

[0070] The wiring is simplified because simply adding the lead 12e to the movable plate 3 allows supplying the drive voltage for driving the piezoelectric substrate 2 from the outside.

[0071] Also, because the Y impressing side leader electrode 9a also serves as one drive electrode 2a for the piezoelectric substrate 2, the lead 12c is shared for connecting to the external circuits. The Y impressing side leader electrode 9a serves for impressing a detection voltage for detecting a pressed position, or for detecting an electric potential of the fixed conductor layer 7. The drive electrode 2a serves for impressing the drive voltage on the movable plate 2 when a pressure is detected as described later. Because detecting the pressed position, and impressing the drive voltage when a pressure is detected are different from each other in timing, and are not conducted simultaneously, the single electrode can be shared by both of them.

[0072] The piezoelectric substrate 2 is a single-layer substrate formed of a piezoelectric material such as piezoelectric single crystal, piezoelectric ceramic typified by PZT (lead zirconium titanate) ceramic, and polyvinylidene fluoride (PVDF), and a piezoelectric ceramic plate made of a PZT piezoelectric ceramic material which has mechanical durability, and is most widely used is used in this case. The piezoelectric substrate 2 is formed into a thin plate in a stripe shape along a side edge of the fixed conductor layer 7. Because the piezoelectric substrate 2 is a thin plate, when it vibrates, it produces a large distortion. In addition, the piezoelectric substrate 2 operates at low voltage.

[0073] The pair of drive electrodes 2a and 2b which impress the drive voltage on the piezoelectric substrate 2 are attached on both the front and the rear surfaces opposing to each other of the piezoelectric substrate 2 using vapor disposition or screen printing, and then are fixed using calcination. The drive electrode 2a which covers the rear surface of the piezoelectric substrate 2 is bent back on one end in the lengthwise direction of the piezoelectric substrate 2, and is exposed on the front surface with a gap to the other drive electrode 2b for avoiding contact with it.

[0074] The piezoelectric substrate 2, with the drive electrodes 2a and 2b fixed on both sides, is placed between the movable plate 3 and the support substrate 4 while using a part of a space for filling the adhesive layer 5 which is filled in between opposing surfaces of the individual frames 3A and 4A for laminating the movable plate 3 and the support substrate 4 with a slight gap as shown in FIG. 2. While the height of the space for filling, namely the gap between the movable plate 3 and the support substrate 4, is generally 100  $\mu\text{m}$  to 1 mm, it is possible that the height of the piezoelectric substrate 2 including the drive electrodes 2a and 2b fixed to the both sides of the piezoelectric substrate 2 is about 200  $\mu\text{m}$  because the piezoelectric substrate 2 has a single-layer thin plate structure. It is possible to find sufficient space to install the piezoelectric substrate 2 in the space for filling.

[0075] The piezoelectric substrate 2 is fixed on the surface of the support substrate 4 such that one drive electrode 2a (the Y impressing side leader electrode 9a) fixed on the rear surface is placed across the other side edge of the fixed conductor layer 7 and the surface of the support substrate 4, and is fixed to the fixed conductor layer 7 and the support substrate 4 using conductive adhesive 13 as shown in the drawing.

[0076] Because the drive electrode 2a of the piezoelectric substrate 2 serves as the leader electrode in the present embodiment, the conductive adhesive is used to fix the piezoelectric substrate 2 to the support substrate 4. When drive electrode 2a is directly fixed to the support substrate 4, the adhesive is not necessarily conductive. Therefore, different types of adhesives such as epoxy adhesive and acrylic adhesive may be applicable.

[0077] Electrostriction effect of the piezoelectric substrate 2 is used to generate a vibration on the support substrate 4 in the present invention. Because the piezoelectric substrate 2 is directly fixed to the support substrate 4, the contraction and expansion of the piezoelectric substrate 2 generates a vibration with a large amplitude on the support substrate 4. For example, when an electric field of  $10^5 \text{ V/m}$  is applied to a PZT piezoelectric material having a dielectric constant of 3400, a piezoelectric constant of  $590 \times 10^{-12} \text{ C/N}$ , and an elastic compliance of  $20 \times 10^{-12} \text{ m}^2/\text{N}$ , a distortion of  $5.9 \times 10^{-4}$  is generated. A large stress of  $3 \times 10^7 \text{ N/m}$  is generated when this distortion is clamped.

[0078] When this electrostriction effect is used, simply impressing a drive voltage of about  $\pm 20 \text{ V}$  between the pair of drive electrode 2a and 2b in a thickness direction indicated by an arrow in FIG. 3(a) generates a vibration with an amplitude large enough for sensing with the finger even through the movable plate 3 on the support substrate 4. Adjusting a driving voltage and/or a length of a part where the piezoelectric substrate 2 is fixed to the support substrate 4 allows adjusting the amplitude of the vibration.

[0079] Because the piezoelectric substrate 2 is fixed on the peripheral edge of the fixed conductor layer 7, the input operation face 3 a does not become narrower. The pair of piezoelectric substrates 2 may be installed on the both peripheral edges of the fixed conductor layer 7 opposed to each other.

[0080] The piezoelectric substrate 2 is fixed on the support substrate 4 through the drive electrode 2a. Then the adhesive layer 5 is applied between the opposing surfaces of the individual frames 3A and 4A to adhere the movable plate 3 and the support substrate 4 to each other as shown in FIG. 2. When the individual frames 3A and 4A of the movable plate 3 and the support substrate 4 are pressed with the adhesive layer 5 are placed between them, the opposing surfaces of the frames 3A and 4A come into close contact with each other through the adhesive layer 5. The movable conductor layer 6 and the fixed conductor layer 7 are positioned in parallel with each other with a slight gap between them. Because the adhesive layer 5 covers the other drive electrode 2b of the piezoelectric substrate 2, the piezoelectric substrate 2 contracts and expands without constraint.

[0081] A pressure detecting circuit (not shown) detects a pressure and a pressed position on the input operation surface 3 a of the movable plate 3 through the connector connected with the external connector 3b, and provides pressed position data on them. The following section describes this action.

[0082] A predetermined voltage for detecting pressure is applied to the X impressing side leader electrode 8a or the X ground side leader electrode 8b. This maintains the movable conductor layer 6 at this electric potential. The