COMB-SHAPED PIEZOELECTRIC DRIVE DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to a comb-shaped piezoelectric drive device composed of a plural number of strip-shaped drive members having first ends joined to a common base part and free ends which flex upon application of a voltage across the drive members. Such a piezoelectric drive device can be employed as a mechanical signal source and is applicable to data transmitting devices and the like. It is well known in the art that a mechanical signal source can be implemented by selectively applying a voltage to the drive members of such a piezoelectric drive device.

Heretofore, the strip-shaped piezoelectric elements were manufactured separately and then secured to a base part. This manufacturing technique requires much labor and time. Moreover, the dimensional accuracy of a piezoelectric drive device manufactured by such a technique is low.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to reduce the amount of labor required in manufacturing such a piezoelectric drive device and to improve the dimensional accuracy of the device.

In accordance with the above and other objects, a piezoelectric drive device is provided in which a plurality of strip-shaped piezoelectric elements extend from a common integral base part and are driven selectively.

More specifically, in accordance with the invention, a comb-shaped piezoelectric drive device is provided including a comb-shaped piezoelectric unit comprising a plurality of strip-shaped drive members extending from a common base part, a first metal electrode layer formed on one main surface of each of the drive members and divided so that the first metal electrode layers of the drive members are electrically insulated from one another, and a common metal electrode layer formed on the other main surface of the drive member, the drive members being electrically coupled to one another through the common electrode layer.

In a preferred embodiment, the piezoelectric units are employed to form a drive device for displaying raised letters, such as may be used to display messages to blind persons. In such a case, plural seats are provided in stepwise form on a base board, and respective ones of the piezoelectric units are fixed to the seats through the base parts on which the common metal electrode layers are formed. Pins are provided at the free end portions of each of the drive members, and the free ends of the pins are capable of being protruded through respective holes formed in a rigid plate upon application of a voltage to the corresponding drive member.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing a comb-shaped piezoelectric drive device according to the invention; and

FIGS. **2A**, **2B**, and **2C** show piezoelectric drive devices which are employed in a raised letter display device, of which FIG. **2A** is top view, FIG. **2B** is a side sectional view taken along a line A—A in FIG. **2A**, and FIG. **2C** is a front view.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** shows an example of a comb-shaped piezoelectric drive device constructed according to the invention. The piezoelectric drive device **1** is of a bimorphic structure and includes a pair of thin piezoelectric ceramic plates **11***a* and **11***b* composed of polarized lead titanium zirconate on main surfaces of which metal electrode layers **111***a* and **111***a'* and metal electrode layers **111***b* and **111***b'* are formed by vacuum-depositing silver or the like, and a shim **12**, formed as a thin plate of relatively elastic metal such as brass, upon which the pair of thin plates **11***a* and **11***b* are stacked. A plurality of groove-shaped cuts which separate drive members **1***b*-**1**, **1***b*-**2**, **1***b*-**3**, . . . and **1***b*-n extend from the base part **1***a* of the structure. In order to individually drive the drive members **1***b*-**1** through **1***b*-n, the metal electrode layer **111***a*, which is a common top layer of the drive members **1***b*-**1** through **1***b*-n, is cut at its base part to form a plurality of metal electrode layers **111***a*-**1**, **111***a*-**2**, **111***a*-**3**, . . . and **111***a*-*n* in the form of parallel belts which are separated from one another at their base part. Lead wires **1***c*-**1**, **1***c*-**2**, **1***c*-**3**, . . . and **1***c*-*n* are connected to the respective metal electrode layers **111***a*-**1**, **11***a*-**2**, . . . and **111***a*-*n* by brazing, and a common lead wire **1***d* is connected to the metal electrode layer **111***b'*, which is the lowest layer in the structure. In addition, a drive circuit (not shown) is provided which is adapted to selectively apply a driving voltage between the lead wire **1***d* and the lead wires **1***c*-**1** through **1***c*-*n*. Furthermore, the lowermost metal electrode layer **111***b'* is welded to a base board **2**. Driving voltage is applied to the drive members to cause their free ends to bend, thus permitting the device to be employed as mechanical signal sources for relays, etc. For such an application, small protrusions (not shown) may be provided at the free ends of the drive pieces.

As described above, in order to individually drive the drive members **1***b*-**1** through **1***b*-n, cuts are formed in the uppermost metal electrode layer **111***a* in the form of parallel belts which extend along the drive members. Since the cuts are used to insulate the uppermost metal layers of the drive members from one another, the metal electrode layer may also be removed in the region between the end of the base part and lines connecting the drive members or lines slightly shifted from the ends of the drive members. In the case where the base board **2** welded to the metal electrode layer **111***b'* at the base part **1***a* is made of an electrically conductive material such as a metal, the common lead wire **1**d may be connected to the base board **2** instead of the metal electrode layer **11***b'*. Furthermore, instead of the illustrated bimorphic structure, a monomorphic structure may be employed in which a single piece of thin piezoelectric ceramic plate is employed. In this case, the thin plate has one main surface covered by a metal electrode layer with cuts extending along the drive members, as in the above-described bimorphic structure. The other main surface is covered in its entirety with a metal electrode layer, and a thin plate of elastic metal is bonded to the other main surface to reinforce the structure.

FIGS. **2A** through **2C** show a six-point raised character display device to which the technical concept of the invention is applied. Such a device may be used, for instance, to construct an automatic Braille display device.