

electrostatic capacitance detection circuits **10** and **30** according to the above embodiments. In this way, a connecting point for the capacitor **15** and the capacitor **17** is connected to the output terminal of the operational amplifier **14** via the resistance **18**, so that having a floating status through a DC form can be avoided and the potential can be fixed.

[0072] Also, a capacitive sensor connected as the capacitor **17** is not limited to a capacitor microphone and includes all of transducers (devices), which detect various physical quantities using a change in the electrostatic capacitance, such as an acceleration sensor, a seismograph, a pressure sensor, a displacement sensor, a proximity sensor, a touch sensor, an ion sensor, a humidity sensor, a raindrop sensor, a snow sensor, a thunder sensor, a placement sensor, a bad contact sensor, a configuration sensor, an endpoint detection sensor, an oscillation sensor, an ultrasonic wave sensor, an angular velocity sensor, a liquid quantity sensor, a gas sensor, an infrared rays sensor, a radiation sensor, a water gauge, a freeze sensor, a moisture meter, a vibrometer, an electrification sensor, a publicly-known capacitive type sensor like a printed circuit board inspection device, or the like.

[0073] As has been clarified from the above explanation, by applying AC voltage to the operational amplifier via the resistance and connecting the capacitance to be detected to the signal line, the electrostatic capacitance detection circuit, the electrostatic capacitance detection device and the microphone device according to the present invention detect capacitance of the capacitor to be detected. That is, the capacitor is connected between the output terminal of the operational amplifier, of which non-inverting input terminal is connected to the specific potential, and the input terminal of the impedance converter, and further the capacitor to be detected is connected between the input terminal of the impedance converter and the specific potential.

[0074] In this way, all of electric current sent to the capacitor to be detected flows to the capacitor, so that an accurate signal corresponding to the capacitance of the capacitor to be detected is output to the output terminal of the operational amplifier, which makes it possible to detect very small capacitance that equals to or is less than several pF or fF.

[0075] Then, because the non-inverting input terminal of the operational amplifier is connected to the specific potential, and the potential at one end of the input terminal is fixed, the operational amplifier is functioned steadily, the operational error is reduced, and the noise mixed in the detection signal is restrained.

[0076] Also, since the capacitor is connected between the operational amplifier and the impedance converter, detection sensitivity, which does not depend on a frequency of the AC voltage applied to the operational amplifier and on a frequency of a change in the capacitance of the capacitor to be detected, is secured. Moreover, when the resistance is connected between the operational amplifier and the impedance converter, it does not cause a problem to degrade an S/N ratio due to thermal noise from the resistance.

[0077] By placing this electrostatic capacitance detection circuit adjacent to the capacitor to be detected, or placing a circuit element connected to the signal line closely, a shield cable connecting between them and a special circuit that cancels stray capacitance generated by the cable become unnecessary.

[0078] Here, it is possible to add the inverting amplification circuit that inverts a signal at the signal output terminal and the adding circuit that adds up the output signal of the impedance converter and the output signal of the inverting amplification circuit to the said electrostatic capacitance detection circuit. By doing so, any unnecessary offset component contained in the output signal of the electrostatic capacitance detection circuit is removed, and a net signal corresponding to the capacitance of the capacitor to be detected can be amplified significantly.

[0079] Also, the capacitor to be detected may be embodied as a capacitor microphone, the electrostatic capacitance detection circuit may be embodied as an IC, and the capacitor microphone and the IC may be integrated into one and put in a shield box as a microphone used for a mobile phone or the like, so that the capacitor microphone and the electrostatic capacitance detection circuit are located very adjacently, and it becomes unnecessary to have a shield cable with a big diameter, which connects the capacitor to be detected and the electrostatic capacitance detection circuit, and a special circuit for applying guard voltage, or the like.

[0080] Additionally, as the electrostatic capacitance detection circuit according to the present invention detects capacitance by sending electric current to the capacitor to be detected, it does not need to paste a highly polymerized film or the like to the electrode of the capacitor to be detected and have it electret like an electret capacitor microphone so that it is applicable to a normal electrostatic capacitance type sensor.

[0081] As has been mentioned, the present invention reduces limitation for a usage environment, detects very small capacitance accurately, and realizes an electrostatic capacitance detection circuit or the like that is suitable for miniaturization, and especially sound performance of lightweight and compact audio communication devices such as a mobile phone is rapidly improved and its practical value is extremely high.

INDUSTRIAL APPLICABILITY

[0082] The electrostatic capacitance detection circuit according to the present invention may be used as a detection circuit of a capacitance type sensor, especially as a microphone device that is equipped with compact and lightweight devices such as a mobile phone.

1. An electrostatic capacitance detection circuit that outputs a detection signal corresponding to electrostatic capacitance of a capacitor to be detected, comprising:

an impedance converter of which input impedance is high and output impedance is low;

a first capacitive impedance element;

an operational amplifier;

an AC voltage generator that applies AC voltage to the operational amplifier; and

a signal output terminal that is connected to an output of the operational amplifier,

wherein an input terminal of the impedance converter is connected to one end of the capacitor and one end of the first impedance element,