

displacement with a certain amplitude, and is constituted while laminating multiple piezoelectric substrates. As a result, the thickness of the piezoelectric actuator **108** is increased. Because the manufacturing process for laminating multiple piezoelectric substrates comprises multiple processes including attaching a pair of drive electrodes to the individual layers, and then laminating the piezoelectric substrates to which the drive electrodes are attached in the thickness direction for integration, the cost of the part is relatively high.

[0019] When a vibrating motor is used as the vibration generating source, the size of the vibrating motor itself is large, and the parts cost is high.

[0020] Because the vibration of the touch panel **100A** is an indirect vibration transmitted from the vibration generating source, it is difficult to transmit a delicate feeling of the vibration from the vibration generating source to the touch panel **100A**. For example, if the frequency of the vibration is changed to transmit different information to an operator, because the touch panel **100A** does not precisely move accordingly, it is impossible for the operator to discern the different information.

[0021] Because a delay exists between the generation of the vibration of the vibration generating source and the vibration of the touch panel **100A**, it is difficult to directly transmit a slight change of the vibration.

[0022] Because it is necessary to vibrate the vibration generating source such as the piezoelectric actuator **108** and a vibrating motor continuously for a certain time period, a drive circuit for driving the vibration generating source is a complicated circuit which uses an oscillation circuit. That is, because the vibration source such as a vibrating motor does not respond to a drive voltage in a momentary pulse waveform, the drive circuit must operate for a certain time period including a start operation control. When a drive voltage in the form of a momentary pulse waveform is applied to the piezoelectric actuator **108**, although the piezoelectric actuator **108** momentarily contracts and expands accordingly, because of damping of the expansion and contraction (a vibration) transmitted to the touch panel **100A**, as described before, an operator cannot sense the momentary vibration. There is also a problem of generating an input operation feeling as well.

[0023] In addition, a complicated structure such as the support stand **109** and the support shaft **110** for rotatably supporting the center of the vibration generating source **108** as described above is necessary to secure the vibration generating source **108** in the housing **105**. The vibration generating source **108** merely vibrates to generate noise which is not transmitted to the touch panel **100A** unless the vibration generating source **108** is secured in a mounting.

[0024] Manufacturing precision is required for the vibration generating source **108**, and the vibration transmission mechanism of the touch panel **100A** such as the support substrate **104**. If a gap is present between the contactor **111** and the support substrate **104**, for example, noise is generated during vibrating, but the vibration is attenuated during transmission.

#### OBJECTS AND SUMMARY OF THE INVENTION

[0025] In view of these conventional problems, it is an object of the present invention to provide a touch panel input

device in which the size of the entire device is not increased and the exterior design is not restricted while a structure of vibrating a movable plate or a support substrate is adopted.

[0026] Another object of the present invention is to provide a touch panel input device for freely and finely controlling the vibration of the movable plate or the support substrate.

[0027] Still, another object of the present invention is to provide a touch panel input device using a simple drive circuit to generate a vibration sensitive to an operator on the movable plate or the support substrate.

[0028] A touch panel input device according to a first aspect of the present invention comprises a movable plate including an input operation surface on its surface, a support substrate placed with a slight insulating gap to the movable plate for supporting a back surface of the movable plate, pressure detecting means for detecting a pressure and a pressed position on the input operation surface based on a contact between conductor layers formed respectively on opposing surfaces of the movable plate and the support substrate, and providing pressed position data, and a piezoelectric substrate including a pair of drive electrodes fixed on both opposing surfaces, and fixed directly or through the drive electrode to the movable plate or the support substrate, wherein a drive voltage is impressed on the pair of drive electrodes, and the contracting and expanding piezoelectric substrate vibrates the movable plate or the support substrate to generate an input operation feeling when a pressure is detected on the input operation surface.

[0029] When a drive voltage is impressed between the pair of drive electrodes, the piezoelectric substrate contracts and expands because of electrostriction effect. Because the piezoelectric substrate is directly fixed to the movable plate or the support substrate thorough one of the drive electrodes, the contraction and expansion of the piezoelectric substrate generates a stress which vibrates with a large amplitude on the movable plate or the support substrate itself to which the piezoelectric substrate is fixed.

[0030] Because the movable plate or the support substrate itself vibrates, changing the waveform of the drive voltage which drives the piezoelectric substrate provides the movable plate or the support substrate with a delicate vibration action.

[0031] A touch panel input device according to a second aspect of the invention is the touch panel input device according to the first aspect, further comprising a spacer member placed at peripheral frames between inner surfaces of the movable plate and the support substrate for laminating and placing the movable plate and the support substrate with a slight gap to each other, and is characterized in that the piezoelectric substrate is fixed directly or through the drive electrode on either one of the inner surfaces of the movable plate and the support substrate facing each other at the frames, and is installed in a space where the spacer is placed.

[0032] Because a single layer substrate made of a piezoelectric material can constitute the piezoelectric substrate, the thickness of the piezoelectric substrate can be made thin, and can be interposed in a slight gap between the movable plate and the support substrate.

[0033] Because a space for placing the spacer member which laminates and places the movable plate and the