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(54) **HORN DEVICE**

(57) A controller for controlling the energization of a coil 44 is constituted by an IC chip 51 that serves as a single package component in which a plurality of electronic components is sealed with a sealing material. As a result thereof, a horn device 10 which can meet the needs of productivity improvement, cost reduction, and a reduction in size and weight, while allowing improvements in reliability without the need for a control circuit board can be achieved. The IC chip 51 itself controls the energization of the coil 44, that is, the IC chip vibrates a diaphragm 22, thereby also allowing elimination of contacts. Consequently, the horn device suppresses generation of abrasion powders or the like due to contact with the contacts, and thus prevents malfunction of the IC chip 51, thereby improving reliability.

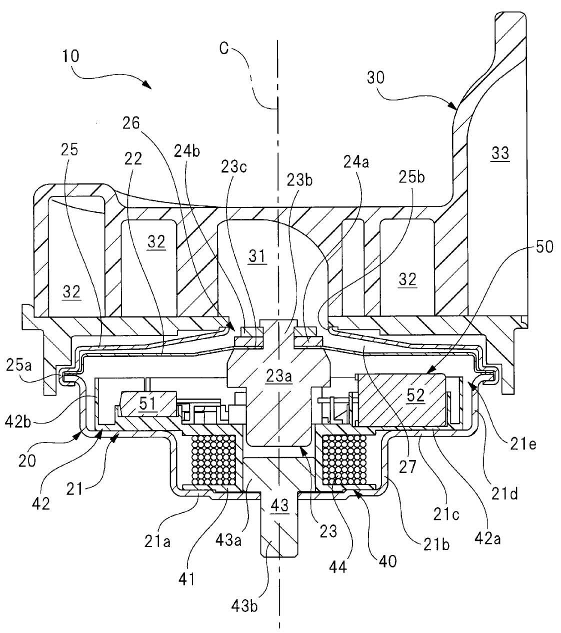

FIG. 2

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Description

[Technical Field]

[0001] The present invention relates to a horn device that generates sound by vibrating a moving core installed in a diaphragm.

[Background Art]

[0002] An electromagnetic horn device is mounted on the front side of a vehicle such as an automobile. Some electromagnetic horn devices generate sound by vibrating a moving core mounted on a diaphragm, and resonate the sound with a resonator. A horn device including such a resonator is described in, for example, Patent Literature 1 and Patent Literature 2.

[0003] The horn device (an electromagnetic alarm) described in Patent Literature 1 includes a case (a body) that accommodates a coil in the center part, a diaphragm (a vibration plate) that closes an opening part of the case, and a moving core (an armature) installed at the center part of the diaphragm. In addition, the case accommodates a contact point (an interrupter) that is opened and closed (on/off) by vertical movement of the moving core, and a control circuit board that controls energization of a coil by opening and closing the contact point.

[0004] A transistor and a power MOS-type FET are mounted on a control circuit board. The transistor controls the power MOS-type FET with a weak current, and the power MOS-type FET supplies a strong current (a drive current) to the coil. That is, the control circuit board is controlled by a weak current, and only a weak current for driving the control circuit board flows through the contact point. Accordingly, it is possible to suppress abrasion of the contact point caused by the flow of a large current (due to generation of a spark).

[0005] In addition, as in the horn device disclosed in Patent Literature 2, there is a method in which a horn device is blown by a control circuit board provided outside a case by eliminating a contact point inside the case.

[Reference List]

[Patent Literature]

[0006]

[Patent Literature 1]
Japanese Patent Laid-Open No. 2003-122369
[Patent Literature 2]
Spanish Patent Application Publication No. 2376690 (ES2376690A1)

[Summary of Invention]

[Technical Problem]

[0007] However, the horn device disclosed in Patent Literature 1 requires a large space for accommodating the control circuit board in the case, and the control circuit board and the contact point are disposed close to each other in the same space in the case. In addition, in the horn device disclosed in Patent Literature 1, since the control circuit board is used, it is necessary to further seal components with a sealing agent or the like to secure corrosion resistance after mounting and soldering an element, and this requires time and costs. Accordingly, there has been a limit to improvement in productivity and cost reduction in the horn device using the control circuit board. In addition, there is a concern regarding the occurrence of a problem such as a migration phenomenon (insulation failure due to metal corrosion or the like) since the above-described control circuit board is used.

[0008] Furthermore, in the horn device disclosed in Patent Literature 2, it is necessary to dispose a relatively large control circuit board outside the case although no contact point is provided inside the case, and there is also a problem that the periphery of a connector part becomes large, and the entire shape of the horn device becomes complicated.

[0009] An objective of the present invention is to provide a horn device that can meet the needs of productivity improvement, cost reduction, and a reduction in size and weight, while allowing improvements in reliability without using a control circuit board.

[Solution to Problem]

[0010] In one aspect of the present invention, a horn device includes a case of which one side is closed and the other side is opened; a diaphragm that closes an opening part of the case; and a moving core that is installed on the diaphragm, in which the case accommodates a fixed core that generates a magnetic force to attract the moving core, a coil that is disposed around the fixed core, and a controller that controls energization of the coil, and the controller is a single package component in which a plurality of electronic components is sealed with a sealing material.

[0011] In another aspect of the present invention, the case accommodates a surge protection component that protects the controller from a large current, and the controller and the surge protection component are disposed around the fixed core while facing each other.

[0012] In still another aspect of the present invention, the case accommodates a coil bobbin made of an insulating material, the coil bobbin includes a coil winding part around which the coil is wound, and a controller mounting part on which the controller is mounted, and a wall part is provided around the controller mounting part while overlapping the controller when the coil bobbin is viewed from a direction intersecting an axial direction.

[0013] In still another aspect of the present invention, a Zener diode that protects the controller from a large current is sealed in the controller.

[0014] In still another aspect of the present invention, the surge protection component is a capacitor, and the case accommodates a snubber circuit in which the capacitor and a resistor are connected in series.

[Advantageous Effects of Invention]

[0015] According to the present invention, a controller for controlling energization of a coil is constituted as a single package component in which a plurality of electronic components is sealed with a sealing material, and the controller is accommodated in a case. Accordingly, without requiring a control circuit board as in the related art, it is possible to meet the needs of productivity improvement, cost reduction, and a reduction in size and weight, while allowing improvements in reliability without using a control circuit board.

[Brief Description of Drawings]

[0016]

Fig. 1 is a perspective view showing a horn device of the present invention.

Fig. 2 is a cross-sectional view showing an internal structure of the horn device of Fig. 1.

Fig. 3 is a perspective view showing an IC chip side (a front side) of a coil bobbin accommodated in a case.

Fig. 4 is a perspective view showing a coil side (a back side) of the coil bobbin accommodated in the case.

Fig. 5 is an electric circuit diagram for driving the horn device of Fig. 1.

Fig. 6 is a cross-sectional view showing a transfer path of heat generated by a coil.

(a), (b), and (c) of Fig. 7 are perspective views showing a connection portion between an electronic component and a conductive member.

(a) and (b) of Fig. 8 are perspective views showing an [insert molding step].

Fig. 9 is a perspective view showing an [electronic component mounting step].

Fig. 10 is a perspective view showing a [laser welding step].

Fig. 11 is a perspective view showing an [assembly step].

Fig. 12 is a perspective view showing a [frequency adjustment step].

Fig. 13 is a perspective view showing a part of a horn device according to Embodiment 2.

Fig. 14 is an electric circuit diagram for driving a horn device of Embodiment 3.

Fig. 15 is a graph showing the operation of a bidirectional Zener diode.

[Description of Embodiments]

[0017] Hereinafter, Embodiment 1 of the present invention will be described in detail with reference to the drawings.

[0018] Fig. 1 is a perspective view showing a horn device of the present invention. Fig. 2 is a cross-sectional view showing an internal structure of the horn device of Fig. 1. Fig. 3 is a perspective view showing an IC chip side (a front side) of a coil bobbin accommodated in a case. Fig. 4 is a perspective view showing a coil side (a back side) of the coil bobbin accommodated in the case. Fig. 5 is an electric circuit diagram for driving the horn device of Fig. 1. Fig. 6 is a cross-sectional view showing a transfer path of heat generated by a coil. (a), (b), and (c) of Fig. 7 are perspective views showing a connection portion between an electronic component and a conductive member. (a) and (b) of Fig. 8 are perspective views showing an [insert molding step]. Fig. 9 is a perspective view showing an [electronic component mounting step]. Fig. 10 is a perspective view showing a [laser welding step]. Fig. 11 is a perspective view showing an [assembly step]. Fig. 12 is a perspective view showing a [frequency adjustment step].

[0019] As shown in Fig. 1, the horn device 10 is mounted on a front side of a vehicle such as an automobile, and generates a warning sound. A base end side of a mounting stay 11 is fixed to the horn device 10, and a distal end side of the mounting stay 11 is fixed to a cross member or the like forming a vehicle body with a fixing bolt. The horn device 10 is an electromagnetic spiral type horn, and is activated and generates a warning sound by operating a horn switch provided on a steering wheel or the like.

[0020] The horn device 10 includes a horn main body 20 and a resonator 30. The resonator 30 is attached to the horn main body 20, resonates a sound generated by the horn main body 20, and emits the sound to the outside. Sounds of different frequencies are generated by preparing a plurality of horn main bodies 20 and resonators 30 having different specifications, and arbitrarily combining each of them. For example, in an ordinary passenger vehicle, two horn devices 10, that is, a horn device 10 for high-pitch sound (High) of 490 Hz and a horn device 10 for low-pitch sound (Low) of 410 Hz are combined.

[0021] As shown in Fig. 2, the horn main body 20 includes a case 21. The case 21 is formed in a stepped and bottomed cylindrical shape by pressing a metal plate (a conductive material) so that one side (the lower side in the drawing) is closed and the other side (the upper side in the drawing) is opened. The one side of the case 21 has a small-diameter accommodation part 21b having a disk-like bottom part 21a. In addition, the other side of the case 21 has a large-diameter accommodation part 21d having an annular bottom part 21c.

[0022] The large-diameter accommodation part 21d has a diameter larger than that of the small-diameter accommodation part 21b, and its diameter dimension is approximately twice as large as that of the small-diameter accommodation part 21b. In addition, a coil bobbin 40 made of a resin material (an insulating material) such as plastic is accommodated in the small-diameter accommodation part 21b and the large-diameter accommodation part 21d.

[0023] An opening part 21e is formed on the side opposite to the side of the disk-like bottom part 21a along an axial direction of the case 21. The opening part 21e is closed by a substantially disk-like diaphragm 22 formed of a thin metal plate. A moving core 23 is installed at a central part of the diaphragm 22, and the moving core 23 is formed in a stepped and substantially columnar shape using a magnetic material.

[0024] The moving core 23 includes a main body part 23a that is attracted to a pole 43 when a coil 44 is energized, and a fixed part 23b that is fixed to a central part of the diaphragm 22. In addition, a step surface 23c is formed between the fixed part 23b and the main body part 23a, and the central part of the diaphragm 22 is placed on the step surface 23c.

[0025] A large-diameter washer 24a and a small-diameter washer 24b for fixing the diaphragm 22 to the main body part 23a are installed on the fixed part 23b. The large-diameter washer 24a is disposed on a base end side of the fixed part 23b, and the small-diameter washer 24b is disposed on a distal end side of the fixed part 23b. In addition, the diaphragm 22 and the pair of washers 24a and 24b are installed on the fixed part 23b, and in this state, the distal end side of the fixed part 23b is swaged, and thereby the diaphragm 22 is firmly fixed to the main body part 23a.

[0026] A shape of the moving core 23 on the resonator 30 side (upper side in the drawing) becomes a tapered shape by overlapping the small-diameter washer 24b with the large-diameter washer 24a. Thereby, a flow path area of an air flow path 26 between an air vibration chamber 27 and a sound generation chamber 31 can be set large. Accordingly, a flow of air flowing through the air flow path 26 becomes smooth, and this stabilizes acoustic characteristics of the horn device 10.

[0027] In addition, an axis of the moving core 23 and an axis of the pole 43 for attracting the moving core 23 coincide with each other at an axis C, and the moving core 23 and the pole 43 are disposed coaxially with each other. Furthermore, a predetermined part of the pole 43 side along an axial direction of the main body part 23a is inserted into a radially inner side of the coil winding part 41 in the coil bobbin 40 via a predetermined gap.

[0028] The diaphragm 22 has a function as a plate spring for disposing the moving core 23 at a "reference position" shown in Fig. 2. That is, the diaphragm 22 is maintained in a state where the moving core 23 is separated from the pole 43, in a free state in which no external force is applied to the diaphragm 22.

[0029] As shown in Fig. 2, a cover 25 formed in a substantially disk-like shape by pressing a steel plate or the like is provided on the side (the upper side in the drawing) opposite to the case 21 side of the diaphragm 22. An annular and swaged fixed part 25a is formed on the outer peripheral part of the cover 25. In addition, the swaged fixed part 25a holds the outer peripheral part of the case 21 and the outer peripheral part of the diaphragm 22 by sandwiching them. Accordingly, both the diaphragm 22 and the cover 25 are firmly fixed to the case 21.

[0030] The cover 25 is disposed between the diaphragm 22 and the resonator 30. A sound output port 25b coaxial with the moving core 23 is provided at a central part of the cover 25, and the annular air flow path 26 is formed between the sound output port 25b and the pair of washers 24a and 24b. Air flows through the air flow path 26 by the vibration of the diaphragm 22.

[0031] As the diaphragm 22 is vibrated, a volume of the air vibration chamber 27 formed between the cover 25 and the diaphragm 22 increases or decreases. As a result, a flow of air is generated in the air flow path 26. The diaphragm 22 is vibrated at a high frequency (for example, 490 Hz or 410 Hz), this vibration becomes a sound, and the sound is emitted from the sound output port 25b.

[0032] As shown in Fig. 2, the resonator 30 is installed on the cover 25 side of the horn main body 20. The resonator 30 is provided to cover the cover 25 side of the horn main body 20. The resonator 30 is formed in a predetermined shape with a resin material such as plastic, and a sound generation chamber 31 disposed on the axis C of the moving core 23 is provided at the center part of the resonator 30 and on the cover 25 side. The diaphragm 22 is vibrated thereby, and air flows in and out between the air vibration chamber 27 and the sound generation chamber 31 through the sound output port 25b.

[0033] The resonator 30 includes a sound path 32 (not shown in detail) formed in a spiral shape. The sound path 32 forms a passage through which a sound generated by the vibration of the diaphragm 22 passes. In addition, the sound generation chamber 31 to which a sound generated by the vibration of the diaphragm 22 reaches first is disposed at an entrance side of the sound path 32, that is, at the center of the spiral. On the other hand, an exit opening part 33 is provided on an exit side of the sound path 32, that is, a part near the outer periphery of the spiral, and sounds are emitted from the exit opening part 33 to the outside.

[0034] An opening area of the sound path 32 gradually increases from the sound generation chamber 31 side toward the exit opening part 33 side. Accordingly, a sound pressure level of a sound generated by the vibration of the diaphragm 22 is amplified, and a loud sound having a predetermined volume can be emitted.

[0035] As shown in Figs. 2 to 4, the coil bobbin 40 that vibrates the moving core 23 and thereby vibrates the diaphragm 22 is accommodated in the case 21. Specifically, the coil bobbin 40 functions as a vibration generating mechanism (sound generating mechanism), and is disposed in a space surrounded by the case 21 and the diaphragm 22.

[0036] The coil bobbin 40 is formed in a predetermined shape with a resin material (an insulating material) such as plastic, and includes a coil winding part 41 having a small diameter and a controller mounting part 42 having a larger diameter than that of the coil winding part 41. The coil winding part 41 is accommodated in the small-diameter accommodation part 21b of the case 21, and the controller mounting part 42 is accommodated in the large-diameter accommodation part 21d of the case 21. That is, the coil winding part 41 and the controller mounting part 42 are provided side by side in an axial direction (an axial direction of the axis C) of the horn main body 20.

[0037] The pole 43 as a fixed core is installed in a radially inner side of the coil winding part 41. The pole 43 is formed by machining or the like of a round bar made of a magnetic material, and includes a main body part 43a having a large diameter and a male thread part 43b having a smaller diameter than that of the main body part 43a. The main body part 43a is firmly fixed to the radially inner side of the coil winding part 41 by serration fitting or the like (not shown), and the male thread part 43b passes through the disk-like bottom part 21a to be disposed outside the case 21. In addition, the base end side of the mounting stay 11 is fixed to the male thread part 43b disposed outside the case 21 by a fixing nut 12 (refer to Fig. 1).

[0038] The coil 44 made of a conductive material (conductive wire) is wound a predetermined number of turns around the radially inner side of the coil winding part 41. That is, the coil 44 is disposed around the pole 43. Accordingly, the pole 43 provided at the center of the coil 44 becomes an electromagnet by supplying a drive current (a large current) to the coil 44, and a magnetic force (attractive force) is generated.

[0039] The controller mounting part 42 includes an annular main body part 42a formed in a substantially disk shape, and an annular wall part (wall part) 42b that is provided integrally with and around the annular main body part, and stands upright in an axial direction (an axial direction of the axis C) of the annular main body part 42a (the coil bobbin 40). Specifically, the annular wall part 42b stands upright on the side opposite to the coil winding part 41 side of the annular main body part 42a.

[0040] A control circuit 50 that supplies a drive current of a predetermined magnitude to the coil 44 at a predetermined timing, that is, drives the horn device 10, is mounted on the annular wall part 42b side of the annular main body part 42a. In addition, as shown in Figs. 3 and 4, the annular main body part 42a is swaged with a first rivet RV1, a second rivet RV2, and a third rivet RV3 (a total of three rivets) to be fixed to the annular bottom part 21c of the case 21 (refer to Fig. 2).

[0041] The control circuit 50 includes an Integrated Circuit (IC) chip 51 formed of a single package component obtained by sealing a plurality of electronic components (not shown) with a sealing material (for example, epoxy resin); a film capacitor (a capacitor) 52 that functions as a surge protection component that protects the IC chip 51 from unexpected large currents; and a resistance element (a resistor) 53 set to a predetermined resistance value. In addition, the IC chip 51, the film capacitor 52, the resistance element 53, and the coil 44 are respectively electrically connected via a plurality of conductive members 54. The IC chip 51 controls the energization of the coil 44, and constitutes a controller in the present invention.

[0042] As shown in Fig. 8, a total of seven conductive members 54 are provided, each having a predetermined shape made of brass or the like having excellent conductivity.

[0043] In addition, these conductive members 54 are respectively provided on the annular main body part 42a by insert molding. Furthermore, the three rivets RV1, RV2, and RV3 are also formed of brass or the like having excellent conductivity, and have a function as an electronic component for supplying a drive current and the like to the control circuit 50 from the outside of the case 21, in addition to a function of fixing the coil bobbin 40 to the case 21 (refer to Fig. 2).

[0044] Furthermore, the film capacitor 52 and the resistance element 53 form a so-called snubber circuit connected in series. By incorporating such a "snubber circuit" in the control circuit 50, a transient high voltage (a large current) generated when opening and closing a horn switch (not shown) or the like is absorbed, thereby protecting the IC chip 51.

[0045] In the present embodiment, the snubber circuit uses the film capacitor 52 having a small change in capacitance due to temperature, and having characteristics of high accuracy and stability using a plastic film as a dielectric. Accordingly, the IC chip 51 can be more reliably protected. However, depending on specifications, for example, another type of less expensive capacitor may be used.

[0046] In addition, parts, which are disposed outside the case, of each of the three rivets RV1, RV2, and RV3 having a function as an electronic component are fixed to a connector member 60 as shown in Fig. 12. That is, the connector member 60 is fixed to the annular bottom part 21c of the case 21 by the three rivets RV1, RV2, and RV3.

[0047] The connector member 60 includes a connector main body 61 made of a resin material such as plastic and formed in a substantially arc shape. The connector main body 61 is disposed along the annular bottom part 21c of the case 21. In addition, the connector main body 61 is integrally provided with a connector connection part 62 to which an external connector (not shown) on a vehicle side is connected. The connector connection part 62 is opened toward the radially outward side of the case 21, and thereby an external connector can be easily inserted.

[0048] A plus (+)-side conductive member and a minus (-)-side conductive member (both not shown) are embedded in the connector member 60 by insert molding. One end of each conductive member is exposed inside the connector connection part 62, and the other end of each conductive member is electrically connected to the first rivet RV1 and the second rivet RV2 via the connector main body 61. Specifically, the plus-side conductive member is connected to the first rivet RV1, and the minus-side conductive member is connected to the second rivet RV2.

[0049] A conductive member is not connected to the third rivet RV3 unlike the first rivet RV1 and the second rivet RV2. Instead, as shown in Fig. 12, a wiring L3 for an adjustment device (a check terminal CH of an adjustment device AD) of the adjustment device AD can be directly electrically connected to the third rivet RV3. The adjustment device AD is a device that corrects variations in sound frequency, which would be caused due to manufacturing errors or the like, of every product of the horn device 10. A specific method of adjusting a sound frequency using the adjustment device AD will be described later.

[0050] As shown in Fig. 5, the IC chip 51 forming the control circuit 50 supplies a drive current to the coil 44 at a predetermined frequency. Thereby, the coil 44 (pole 43) generates a magnetic force at a predetermined frequency, and the moving core 23 is vibrated at a predetermined frequency. Accordingly, the diaphragm 22 is also vibrated at a predetermined frequency, a volume of the air vibration chamber 27 (refer to Fig. 2) between the cover 25 and the diaphragm 22 increases and decreases, and air flows in the air flow path 26. In this manner, the vibration becomes a sound when the diaphragm 22 is vibrated at a predetermined frequency, and the sound is emitted from the air flow path 26 toward the sound generation chamber 31.

[0051] The IC chip 51 has a control unit 51a, a drive unit 51b, a temperature measurement unit 51c, a current measurement unit 51d, and a storage unit 51e therein. In addition, as shown in Figs. 3 and 5, a power supply device BT is electrically connected to two terminals T1 of a plurality of terminals T1 provided on the IC chip 51, respectively via the conductive member 54, and the first rivet RV1 and second rivet RV2.

[0052] Furthermore, as shown in Fig. 3, the coil 44 is electrically connected to another terminal T1 of the plurality of terminals T1 via the conductive member 54, the film capacitor 52, and the resistance element 53. Furthermore, as shown in Figs. 3 and 5, the adjustment device AD can be electrically connected to still another terminal T1 of the plurality of terminals T1 via the conductive member 54 and the third rivet RV3.

[0053] The IC chip 51 of the present embodiment is a package component having a so-called single inline package (SIP) structure in which the plurality of terminals T1 is provided in a line on one side of the package.

[0054] As shown in Fig. 5, the control unit 51a outputs a pulse width modulation (PWM) signal PS to the drive unit 51b, whereby the drive unit 51b supplies a drive current of a predetermined frequency to the coil 44. Accordingly, the diaphragm 22 is vibrated at a predetermined frequency. The control unit 51a adjusts (corrects) a duty cycle of the PWM signal PS according to an ambient temperature of the IC chip 51 and a magnitude of a current flowing through the coil 44.

[0055] The drive unit 51b converts a DC current from the power supply device BT into an AC current based on the PWM signal PS from the control unit 51a, and outputs the converted AC current (a drive current) to the coil 44.

[0056] The temperature measurement unit 51c measures a temperature around the horn device 10 (an ambient temperature), and it is formed of, for example, a negative temperature coefficient (NTC) thermistor whose resistance value decreases as an ambient temperature increases, or the like. In addition, the temperature measurement unit 51c outputs measured temperature data T to the control unit 51a. Thereafter, the control unit 51a refers to a temperature correction map (not shown) stored in the storage unit 51e in advance, based on the temperature data T from the temperature measurement unit 51c. Next, the control unit 51a obtains a duty cycle corresponding to input temperature data T from the temperature correction map, and outputs a PWM signal PS having the duty cycle to the drive unit 51b.

[0057] As described above, the correction of the PWM signal PS according to an ambient temperature in the IC chip 51 is to prevent a frequency of a sound generated from the horn device 10 from changing due to a change in ambient temperature. That is, the horn device 10 according to the present embodiment is capable of generating a sound having a constant frequency regardless of the degree of ambient temperature.

[0058] The current measurement unit 51d measures a current value I flowing through the coil 44, and outputs the measured current value I to the control unit 51a. The current measurement unit 51d includes a shunt resistor (not shown) provided in a path of a current flowing through the coil 44, and is formed by a current measurement circuit that measures a current value I from a voltage of both ends of the shunt resistor.

[0059] Then, the control unit 51a refers to a current correction map (not shown) stored in the storage unit 51e in advance, based on the current value I from the current measurement unit 51d. Next, the control unit 51a obtains a duty cycle corresponding to input current value I from the current correction map, and outputs a PWM signal PS having the duty cycle to the drive unit 51b.

[0060] As described above, the correction of the PWM signal PS according to the current value I flowing through the coil 44 in the IC chip 51 is to suppress the current value I flowing through the coil 44 from increasing as the ambient temperature decreases. Accordingly, even in a case where an ambient temperature is low, an increase in the current value I flowing through the coil 44 is suppressed, the moving core 23 and the pole 43 are then prevented from colliding with each other, and thereby generation of collision noise (abnormal noise) is effectively suppressed.

[0061] The power supply device BT is a vehicle-mounted battery (12 V), and supplies a drive current (a small current) to the IC chip 51 and supplies a drive current (a large current) to the coil 44. A secondary battery such as a nickel hydride battery or a lithium ion battery can be used as the power supply device BT. In addition, an electric double layer capacitor (capacitor) or the like can be used instead of the secondary battery.

[0062] Next, a mounting structure of the control circuit 50 on the controller mounting part 42 will be described in more detail with reference to the drawings.

[0063] As shown in Figs. 3, 6, and 7, the control circuit 50 is mounted on the controller mounting part 42 of the coil bobbin 40. More specifically, the IC chip 51, the film capacitor 52, and the resistance element 53 forming the control circuit 50 are respectively fixed to a first fixing part FX1, a second fixing part FX2, and a third fixing part FX3 which are integrally provided on the annular main body part 42a.

[0064] These first fixing part FX1, second fixing part FX2, and third fixing part FX3 are respectively formed in a substantially box shape, and the IC chip 51, the film capacitor 52, and the resistance element 53 are accommodated therein so as not to rattle. It is desired that an adhesive be applied to reliably prevent the IC chip 51, the film capacitor 52, and the resistance element 53 from rattling inside the first fixing part FX1, the second fixing part FX2, and the third fixing part FX3.

[0065] In addition, as shown in Fig. 3, the IC chip 51 (the first fixing part FX1) and the film capacitor 52 (the second fixing part FX2) are disposed to face each other around the axis C. That is, the IC chip 51 and the film capacitor 52 are disposed to face each other around the moving core 23 and the pole 43 (refer to Fig. 2), whereby the IC chip 51 and the film capacitor 52 are provided on the annular main body part 42a in a well-balanced manner. Specifically, a weight balance of the coil bobbin 40 around the axis C becomes favorable.

[0066] In addition, as shown in Fig. 6, when the coil bobbin 40 is viewed from a direction intersecting its axial direction (a direction of arrow A) in a state where the IC chip 51 is fixed to the first fixing part FX1, the IC chip 51 overlaps with the annular wall part 42b. That is, when the coil bobbin 40 is viewed from the direction of arrow A in the drawing, the IC chip 51 is covered by the annular wall part 42b. Fig. 6 shows a state in which the resonator 30 has been removed from the horn main body 20.

[0067] Accordingly, even when the horn device 10 is driven for a long time and a temperature of the coil 44 becomes high, heat HT generated by the coil 44 at that time is transmitted to the case 21 as shown by a thick arrow in the drawing. Thereafter, the heat is radiated to the outside from the swaged fixed part 25a of the cover 25. At this time, since the IC chip 51 is shielded from the case 21 by the annular wall part 42b, the heat HT transmitted to the case 21 is barely transmitted to the IC chip as indicated by a thick broken arrow. Accordingly, the heat HT barely reaches the IC chip 51, and the IC chip 51 is prevented from being heated by the heat HT of the coil 44. Therefore, damage, malfunction, or the like of the IC chip 51 due to heat is reliably prevented.

[0068] The IC chip 51 and the coil 44 are disposed close to each other inside the case 21. However, the annular main body part 42a is interposed between the IC chip 51 and the coil 44. Since the annular main body part 42a is formed of a resin material such as plastic, thermal conductivity is smaller than that of the case 21 made of metal. Accordingly, transmission of the heat HT of the coil 44 to the IC chip 51 via the annular main body part 42a is suppressed.

[0069] As shown in Fig. 7, end parts of the plurality of conductive members 54 are exposed in the vicinity of the first fixing part FX1, the second fixing part FX2, and the third fixing part FX3 in the annular main body part 42a. In addition, the terminals T1 provided on the IC chip 51, leg parts T2 provided on the film capacitor 52, and lead wires T3 provided on the resistance element 53 are respectively electrically connected to these end parts of the conductive members 54.

[0070] As shown in (a) of Fig. 7, placement parts 54a bent in an extending direction of the annular main body part 42a are respectively integrally provided on the conductive members 54 exposed near the first fixing part FX1. More specifically, each of the plurality of placement parts 54a extends toward the center of the coil bobbin 40. That is, a bending direction of the plurality of placement parts 54a is directed to the axis C (refer to Fig. 3).

[0071] The terminals T1 of the IC chip 51 are placed on the plurality of placement parts 54a. Specifically, each of the terminals T1 of the IC chip 51 can be placed on each of the plurality of placement parts 54a by accommodating the IC chip 51 in the first fixing part FX1. Accordingly, the terminals T1 and the conductive members 54 are positioned relative to each other, and electrical connection (laser welding which will be described later) between them can be facilitated (improvement in assemblability).

[0072] An amount of the adhesive applied between the IC chip 51 and the first fixing part FX1 is adjusted to an amount that does not allow the formation of a gap between the terminal T1 and the placement part 54a when the IC chip 51 is accommodated in the first fixing part FX1.

[0073] In addition, as shown in (a) of Fig. 7, a height dimension of a welded portion (adhered portion) to the annular main body part 42a is set to "h1" in portions of all the terminals T1 and the placement parts 54a. The welded portion is a portion at which the terminal T1 and the placement part 54a are welded to be integrated, and is a focal point of a laser beam LS (refer to Fig. 10) of a laser welding machine (not shown) in the present embodiment.

[0074] As shown in (b) of Fig. 7, opening parts 54b opened in the axial direction of the annular main body part 42a (an extending direction of the axis C) are respectively integrally provided on the conductive members 54 exposed near the second fixing part FX2. In addition, the leg parts T2 of the film capacitor 52 are inserted into these openings 54b from the extending direction of the axis C (upward in the drawing).

[0075] Specifically, each of the leg parts T2 of the film capacitor 52 enter each of the opening parts 54b by accommodating the film capacitor 52 in the second fixing part FX2. Accordingly, the leg parts T2 and the conductive members 54 are positioned relative to each other, and electrical connection between them can be facilitated.

[0076] An amount of the adhesive applied between the film capacitor 52 and the second fixing part FX2 is also adjusted to an amount that allows contact of the leg parts T2 and the opening parts 54b without a gap therebetween when the film capacitor 52 is accommodated in the second fixing part FX2.

[0077] In addition, as shown in (b) of Fig. 7, a height dimension of a welded portion to the annular main body part 42a is set to "h2" in portions of all the leg parts T2 and the opening parts 54b. As described above, the welded portion is a portion at which the leg parts T2 and the opening parts 54b are welded to be integrated, and is a focal point of the laser beam LS (refer to Fig. 10) of the laser welding machine in the present embodiment.

[0078] As shown in (c) of Fig. 7, opening parts 54c opened in the axial direction of the annular main body part 42a (an extending direction of the axis C) are respectively integrally provided on the conductive members 54 exposed near the third fixing part FX3. In addition, the lead wires T3 of the resistance element 53 are inserted into these openings 54c from the extending direction of the axis C (upward in the drawing).

[0079] Specifically, each of the lead wires T3 of the resistance element 53 enter each of the opening parts 54c by accommodating the resistance element 53 in the third fixing part FX3. Accordingly, the lead wires T3 and the conductive members 54 are positioned relative to each other, and electrical connection between them can be facilitated.

[0080] An amount of the adhesive applied between the resistance element 53 and the third fixing part FX3 is also adjusted to an amount that allows contact of the lead wires T3 and the opening parts 54c without a gap therebetween when the resistance element 53 is accommodated in the third fixing part FX3.

[0081] In addition, as shown in (c) of Fig. 7, a height dimension of a welded portion to the annular main body part 42a is set to "h3" in portions of all the lead wires T3 and the opening parts 54c. As described above, the welded portion is a portion at which the lead wires T3 and the opening parts 54c are welded to be integrated, and is a focal point of the laser beam LS (refer to Fig. 10) of the laser welding machine in the present embodiment.

[0082] Here, height dimensions h1, h2, and h3 of the respective welded portions from the annular main body part 42a are all set to the same height dimensions (h1 = h2 = h3). Accordingly, it is possible to control (X-Y control) a base (not shown) of the laser welding machine on a two-dimensional plane when performing laser welding on each of the welded portions, and it is possible to simplify control logic of the laser welding machine.

[0083] In addition, since the height dimensions h1, h2, and h3 of the respective welded portions from the annular main body part 42a are all set to the same height dimensions, connection strength can be the same at any portion of the respective welded portions. Accordingly, variations in connection strength at the respective welded portions are suppressed, and reliability can be improved.

[0084] Furthermore, as shown in Fig. 3 and (a) and (b) of Fig. 7, a connection portion between the terminal T1 of the IC chip 51 and the placement part 54a, and a connection portion between the leg part T2 of the film capacitor 52 and the opening part 54b are disposed near the central part of the annular main body part 42a (the coil bobbin 40). Thereby, a work range of the base of the laser welding machine is narrowed, and an assembling time can be shortened.

[0085] Next, an assembling procedure of the horn device 10 (refer to Fig. 2) formed as described above will be described in detail with reference to the drawings.

[Insert molding step]

[0086] First, as shown in (a) of Fig. 8, the plurality of conductive members 54 (total of seven) manufactured in another manufacturing step in advance is prepared. Next, as shown by an arrow M1, each of the plurality of conductive members 54 is disposed (fixed) at predetermined positions of a concave part 71 (not shown in detail) of a lower die 70 forming an injection molding device (not shown).

[0087] Thereafter, the injection molding device is driven to lower an upper die 72 toward the lower die 70. Thereby, the lower die 70 and the upper die 72 abut each other as shown in (b) of Fig. 8. Then, the upper die 72 is brought into close contact with the lower die 70, and a cavity (not shown) that forms the coil bobbin 40 (refer to Figs. 3 and 4) is formed therein.

[0088] Next, a molten resin (not shown) is supplied to a supply passage (not shown) formed in the upper die 72 and connected to the cavity as shown by an arrow M2. At this time, the molten resin is supplied at a predetermined pressure from a dispenser 73 of the injection molding device. As described above, the molten resin is pressure-fed toward the cavity, and thereby the molten resin is evenly distributed to every corner in the cavity. Accordingly, the coil bobbin 40 is accurately formed without generating bubbles or the like in the coil bobbin 40.

[0089] Thereby, the coil bobbin 40 in which the plurality of conductive members 54 is inserted (embedded) is completed, and the insert molding step ends. The operation of removing the completed coil bobbin 40 from the lower die 70 and the upper die 72 (a release operation) is performed after the coil bobbin 40 is sufficiently cooled and hardened.

[Electronic component mounting step]

[0090] Next, as shown in Fig. 9, the coil bobbin 40 having undergone the insert molding step is prepared, and the IC chip 51, the film capacitor 52, the resistance element 53, and the first rivet RV1, second rivet RV2, and third rivet RV3, which are to be mounted on the controller mounting part 42, are prepared. In addition, the pole 43 and the coil 44 to be mounted on the coil winding part 41 are prepared.

[0091] In addition, first, as shown by an arrow M3, the first rivet RV1, second rivet RV2, and third rivet RV3 are installed at predetermined positions from the side (the upper side in the drawing) opposite to the coil winding part 41 side along the axial direction of the coil bobbin 40. Thereby, the first rivet RV1, the second rivet RV2, and the third rivet RV3 are respectively electrically connected to the conductive members 54.

[0092] The third rivet RV3 is installed inside the first fixing part FX1, and thereby overlaps with the IC chip 51 when the coil bobbin 40 is viewed from its axial direction (an arrow B direction) as shown in Fig. 10. As described above, by mounting the third rivet RV3 inside the first fixing part FX1, which is a relatively large space, it is possible to realize reduction in size of the horn device 10.

[0093] In addition, since the third rivet RV3 can be disposed closer to the IC chip 51 as compared with the first rivet RV1 and the second rivet RV2, it is possible to realize shortening of the conductive member 54 (which is for the adjustment device AD shown in Fig. 12) between the third rivet RV3 and the IC chip 51.

[0094] Next, as shown by an arrow M4, the IC chip 51, the film capacitor 52, and the resistance element 53 are respectively accommodated in the first fixing part FX1, the second fixing part FX2, and the third fixing part FX3. At this time, an adhesive is thinly applied to the first fixing part FX1, the second fixing part FX2, and the third fixing part FX3 in advance.

[0095] Thereby, as shown in Fig. 7, positioning of the IC chip 51, the film capacitor 52, and the resistance element 53 relative to the controller mounting part 42 (the annular main body part 42a) is completed. In addition, as shown in Fig. 7, the terminals T1 of the IC chip 51 are respectively placed on the placement parts 54a, the leg parts T2 of the film capacitors 52 are inserted into the respective opening parts 54b, and the lead wires T3 of the resistance element 53 are inserted into the respective opening parts 54c.

[0096] In addition, as shown by an arrow M5, the main body part 43a of the pole 43 is fixed to the radially inner side of the coil winding part 41 (refer to Figs. 2 and 4) by serration fitting. Furthermore, as indicated by an arrow M6, the coil 44 is wound on the radially outer side of the coil winding part 41.

[0097] Accordingly, the IC chip 51, the film capacitor 52, the resistance element 53, the first rivet RV1, the second rivet RV2, and the third rivet RV3 are mounted on the controller mounting part 42, the pole 43 and the coil 44 are installed on the coil winding part 41, and the electronic component mounting step ends.

[Laser welding step]

[0098] Next, as shown in Fig. 10, the coil bobbin 40 having undergone the electronic component mounting step is prepared, and the coil bobbin 40 is set on a base (not shown) of the laser welding machine. At this time, the electronic components such as the IC chip 51 mounted on the controller mounting part 42 face a laser nozzle LN side of the laser welding machine.

[0099] The laser welding machine includes the base (X-Y table) on which the coil bobbin 40 as work is set and which moves in the directions of arrows M7 and M8; the laser nozzle LN disposed above the base; and a control panel (not shown) for control thereof.

[0100] Then, by driving the laser welding machine with predetermined control logic, the base on which the coil bobbin 40 is set is moved in the directions of arrows M7 and M8, and the laser beam LS is emitted from the laser nozzle LN toward the plurality of welded portions at predetermined timing.

[0101] Accordingly, the terminal T1 of the IC chip 51 and the placement part 54a of the conductive member 54 (refer to (a) of Fig. 7) are melted to be integrated, the leg part T2 of the film capacitor 52 and the opening part 54b of the conductive member 54 (refer to (b) of Fig. 7) are melted to be integrated, and the lead wire T3 of the resistance element 53 and the opening part 54c of the conductive member 54 (refer to (c) of Fig. 7) are melted to be integrated.

[0102] Therefore, the electronic components such as the IC chip 51 mounted on the controller mounting part 42 are each electrically connected, the control circuit 50 is formed on the controller mounting part 42, and the laser welding step ends.

[Assembly step]

[0103] Next, as shown in Fig. 11, the coil bobbin 40 having undergone the laser welding step and the case 21 manufactured in another manufacturing process are prepared, and the coil bobbin 40 is accommodated in the case 21 as shown by an arrow M9. At this time, the coil winding part 41 (refer to Fig. 4) is accommodated in the small-diameter accommodation part 21b, and the controller mounting part 42 is accommodated in the large-diameter accommodation part 21d.

[0104] Next, the end parts (refer to Fig. 4) of the first rivet RV1, the second rivet RV2, and the third rivet RV3, which protrude from the annular bottom part 21c of the case 21 to the outside of the case 21, are swaged using a swaging jig (not shown). Thereby, the coil bobbin 40 is fixed to the case 21, and the first rivet RV1, the second rivet RV2, and the third rivet RV3 are electrically connected to the connector member 60, as shown in Fig. 12.

[0105] Thereafter, as shown in Fig. 2, the diaphragm 22 and the cover 25 are attached to the case 21 to close the opening part 21e, and the outer peripheral part of the cover 25 is swaged using a swaging jig (not shown). Thereby, an annular and swaged fixed part 25a is formed, and the assembly of the horn main body 20 is completed.

[0106] Next, the resonator 30 manufactured in another manufacturing step is prepared, and the resonator 30 is assembled to the horn main body 20 as shown in Fig. 2. Thereby, the assembly of the horn device 10 is completed, and the assembly step ends.

[Frequency adjustment step]

[0107] Next, as shown in Fig. 12, the completed horn device 10 is prepared, and the adjustment device AD is connected to the horn device 10. Specifically, a pair of power supply lines L1 and L2 of the adjustment device AD are connected to the connector connection part 62, and the wiring L3 for an adjustment device of the adjustment device AD is connected to the third rivet RV3 exposed outside the case 21. In addition, a microphone MC of the adjustment device AD is set in front of the horn device 10.

[0108] Then, the adjustment device AD is operated to blow the horn device 10. Then, the adjustment device AD picks up the sound frequency of the horn device 10 at this time with the microphone MC, and grasps the state of the horn device 10 before adjustment.

[0109] Next, the adjustment device AD outputs a correction signal to the IC chip 51 through the wiring L3 for an adjustment device (refer to Fig. 5) in a case where there is a difference ($A \neq B$) between a target sound frequency (AHz) and an actual sound frequency (BHz) picked up by the microphone MC via the wiring L3 for an adjustment device. Then, the IC chip 51 changes a vibration frequency of the diaphragm 22 based on the correction signal from the adjustment device AD so that the target sound frequency (AHz) is generated.

[0110] Thereafter, the adjustment device AD allows the storage unit 51e (refer to Fig. 5) of the IC chip 51 to store the correction signal (target drive signal) for generating the vibration frequency when it is determined that the target sound frequency (AHz) and the actual sound frequency (BHz) picked up by the microphone MC are substantially the same frequencies ($A \approx B$).

[0111] Then, the frequency adjustment step (a final finishing step) ends, the completed horn device 10 is driven by the target drive signal by the IC chip 51, and the horn device 10 can generate sounds of substantially the same sound frequency as the target sound frequency. Accordingly, it is possible to improve reliability by eliminating variations in sound frequency of each product which are caused by manufacturing errors of the components constituting the horn device 10, such as a difference in a degree of swaging of the swaged fixed part 25a.

[0112] As described in detail above, according to the horn device 10 according to Embodiment 1, a controller for controlling energization of the coil 44 is constituted by the IC chip 51 that serves as a single package component in which the plurality of electronic components is sealed with a sealing material, and the IC chip 51 is accommodated in the case 21. Accordingly, without requiring a control circuit board as in the related art, it is possible to meet the needs of productivity improvement, cost reduction, and a reduction in size and weight, while allowing improvements in reliability without using a control circuit board.

[0113] In addition, since the IC chip 51 itself, which is a package component, controls the energization of the coil 44, that is, vibrates the diaphragm 22, it is possible to eliminate contact points that are mechanically in contact with each other. Accordingly, no abrasion powder or the like due to contact of the contact points is generated, and it is possible to suppress malfunction of the IC chip 51, thereby improving reliability.

[0114] In addition, according to the horn device 10 according to Embodiment 1, the case 21 accommodates the film capacitor 52 that protects the IC chip 51 from a large current, and the IC chip 51 and the film capacitor 52 are disposed to face each other around to the axis C (refer to Fig. 3).

[0115] Accordingly, the IC chip 51 and the film capacitor 52 are disposed in a well-balanced manner on the annular main body part 42a, and a weight balance of the coil bobbin 40 around the axis C becomes favorable. Therefore, the coil bobbin 40 can be easily assembled to the case 21 by an automatic assembling apparatus or the like.

[0116] In addition, according to the horn device 10 according to Embodiment 1, the case 21 accommodates the coil bobbin 40 made of an insulating material, the coil bobbin 40 includes the coil winding part 41 around which the coil 44 is wound, and the controller mounting part 42 on which the IC chip 51 is mounted, and the annular wall part 42b is provided around the controller mounting part 42 while overlapping the IC chip 51 when the coil bobbin 40 is viewed from a direction intersecting an axial direction.

[0117] Accordingly, even when the horn device 10 is driven for a long time and a temperature of the coil 44 becomes high, the IC chip 51 can be shielded from the case 21 by the annular wall part 42b, and the heat HT radiated from the case 21 is barely transmitted to the IC chip 51. Therefore, it is possible to reliably prevent damage, malfunction, or the like of the IC chip 51 due to heat.

[0118] Next, Embodiment 2 of the present invention will be described in detail with reference to the drawings. Parts having the same functions as those in Embodiment 1 are denoted by the same reference numerals, and detailed description thereof will be omitted.

[0119] Fig. 13 is a perspective view showing a part of a horn device according to Embodiment 2.

[0120] As shown in Fig. 13, a horn device 80 according to Embodiment 2 differs from the horn device 10 of Embodiment 1 (refer to Fig. 12) in the shape of a connector member 81. More specifically, a plus-side conductive member 83 and a minus-side conductive member 84, and additionally, a conductive member 85 for adjustment are embedded inside a connector main body 82 of the connector member 81 of the horn device 80 by insert molding.

[0121] One end of each of the three conductive members 83, 84, and 85 are exposed inside a connector connection part 86. The other ends of the three conductive members 83, 84, and 85 are respectively electrically connected to the first rivet RV1, the second rivet RV2, and the third rivet RV3. That is, in Embodiment 2, a conductive member (the conductive member 85 for adjustment) is also provided outside the case 21, between the third rivet RV3 and the connector connection part 86.

[0122] The conductive members 54 are provided between the first rivet RV1, the second rivet RV2, and the third rivet RV3, and the terminal T1 (refer to Fig. 3) of the IC chip 51 in the same manner as in the horn device 10 of Embodiment 1.

[0123] One end of each of the three conductive members 83, 84, and 85 are respectively exposed inside the connector connection part 86, and distal portions of the plus-side conductive member 83 and the minus-side conductive member 84, and a distal portion of the conductive member 85 for adjustment are separated by a predetermined distance S in an insertion direction of the connector connection part 86.

[0124] An insertion depth of an external connector (not shown) on a vehicle side into the connector connection part 86 is a dimension D in the insertion direction of the connector connection part 86. In addition, the distal portions of the plus-side conductive member 83 and the minus-side conductive member 84 are respectively disposed within the range of the dimension D as shown in Fig. 13. On the other hand, the distal portion of the conductive member 85 for adjustment is disposed outside the range of the dimension D. That is, the distal portion of the conductive member 85 for adjustment is disposed at a position further retracted from the bottom part of the connector connection part 86.

[0125] Accordingly, the external connector on the vehicle side does not come into contact with the distal portion of the conductive member 85 for adjustment, but comes into contact only with and is electrically connected only to the distal portions of the plus-side conductive member 83 and the minus-side conductive member 84.

[0126] On the other hand, the adjustment device AD (refer to Fig. 12) includes a dedicated connector (not shown) that can be electrically connected to all (three places) the distal portions of the plus-side conductive member 83 and the minus-side conductive member 84, and the distal portion of the conductive member 85 for adjustment. More specifically, the end parts of the pair of power supply lines L1 and L2, and the wiring L3 for an adjustment device (refer to Fig. 12) are collectively disposed inside the connector of the adjustment device AD.

[0127] Then, only by inserting the connector of the adjustment device AD into the connector connection part 86, preparation for the above-described frequency adjustment step is completed. That is, two preparation operations were required in Embodiment 1, which are connection of the pair of power supply lines L1 and L2 of the adjustment device AD to the connector connection part 62, and thereafter, connection of the wiring L3 for an adjustment device of the adjustment device AD to the third rivet RV3 exposed outside the case 21. On the other hand, in Embodiment 2, only the operation of inserting the connector of the adjustment device AD into the connector connection part 86 is required.

[0128] The horn device 80 according to Embodiment 2 formed as described above can also achieve the same operation and effect as the horn device 10 according to Embodiment 1 described above. In addition, in Embodiment 2, the frequency adjustment step can further be simplified.

[0129] Next, Embodiment 3 of the present invention will be described in detail with reference to the drawings. Parts having the same functions as those in Embodiment 1 are denoted by the same reference numerals, and detailed description thereof will be omitted.

[0130] Fig. 14 is an electric circuit diagram for driving a horn device of Embodiment 3, and Fig. 15 is a graph showing the operation of a bidirectional Zener diode.

[0131] As shown in Fig. 14, Embodiment 3 differs from Embodiment 1 only in the configuration of the control circuit 50.

[0132] Specifically, a control unit 51a forming the control circuit 50 of Embodiment 3 includes a calculation unit 90 and a PWM signal generation circuit 91. In addition, a drive unit 51b forming the control circuit 50 of Embodiment 3 includes a power MOS-type FET 92 and a bidirectional Zener diode (Zener diode) 93.

[0133] The calculation unit 90 is a unit that calculates and adjusts a duty cycle of a PWM signal PS. The calculation unit 90 includes a temperature measurement unit 51c, a current measurement unit 51d, and a storage unit 51e therein. In addition, the PWM signal generation circuit 91 includes a pair of MOS-type FETs 91a and 91b, one resistance element 91c, and a switching power supply (low voltage) 91d for operating the power MOS-type FET 92.

[0134] Accordingly, the PWM signal PS that has been optimally adjusted is output from the control unit 51a to the drive unit 51b in the same manner as in Embodiment 1 described above.

[0135] The power MOS-type FET 92 forming the drive unit 51b is a relatively inexpensive, small, and lightweight 100V withstand voltage FET, and has a size suitable for sealing the IC chip 51. The power MOS-type FET 92 includes a gate G, a source S, and a drain D, and the PWM signal PS from the control unit 51a is input to the gate G. Accordingly, the power MOS-type FET 92 performs a switching operation at a predetermined duty cycle (high frequency).

[0136] In addition, the bidirectional Zener diode 93 forming the drive unit 51b is a Zener diode that protects the IC chip 51 from a large current (a counter-electromotive force), and is provided by being electrically connected between the gate G and the drain D of the power MOS-type FET 92. The bidirectional Zener diode 93 clamps (limits) a counter-electromotive force particularly caused by an inrush current generated immediately after a horn switch HS is turned on. Specifically, in the present embodiment, a clamp voltage of bidirectional Zener diode 93 is set to "85 to 95V."

[0137] Accordingly, it becomes possible to adopt a relatively inexpensive, small, and lightweight Zener diode (a general-purpose product) as the bidirectional Zener diode 93. Therefore, the IC chip 51 can be easily sealed, and an increase in size of the IC chip 51 is suppressed.

[0138] A reference numeral ET in Fig. 14 indicates a vehicle body (body ground) of a vehicle such as an automobile.

[0139] Immediately after the horn switch HS is turned on, a state in which the counter-electromotive force is large in accordance with generation of the inrush current continues for a predetermined time (for an extremely short time) as shown in a "horn-sounding region" of Fig. 15. A magnitude of the counter-electromotive force at this time is within the range of 85 to 95 V (a shaded part in the drawing), and the bidirectional Zener diode 93 clamps the counter-electromotive force. That is, a "clamp circuit" including the bidirectional Zener diode 93 functions in the "horn-sounding region."

[0140] A "snubber circuit" in which the film capacitor 52 and the resistance element 53 are connected to each other in series also functions in the "horn sounding region."

[0141] Accordingly, it becomes possible to prevent a high load from being applied to, particularly, the power MOS-type FET 92 (100 V withstand voltage FET) of the IC chip 51, and to protect the IC chip 51 from burning or the like. At this time, only the counter-electromotive force is applied to the bidirectional Zener diode 93 itself in an extremely short time, and functional loss and heat generation of the bidirectional Zener diode 93 are suppressed. Also in this viewpoint, a smaller and lighter (inexpensive) Zener diode can be adopted as the bidirectional Zener diode 93.

[0142] Then, in the "horn-steady-operating region" of Fig. 15, no transient high voltage (counter-electromotive force) is generated, and the "clamp circuit" for protecting the IC chip 51 does not function. Accordingly, since a high load is not constantly applied to the IC chip 51, heat generation of the bidirectional Zener diode 93 is suppressed.

[0143] The horn device (the control circuit 50) according to Embodiment 3 formed as described above can also achieve the same operation and effect as the horn device 10 according to Embodiment 1 described above. In addition, since the IC chip 51 is sealed with the bidirectional Zener diode 93 that protects the IC chip 51 from a large current in Embodiment 3, the "clamp circuit" by the bidirectional Zener diode 93 and the "snubber circuit" by the film capacitor 52 and the resistance element 53 can respectively absorb the counter-electromotive force (large current) separately. Accordingly, it is possible to more reliably protect the IC chip 51, thereby improving reliability.

[0144] In addition, since a Zener diode that clamps a counter-electromotive force caused by an inrush current generated immediately after the horn switch HS is turned on (a clamp voltage of 85 to 95 V) is used, a relatively inexpensive, small, and lightweight Zener diode can be used as the bidirectional Zener diode 93, and thus it can be easily sealed in the IC chip 51.

[0145] In addition, it is possible to reduce a load on the "snubber circuit" by providing the bidirectional Zener diode 93, and thereby the size of the film capacitor 52 can be reduced. Accordingly, it is possible to reduce the entire size of the control circuit 50 as compared to Embodiment 1.

[0146] The present invention is not limited to the above embodiments, and it goes without saying that various changes can be made within the range not departing from the spirit of the present invention. For example, in each of the above embodiments, a horn device mounted on vehicles such as an automobile has been described; however, the present invention is not limited thereto and is also applicable to a horn device of railway vehicles, ships, construction machines, or the like.

[0147] In addition, in each of the above embodiments, a spiral type horn including the resonator 30 has been described; however, the present invention is not limited thereto and is also applicable to a flat type horn that does not have a resonator and generates a collision sound by colliding a movable core and a fixed core at a predetermined frequency.

[0148] Furthermore, the materials, shapes, sizes, numbers, installation locations, and the like of each component in the respective embodiments are arbitrary and are not limited to the above embodiments as long as the present invention can be achieved.

[Industrial Applicability]

[0149] The horn device is provided in the front of a vehicle such as an automobile, and is used to generate a warning sound (sound) around the vehicle such as an automobile for promoting attention by operating a horn switch.

Claims

1. A horn device comprising:

a case of which one side is closed and the other side is opened;

a diaphragm that closes an opening part of the case; and
a moving core that is installed on the diaphragm, wherein the case accommodates

a fixed core that generates a magnetic force to attract the moving core,
a coil that is disposed around the fixed core, and
a controller that controls energization of the coil, and

the controller is a single package component in which a plurality of electronic components is sealed with a sealing material.

2. The horn device according to claim 1,
wherein the case accommodates a surge protection component that protects the controller from a large current, and
the controller and the surge protection component are disposed around the fixed core while facing each other.

3. The horn device according to claim 1,
wherein the case accommodates a coil bobbin made of an insulating material, the coil bobbin comprises

a coil winding part around which the coil is wound, and
a controller mounting part on which the controller is mounted, and a wall part is provided around the controller mounting part while overlapping the controller when the coil bobbin is viewed from a direction intersecting an axial direction.

4. The horn device according to claim 2,
wherein a Zener diode that protects the controller from a large current is sealed in the controller.

5. The horn device according to claim 4,
wherein the surge protection component is a capacitor, and
the case accommodates a snubber circuit in which the capacitor and a resistor are connected in series.

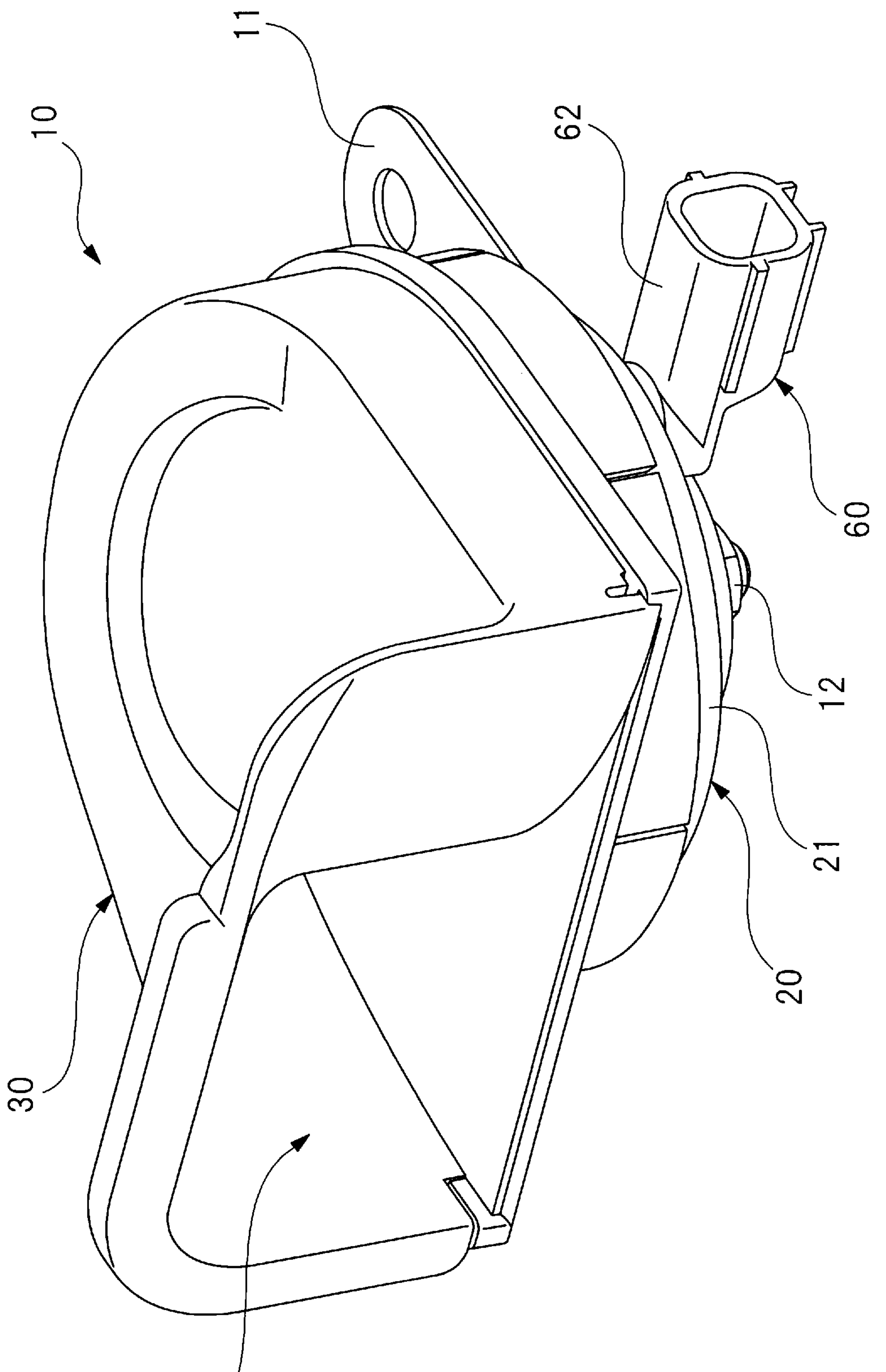
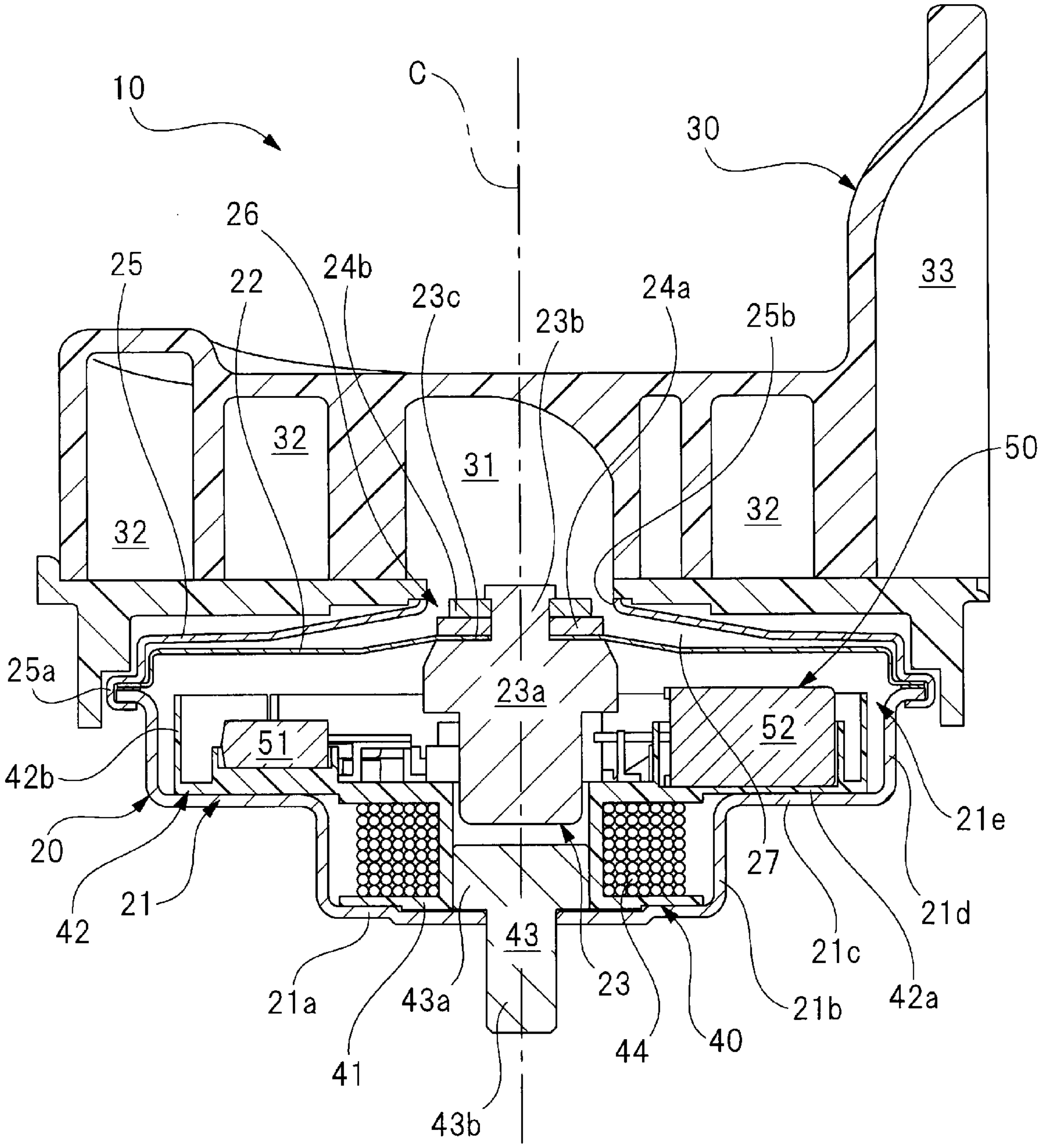


FIG. 1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42b
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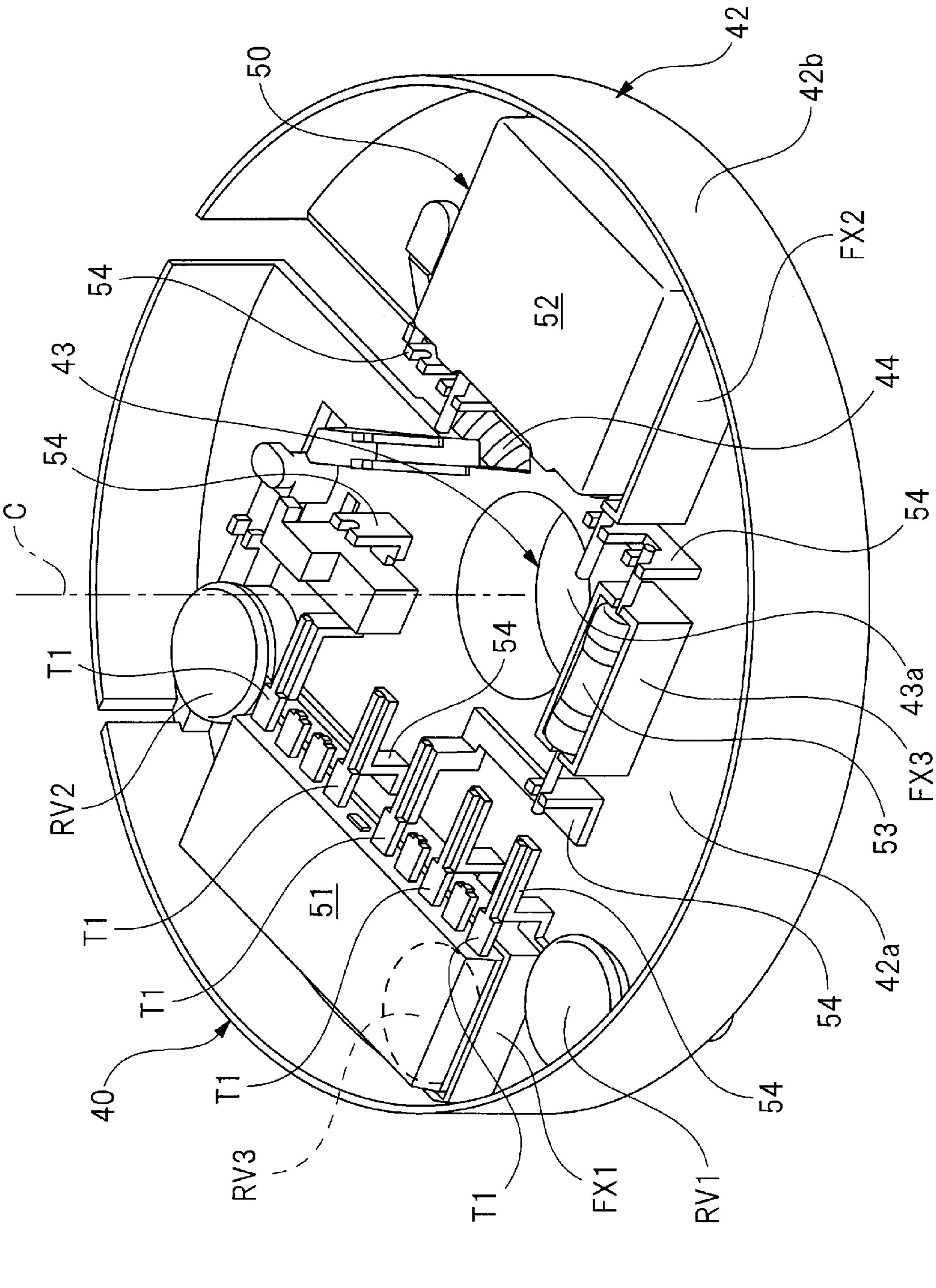
43b

FIG. 2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54
FX2
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44
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T1
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RV2
FX3
53
T1
51
T1
42a
54
T1
40
54
RV3
T1
FX1
RV1

FIG. 3

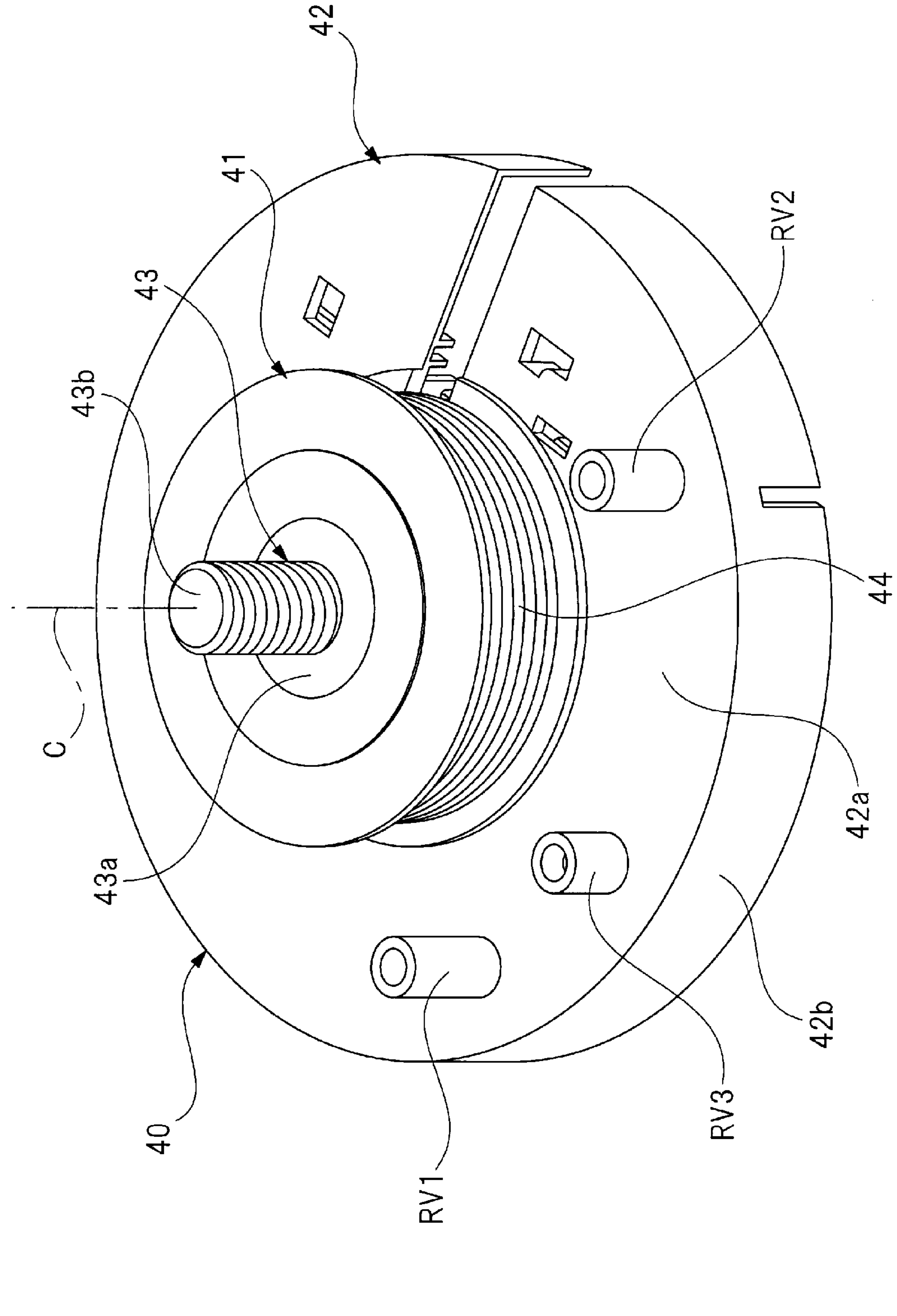

FIG. 4

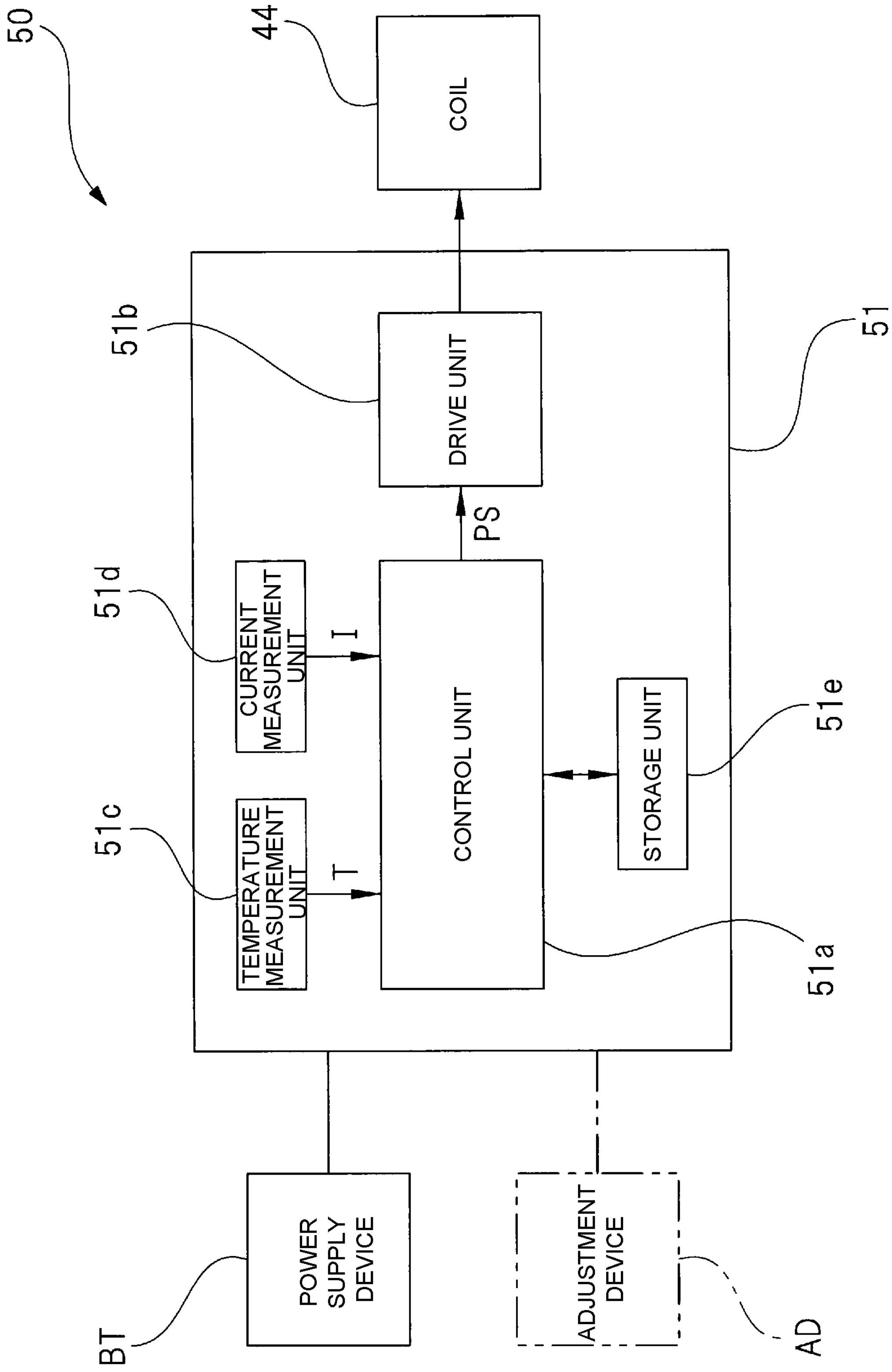
50
44
COIL
51b
DRIVE UNIT
51
PS
51d
CURRENT MEASUREMENT UNIT
I
CONTROL UNIT
51c
TEMPERATURE MEASUREMENT UNIT
T
STORAGE UNIT
51e
51a
BT
POWER SUPPLY DEVICE
ADJUSTMENT DEVICE
AD

FIG. 5

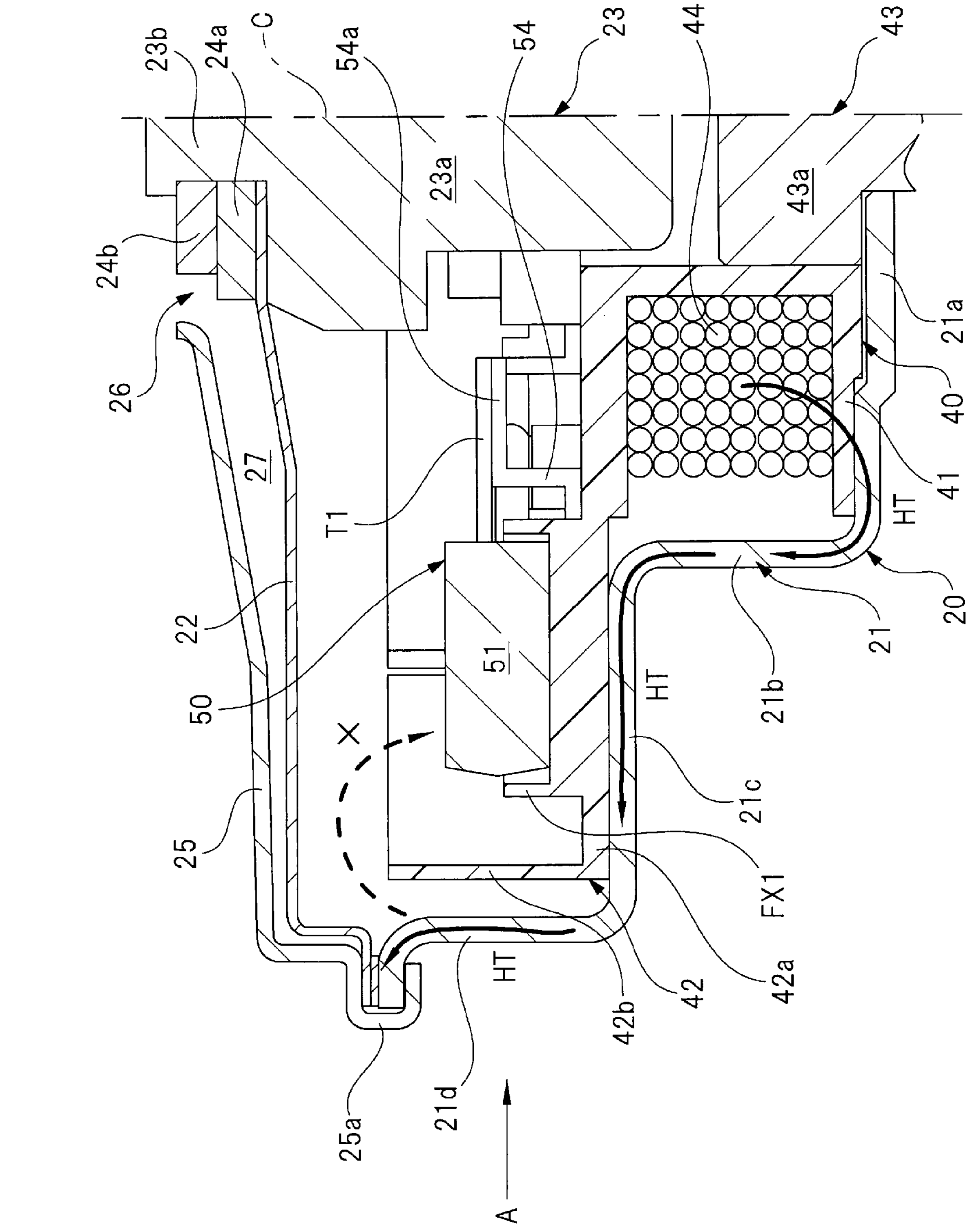
23b
24a
C
54a
54
23
44
43
23a
43a
24b
26
27
T1
22
50
51
25
X
HT
21a
40
41
HT
20
21
21b
HT
21c
FX1
42a
42
42b
HT
21d
25a
A

FIG.6

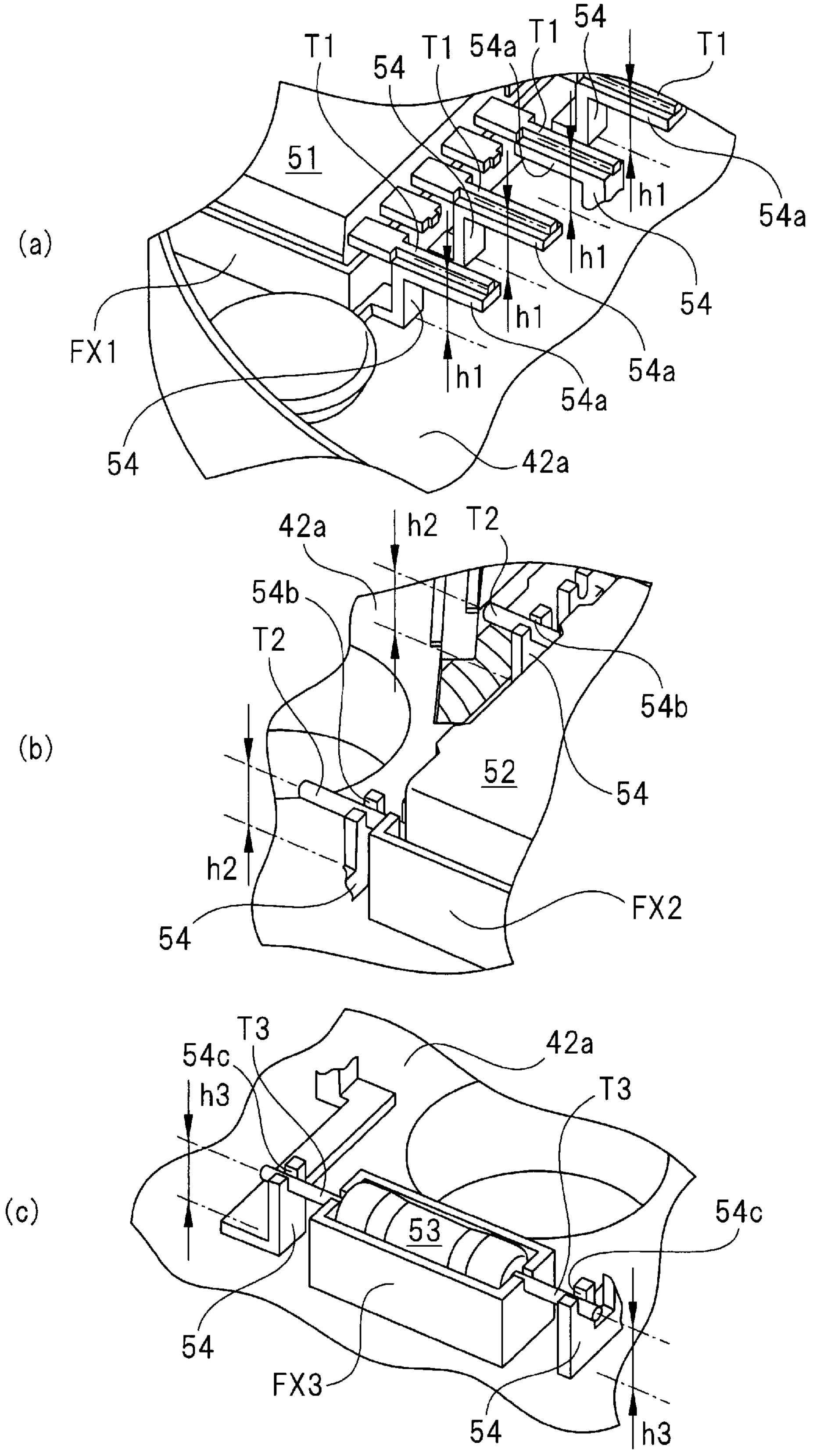
(a)
T1
54
T1
54a
T1
54
T1
51
h1
54a
h1
54
h1
54a
FX1
h1
54a
54
42a
(b)
42a
h2
T2
54b
T2
54b
52
54
h2
54
FX2
(c)
T3
54c
h3
42a
T3
53
54c
54
FX3
54
h3

FIG. 7

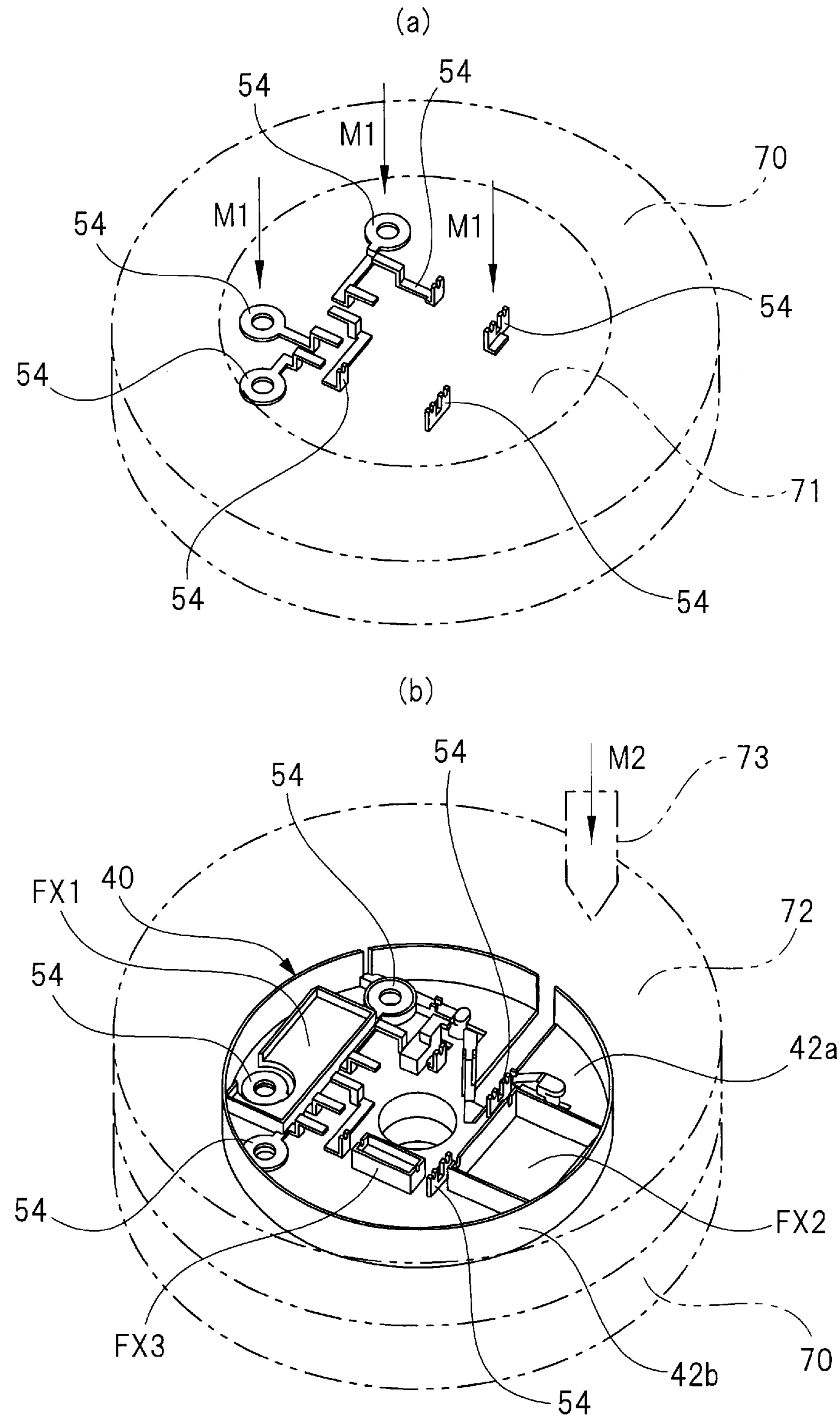
(a)
54
M1
54
70
54
M1
M1
54
54
71
54
54
(b)
54
M2
73
54
FX1
40
72
54
42a
54
FX2
FX3
70
42b
54

FIG. 8

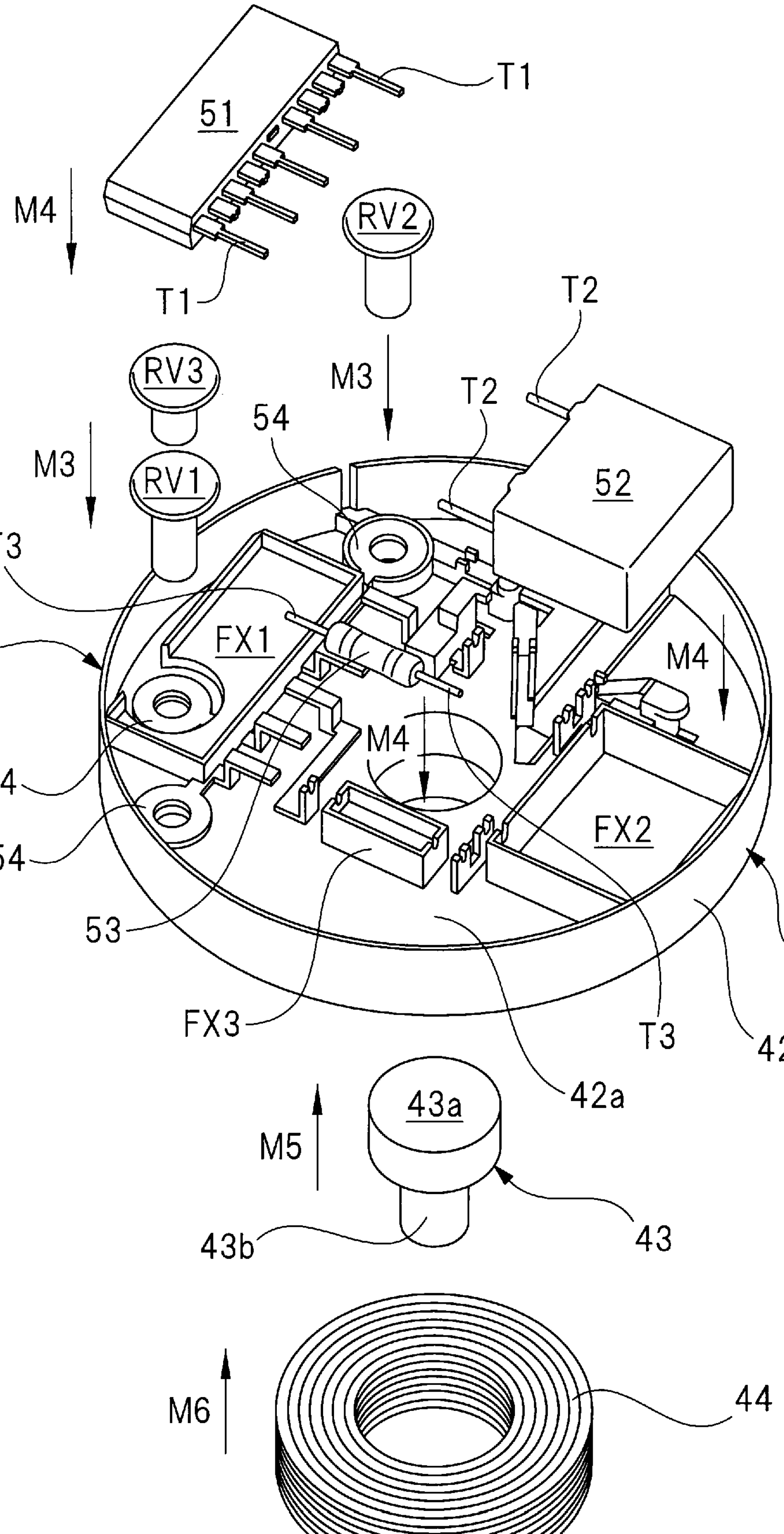
T1
51
M4
RV2
T1
T2
RV3
M3
T2
54
52
M3
RV1
T3
40
FX1
M4
M4
54
54
FX2
53
42
FX3
T3
42b
42a
43a
M5
43
43b
M6
44

FIG. 9

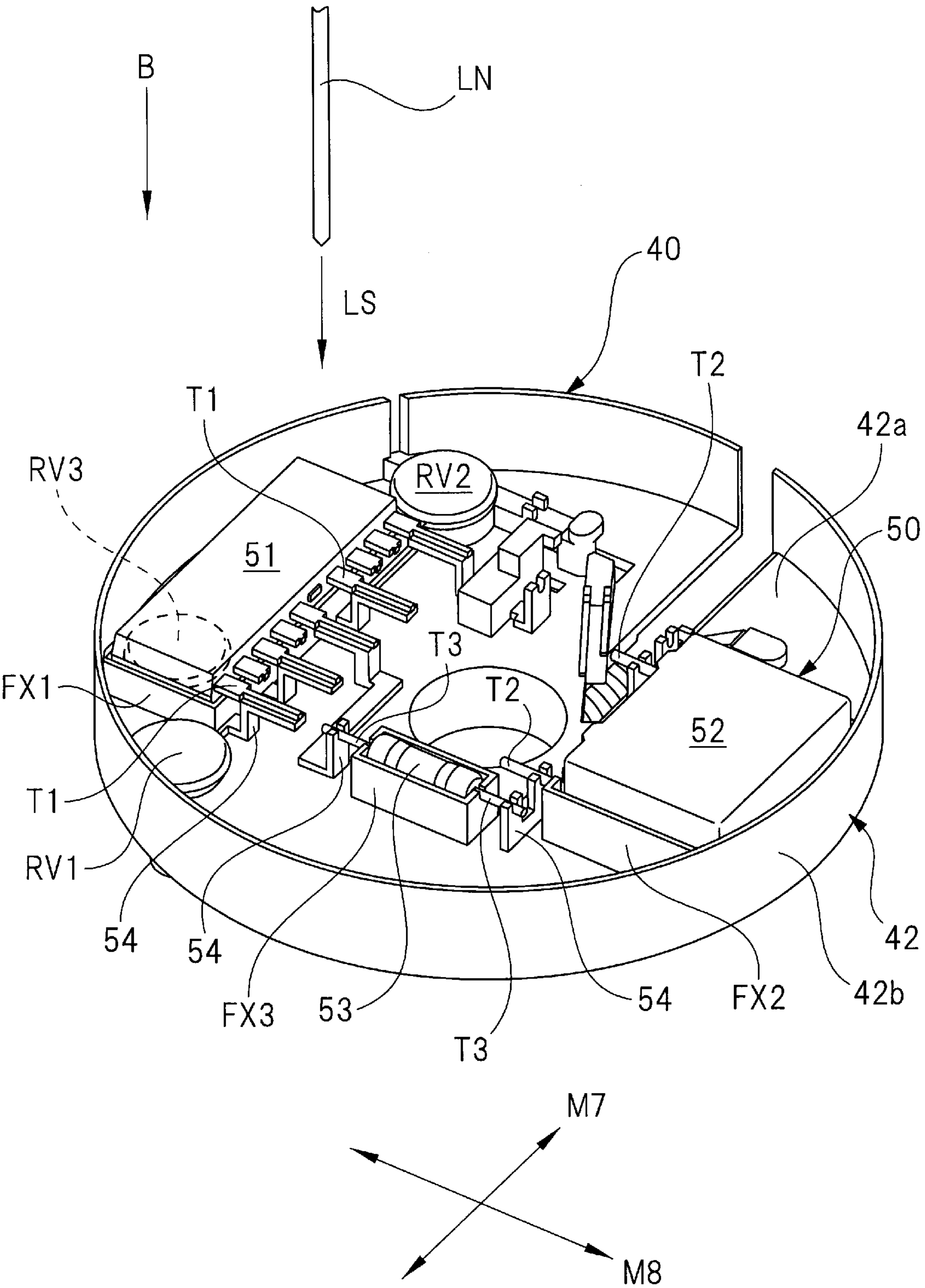
B
LN
LS
40
T2
42a
50
T1
RV3
RV2
51
T3
T2
52
FX1
T1
RV1
54
54
FX3
53
T3
54
FX2
42b
42
M7
M8

FIG. 10

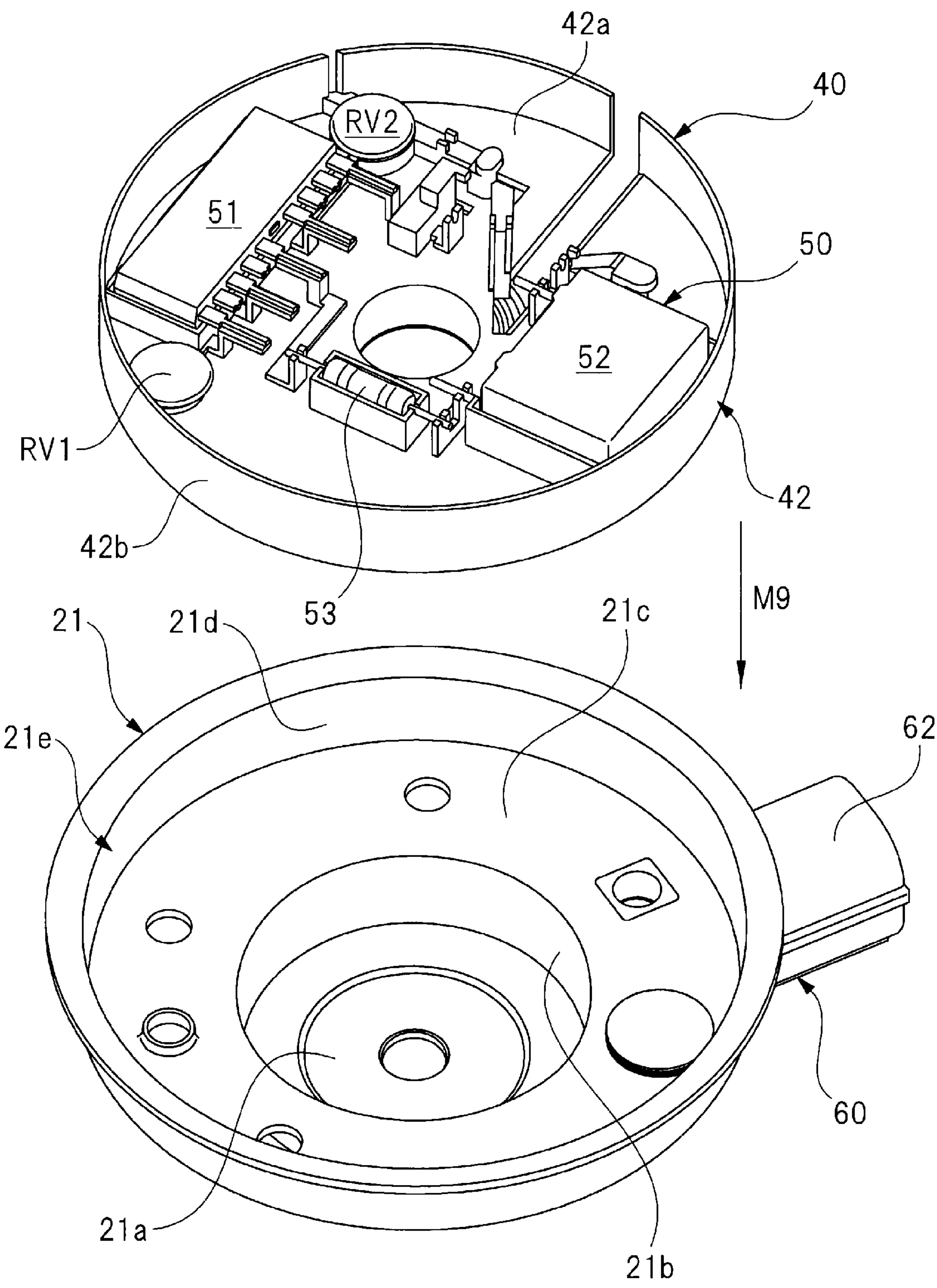

FIG. 11

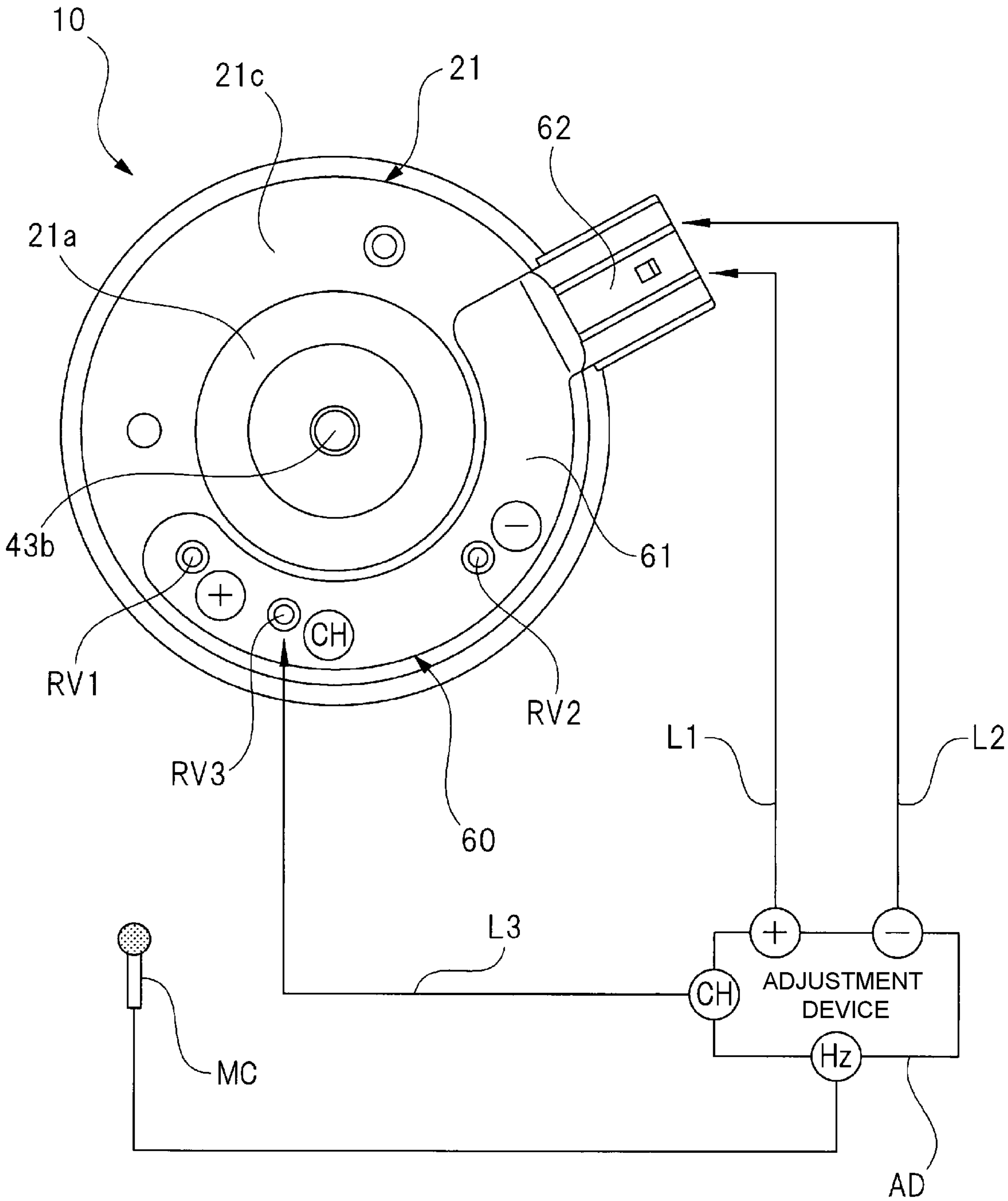
10
21c
21
62
21a
43b
61
RV1
CH
RV2
RV3
60
L1
L2
L3
MC
CH
ADJUSTMENT
DEVICE
Hz
AD

FIG. 12

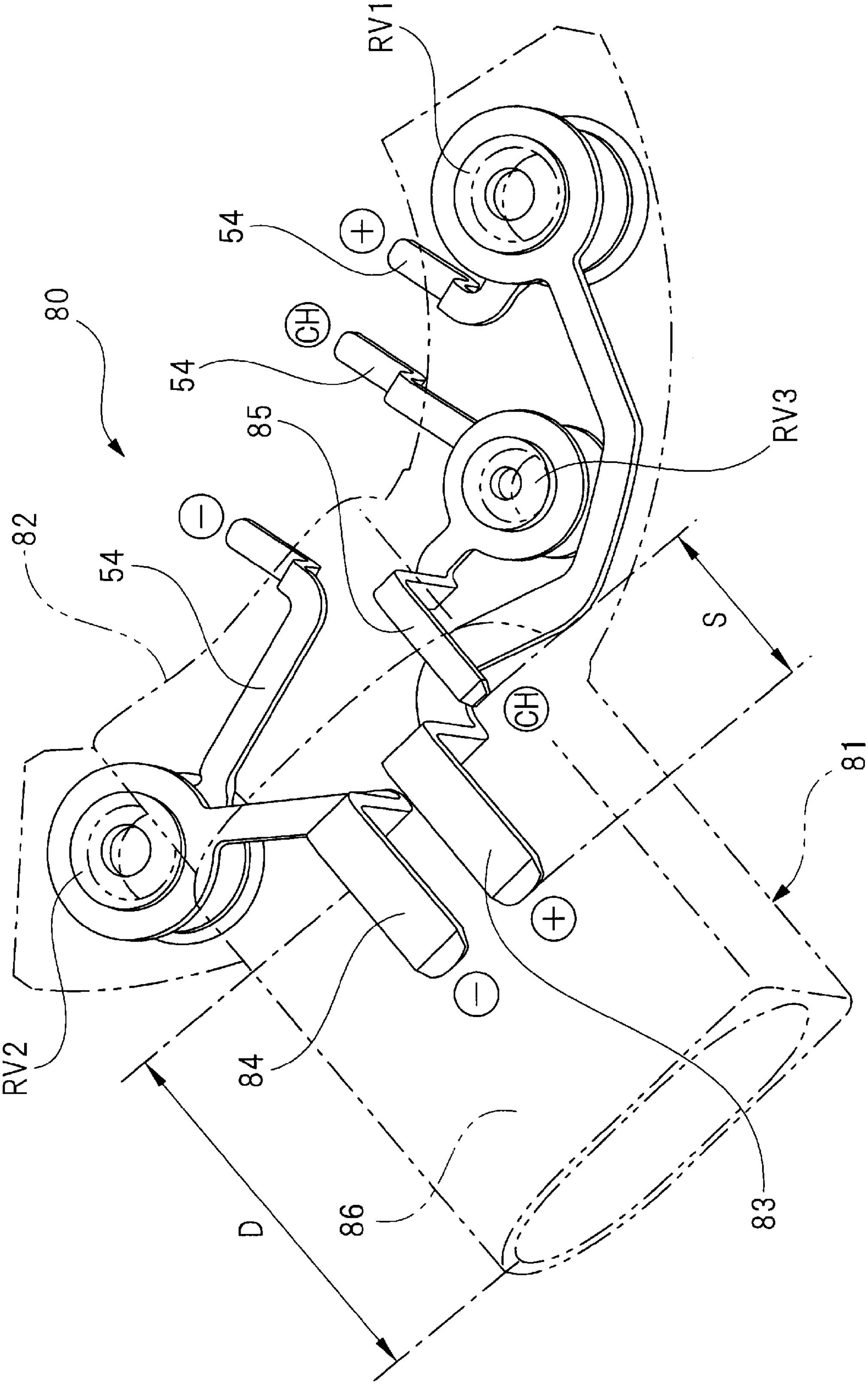

FIG. 13

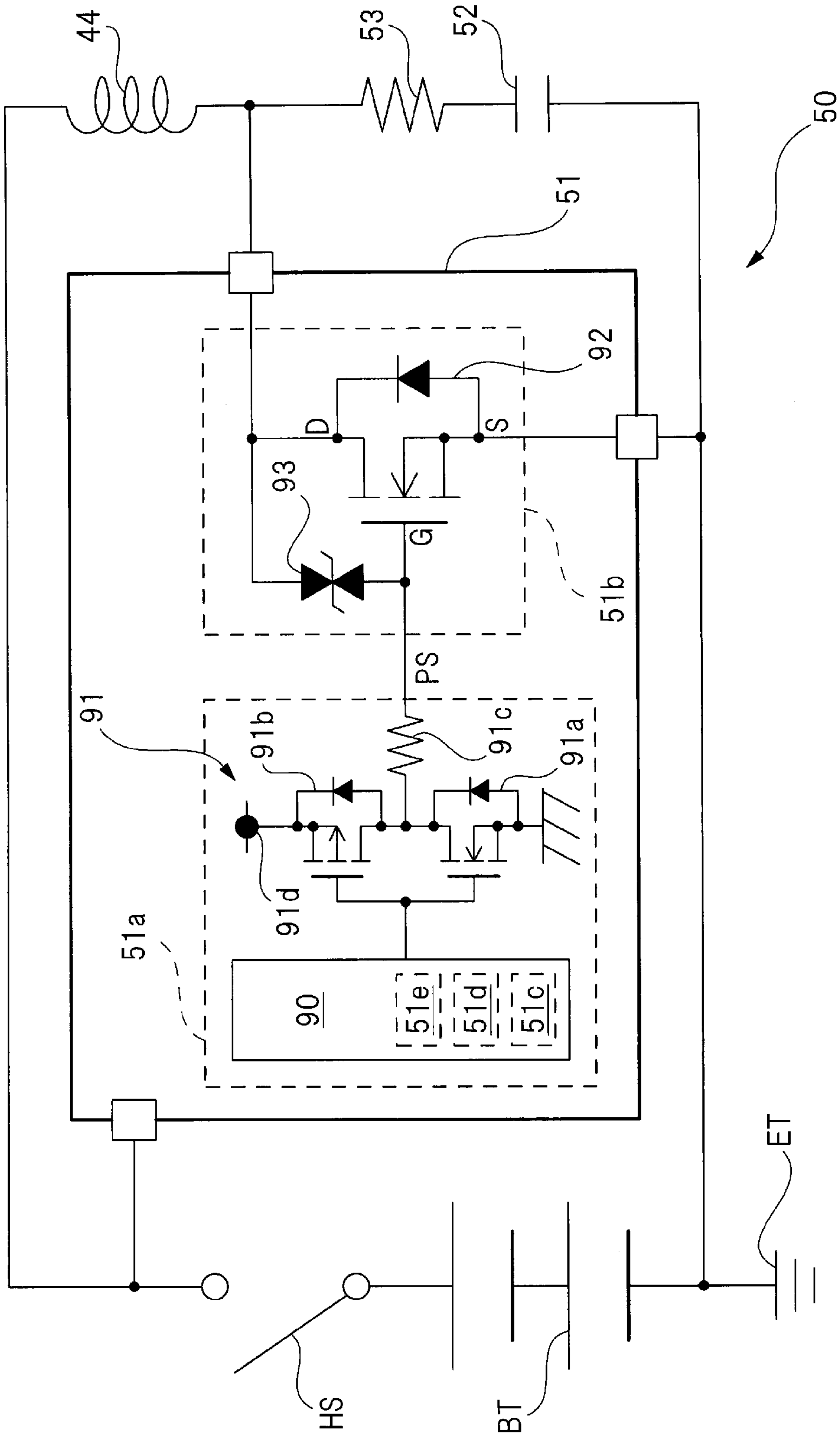
44
53
52
50
51
92
D
S
93
G
51b
PS
91
91b
91c
91a
91d
51a
90
51e
51d
51c
ET
HS
BT

FIG. 14

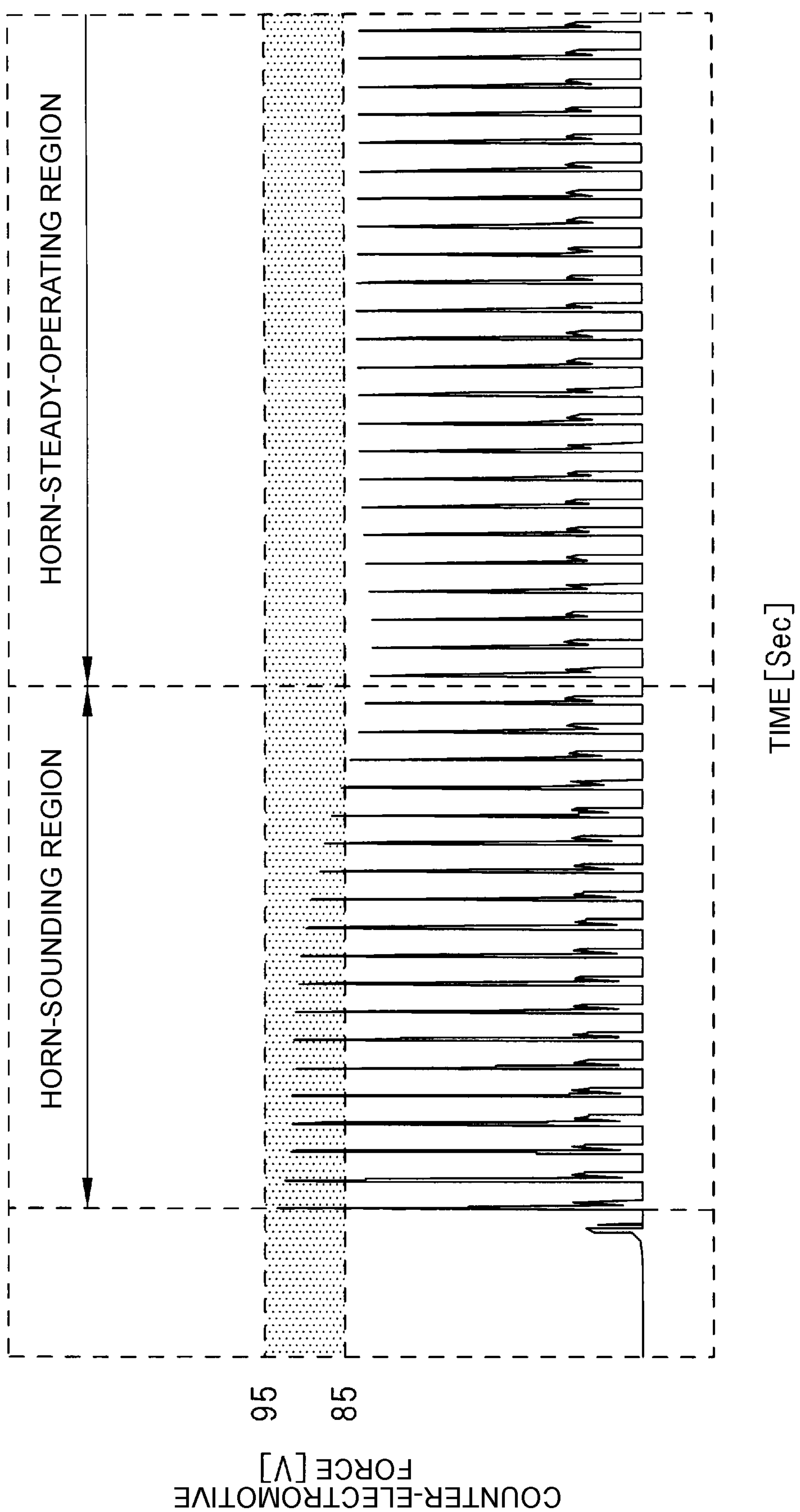
HORN-STEADY-OPERATING REGION
HORN-SOUNDING REGION
95
85
COUNTER-ELECTROMOTIVE FORCE [V]
TIME [Sec]

FIG. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/031827

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. G10K9/13(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. G10K9/13

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 6-506545 A (SPARTON CORPORATION) 21 July 1994, page 5, upper right column, line 18 to lower right column, line 21, page 6, lower left column, lines 1-5, fig. 1, 3 & US 5266921 A, column 4, line 20 to column 5, line 9, column 6, lines 4-9 & WO 1993/015500 A1 & EP 578787 A1 & CA 2105070 A & CN 1076802 A	1-2, 4-5 3
Y	JP 61-210399 A (MITSUBA ELECTRIC MFG. CO., LTD.) 18 September 1986, page 2, lower right column, line 11 to page 3, upper left column, line 13, fig. 3 (Family: none)	1-2, 4-5

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26.10.2018	06.11.2018

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2018/031827

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2008-298823 A (HAMANAKO DENSO CO., LTD.) 11 December 2008, paragraphs [0033]-[0037], fig. 1, 5 (Family: none)	2, 4-5
Y	JP 62-21198 A (FUJIKURA DENKO KK) 29 January 1987, page 2, lower right column, lines 15-20, fig. 3 (Family: none)	2, 4-5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2003122369 A **[0006]**
- ES 2376690 **[0006]**
- ES 2376690 A1 **[0006]**