

The displacing movement of the free end portions of the piezo-electric actuating elements in the horizontal direction can be readily and efficiently converted to the vertical movement of the sensing rods by the pushing-up cams axially and pivotally supported on the support rods. Therefore, the piezo-electric actuating elements can be downsized. Since the force applied by the sensing rods can be converted to a force only in the displacing direction of the piezo-electric actuating elements by the pushing-up cams, no excessive force is applied to the piezo-electric actuating elements, thereby preventing damage to the piezo-electric actuating elements.

When a predetermined angle or predetermined curved surface, with respect to the horizontal direction, is formed on the mounting side plane of the second lever of each pushing-up cam, a required depression force can be applied to the corresponding sensing rod throughout each stroke.

When projections are formed at portions of the first levers of the pushing-up cams which are abutted against the free end portions of the piezo-electric actuating elements, abutment between the first levers and the free end portions of the piezo-electric actuating members can be made smoothly.

When a rotational moment is imparted to the pushing-up cams so that the side surfaces at the distal end portions of the first levers are always abutted against the free end portions of the piezo-electric actuating elements, the sensing rods will not be interfered within returning to the reset position in the reset state.

When the piezo-electric actuating elements of the sensing rods on one side, belonging to the adjacent sensing rods opposing each other, are provided below the sensing rods of the other side, the limited space is effectively utilized to obtain an optimum depression force.

When the cassette that integrally houses the pushing-up cams and the support rods supporting the pushing-up cams is detachably mounted on the frame body, assembly and maintenance of the tactile reading device are facilitated.

When the piezo-electric actuating elements are directly connected to the lead terminals provided to the housing and the housing is detachably mounted on the frame body, lead wires to be connected to the electrodes on the front and rear surfaces of the piezo-electric actuating elements become unnecessary, and assembly of the braille type cell module is facilitated.

When the control drive circuits are housed in the device, the piezo-electric actuating elements and the control drive circuits can be integrally formed.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention and, together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 is an exploded view showing a structure of a tactile reading device according to a first embodiment of the present invention;

FIG. 2 is an exploded view of a main portion of the tactile reading device according to the first embodiment of the present invention;

FIG. 3 is an exploded view showing a final built up structure of the tactile reading device according to the first embodiment of the present invention;

FIG. 4 is a sectional view showing an operational relation between a sensing rod, a pushing up cam and a piezo-electric actuating element;

FIG. 5 is a sectional view showing the sensing rods arranged in two rows and a disposing relation between the pushing-up cams and the piezo-electric actuating elements corresponding to the sensing rods;

FIGS. 6A and 6B are a perspective diagram showing a structure of a housing;

FIG. 7A is a sectional view for explaining the operational diagram shown in FIG. 7C;

FIG. 7B is an enlarged sectional view shown in FIG. 7A;

FIG. 7C is an operational diagram showing a relationship between a stroke and a pushing-up force of the sensing rod;

FIGS. 8A to 8C are sectional views showing an engaging relation between the sensing rod and the pushing-up cams having a curved portion formed on a mounting plane of a second lever;

FIG. 9 is a sectional view showing an engaging relation between the piezo-electric actuating element and a projection formed in a side member of a first lever of the pushing-up cam;

FIG. 10 is an exploded view showing a structure of a tactile reading device according to a second embodiment of the present invention;

FIG. 11 is an exploded view showing a structure of a tactile reading device according to a third embodiment of the present invention;

FIG. 12 is an exploded view of a first step showing assembling a tactile reading device according to a fourth embodiment of the present invention;

FIG. 13 is an exploded view of a second step showing assembling a tactile reading device according to the fourth embodiment of the present invention; and

FIG. 14 is an exploded view of a final step showing assembling a tactile reading device according to the fourth embodiment of the present invention.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the present invention will be described with reference to the accompanying drawings. FIGS. 1 to 3 are views for describing the assembly method and the structure of a tactile reading device according to the first embodiment of the present invention. Referring to FIG. 1, reference numeral 1 denotes a frame body composed of a molded product of a synthetic resin or the like. Locking pawls 2a of a sensing plate 2 are engaged with recessed locking portions 1b of an upper body 1a of this frame body 1 to fix the sensing plate 2. A total of eight (=4×2 columns) sensing rods 3 for displaying a braille type character are held in the gap between the frame body 1 and the sensing plate 2 with their flanges 3a such that the sensing rods 3 will not be disengaged from the frame body 1 and the sensing plate 2 and that they are movable in the vertical direction within a predetermined stroke. The