Decision on opposition

Opposition No. 2017-700149

Tokyo, Japan
Patent Right Holder YOKOGAWA ELECTRIC CORPORATION

Kanagawa, Japan
Patent Opponent NAKAZAWA, Yoshiki

The case of an opposition to a granted patent regarding Japanese Patent No. 5970847, entitled "POWER SUPPLY DEVICE USING PIEZOELECTRIC TRANSFORMER," is concluded as follows.

Conclusion

The patent according to Claims 1 and 2 of Japanese Patent No. 5970847 is maintained.

Reason

1. History of the procedures

The application for the patent regarding Claims 1 and 2 of Japanese Patent No. 5970847 was filed on February 17, 2012, and the establishment of patent right was registered on July 22, 2016. Thereafter, the opposition to the granted patent was filed by the opponent, NAKAZAWA, Yoshiki.

2. The Invention

The inventions of the patent regarding Claims 1 and 2 of Japanese Patent No. 5970847 are specified by matters described in Claims 1-2 of the scope of claims as follows. The inventions regarding the patent of Claims 1-2 are referred to as "Patent

invention 1" and "Patent invention 2," respectively.

"[Claim 1]
A power supply device using a piezoelectric transformer including:
a piezoelectric transformer having primary-side terminals and a pair of secondary-side terminals, and configured to insulate a voltage applied to the primary-side terminals, to be output to the secondary-side terminals;
a driving part which outputs a voltage to the primary-side terminals of the piezoelectric transformer;
a rectifying and smoothing part which rectifies and smooths the voltage output from the secondary-side terminals of the piezoelectric transformer, to be converted to a DC voltage for output;
a differential amplifying part having two input terminals, and configured to output, to the driving part, a voltage relating to a difference of voltages applied to the input terminals;
a second capacitor having one end connected to one of the pair of secondary-side terminals of the piezoelectric transformer, and the other end connected to one of the input terminals of the differential amplifying part; and
a third capacitor having one end connected to the other one of the pair of secondary-side terminals of the piezoelectric transformer, and the other end connected to the other one of the input terminals of the differential amplifying part.
[Claim 2]
The power supply device using piezoelectric transformer described in Claim 1, configured to use a capacitor formed with a wiring layer of a printed board, as at least one of the second capacitor and the third capacitor."

3. Outline of grounds for opposition

The opponent, NAKAZAWA, Yoshiki submitted Evidences A No. 1-11 as evidence, and alleges that the patent regarding Claims 1-2 violates the provisions of Article 29(2) of the Patent Act and that the patent regarding Claims 1-2 shall be revoked.

Evidence A No. 1: Japanese Unexamined Patent Application Publication No. H4-49845 (hereinafter referred to as "Publication 1")

Evidence A No. 2: Japanese Unexamined Patent Application Publication No. H11-266041 (hereinafter referred to as "Publication 2")

Evidence A No. 3: Report of technical research in The Institute of Electronics, Information and Communication Engineers. EE, Telecommunication energy technology, published on June 19, 1998, The Institute of Electronics, Information and Communication Engineers, Vol. 98 No. 132, p. 81-86 (hereinafter referred to as "Publication 3")

Evidence A No. 4: Collection of papers on the grand meeting in 1999, The Institute of Electronics, Information and Communication Engineers, p. 353 (hereinafter referred to as "Publication 4")

Evidence A No. 5: Practical circuitry design using OP-amplifier (OP-Amplifier niyoru Jitsuyou Kairo Sekkei), written by Seitaro BABA, published on May 1, 2004, p. 133-158 (hereinafter referred to as "Publication 5")

Evidence A No. 6: Quick-understanding electronic circuit (Sokkai Denshi Kairo), written by Takeo MIYATA, published on December 10, 1991, p. 104-111, p. 124-127, and p. 168-169 (hereinafter referred to as "Publication 6")

Evidence A No. 7: Easy-to-learn analog electronic circuit (Manabiyasui Anarogu Denshi Kairo), written by Tamotsu NINOMIYA and Teruhiko KOHAMA, published on April 25, 2007, p. 106-116 (hereinafter referred to as "Publication 7")

Evidence A No. 8: Japanese Unexamined Patent Application Publication No. 2003-249393 (hereinafter referred to as "Publication 8")

Evidence A No. 9: Japanese Unexamined Patent Application Publication No. H10-51045 (hereinafter referred to as "Publication 9")

Evidence A No. 10: Microfilm of Japanese Utility Model Publication No. S62-93279 (Japanese Unexamined Utility Model Application Publication No. S63-201362) (hereinafter referred to as "Publication 10")

Evidence A No. 11: Japanese Unexamined Patent Application Publication No. H11-167959 (hereinafter referred to as "Publication 11")

Especially, the opponent alleges that Patent invention 1 could have easily been invented by a person skilled in the art on the basis of the descriptions in Publication 1, Publication 8 to Publication 10, in light of the state of the art at the time of filing the application for the patent of the case described in Publication 2 to Publication 7, and that Patent invention 2 could have easily been invented by a person skilled in the art on the basis of the description in Publication 11.

4. Descriptions in Publications and Invention of Publication 1

(1) Publication 1 includes the following description together with drawings. (Underlines indicate the points especially noted.)

A. "FIG. 1 is a circuit block diagram illustrating one example of this invention.

A self-excited piezoelectric transformer converter includes an input power supply 1, a drive circuit 2, a piezoelectric transformer 3, a rectifying and smoothing circuit 4, a load 5, and an amplifier 6.

The input power supply 1 is a power supply for actuating the drive circuit 2.

The drive circuit 2 is a self-oscillating drive circuit for driving the piezoelectric transformer 3. The input power supply 1 (Note by the body: the "input power supply 1" is recognized as an error for "the drive circuit 2") is controlled by a signal from the amplifier 6.

The piezoelectric transformer 3 transmits mechanical vibration energy on a primary side of the piezoelectric transformer generated by driving of the drive circuit 2 to a secondary side, to generate a voltage, and supplies it to the rectifying and smoothing circuit 4. And the output voltage is also supplied to the amplifier 6.

The rectifying and smoothing circuit 4 rectifies and smooths the output voltage generated in the piezoelectric transformer 3, to be supplied to the load 5.

The amplifier 6 is a feedback circuit which amplifies the output voltage of the piezoelectric transformer 3, to be fed back to the drive circuit 2. The maximum output voltage can be extracted from the piezoelectric transformer 3 by means of the feedback circuit of the amplifier 6." (p. 2 upper right column l. 7-p. 2 lower left column l. 8)

B. FIG. 1 illustrates the piezoelectric transformer 3 including a pair of primary-side terminals connected to the drive circuit 2 and a pair of secondary-side terminals connected to the rectifying and smoothing circuit 4, and configured to connect the amplifier 6 to one of the pair of secondary-side terminals.

Considering the above described matters in light of related drawings and technical common sense, and focusing on the points underlined, it can be said that Publication 1 describes the following invention (hereinafter referred to as "Invention of Publication 1")

"A self-excited piezoelectric transformer converter including an input power supply 1, a drive circuit 2, a piezoelectric transformer 3, a rectifying and smoothing circuit 4, a load 5, and an amplifier 6,

the input power supply 1 being a power supply for actuating the drive circuit 2,

the drive circuit 2 being a self-oscillating drive circuit for driving the piezoelectric transformer 3,

the piezoelectric transformer 3 transmitting mechanical vibration energy on a primary side of the piezoelectric transformer generated by the drive circuit 2 to a secondary side, to generate a voltage, and supplying it to the rectifying and smoothing circuit 4, the output voltage being supplied also to the amplifier 6,

the rectifying and smoothing circuit 4 rectifying and smoothing the output voltage generated in the piezoelectric transformer 3, to be supplied to the load 5,

the amplifier 6 amplifying the output voltage of the piezoelectric transformer 3, to be fed back to the drive circuit 2,

and the piezoelectric transformer 3 including a pair of primary-side terminals connected to the drive circuit 2 and a pair of secondary-side terminals connected to the rectifying and smoothing circuit 4, and being configured to connect the amplifier 6 to one of the pair of secondary-side terminals."

(2) Publication 2 describes the following matters.

A. "[0003] In the piezoelectric transformer, there exists little radiation noise. As for conductive noise, which appears in a capacitive element, a large coupling capacitance exists between an input and an output. An impedance between the input and the output is extremely low, and resistance to the conductive noise is low. Thus, the piezoelectric transformer needs to take more measures against especially common-mode (conductive) noise than does a conventional inductive transformer." ([0003])

(3) Publication 3 describes the following matters.

A. "Outline a piezoelectric transformer, which transmits power by mechanical vibration, is expected as a low-noise device. However, noise characteristics of the piezoelectric transformer have not been clarified, and noise reduction of a converter has not been implemented. Here we propose a model of parasitic impedance existing between an input and an output of the piezoelectric transformer, and compared a simulation using the model with an experimental result in order to clarify the mechanism of generation of common-mode noise. As a result, we found that the parasitic impedance has a large influence on generation of common-mode noise.

We also propose a new drive circuit of the piezoelectric transformer in order to reduce common-mode noise. Next, we report that we have obtained a positive result with a sample converter manufactured using the drive circuit." (p. 81 "Outline")

(4) Publication 4 describes the following matters.

A. "1. Introduction

A piezoelectric transformer transmits power, while implementing insulation between an input and an output, using mechanical vibration, and is made lower in profile, weight, thickness, and noise than a conventional inductive transformer. A smaller converter was made by developing a piezoelectric transformer converter using the piezoelectric transformer [1-3]. Currently, a more compact and lightweight piezoelectric transformer is being developed. However, accordingly, a parasitic capacitance existing between a primary side and a secondary side of the piezoelectric transformer increases. There are concerns about the influence of the parasitic

capacitance on the common-mode noise. Here we examine the influence of increase in parasitic capacitance in the piezoelectric transformer converter on common-mode noise, and values and arrangement of inductors of a filter circuit which effectively reduces noise." (p. 353 "1. Introduction")

(5) Publication 5 describes the following matters.

A. "-Differential signal and In-phase signal

As shown in FIG. 12-1, the signals to be applied to two input terminals of an amplifying circuit are as follows.

-Differential signal ... a difference of signals to be applied between input terminals

(FIG. 12-1 omitted)

-In-phase signal ... a common signal to be applied to both input terminals

The differential signal is a differential-mode signal or a normal-mode signal. The in-phase signal is a common-mode signal.

A differential amplifying circuit can amplify a differential signal, while removing the common-mode signal." (p. 133-134 "*Differential signal and In-phase signal)

(6) Publication 6 describes the following matters.

A. "A differential amplifier is utilized effectively in various cases. One application to a transmission system with noise is shown in FIG. 6. 19, as one example.

(FIG. 6. 19 omitted)

In FIG. 6. 19, since both transmission lines connected to input voltages v1 and v2 of a differential amplifier are in the same electric state, noise is contained in the same state, and a noise voltage vn is contained in both transmission lines. A signal voltage vs is applied to the transmission line connected to v1, and the transmission line connected to v2 is connected to earth. Thus, v1 and v2 are as follows.

$$v1=vs+vn \quad (6.45)$$

$$v2=vn \quad (6.46)$$

If the equations (6.45) and (6.46) are substituted in the equation (6.33), an output voltage vo is

vo=R3/R1[vn-(vs+vn)]

=-R3/R1vs (6.47)

vn does not appear in vo, so that the influence of noise is eliminated."

(p. 109 l. 4-p. 110 l. 4)

(7) Publication 7 describes the following matters.

A. "8. 2. 1 Characteristics of differential amplifier

A differential amplifier is shown in FIG 8. 1. The differential amplifier is basically structured by arranging emitter grounded amplifiers symmetrically at respective sides, and has the following characteristics:

(1) requiring no capacitor,

(2) enabling DC amplification,

(3) having high input impedance,

(4) having resistance to drift (having little influence of the change in transistor characteristics due to temperature change),

(5) having two input terminals and two output terminals, based on ground,

(6) and having resistance to noise (canceling in-phase noise).

Generally, in using the differential amplifier, an input signal Vin is applied between the input terminals and an output voltage Vo is obtained from between the output terminals. (FIG. 8. 1 omitted) In FIG. 8. 1, the following are satisfied.

Vin=V2-V1 (8.1)

Vo= Vo2-Vo1 (8.2)

Next, we will give a detailed description about the operation of the differential amplifier." (p. 107-108 "8. 2. 1 Characteristics of differential amplifier")

(8) Publication 8 describes the following matters.

A. "[0010]

[Embodiments of the invention] A high-voltage circuit can be insulated (separated)

from a current detection circuit by use of a current transformer. An output thereof is input to a differential amplifier of a processing part, thereby cancelling in-phase noise.

[0011]

[Examples] An example of this invention is described as follows with reference to drawings. FIG. 1 is a block diagram illustrating an example of this invention. A piezoelectric transformer 12 is driven with a predetermined frequency by a switching circuit of a piezoelectric transformer driving part 11 which applies an input voltage (not shown). At the start of ignition, frequency sweep is executed from high frequency to resonance frequency at the time of high impedance, in order to obtain high-voltage output.

[0012] A high voltage obtained in the piezoelectric transformer 12 is applied to electrodes at respective ends of a cold-cathode fluorescent tube 13. Generally, a balanced output circuit is configured by connecting both electrodes to the output of the piezoelectric transformer, without grounding one of the electrodes. Thus, the high voltage is applied to both electrodes of the fluorescent tube, thereby preventing luminance unevenness, resulting in igniting the whole of the tube uniformly.

[0013] Since a tube current cannot be detected with a resistor in this circuit configuration, this invention includes a current transformer 14 arranged between the piezoelectric transformer 12 and the cold-cathode fluorescent tube 13. A secondary-side voltage induced by the change in primary-side voltage of a high-voltage current path is detected. A tube current can be detected in the circuit separated from the high-voltage current path.

[0014] The tube current detected in the current transformer 14 is input to a differential amplifier 15 of a tube-current detection processing part 16, to be converted to a voltage, and is compared with a reference voltage. A feedback signal is generated from an output as a result of the comparison, to control a drive frequency of a piezoelectric transformer drive circuit 11. The cold-cathode fluorescent tube 13 is turned on, impedance decreases, and resonance frequency thereof changes. Efficient driving can be achieved near the resonance frequency, accordingly.

[0015] In the signal line from the current transformer 14 to the differential amplifier, an

induced voltage of a high-voltage output is generated due to a floating capacitance. The induced voltages applied to positive and negative terminals of the differential amplifier are in phase, and cancelled. Therefore, an output of the differential amplifier 15 is controlled only with a tube current, thereby configuring a stable control circuit.

[0016] FIG. 2 illustrates an example in igniting two cold-cathode fluorescent tubes. An output of a piezoelectric transformer 22 driven by a piezoelectric transformer drive circuit 21 is applied to cold-cathode fluorescent tubes 23A, 23B connected in parallel. Tube currents of the cold-cathode fluorescent tubes 23A, 23B are detected in current transformers 24A, 24B, and input to differential amplifiers 25A, 25B of a tube-current detection processing part 26 and processed.

[0017]

[Advantage of the Invention] In this invention, the current transformer detects a tube current of a cold-cathode fluorescent tube to be used in the balanced output circuit, thereby separating a high-voltage circuit from a detection circuit, and preventing fluctuations in the detection circuit due to the change of load condition. The differential amplifier used in an input stage of the processing part eliminates the influence of in-phase noise, and reliability of the control circuit is improved, while obtaining stable operation even when a power supply voltage or a load state is changed." ([0010]-[0017])

(9) Publication 9 describes the following matters.

A. "[0019] A difference is generated between output signals of two monitor electrodes arranged independently in a power generation part. A comparison is made with a reference signal in order to determine whether or not the difference of the monitor output signals is noise. When the difference of the monitor output signals exceeds the reference signal, presence of a crack in a piezoelectric transformer is determined, and a warning is issued.

[0020]

[Embodiments of the invention] We will give a detailed description of an embodiment of this invention with reference to drawings.

[0021] FIG. 1 is a structural block diagram illustrating a structure of a first-order Rosen type piezoelectric transformer of a first embodiment of this invention.
[0022] In FIG. 1, a left half of a long-plate piezoelectric transformer 1 is a drive part 2 polarized in a thickness direction, and a right half thereof is a power generation part 3 polarized in a longitudinal direction. Input electrodes 4 are formed by applying a silver-palladium material on the entire surface of the top and bottom of the drive part 2. The input electrodes 4 are connected to an input signal 17 via lead wires from input terminals 5. An output electrode 6 is formed by applying a silver-palladium material on an end surface of the power generation part 3. The output electrode 6 extracts an output signal 18 to the outside via a lead wire from an output terminal 7. Monitor electrodes 8a, 8b independent from the output electrode 6 are arranged symmetrically at respective ends on the end surface of the power generation part 3.
[0023] The two monitor electrodes 8a, 8b are arranged so as to detect mechanical vibration generated at the front of the piezoelectric transformer 1 and mechanical vibration generated at the back, independently, in FIG. 1, of the mechanical vibration generated in the polarization direction of the power generation part 3. The monitor electrodes 8a, 8b are connected to an input of a differential amplifying circuit 10 via lead wires from monitor output terminals 9a, 9b. A signal corresponding to an output difference between the monitor electrodes 8a, 8b is output by the differential amplifying circuit 10. An output of the differential amplifying circuit 10 is converted into a direct current by a rectifying and smoothing circuit 11, and enters an input of a comparator 12, to be compared with a preset reference signal 13. When the signal obtained by converting the output of the differential amplifying circuit 10 by the rectifying and smoothing circuit 11 exceeds the reference signal 13, the comparator 12 outputs a signal. The output of the comparator 12 is connected to a switching element 15 of a warning display circuit 14. The switching element 15 turns on the switch upon receipt of the output signal from the comparator 12, to turn on a light-emitting diode 16.
[0024] Therefore, a warning about an occurrence of crack in the piezoelectric transformer 1 is indicated by turning on the light-emitting diode 16." ([0019]-[0024])

(10) Publication 10 describes the following matters.

A. "A device 1 shown in FIG. 1 has the following different points from a conventional device 20: using a piezoelectric transformer 3 configured by employing the same piezoelectric element as a piezoelectric transformer 13 of the conventional device 20, and including excitation electrodes 3a, 3b and an output electrode 3d only, but not including a feedback electrode 3c; connecting one terminal of a feedback circuit 4 to the output electrode 3d of the piezoelectric transformer 3; and using only a feedback capacitor CF as the feedback circuit 4. An oscillation active circuit 2 (Note by the body: "2" is recognized as an error for "12"), the piezoelectric transformer 3, and the feedback circuit 14 (Note by the body: "14" is recognized as an error for "4") configure a self-excited oscillation circuit." (Specifications p. 5 l. 16-p. 6 l. 6)

(11) Publication 11 describes the following matters.

A. "[0020] As shown in FIG. 8, in using plane parallel plates, planar conductors (plane parallel plates) 802, 803 formed by thickening a part or all of a wiring pattern are arranged in the same positions on both sides of a printed board 801, to obtain a capacitance by use of the principle of plane-parallel capacitor. This configuration can be manufactured by the same technology as in the case of manufacturing a wiring pattern, thereby reducing cost and facilitating calculation of capacitance." ([0020])

5. Comparison/Judgment

(1) Patent invention 1

Patent invention 1 is compared with the Invention of Publication 1.

A. The "piezoelectric transformer 3" of the Invention of Publication 1 includes a pair of primary-side terminals connected to the drive circuit 2 and a pair of secondary-side terminals connected to the rectifying and smoothing circuit 4, and corresponds to "a piezoelectric transformer having primary-side terminals and a pair of secondary-side terminals, and configured to insulate a voltage applied to the primary-side terminals, to be output to the secondary-side terminals" of Patent invention 1.

B. The "drive circuit 2" of the Invention of Publication 1 is "a self-oscillating drive circuit for driving the piezoelectric transformer 3," which is connected to "a pair of primary-side terminals" of the "piezoelectric transformer 3," and corresponds to "a driving part which outputs a voltage to the primary-side terminals of the piezoelectric transformer" of Patent invention 1.

C. The "rectifying and smoothing circuit 4" of the Invention of Publication 1 is connected to "a pair of secondary-side terminals" of the "piezoelectric transformer 3" and "rectifies and smooths the output voltage generated in the piezoelectric transformer 3, to be supplied to the load 5," and corresponds to the "rectifying and smoothing part which rectifies and smooths the voltage output from the secondary-side terminals of the piezoelectric transformer, to be converted to a DC voltage for output" of Patent invention 1.

D. Since the "amplifier 6" of the Invention of Publication 1 "amplifies the output voltage of the piezoelectric transformer 3, to be fed back to the drive circuit 2," the "amplifier 6" of the Invention of Publication 1 and "differential amplifying part having two input terminals, and configured to output a voltage relating to a difference of voltages applied to the input terminals, to the driving part" of Patent Invention 1 are common in the point of "an amplifying part which outputs a voltage relating to a voltage applied to an input terminal, to the driving part."

E. The "self-excited piezoelectric transformer converter" of the Invention of Publication 1 "rectifies and smooths the output voltage generated in the piezoelectric transformer 3, to be supplied to the load 5," and corresponds to the "power supply device using piezoelectric transformer" of Patent invention 1.

Thus, the corresponding features and different features between Patent invention 1 and the Invention of Publication 1 are as follows.

<Corresponding features>

"A power supply device using piezoelectric transformer including:

a piezoelectric transformer having primary-side terminals and a pair of secondary-side terminals, and configured to insulate a voltage applied to the primary-side terminals, to be output to the secondary-side terminals;

a driving part which outputs a voltage to the primary-side terminals of the piezoelectric transformer;

a rectifying and smoothing part which rectifies and smooths the voltage output from the secondary-side terminals of the piezoelectric transformer, to be converted to a DC voltage for output; and

an amplifying part which outputs a voltage relating to a voltage applied to an input terminal, to the driving part."

<Different feature 1>

The "amplifying part" is the "differential amplifying part having two input terminals, and is configured to output a voltage relating to a difference of voltages applied to the input terminals, to the driving part" in Patent invention 1. However, in the Invention of Publication 1, the amplifying part "amplifies the output voltage of the piezoelectric transformer 3, to be fed back to the drive circuit 2," and is not a "differential amplifying part" "having two input terminals" or an amplifier which "outputs" "the voltage relating to a difference of voltages applied to the input terminals."

<Different feature 2>

Patent invention 1 includes "a second capacitor having one end connected to one of the pair of secondary-side terminals of the piezoelectric transformer, and the other end connected to one of the input terminals of the differential amplifying part; and

a third capacitor having one end connected to the other one of the pair of secondary-side terminals of the piezoelectric transformer, and the other end connected to the other one

of the input terminals of the differential amplifying part." However, the Invention of Publication 1 does not include the above capacitors, and is configured by "connecting the amplifier 6 to one of a pair of secondary-side terminals" of the "piezoelectric transformer 3."

F. We will examine the above <Different feature 1> and <Different feature 2>.
(A) As described in Publications 2-4 described in 4. (2)-4. (4), the problem of common-mode noise in the piezoelectric transformer had been recognized to be a well-known technical problem before filing the application for the patent.

As described in Publications 5-7 described in 4. (5)-4. (7), the differential amplifier used for removing common-mode noise had been recognized to be a well-known art before filing the application for the patent.

However, none of the above publications 2-7 describes or suggests a configuration of using a differential amplifier in a feedback circuit of a piezoelectric transformer (configuration relating to the Different feature 1), or a configuration of connecting a pair of secondary-side terminals of a piezoelectric transformer to two input terminals of a differential amplifier (configuration relating to the Different feature 2).

(B) As described in 4. (8), Publication 8 describes a piezoelectric transformer drive circuit having a current transformer 14 arranged between a piezoelectric transformer 12 and a fluorescent tube 13 in order to detect a tube current flowing in the fluorescent tube 13 connected to the piezoelectric transformer 12, and configured to cancel in-phase noise (common-mode noise) by inputting the tube current detected in the current transformer 14 to a differential amplifier 15, and to obtain stable operation even when a power supply voltage or load state is changed, while improving reliability of control circuit, without any influence of in-phase noise.

However, Publication 8 is configured to connect the current transformer to the differential amplifier, and does not describe or suggest a configuration of connecting a pair of secondary-side terminals of a piezoelectric transformer to two input terminals of a differential amplifier (configuration relating to the Different feature 2).

(C) As described in 4. (9), Publication 9 describes that monitor electrodes 8a, 8b independent from an output electrode 6 of a piezoelectric transformer 1, arranged symmetrically, to detect mechanical vibration generated at the front of the piezoelectric transformer 1 and mechanical vibration generated at the back independently, connected to input of a differential amplifying circuit 10 via lead wires from monitor output terminals 9a, 9b, that an output of the differential amplifying circuit 10 is DC-converted to be input to a comparator 12, and that an output of the comparator 12 is connected to a switching element 15 of a warning display circuit 14, to indicate a warning of an occurrence of a crack in the piezoelectric transformer 1 by turning on a light-emitting diode 16.

However, Publication 9 indicates a warning of an occurrence of a crack in a piezoelectric transformer, and does not relate to a feedback circuit of the piezoelectric transformer.

Publication 9 does not describe or suggest a configuration of using a differential amplifier in a feedback circuit of a piezoelectric transformer (configuration relating to the Different feature 1), or a configuration of connecting a pair of secondary-side terminals of a piezoelectric transformer to two input terminals of a differential amplifier (configuration relating to the Different feature 2).

(D) As described in 4. (10), Publication 10 describes a configuration of connecting one terminal of a feedback circuit 4 to an output electrode 3d of a piezoelectric transformer 3, and using only a feedback capacitor CF as the feedback circuit 4.

However, Publication 10 does not describe or suggest a configuration of using a differential amplifier in a feedback circuit of a piezoelectric transformer (configuration relating to the Different feature 1), or a configuration of connecting a pair of secondary-side terminals of a piezoelectric transformer to two input terminals of a differential amplifier (configuration relating to the Different feature 2).

(E) As described in (A), it is recognized that the problem of common-mode noise in the

piezoelectric transformer had been a well-known technical problem before filing the application for the patent and that the differential amplifier used for removing common-mode noise had been a well-known art before filing the application for the patent. However, Publications 2-4 do not indicate that the influence of common-mode noise on a feedback circuit of a piezoelectric transformer had been a well-known technical problem before filing the application for the patent. Publication 1 also does not describe the problem of the influence of common-mode noise on a feedback circuit of a self-excited piezoelectric transformer converter. As described in Publications 5-7, even if the differential amplifier to be used for removing common-mode noise had been well-known arts, it cannot be said that a person skilled in the art could have easily employed a configuration (configuration relating to the Different feature 1) of using a differential amplifier in a feedback circuit of a piezoelectric transformer in order to remove common-mode noise in the piezoelectric transformer in the Invention of Publication 1.

As described in (A) to (D), since none of the Publications 2-10 describes a configuration (configuration relating to the Different feature 2) of connecting a pair of secondary-side terminals of a piezoelectric transformer to two input terminals of a differential amplifier, it cannot be said that a person skilled in the art could have easily conceived of using a differential amplifier for a feedback circuit of a piezoelectric transformer, in order to remove common-mode noise of the feedback circuit of the piezoelectric transformer, in the Invention of Publication 1, and connecting a pair of secondary-side terminals of a piezoelectric transformer to two input terminals of a differential amplifier, from the technical matters described in Publications 2-10, in consideration of the above well-known technical problem and well-known arts.

(G) The opponent alleges, in "3 (4) D) (b)" of Written opposition, as follows,

"However, as described in Evidences A No. 2 to No. 4, before filing the application for the Patent invention 1, it had been widely known that common-mode noise is generated in a piezoelectric transformer. As described in Evidences A No. 5 to No. 7, it had also been widely known that a differential amplifier is used for removing noise.

Evidence A No. 8 describes that in-phase noise is cancelled by inputting an output of a piezoelectric transformer to a differential amplifier. Similarly, Evidence A No. 9 describes that a pair of terminals are arranged in an output of a piezoelectric transformer, to detect noise by inputting outputs extracted from the pair of terminals to a differential amplifier.

Thus, in the well-known arts described in Evidences A No. 2 to No. 7, it is extremely easily for a person skilled in the art to apply the technology of 'using a differential amplifier as countermeasures against noise of a piezoelectric transformer' described in Evidences A No. 8 and No. 9, to the power supply device in Evidence A No. 1.

The invention of the Evidence A No. 9 is configured to input voltages extracted from a pair of terminals arranged in an output of a piezoelectric transformer, to a differential amplifier, to be compared with each other. If combining the invention of Evidence A No. 9, which inputs outputs of a pair of output terminals to a differential amplifier, with Evidence A No. 1 having a pair of output terminals, to apply the invention of Evidence A No. 8 which uses a differential amplifier for removing noise in the piezoelectric transformer, a person skilled in the art can extremely easily invent the Patent invention 1 for taking measures against noise by inputting the outputs from the pair of output terminals arranged in the piezoelectric transformer to the differential amplifier."

However, as described in (B), Publication 8 is an invention of connecting a current transformer to a differential amplifier, and does not describe or suggest the configuration (configuration relating to the Different feature 2) of connecting a pair of secondary-side terminals of a piezoelectric transformer to two input terminals of a differential amplifier. As described in (C), Publication 9 is an invention of indicating a warning about an occurrence of a crack in a piezoelectric transformer, and does not relate to a feedback circuit of the piezoelectric transformer. The technologies of Evidence A No. 8 (Publication 8) and Evidence A No. 9 (Publication 9) cannot be applied to Evidence A No. 1 (Invention of Publication 1), accordingly. Even if the technologies can be applied, the configuration (configuration relating to the Different

feature 1) of using a differential amplifier in a feedback circuit of a piezoelectric transformer and the configuration (configuration relating to the Different feature 2) of connecting a pair of secondary-side terminals of a piezoelectric transformer to two input terminals of a differential amplifier cannot be achieved.

Thus, the allegation of the opponent is groundless.

(2) Patent invention 2

As described in Publication 11 described in 4. (11), the technology of arranging planar conductors (plane parallel plates) in the same positions on both sides of a printed board to obtain a capacitance by use of the principle of plane-parallel capacitor, is recognized to have been well-known arts before filing the application for the patent.

However, Publication 11 does not describe or suggest a configuration of using a differential amplifier in a feedback circuit of a piezoelectric transformer (configuration relating to the Different feature 1) or a configuration of connecting a pair of secondary-side terminals of a piezoelectric transformer to two input terminals of a differential amplifier (configuration relating to the Different feature 2).

Patent invention 2 is an invention obtained by further restricting Patent invention 1. Therefore, a person skilled in the art cannot easily achieve Patent invention 2 from the inventions described in Publications 1-11 and the technical matters, due to the similar reason as cited in the judgment on Patent invention 1.

As described above, Patent inventions 1-2 could not be easily invented by a person skilled in the art from the inventions described in Publications 1-11.

6. Closing

Thus, the reasons and the evidences of the opposition to the patent cannot revoke the patent according to Claims 1-2.

No other reason for revoking the patent according to Claims 1-2 is found.

Therefore, the decision shall be made as described in the conclusion.

May 8, 2017

Chief administrative judge: WADA, Shiro

Administrative judge: YAMADA, Masafumi

Administrative judge:
CHIBA, Teruhisa