Aug. 2, 1960 W. T. HARRIS 2,947,888

TRANSDUCER CONSTRUCTION

Filed May 11, 1956

FIG. 1.

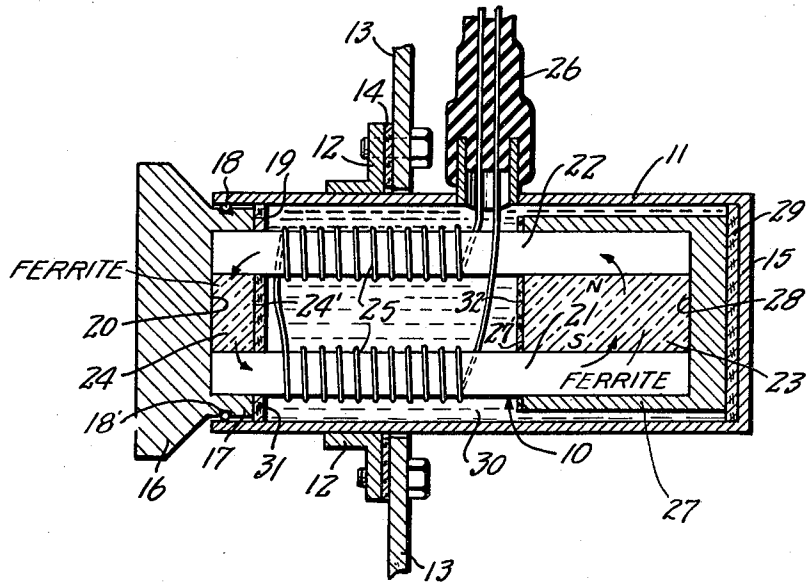


FIG. 2.

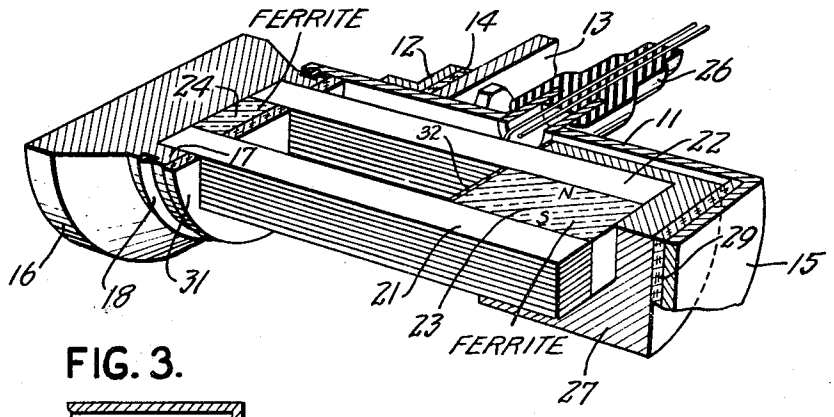
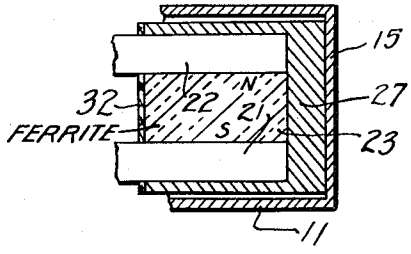


FIG. 3.



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TRANSDUCER CONSTRUCTION

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6 Claims. (Cl. 310—26)

My invention relates to an electro-mechanical transducer assembly, and this application discloses improvements over the invention covered in my copending application, Serial No. 475,462, filed December 15, 1954, now abandoned.

It is an object of the invention to provide an improved transducer construction of the character indicated.

It is another object to provide an improved transducer construction lending itself particularly to industrial sonic and ultrasonic applications involving excitation within a fluid medium.

It is a further object to provide an improved transducer construction employing liquid cooling without impairing efficiency of operation.

It is also an object to provide an improved liquid-immersion transducer construction in which inadvertent or careless operation in air will not necessarily ruin the transducer.

It is a specific object to meet the above objects with a construction which may be unit-handling and which may be directly adaptable to a tank, or other vessel, within which a liquid is to be excited.

Other objects and various other features of novelty and invention will be pointed out or will occur to those skilled in the art from a reading of the following specification in conjunction with the accompanying drawings. In said drawings, which show, for illustrative purposes only, preferred forms of the invention,

Fig. 1 is a longitudinal sectional view through a transducer assembly of my invention;

Fig. 2 is a partly broken-away fragmentary perspective view of the transducer of Fig. 1, the principal sectional cut of Fig. 2 being in the plane of Fig. 1; and

Fig. 3 is a fragmentary view similar to Fig. 1 and showing a modification.

Briefly stated, my invention contemplates a completely self-contained transducer assembly incorporating liquid filling, primarily for cooling and electrical-insulation purposes, and yet embodying means whereby the external response of the transducer is not thereby impaired. The invention is shown in application to a transducer comprising head and tail-weight members bonded to longitudinal ends of plural electro-mechanical force elements, all contained within a housing, the interior of the housing being flooded with the liquid filling; efficient output is achieved by directly exposing the driver externally of the assembly, so as to permit direct coupling to a liquid medium to be excited. Further efficiency results from decoupling the liquid filling from one or both of the head and tail weights, as by applying a pressure-release layer to the axially inner wall of one of the head and tail weights.

Referring to the drawings, my invention shown in application to a magnetostrictive transducer element **10** contained within a cylindrical housing or can **11**. The housing **11** includes a mounting flange **12** extending peripherally thereof and at essentially a single central location to permit adaptation of the transducer assembly to the wall **13** of a tank or other vessel, containing fluid to be excited

by the transducer. A gasket **14** seals the transducer assembly in the tank wall **13** so that operation may proceed below the liquid level within the tank **13**. For the arrangement shown in the drawings, the liquid within the tank **13** is on the left side of the wall **13**.

The transducer in the arrangement shown in Fig. 1 is unidirectional and is constructed for response substantially only in the direction into the volume of liquid contained within the vessel **13** (i.e. to the left, in the sense of the drawing). For this reason, the housing **11** may be closed at the end **15** exposed outside the vessel **13**, while the end facing into the vessel **13** may be open. The transducer proper is shown to include a head-weight, diaphragm, or piston element **16** directly exposed to the liquid to be excited and including a reduced cylindrical portion **17** longitudinally overlapping the open end of the housing **11** and preferably in close radial-clearance relation therewith. A longitudinally yieldable seal member, such as a ring **18** of rubber, neoprene, or the like, connects the head **16** to the open end of the housing **11** and yet resiliently yields to the driving displacements of the head **16**; a circumferential groove **18'** in the reduced cylindrical portion of head **16** receives and locates ring **18** and holds the same in circumferentially continuous radially stressed sealing engagement with the adjacent part of the inner wall of housing **11**.

The inner end **19** of the head-weight **16** is shown recessed at **20** to accommodate the head ends of various parts of the transducer element **10**. In the form shown, the element **10** is of the general variety disclosed in said copending application and comprises a plurality of elongated legs **21—22** of magnetostrictive material joined at their respective longitudinal ends by magnetic flux-conducting means **23—24**. The elements **21—22—23—24** may all be formed as a unit, but in the arrangement shown, each of the legs **21—22** is independent and comprises a consolidated stack of like laminations of magnetostrictive strip material; the view of Fig. 1 will be understood to display a plan view of one such lamination for each of the legs **21—22**.

The magnetic flux-conducting means **23—24** may each be a ferrite block bonded to the respective stacks **21—22**. The block **23** may be a permanently magnetized ferrite, and the block **24** may be a magnetically soft ferrite coupler.

Winding means **25** is developed along exposed lengths of the flux path defined by elements **21—23—22—24**, and the arrows traversing these elements suggest polarized flux in this path. The sealed lead-in connection **26** may be made to the externally exposed part of the housing **11** (i.e. outside the tank wall **13**).

For greater efficiency, I provide loading for the tail of my transducer element and have shown a tail-weight **27** which may be of cylindrical configuration having close radial-clearance relation with the housing **11** and recessed to receive the tail end of the transducer element **10**. For applications in which bi-directional radiation is desired, the back end of the tail-weight **27** may be directly connected to the back wall **15** of the housing **11** (as shown in Fig. 3, where these parts are bonded), but in the form shown in Figs. 1 and 2, unidirectional radiation is desired, and I therefore employ a layer of pressure-release material, such as the cork layer **29**, to connect the tail-weight **27** to the back wall **15**, as by bonding these parts. The back wall **15** may thus serve to centrally position the back end of the transducer element **10**.

In accordance with the invention, I provide a liquid filling to flood the interior **30** of the housing **11**. The liquid may be transformer oil or a like dielectric liquid for the purpose of dissipating heat generated within the legs **21—22**, for radiation at the exposed outer walls of the housing **11**; this filler liquid also serves importantly

to provide improved electrical insulation within the transducer. Furthermore, by thus immersing internal active parts of the transducer, I provide a measure of protection against permanent damage to the unit, should the assembly be inadvertently or carelessly excited in air.

In order further to enhance the efficiency of operation, I provide pressure-release means for decoupling the head and tail members **16—27** from the liquid filling. For certain applications, it may suffice to provide a single pressure-release layer **31** (as of cork) bonded to the tail face of the head-weight **16**; thus, the exposed rear face **24'** of the magnetic coupler **24** may be in essentially the same radial plane as the exposed rear face **19** of the head-weight **16**, so that the single layer **31** of pressure-release material may be applied over the full cross-sectional area of the housing **11**, except for that displaced by the legs **21—22**. In the form shown, I indicate my preference for a second decoupling pressure-release layer **32** similarly applied to the head end **27'** of the tail-weight **27**.

In operation, maximum coupling is achieved to the liquied contained within the vessel **13** because the active radiating member is directly exposed to the response medium; in Fig. 1, the head **16** is the radiating member, while in Fig. 3, both head **16** and tail **27—15** are the radiating members. Efficiency is promoted by flooding the interior with dielectric heat-conducting liquid filling and by decoupling internal transducer end parts from this liquid filling.

It will be appreciated that I have described a highly efficient transducer construction, particularly applicable to industrial use. The transducer assembly is self-contained and readily mountable in the tank within which it is to be employed, without requiring substantial servicing with liquid filling. The employment of liquid filling in no way impairs, but on the other hand enhances, efficiency of operation of the device and additionally provides a means of protection against abuse or careless use.

While I have described the invention in detail for the preferred forms shown, it will be understood that modifications may be made within the scope of the invention as defined in the claims which follow.

I claim:

1. In a transducer of the character indicated, an elongated cylindrical housing closed at one end and open at the other, a head-weight having a cylindrical portion longitudinally overlapping the open end of said housing with relatively close radial clearance, a yieldable seal member closing said clearance, said head-weight being recessed at the end facing the interior of said housing, an elongated transducer element comprising two spaced elongated magnetostrictive legs and magnetic flux-conducting means bonded to and joining the respective ends of opposite side walls of said legs to each other, one end of said legs and of one of magnetic flux-conducting means being received in said recess, a tail-weight recessed to accommodate the other ends of said legs and of the magnetic flux-conducting means associated therewith, the interior exopsed face of said head-weight and of the magnetic flux-conducting means at the head end being in substantially the same radial plane, a layer of pressure-release material applied to said face and to the magnetic flux-conducting means at said head end, and a liquid flooding the interior of said housing.

2. In a transducer of the character indicated, an elongated cylindrical housing closed at one end and open at the other, a head-weight having a cylindrical portion longitudinally overlapping the open end of said housing with relatively close radial clearance, a yieldable seal member closing said clearance, said head-weight being recessed at the end facing the interior of said housing, an elongated transducer element comprising two spaced elongated magnetostrictive legs and magnetic flux-conducting means bonded to and joining the respective ends of opposite side walls of said legs to each other, one end of said legs and of one of said magnetic flux-conducting means being received in said recess, a tail-weight recessed to accommodate the other ends of said legs and of the magnetic flux-conducting means associated therewith, a layer of pressure-release material applied to the axially inner surfaces of said head-weight and said magnetic flux-conducting means at said head end, and a liquid flooding the interior of said housing.

3. In a transducer of the character indicated, an elongated cylindrical housing closed at one end and open at the other, a head-weight having a cylindrical portion longitudinally overlapping the open end of said housing with relatively close radial clearance, a yieldable seal member closing said clearance, said head-weight being recessed at the end facing the interior of said housing, an elongated transducer element comprising two spaced elongated magnetostrictive legs and magnetic flux-conducting means bonded to and joining the respective ends of opposite side walls of said legs to each other, one end of said legs and of one of said magnetic flux-conducting means being received in said recess, a tail-weight recessed to accommodate the other ends of said legs and of the magnetic flux-conducting means associated therewith, a layer of pressure-release material applied to the axially inner surfaces of said tail-weight and the magnetic flux-conducting means at said tail end, and a liquid flooding the interior of said housing.

4. In a transducer of the character indicated, an elongated cylindrical housing closed at one end and open at the other, a head-weight having a cylindrical portion longitudinally overlapping the open end of said housing with relatively close radial clearance, a yieldable seal member closing said clearance, said head-weight being recessed at the end facing the interior of said housing, an elongated transducer element comprising two spaced elongated magnetostrictive legs and magnetic flux-conducting means bonded to and joining the respective ends of opposite side walls of said legs to each other, one end of said legs and of one of said magnetic flux-conducting means being received in said recess, a tail-weight recessed to accommodate the other ends of said legs and of the magnetic flux-conducting means associated therewith, a layer of pressure-release material applied to the axially inner surfaces of one of said head-weight and said tail-weight and of the magnetic flux-conducting means at the corresponding end of said transducer element, and a liquid flooding the interior of said housing.

5. In a transducer of the character indicated, an elongated magnetostrictive element comprising two spaced rectangularly prismatic legs in face-to-face relation, magnetic flux-conducting means bonded to and joining the respective ends of adjacent faces of said legs, thereby defining a single flux-conducting path through said legs, said path being polarized to circulate flux in one leg and out the other leg, winding means including turns linked to said legs, a cylindrical head-weight member of greater cross-sectional area than said element and bonded to said element at one end thereof, a cylindrical tail-weight member of greater cross-sectional area than said element and bonded to the other end of said element, a cylindrical housing closed at one end and open at the other and fully containing said element and said tail-weight member with a portion of said head-weight member in axially-overlapping close clearance relation with the bore of said housing near the open end thereof, an axially yieldable circumferentially continuous seal between said head-weight member and said housing at the region of overlap, and a filling of dielectric liquid flooding said element within said housing, said head-weight member and said tail-weight member being each recessed at their opposed faces, said recesses axially receiving the respective ends of said element including portions of said flux-conducting means at each end respectively.

6. In the transducer of claim 5, a layer of pressure-

release material on the axially inner surface of one of said head and tail-weight members and on the axially inner surface of the magnetic flux-conducting means at the corresponding end of said element.

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