Oct. 11, 1966 W. P. MASON 3,278,696

TRANSISTOR MICROPHONE

Filed June 12, 1963

FIG. 1

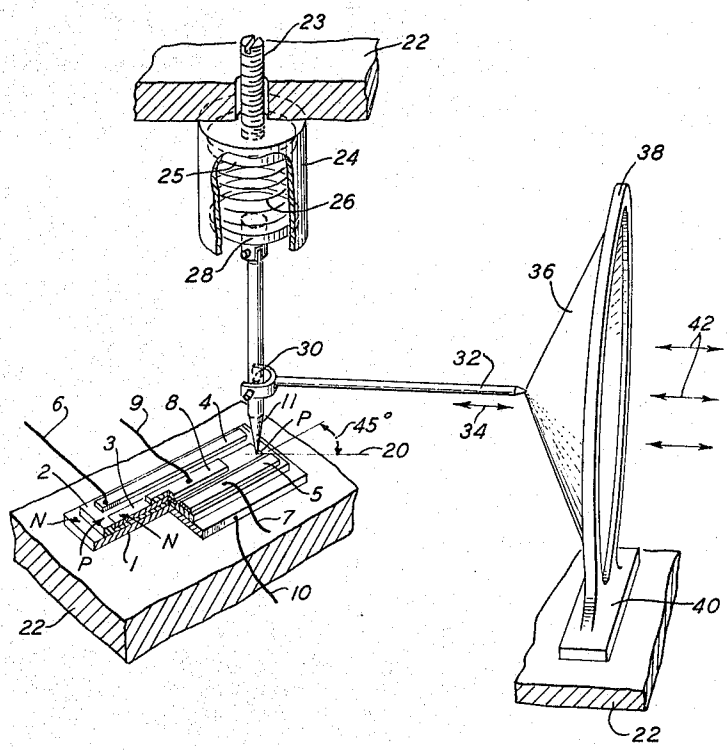
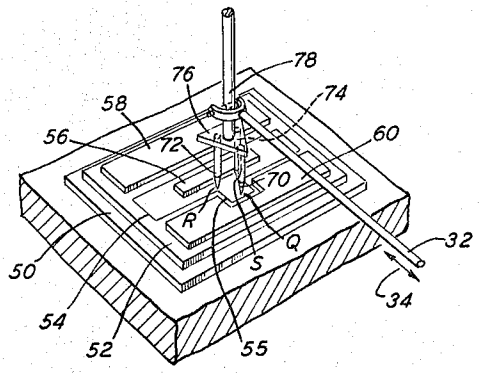


FIG. 2



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TRANSISTOR MICROPHONE

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This invention relates to electroacoustic and electromechanical transducers. More particularly, it relates to electroacoustic and electromechanical transducers employing transistors.

In the copending joint application of P. Andreatch, Jr., and M. E. Sikorski (Case 3–3), Ser. No. 216,456, filed Aug. 13, 1962, it is disclosed that a transistor will respond as an electromechanical transducer to linearly directed stress applied normally to a point on the emitter region which is independent of the electrical connecting facilities to the emitter region.

In the copending sole application of M. E. Sikorski (Case 7), Ser. No. 282,792, filed May 23, 1963, it is further disclosed that a transistor is much more sensitive to stress applied normally to the emitter region if the point of application of the stress is in close proximity to the edge of the emitter region. The above-mentioned sole application also discloses that a statically prestressed transistor may be even more sensitive to superimposed variable stresses and may have a more linear response to such stresses where the amount of prestressing is adjusted to cause the transistor to be operating in a range of maximum sensitivity and linearity.

The present invention makes use of the above-mentioned disclosures by placing the stress supplying indenter or needle on a point closely adjacent to the edge of the emitter region of the transistor. In the case of a transistor having a rectangularly shaped emitter region, the point is preferably at a corner of the emitter region in close proximity to both edges forming the corner.

The indenter applies a normally directed prestress as taught in the above-mentioned sole application, and, in addition, applies the vibratory signal energy laterally to the indenter near its point of contact with the emitter region in a direction such that the point of the indenter tends to move alternately toward and away from the proximate edges of the emitter region. The result is an appreciably enhanced sensitivity of the transducer to stress as compared with any known prior art transducer including the above-mentioned transducers of Sikorski and Andreatch.

In accordance with a further teaching of the present invention, the use of a tripod of three indenters to apply stress to three spaced points near the edges of the emitter region is taught. The use of three indenters provides an arrangement which is mechanically much more stable than one employing a single indenter only. A correspondingly increased portion of the emitter periphery can also be subjected to the signal vibrations. Furthermore, the total normal force may be divided between the three indenters thereby reducing the force on each indenter.

Accordingly, a principal object of the invention is to increase the sensitivity of transducers which employ the stress responsive characteristics of transistors.

Another object is to increase the mechanical stability of devices of the invention.

Other and further objects, features and advantages of the invention will become apparent from a perusal of the following detailed description of illustrative structural arrangements embodying the principles of the invention taken in conjunction with the acompanying drawing, in which:

FIG. 1 illustrates a structure of the invention employing a single indenter; and

FIG. 2 illustrates a structure of the invention employing three indenters.

In more detail in FIG. 1, a transistor is shown which comprises a collector portion **1**, a base portion **2** and an emitter portion **3**, the last-named portion being induced in the base portion **2**, for example, by diffusion of appropriate impurities, all substantially as illustrated and described in the above-mentioned copending joint and sole applications of M. E. Sikorski. Electrical connections are made, to the emitter portion by lead **9** connecting to metallized terminal strip **8**, to the base portion by leads **6** and **7** connecting to metallized terminal strips **4** and **5**, respectively, on the base portion, and to the collector portion by lead **10** making an ohmic connection thereto. Appropriate electrical circuits for association with the transistor are illustrated and described in the above-mentioned sole application of M. E. Sikorski. Other appropriate circuits of numerous varieties are well known and extensively used by those skilled in the art.

The over-all structural arrangement of FIG. 1 differs from any known prior art in that the vibratory signal energy illustrated as being derived from acoustic waves represented by arrows **42** impinging on diaphragm **36** is impressed transversely on the indenter **11** via link rod **32**, as shown. Diaphragm **36** is held by a rigid rim **38**, the latter being held by base **40** resting on a fixed support **22**.

Assuming that the point of contact P of indenter **11** with the emitter region **3** is at a corner of the upper surface of the emitter region, the direction of the vibratory energy transmitted through link rod **32** is along line **20**, bisecting the right angle formed by the corner.

A small vertical pressure is exerted longitudinally along indenter **11** by an adjustable spring arrangement comprising a housing cylinder **24**, supported by a fixed support **22**, housing **24** enclosing spring **26** between the upper piston **25** and lower piston **28**, the latter including a hinged connection to indenter **11** which permits transverse motion of the lower end of indenter **11** along the line **20** previously mentioned. The upper piston **25** is supported on threaded rod **23** which projects through an appropriately threaded hole in the upper surface of housing **24** so that the force exerted by spring **26** on indenter **11** can be readily adjusted for optimum performance. As stated in Sikorski's above-mentioned copending sole application, with indenter **11** pressing on a point P at the corner of the emitter region only a slight prestress is required to insure maximum sensitivity and linearity.

When rod **32** is exerting a force directed along line **20** toward the more central portion of the emitter region the response of the transistor is appreciably decreased and when rod **32** is exerting a force in the opposite direction, that is, toward the adjacent edges of the emitter region, the response of the transistor is appreciably augmented. Thus the over-all structure of FIG. 1 constitutes a highly sensitive transistor microphone. Alternatively, link bar **32** can obviously transmit vibratory mechanical energy from a phonograph pickup device or the like.

It should be borne in mind that transistors are normally of very small dimensions and for adequately illustrative drawings it is necessary to show them to a greatly enlarged scale.

The arrangement of FIG. 2 can be similar to that of FIG. 1, correspondingly numbered details being identical, except that the emitter region **54** having a metallized terminal **56** thereon includes a small tab or projection **55**, and metallized terminal **60** on base region **52** is notched to partially enclose tab **55**, as shown. Also, three indenters

70, 72 and 74 on triangular plate 76 are carried in a tripod arrangement on rod 78 and make contact with points Q, R and S, respectively, as indicated in the drawing. The base region 52 has a second metallized terminal region 58 on the other side of the emitter region 54.

Electrical connections to the three regions 50, 52 and 54, respectively, of the transistor can be made as for the structure of FIG. 1. In FIG. 2 link rod 32 transmits its transverse vibratory energy in the direction of the horizontal center line of tab 55, to supporting rod 78, so that all three indenters are simultaneously impelled alternately toward and away from the proximate portions of the edges of the emitter region.

The arrangement of FIG. 2 offers in the tripod arrangement of indenters a mechanically more stable arrangement effective over an increased portion of the emitter edge. Furthermore, the total vertical force or prestress can be divided between the three indenters.

Numerous and varied modifications and rearrangements of the above-described illustrative embodiments can readily be devised by those skilled in the art without departing from the spirit and scope of the principles of the invention.

What is clamied is:

1. An electromechanical transducer comprising a transistor having a three-dimensional emitter region, a three-dimensional base region, a p-n junction between said emitter and base regions enveloping all but an outer surface of said emitter region, an indenter impinging normally upon the outer surface of the emitter region at a point closely adjacent an edge of the outer surface of said emitter region, means for exerting a specific static force longitudinally through the indenter at said point, and means for exerting a vibratory mechanical signal upon said indenter transversely to said indenter and to the adjacent edge of said emitter region.

2. The arrangement of claim 1 in which the static force is of an amplitude to prestress the emitter region to an operating point of its stress-responsive characteristic at which substantially maximum sensitivity and linearity are obtained.

3. The arrangement of claim 1 in which a tripod arrangement of three indenters is employed, the specific static force being divided equally between the three indenters.

No references cited.

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