodiment of the invention and not as a restriction or limitation therein as many changes may be made in the construction and arrangement of the parts without departing from the spirit and scope of the invention.

I claim:

1. In an ultrasonic transducer, a pair of outer and inner annular clamping members having mutually facing outer and inner annular clamping gaskets, a piezoelectric disc crystal, film electrodes plated on the faces of the crystal and marginally confronting the respective gaskets, means clamping the members toward each other to securely support the crystal marginally, a retainer ring, a lens inward of the crystal and marginally disposed between the ring and the inner clamping member, a good-sound-transmitting liquid film separating the lens from the crystal, an annular gasket between the ring and the inner juncture of the lens with the inner clamping member, and means including the ring for clamping the last-mentioned gasket against the juncture and clamping the lens between the inner clamping member and the ring.

2. The structure of claim 1, characterized in that the second clamping means is independent of the first-mentioned clamping means and is detachable to enable the transducer to operate selectively with and without a lens.

3. The structure of claim 1, characterized in that the two clamping means are detachable to enable different crystals and lenses to be used and to enable the desired crystal to be used selectively with and without a lens.

4. In an ultrasonic transducer, a conductor sleeve, an annular insulator embracing the sleeve, a ring inward of the sleeve and insulator, a first annular gasket between the ring and sleeve, a second annular gasket, means clamping the ring to the inner faces of the sleeve and insulator, the first gasket between the ring and sleeve, and the second gasket between the ring and insulator, a conductor

collar having a cylindrical portion extending inward from the insulator and surrounding and spaced radially from the ring, a third annular gasket between the inner face of the insulator and the outer end of the cylindrical portion, the collar having an inner end flange projecting toward the collar axis, the ring and collar having axially spaced mutually facing outer and inner fourth and fifth annular gaskets, a piezoelectric disc crystal having parallel outer and inner faces respectively plated by film electrodes and arranged marginally between the fourth and fifth gaskets, means clamping the crystal to the fourth and fifth gaskets, whereby the insulator, ring, collar, crystal edge, and the second to fifth gaskets define an annular chamber for insulating oil, the chamber having an opening and a closure therefor, a conductor for connecting the sleeve to high frequency high voltage, a conductor clamped at one end between the sleeve and the first gasket and at its other end between the fourth gasket and the outer electrode, and a conductor grounded to the collar and having a terminal clamped at one end between the inner electrode and the fifth gasket.

5. The structure of claim 4, together with a sound-converging lens closely spaced inward from the inner electrode and having an outer portion embraced by the fifth gasket and the flange, a film of good-sound-transmitting liquid in the space defined by the inner electrode, the fifth gasket, and the lens, the flange having an annular inwardly facing ledge, the lens having an outwardly facing annular shoulder confronting the ledge, a retainer ring at the inner sides of the flange and lens, a sixth annular gasket at the inner juncture of the flange with the lens, and means clamping the lens against the ledge, and the sixth gasket against the juncture, whereby the lens is held in place and the liquid film is sealed in place.

References Cited in the file of this patent

UNITED STATES PATENTS

2,430,013	Hansell	Nov. 4, 1947
2,477,246	Gillespie	July 26, 1949
2,484,014	Peterson	Oct. 11, 1949
2,496,293	Kiernan	Feb. 7, 1950
2,592,703	Jaffe	Apr. 15, 1952
2,626,992	Holman	Jan. 27, 1953

FOREIGN PATENTS

668,343	Great Britain	Mar. 12, 1952
---------	---------------	---------------

OTHER REFERENCES

Ser. No. 337,106, John (A. P. C.), published May 18, 1943.

UNITED STATES PATENT OFFICE
Certificate of Correction

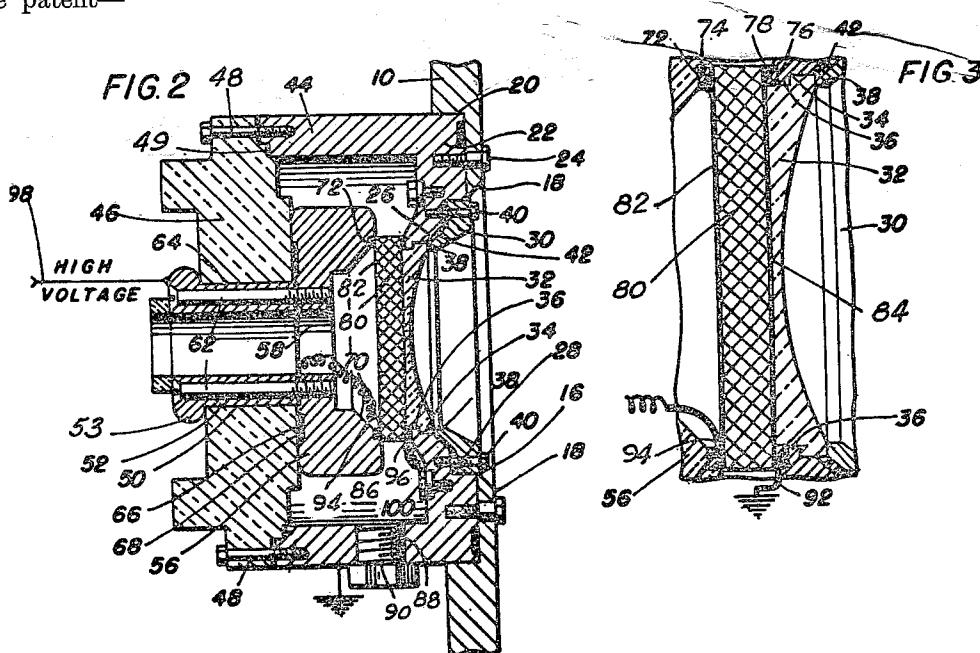
Patent No. 2,863,075

December 2, 1958

Francis J. Fry

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the drawings, Figures 2 and 3 should appear as shown below instead of as in the patent—



Signed and sealed this 2nd day of June 1959.

[SEAL]

Attest:
KARL H. AXLINE,
Attesting Officer.

ROBERT C. WATSON,
Commissioner of Patents.

UNITED STATES PATENT OFFICE
Certificate of Correction

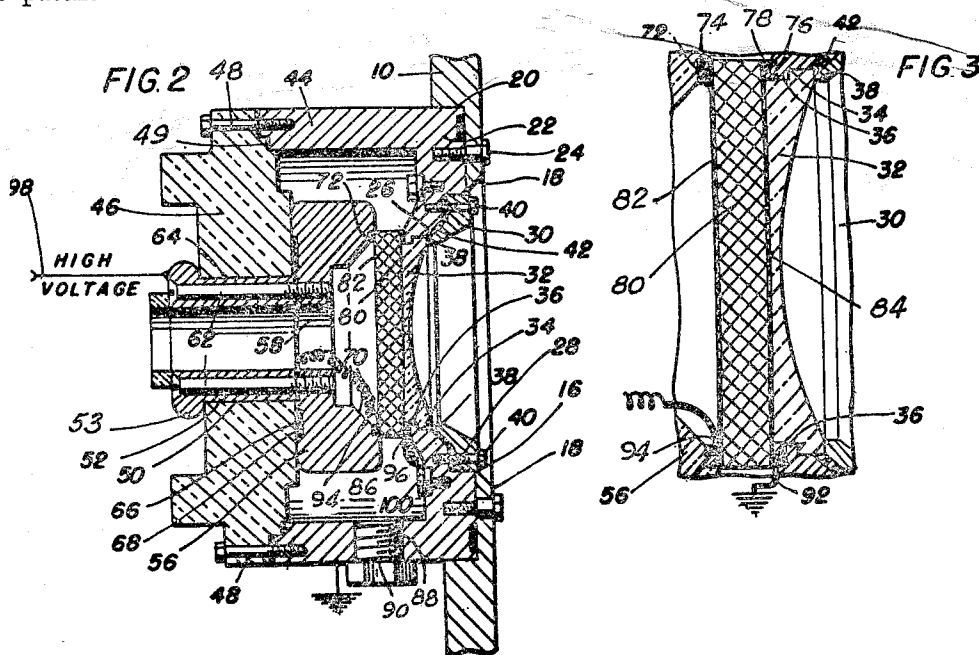
Patent No. 2,863,075

December 2, 1958

Francis J. Fry

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the drawings, Figures 2 and 3 should appear as shown below instead of as in the patent—



Signed and sealed this 2nd day of June 1959.

[SEAL]

Attest:
KARL H. AXLINE,
Attesting Officer.

ROBERT C. WATSON,
Commissioner of Patents.