Oct. 11, 1966 J. C. CRAIG ET AL 3,278,695

CONSTRUCTION OF EARPHONES AND MICROPHONES

Filed March 21, 1963

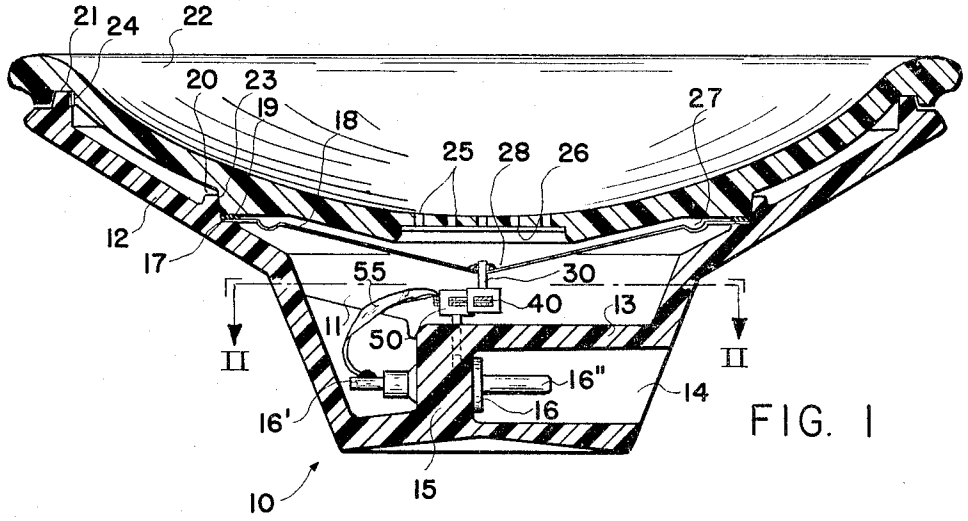
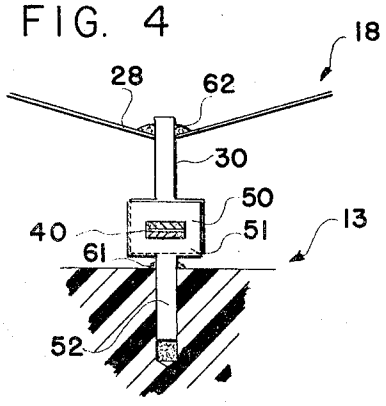


FIG. 1

FIG. 4



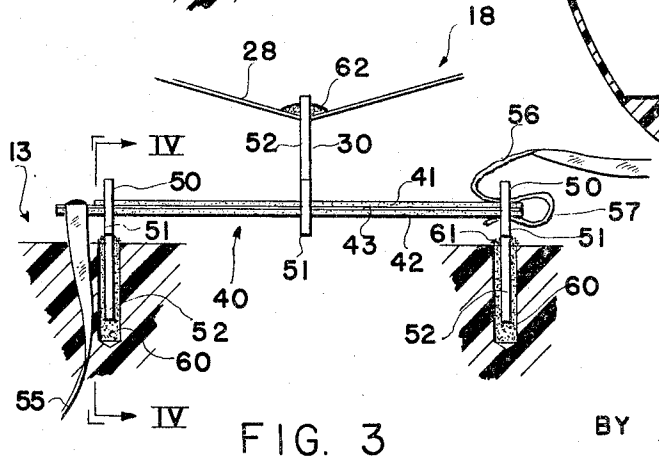


FIG. 3

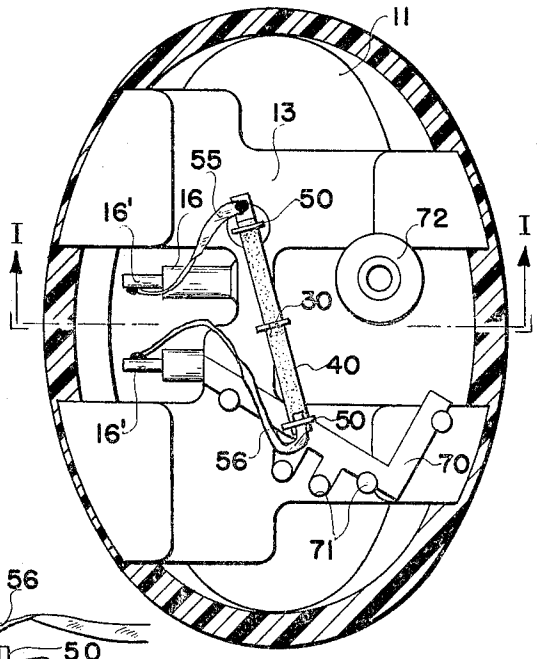


FIG. 2

INVENTORS

JAMES C. CRAIG
ALEXANDER L. DVORSKY

BY Francis J. Klempay

ATTORNEY

United States Patent Office

3,278,695

Patented Oct. 11, 1966

3,278,695

CONSTRUCTION OF EARPHONES AND MICROPHONES

James C. Craig and Alexander L. Dvorsky, Conneaut, Ohio, assignors to The Astatic Corporation, Conneaut, Ohio, a corporation of Ohio

Filed Mar. 21, 1963, Ser. No. 266,968
5 Claims. (Cl. 179—110)

This invention relates to the construction of earphones, microphones and the like, and more particularly to improved means for securing the electro-mechanical transducer elements within such devices.

In the construction of earphones and microphones, it is essential to provide an edge-supported diaphragm for vibratory motion in air, a mechanical connection from a vibratile portion for said diaphragm to a transducer which is capable of converting electrical currents into mechanical motion or vice versa, and suitable mounting means for said transducer. The present invention provides improved means for performing the latter function especially.

In U.S. Patent No. 2,931,865 to A. L. Dvorsky and in U.S. Patent No. 3,007,013 to C. F. Paull et al, there are disclosed and claimed certain preferred constructions for the supporting and securing of transducer elements in microphones. The present invention seeks to provide new and improved means for achieving the same functions in the construction of microphones and further discloses transducer mounting means of particular utility in the building of earphones. It is to be noted that most of the same parameters which govern the design of microphones apply equally to the design of earphones, the prime difference being in the direction of transduction. Whereas, in a microphone the diaphragm is subjected to pressure waves in air and the transducer linked to the diaphragm converts these to fluctuating electrical signals, in earphones the converse is true. i.e. electrical signals are applied to the transducer member which deforms physically and causes motion of its associated diaphragm so that acoustical waves are set up in space surrounding the diaphragm. In the case of the earphones of the present invention these acoustical waves are impressed upon the eardrums of the user to convey audible signals.

In the earphone construction of the present invention there is provided a novel and highly efficient means for mounting a transducer element. The accessory parts used to mount the transducer are but three in number and they are duplicate parts stamped from sheet plastic material in a highly economical manner. The mounting parts being of selected hardness, exhibit highly desirable elastic restraint to the transducer member to achieve a further object of the invention. The relative thinness of the mounting parts allows substantially unimpeded freedom for the transducer to flex and thus achieves increased efficiency which is a further object of the invention.

A still further object is the provision of novel means to secure electrical connection to the electrodes of the transducer and the mounting parts assist in this also.

These and other objects and advantages of the invention will become apparent upon consideration of the following specification and the accompanying drawing wherein there is disclosed a preferred embodiment of the invention.

In the drawing:

FIGURE 1 is a sectional view thru the earphone or the like of the present invention, this view being taken along the line I—I of FIGURE 2;

FIGURE 2 is a plan view, partly in section, of the earphone of FIGURE 1 and taken along the line II—II of FIGURE 1;

FIGURE 3 is a side elevation of the transducer element and its mounting means as used in FIGURES 1 and 2; and

FIGURE 4 is a view, partly in section taken along the line IV—IV of FIGURE 3.

Referring now to the drawing in detail, and particularly to FIGURES 1 and 2, reference numeral **10** indicates a back housing of the earphone, made preferably of molded plastic material, and comprising a cup-like portion **11** and a flaring flange-like upper skirt **12**. In a raised position within cup-like portion **11** a flat-faced platform **13** is provided. Under platform **13** a cavity **14** is provided and it is closed off from the cup-like portion **11** by a vertically disposed wall **15**. Extending through wall **15** and secured therein is a pair of terminal pins **16**. The inner ends **16'** of these pins extend into cup portion **11** and the outer ends **16''** thereof extend into cavity **14** where they may be attached to electrical leads, not shown.

On the inner face of upper skirt **12** a flat ledge **17** is provided to support the edge of a thin formed diaphragm **18**. A gasket **19** overlies the supported edge of diaphragm **18** and both gasket **19** and diaphragm **18** are located centrally of back housing **10** by an upstanding rim **20** formed integrally with skirt **12**. At the extreme upper edge of skirt **12** a second upstanding rim **21** is provided.

A contoured face plate **22** is assembled against the skirt **12** and plate **22** is formed with a shoulder **23** and a groove **24** to mate with rims **20** and **21**, respectively, and to hold plate **22** centrally located with respect to skirt **12**. The lower face of shoulder **23** bears on gasket **19** and holds it and the edge of diaphragm **18** securely clamped. A suitable adhesive, for example, may be applied in the space between rim **21** and groove **24** to keep the face plate **22** and skirt **12** together.

The outer surface of face plate **22** is suitably contoured to fit against the ear of the user in a comfortable manner. At the center of face plate **22** a plurality of holes **25** afford an acoustical path from the face of diaphragm **18** to the outer surface of face plate **22**. A disk of cloth or other foraminous material **26** may be applied over the inner ends of holes **25**, if desired, to modify the acoustical character of the assembly and/or to exclude dust.

The diaphragm **18** has an annular groove **27** formed about its outer edge. Groove **27** defines an area of flexibility by virtue of which the center conical portion **28** of the diaphragm **18** may move upwardly and downwardly as a substantially rigid piston, in well known manner. The apex of the conical portion **28** affords an ideal point at which to attach the diaphragm **18** to a drive member **30**.

In mounting the transducer element in accordance with the present invention use is made of the substantially flat area afforded by the top surface of platform **13**. Transducer element **40** is illustrated, in FIGURES 2 and 3 especially, as being of the ceramic bimorph type. Element **40** comprises an upper slab **41** and a lower slab **42** of polarized piezoelectric ceramic material such as lead zirconia titanate, for example, adhered to a center conductive electrode **43**. Outer conductive electrode areas occur

also on the two outer major faces of the slabs **41** and **42**. The entire element **40** is adapted by its structure and by its induced electrical properties to be applied as a beam supported at both ends.

To support the element **40** in a manner to achieve the objects of the present invention, the opposite ends thereof are held in novel support members **50**. Each support member **50** comprises a single-piece stamping punched from a sheet of medium hard polymeric plastic, such as polypropylene, for example. The two support members **50** and the drive member **30**, referred to above, preferably are identical in structure to achieve the economies envisaged. The support members **50** and the drive member **30** consist of a large rectangular frame portion **51** adapted to securely encircle element **40** and an outwardly protruding stem **52** made integral therewith.

In assembling the various parts of the earphone of the present invention, the drive member **30** is first slipped over the middle of element **40** with its stem **52** disposed upwardly. The support member **50** at the left end of element **40**, as viewed in FIGURE 3, is next slipped over the element **40** with its stem **52** protruding downwardly. A foil lead **55** is now attached to the center electrode **43** by soldering for example. A second foil lead **56** is folded over the right end of element **40**, as viewed in FIGURE 3, and the right support member **50** is slipped over both the foil lead **56** and the right end of element **40**. Lead **56** is freedup slightly to provide a free-standing foil loop **57**, which affords clearance between the center of loop **57** and the end of electrode **43**, as shown. Support member **50**, by its resilience, presses the captured portions of lead **56** into firm contact with the upper electrode of ceramic slab **41** and the lower electrode of slab **42** of element **40** to establish electrical connection therewith.

On the flat-faced platform **13** within cup **11**, a pair of spaced holes **60** are provided to accommodate the downwardly extending stems **52** of support members **50**. Stems **52** are secured in holes **60** by pressfitting, together with the use of a suitable cement **61**, if required, and the element **40** is thus secured above the platform **13**, spaced therefrom, and lying parallel therewith. The foil leads **55** and **56** are next secured in electrical contact to the respective ones of the inner ends **16'** of terminal pins **16** by soldering, for example. The drive member **30** has its stem **52** extending up toward the apex **28** of diaphragm **18** where it is received in an aperture and is secured by adhesive **62**. The placing of gasket **19** and face plate **22** over the diaphragm **18** and the adhering of plate **22** to skirt **12** completes the closing up of the assembled earphone of the present invention.

In addition to the novel features above disclosed for practicing the present invention, there are also provided in the presently disclosed earphone means for advantageously practicing the invention of the above identified Dvorsky U.S. patent. In the cup-like molding **11** of FIGURE 2, there are provided mounting ribs **70**, locating pins **71** and contact supporting bosses **72** which are to be utilized in mounting a Rochelle Salt transducer element in the present earphone, in a manner taught by the Dvorsky patent. While the present disclosure shows a bimorph transducer element **40**, having two layers of ceramic material **41** and **42**, and a metal electrode **43** in its structure, it is contemplated that other and improved types of transducer elements may be used to advantage in the assembly of the earphone disclosed herein. For example, a four-layer transducer of the kind disclosed in co-pending application for U.S. Patent Serial No. 256,707 filed on February 6, 1963 and assigned to the assignee of the present invention, will be understood to find advantageous application in the instant device.

Thus, there has been disclosed a preferred assembly of novel parts which accomplishes the objects initially set forth. The mounting members **50**, to be used in securing the element **40** in operative position and for connecting it to the diaphragm **18**, are simple and extremely cheap to fabricate. They are easily and quickly assembled to the element **40** and, when assembled in the manner contemplated, support the element **40** with an optimum degree of mechanical compliance. The relative thinness of the support members **50** afford substantially "knife-edge" support for element **40** and permit an extensive free portion of the same to operate with utmost efficiency in driving diaphragm **18**. The resilient character of the plastic material, from which mounting members **50** are fabricated, afford clamping for suppression of resonances in the earphone unit of the invention. The inherent resilience of the mounting members **50** is used to assure secure electrical contact to the electrode areas of transducer element **40**.

Application of the principles of our invention makes possible the commercial production of high quality sound reproduction components at extremely low cost. While we have disclosed specifically an earphone, it should be quite obvious that substantially the same construction is ideally suited for microphones and similar devices necessitating only variations in the shape and dimension of the principal housing sections, corresponding to members **10** and **22** of FIGURE 1. It should be noted particularly that the well portion of section **10** together with the diaphragm **28** provides a fluid-tight enclosure for the piezoelectric transducer employed as well as a housing for the electrical leads. Further economies are affected by utilizing the inherent material of the section **10** itself to support the transducer, thereby dispensing with any need for further housing or support members.

Having thus described our invention, we claim:

1. Structure for earphones, microphones, and the like, comprising a casing having an open side, a flat surface in said casing facing said open side, a pair of spaced bores in said flat surface, a bar-like piezoelectric transducer overlying said surface but spaced therefrom, a transducer supporting member secured in each of said bores, said transducer supporting members each comprising a frame adapted to surround said bar-like transducer and a stem adapted to be secured in one of said bores, a diaphragm secured to the open side of said casing and a mechanical connection joining said diaphragm and said transducer.

2. Structure for earphones, microphones, and the like, comprising a casing, a plurality of spaced supporting frames secured in spaced bores in a wall of said casing and extending vertically from said wall of said casing, a piezoelectric transducer element disposed in said frames and bridging the space therebetween, the resilience of said frames securing said transducer, a diaphragm, a drive member secured to said transducer between said frames and connecting said transducer and diaphragm.

3. A formed plastic elastomer member for supporting a bar-like piezoelectric transducer element of an earphone or a microphone in the internal cavity of the housing thereof/and for coupling said element to an acoustic diaphragm, said member having a rectangular frame portion adapted to encompass and elastically secure itself around said element and having an integral stem protruding outwardly of a side of said frame, said stem being adapted to be secured to said casing or to said diaphragm.

4. Structure for an earphone, microphone or the like, which comprises an open-sided casing having a flat interior supporting surface, spaced bores in said surface, a diaphragm supported over the open side of said casing, an aperture in said diaphragm, a transducer element encircled by three separate frame-like elastomeric members each having a radially extending stem portion thereon, two of said stem portions adhered in said spaced bores and one of said stem portions adhered in said aperture in said diaphragm.

5. Structure for earphones, microphones, and the like, comprising a casing, a bar-like piezoelectric transducer having an electrode area on one of its outer surfaces, a

resilient insulating member supported by and secured within said casing and having a window for the tight reception of a portion of said transducer, and a flexible metal foil electrical conductor constituting a connector for said transducer, said conductor being clamped in said window in tight contact with said electrode area, said transducer being of the bimorph type and having a centrally disposed electrode and electrode areas on opposite side faces of the transducer, and said flexible conductor being looped over an end of said transducer and tightly received in said window in pressure contact with both said electrode areas.

References Cited by the Examiner

UNITED STATES PATENTS

2,506,608	5/1950	McLoad	340—10
2,933,628	4/1960	Samuelson	310—9.1
3,007,013	10/1961	Paull et al.	179—121

KATHLEEN H. CLAFFY, *Primary Examiner.*

ROBERT H. ROSE, *Examiner.*

F. N. CARTEN, *Assistant Examiner.*