Acoustic apparatus and driving apparatus constituting the same

Typo correction: Acoustic apparatus and driving apparatus constituting the same

Akustisches Gerät und dazugehörendes Steuerungsgerät

Appareil acoustique et appareil de commande associé

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an acoustic apparatus which is connected to a general-purpose or usual power amplifier for normally driving a loudspeaker and improve electro-acoustic reproduction (transduction) characteristics of a loudspeaker constituting the acoustic apparatus, and a driving apparatus for driving the loudspeaker to improve its electro-acoustic reproduction characteristics in cooperation with the general-purpose power amplifier.

2. Prior Art

A conventional power amplifier for driving a loudspeaker (loudspeaker unit or a loudspeaker system) normally has a substantially zero output impedance, and constant-voltage drives the loudspeaker.

In contrast to this, recently, there are proposed acoustic systems which improve acoustic reproduction characteristics of loudspeakers or make a loudspeaker vibration system compact without impairing acoustic reproduction characteristics by so-called negative impedance driving (a negative impedance component is included in an output impedance) or so-called motion feedback (MFB) driving (a loudspeaker output is detected by a certain method) (European Patent Application Publication No. 0 322 686, No. 0 322 679, No. 0 332 053, United States Patent No. 4 118 600 and the like).

However, these acoustic systems need special-purpose driving apparatuses (power amplifiers) corresponding to loudspeakers to be used. For this reason, when a user who possesses and regularly uses a general-purpose power amplifier wants to constitute the system, he or she cannot utilize his power amplifier at all.

Japanese Patent Application Laid-Open Gazette No. Sho 58-29295 discloses a technique that a loudspeaker is connected in series with a negative resistance circuit having a negative resistance at a predetermined frequency or less, and the series circuit of the loudspeaker and the negative resistance is driven by a general-purpose power amplifier to improve bass tone range characteristics of the loudspeaker. However, as shown in Fig. 9, the negative resistance circuit uniquely disclosed in the embodiment of Japanese Patent Application Laid-Open Gazette No. Sho 58-29295 is a transistor class-A single amplifier which has a resistor as a load. Such a transistor class-A single amplifier is not used for supplying power to a low-impedance load such as a loudspeaker in terms of voltage utilization efficiency, power loss, cost, and the like except for a case wherein it is used for a very small power such as an earphone or a headphone, or a very special case like in a hobby use. More specifically, this transistor class-A single amplifier does not belong to a category of power amplifiers for driving a loudspeaker in a general idea. Furthermore, in this negative resistance circuit, an impedance Z which is a detection resistor corresponding to a detection resistor Rs for speaker current detection according to the present invention, is connected in series with the loudspeaker unit through a transistor and, an emitter resistor is connected at one end to a point where the emitter of the transistor and loudspeaker unit 2 are connected each other and is also connected at its other end to a grounding point. With this arrangement, a current that flows through the loudspeaker (speaker current) also flows through the emitter resistor at the time when the loudspeaker is driven, whereby it is made impossible to precisely detect the current (speaker current) flowing through the loudspeaker unit. Since this negative resistance circuit is not constituted by a push-pull circuit and; among A class amplifiers, the negative resistance circuit is restricted in its applicability, it cannot simply be replaced with a power amplifier circuit which precisely detects the speaker current thereby to enable it to output the optimal negative resistance and is generally suitable for driving the speaker.

More specifically, although Japanese Patent Laid-Open Gazette No. Sho 58-29295 theoretically suggests that a loudspeaker can be negative-resistance driven using a general-purpose power amplifier by connecting the loudspeaker in series with a negative resistance circuit, it does not disclose or suggest an arrangement of a practical negative resistance circuit which can drive a loudspeaker without posing any problem.

The EP-A 0 293 806 discloses a dynamic loudspeaker driving apparatus, which comprises an amplifier to one input of which the motion signal of the loudspeaker is negatively fed back. This loudspeaker driving apparatus corresponds to the apparatus which are disclosed in the above-mentioned EP-A 0 322 686, 0 322 679 and 0 332 053 since, also the so-called motion feedback driving (MFB-driving) is applied. As it is disclosed above, also the loudspeaker driving apparatus disclosed in the EP-A-0 293 806 needs a special power amplifier corresponding to the loudspeaker to be used. Therefore, also in this case the power amplifier cannot be used, if the user who possesses and regularly uses a general-purpose power amplifier wants to constitute the MFB-system.

In order to achieve the above object, according to the present invention, an apparatus for driving a loudspeaker unit in cooperation with an external power amplifier for constant-voltage-driving a loudspeaker is provided as set forth in claim 1. Preferred embodiments are disclosed in the dependent claims.

According to the invention, a dynamic loudspeaker driving apparatus is provided in which, in addition to the conventional external power amplifier, an additional power amplifier unit is provided for driving a loudspeaker in cooperation with said conventional general-purpose
power amplifier to improve the electro-acoustic reproduction characteristics of the loudspeaker, and for generating an electric energy corresponding to an increase in energy from that in a normal or conventional driving operation during driving operation for improving the characteristics. A normal driving energy as another energy is supplied from the general-purpose power amplifier.

With this arrangement, since the normal driving energy is supplied from the general-purpose power amplifier as a conventional power amplifier, a user who regularly uses the general-purpose power amplifier can utilize it to realize negative-impedance driving or MFB driving, thereby improving electro-acoustic reproduction characteristics of his or her or a commercially available loudspeaker. Furthermore, a compact acoustic apparatus (loudspeaker system) which can automatically attain negative-impedance driving or MFB driving when it is driven by a general-purpose power amplifier, and has good electro-acoustic reproduction characteristics can be realized.

In the driving apparatus of the present invention, since an electric energy corresponding to an increase in energy caused by the negative-impedance driving or MFB driving is supplied from the second power amplifier, an output from the general-purpose power amplifier which cooperates with the second power amplifier can be efficiently utilized. Furthermore, since the second power amplifier need only supply an electric energy corresponding to an increase in energy caused by the negative-impedance driving or MFB driving, it can be rendered compact and inexpensive as compared to a conventional driving apparatus exclusively used for negative-impedance driving or MFB driving.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a circuit diagram showing an arrangement of an acoustic apparatus according to an embodiment of the present invention;

Fig. 2 is a circuit diagram showing an arrangement of an acoustic apparatus according to the second embodiment of the present invention;

Figs. 3A to 3C are respectively an equivalent circuit diagram of the acoustic apparatus shown in Fig. 2 and equivalent circuit diagrams of acoustic apparatuses according to the first and second prior arts;

Fig. 4 is a circuit diagram of an acoustic apparatus according to the third embodiment of the present invention;

Fig. 5 is a detailed circuit diagram of the acoustic apparatus shown in Fig. 4;

Fig. 6 is a circuit diagram of an acoustic apparatus according to the fourth embodiment of the present invention;

Fig. 7 is a detailed circuit diagram of the acoustic apparatus shown in Fig. 6; and

Fig. 8 is a circuit diagram of an acoustic apparatus according to the fifth embodiment of the present invention.

Fig. 9 is a circuit diagram showing an arrangement of an acoustic apparatus according to a prior art (Japanese Patent Application Laid-Open Gazette No. Sho 58-29295).

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will be described below with reference to the accompanying drawings. The same reference numerals or those with the same suffixes denote the common or corresponding parts throughout figures.

Fig. 1 shows an arrangement of an acoustic apparatus according to an embodiment of the present invention. This acoustic apparatus performs negative-impedance driving to improve loudspeaker characteristics. In this apparatus, a loudspeaker unit 2 and an amplifier unit 3 serving as a negative-impedance driving apparatus as the characteristics feature of the present invention are disposed in a cabinet 1 having a resonance duct port 11. The apparatus also has a pair of external input terminals P1 and P2 for connecting this acoustic apparatus to output terminals of a power amplifier 5 as a general-purpose power amplifier. The amplifier unit 3 comprises a power amplifier circuit 31, a positive feedback circuit 32, and a transfer function control circuit 33. The positive feedback circuit 32 comprises a feedback amplifier A1 given with a predetermined transfer function \( \beta \) by an impedance element \( Z_s \) for detecting a loudspeaker current, impedance elements \( Z_a \) and \( Z_b \), and the like. The impedance value of the impedance element \( Z_s \) has a negligible magnitude as compared to that of the loudspeaker unit 2.

In the apparatus shown in Fig. 1, one external input terminal P1 is connected to one input terminal P3 of the loudspeaker unit 2 via the impedance element \( Z_s \) for detecting the loudspeaker current, and the other input terminal P4 of the loudspeaker unit 2 is connected to an operation reference potential point of the amplifier unit 3. Furthermore, a detection output obtained by detecting a current flowing through the loudspeaker unit 2 by the impedance element \( Z_s \) is positively fed back to the input of the power amplifier circuit 31 via the feedback amplifier A1. In addition, an input signal supplied to the external input terminal P1 is also supplied to the input of the power amplifier circuit 31 via the transfer function control circuit 33 having a predetermined transfer function.

Various characteristics of the amplifier unit 3 are as follows. That is, if an internal impedance of the loudspeaker unit 2 is represented by \( Z_L \), a transfer function (gain) of the transfer function control circuit 33 is represented by \( T(s) \), a transfer gain of the positive feedback circuit 32 is given by the equation \( \beta = \frac{Z_b}{Z_a} \), a transfer gain of the power amplifier circuit 31 with respect to an output voltage of the transfer function control circuit 33
is given by the equation, \( \alpha = \frac{Z_l}{Z_c} \), and a transfer gain of the power amplifier circuit 31 with respect to the output voltage of the positive feedback circuit 32 is given by \( A = \frac{Z_f}{Z_d} \).

(a) Transfer characteristics \( G(s) \) are expressed by:

\[
G(s) = \frac{V_o}{V_i} = \frac{1 + A^*T(s)}{1 + Z_s/Z_L (1 - \alpha^*\beta)}
\]

(b) A driving impedance \( Z_o \) when viewed from the loudspeaker unit 2 is given by:

\[
Z_o = Z_L \left( \frac{G_{ZL} = \infty}{G_{ZL} = Z_L} \right) - 1
\]

\[
= Z_s (1 - \alpha^*\beta)
\]

(c) A load impedance \( Z_l \) when viewed from the power amplifier 5 is given by:

\[
Z_l = \frac{Z_L + Z_o}{1 + A^*T(s)}
\]

From these equations,

(d) \( T(s) \) for making the transfer characteristics to be 1, i.e., for causing the output sound pressure of the loudspeaker to have the same frequency characteristics as those in a usual constant-voltage driving mode is given by:

\[
T(s) = \frac{Z_o}{A Z_L}
\]

(e) \( T(s) \) for making an amplitude of a voltage \( (V_a) \) at a negative impedance output terminal (output terminal of the power amplifier circuit 31) zero, i.e., for making \( V_a \) zero when a loudspeaker is driven without being caused a counteraction from surrounding while maintaining an effect of a perfect damping state (Q of a loudspeaker driving system is 0) is given by:

\[
T(s) = \frac{Z_o - Z_s}{A (Z_L + Z_s)}
\]

In practice, however, since a counteraction from surrounding to the loudspeaker occurs, \( V_a \) cannot be zero even if \( T(s) \) is set like in equation (5).

Operations of the variables in the acoustic apparatus shown in Fig. 1 were examined. Examination results are as follows.

(a) When \( \alpha^*\beta = 1 \) is set, since \( Z_o = 0 \) from equation (2), the apparatus is set in a constant-voltage driving state. In addition, since transfer characteristics are given by \( 1 + A^*T(s) \) from equation (1), frequency characteristics can be controlled by controlling \( T(s) \).

(b) From equation (2), in a region of \( \alpha^*\beta > 1 \), the output impedance \( Z_o \) becomes negative.

(c) When \( T(s) = 0 \), the apparatus can be operated as a negative impedance circuit aimed by Japanese Patent Application Laid-Open Gazette No. Sho. 58-29295.

(d) From equation (5), the magnitude of the negative impedance generator, i.e., the power amplifier 33 of the amplifier unit 3 can be reduced, and power consumption can be reduced.

(e) Optimal conditions can be set by setting \( \alpha, \beta, A, \) and \( T(s) \). In this case, \( T(s) \) serves as a transfer system for a phase inversion system \((-IT(s))\).

In Fig. 1, the amplifier unit 3 negative-impedance drives the loudspeaker unit 2 in cooperation with the power amplifier 5. This negative-impedance driving is performed in the same manner as in the acoustic apparatus disclosed in European Patent Application Publication No. 0 322 686. Accordingly, in the circuit shown in Fig. 1, for example, in a low frequency range, such negative resistance drive that is disclosed in European Patent Application Publication No. 322 686 is performed, whereby the speaker unit 2 is damped and driven extremely strongly and the reproduction characteristics, especially low frequency range characteristics thereof, is improved or whereby a cabinet can be made small in size, or a speaker system as a whole can be made small in size without damaging the reproduction characteristics.

Fig. 2 shows the second embodiment of the present invention. In this acoustic apparatus, a dynamic loudspeaker is used as the loudspeaker unit 2 to express the overall circuit in more detail as compared to the circuit shown in Fig. 1, and loudspeaker current detection operation is performed at a ground side. An internal impedance of the dynamic loudspeaker mainly consists of a resistance \( (R_v) \) of a voice coil, and slightly includes an inductance component. In this embodiment, a resistor \( R_s \) is used as the loudspeaker current detection impedance element \( Z_s \) so that the output impedance \( Z_o \) expressed by equation (2) serves as a negative resistance \((-R_v)\) for canceling the internal resistance \( R_v \). In addition, resistors are also used as impedance elements for determining the positive feedback gain \( \alpha^*\beta \) and the amplifier gain \( A \).
Furthermore, in the apparatus shown in Fig. 2, an amplifier A3 constituting the transfer function control circuit 33 also serves as a DC servo amplifier. More specifically, a signal supplied to the external input terminal P1 is non-inverting amplified by the amplifier A3 of the transfer function circuit 33, and the amplified signal is inputted to the non-inverting input terminal of an amplifier (internal power amplifier) A2 constituting the power amplifier circuit 31. In addition, by utilizing the inverted input terminal of the amplifier A3, a DC fluctuation of the internal power amplifier A2 is compensated for by negative feedback circuit (amplifier A2 and a capacitor).

As shown in the equivalent circuit diagram of Fig. 3A, the acoustic apparatus shown in Fig. 2 generates a negative resistance (-Rv) for canceling the internal impedance Rv of the loudspeaker unit 2 independently of the loudspeaker unit 2. For this reason, the loudspeaker unit 2 is equivalent to a circuit in which a motional impedance ZM is directly connected to voltage sources 5 and 31 without going through an impedance such as the internal impedance Rv or the like. Since the voltage sources have an internal impedance of zero respectively, the motional impedance ZM of the loudspeaker unit 2 is short-circuited at its two ends so that its resonance frequency Q becomes zero. As a result, the loudspeaker is set in a perfect dead state, and is very strongly driven and damped. In this acoustic apparatus, the transfer function T(s) of the transfer function control circuit 33 is appropriately set so that the output voltage of the power amplifier circuit 31 for generating a negative resistance is decreased, thus power supply from the power amplifier 5 can be increased, and desired frequency compensation in a negative-impedance driving mode can be performed.

This acoustic apparatus has a merit in that a conventional general-purpose power amplifier can be directly used, and characteristics unique to the power amplifier can be directly used, and characteristics unique to the power amplifier can be sufficiently reflected when the loudspeaker is driven.

In contrast to this, as shown in the equivalent circuit diagram of Fig. 3B, since a negative impedance driving apparatus disclosed in European Patent Application Publication No. 0 322 686 cause an amplifier 5's side (left side of the one dotted and one dashed line in Fig. 3B) to have a negative impedance, a special-purpose amplifier which includes a negative impedance in its output impedance must be used as the amplifier 5', and the amplifier and the loudspeaker must be paired, resulting in poor versatility (or generality).

In a loudspeaker driving apparatus disclosed in Japanese Patent Laid-Open Sho. No. 58-29295, as shown in the equivalent circuit diagram of Fig. 3C, a negative resistance (-Rv) is connected in series with a loudspeaker 1*. When the negative resistance is connected in this manner, an equalizer circuit such as the transfer function control circuit 33 is required to adjust output characteristics of the loudspeaker. The equalizer circuit may be connected in series with the loudspeaker unit 2*, as indicated by ZEQ in Fig. 3C. In this case, the effect of the negative resistance -Rv is reduced, and the damping force of the motional impedance ZM of the loudspeaker unit 2 is decreased. Furthermore, as shown in Fig. 9, since the negative resistance (-Rv) circuit is constituted by a transistor class-A single amplifier including an emitter resistor as a resistance load, this transistor equivalently drives a parallel circuit of the loudspeaker 2 and the emitter resistor. Therefore, when this emitter resistance is set to be sufficiently smaller than the impedance of the loudspeaker unit 2, power consumption of the negative resistance transistor is increased beyond a practical level. On the other hand, when the emitter resistance is increased, since the emitter resistance is connected in series with the loudspeaker unit 2 with respect to the amplifier 5, the output from the amplifier 5 is consumed and decreased by the emitter resistance. In any case, the negative resistance circuit disclosed in Japanese Patent Appln. Laid-Open Gazette No. Sho 58-29295 is not practical in terms of cooperation with a general-purpose amplifier.

The apparatus of the present invention has not such defects as those in the conventional apparatus disclosed in Japanese Patent Appln. Laid-Open Gazette No. Sho 55-29295 since the former has an element (resistor) for detecting a current flowing through the speaker, between the loudspeaker unit and the negative resistance circuit. In addition, the conventional apparatus wherein an element for detecting a current through a speaker is arranged between a power source B+ and a negative resistance circuit, cannot constitute a push-pull circuit (since + and - must be taken into consideration). Fig. 4 shows the third embodiment of the present invention.

In the acoustic apparatus shown in Fig. 4, an output from the transfer control function control circuit 33 is shifted by a voltage across the loudspeaker current detection resistor Rs, and is amplified by the amplifier circuit 31 with reference to a voltage at the right terminal side (Fig. 4) of the resistor Rs. Fig. 5 is a detailed circuit diagram of the acoustic apparatus shown in Fig. 4. In the apparatus shown in Fig. 5, the transfer function control circuit 33 is constituted by only passive elements. Fig. 6 shows the fourth embodiment of the present invention.

The acoustic apparatus shown in Fig. 6 drives a woofer WF of a two-way loudspeaker system by a negative-impedance circuit as the characteristic feature of the present invention. In Fig. 6, a power supply 7 generates DC power supply voltages +B+ and -B- for the power amplifier A2 and DC power supply voltages +B2 and -B2 for the current detection amplifier A1, the amplifier A3 in the transfer function circuit 33, and a protection circuit 8 on the basis of an AC power supply, e. g., a commercial power supply of 100 V. The protection circuit 8 is used to prevent destruction or degradation of...
the circuits and the loudspeaker units caused by an overload, transient, or abnormal operation. The protection circuit 8 has a DC protection function of turning off a relay contact rY1 when a DC current exceeding a predetermined value flows through the loudspeaker unit, an overcurrent protection function of turning off the relay contact rY1 when an overcurrent flows through the loudspeaker unit, a heat radiation plate temperature protection function of turning off the relay contact rY1 when the temperature of the heat radiation plate exceeds a predetermined value, and a power-on muting function of turning on the relay contact rY1 after the lapse of a predetermined delay time when a power switch is turned on. This apparatus also has protection means, e.g., for a primary fuse, a temperature fuse in a transformer, and the like (not shown).

Fig. 7 is a detailed circuit diagram of the acoustic apparatus shown in Fig. 6. In Fig. 7, an IC (STK4040V) 30 is a hybrid IC formed by integrating the amplifiers A1, A2, and A3, and some of their peripheral circuits shown in Fig. 6. A DC power supply 7 comprises a power supply transformer 71 having a central tap type secondary winding voltage, and a full-wave rectification circuit 72, and generates two DC voltages +B1 and -B1. These voltages are directly supplied to the amplifier A2 in the IC 30, and are also supplied to a circuit including the amplifiers A1 and A3, and the like as voltages +B2 and -B2 via a decoupling circuit 73. The speaker current detection resistor Rs has a resistance of 0.2 Ω.

In the protection circuit 8, a resistor R81 and a capacitor C81 allow only a DC voltage component of a signal appearing at the external input terminal P1 to pass therethrough. When this DC voltage is equal to or higher than +0.6 V, a transistor Q81 is turned on, and transistors Q82 and Q83 are turned off to deenergize the relay solenoid RY1. This AC voltage is supplied to the base of the transistor Q81 via the diode D82, and is turned on. The transistors Q82 and Q83 are turned off to deenergize the relay solenoid RY1, and the relay contact rY1 is turned off. That is, the heat radiation plate temperature protection function can be realized. When the power switch 9 is turned on, a capacitor C82 is charged through a resistor R83, and the transistors Q82 and Q83 are kept off until the terminal voltage across the capacitor C82 exceed 0.6 V. Therefore, during this interval, the relay contact rY1 is kept off, and a signal to the woofer WF. and a circuit corresponding to the amplifier unit 3 is cut off. That is, the power-on muting function can be realized.

As the protection means for this apparatus, a primary fuse FS is arranged. In addition, a temperature fuse (not shown) is also arranged in the power supply transformer 71.

Fig. 8 shows the fifth embodiment of the present invention. This acoustic apparatus can perform the same MFB (motional feedback) driving as in the acoustic apparatus disclosed in European Patent Application Publication No. 0 332 053 by utilizing the general-purpose power amplifier 5. In this apparatus, a loudspeaker unit 2 having a vibration sensor 21, and an amplifier unit 3 serving as an MFB driving apparatus as the characteristic feature of the embodiment are arranged in a cabinet 1 having a resonance duct port 11. Furthermore, this apparatus also has a pair of external input terminals P1 and P2 for connecting this acoustic apparatus to the output terminals of the power amplifier 5 as the general-purpose power amplifier. In this embodiment, one external input terminal P1 is connected to one input terminal P3 of the loudspeaker unit 2, and the other input terminal P4 of the loudspeaker unit 2 is connected to an operation reference potential point of the amplifier unit 3. A detection output of a vibration state of the loudspeaker unit 2 by the vibration sensor 21 is negatively fed back to the input of a power amplifier circuit 31 of the amplifier unit 3, and a signal supplied to the external input terminal P1 is supplied to the input of the power amplifier circuit 31 via a transfer function control circuit 33 having a predetermined transfer function.

The vibration sensor 21 detects a vibration state of a diaphragm 22 of the loudspeaker unit 2 by any method, and comprises, e.g., a velocity sensor, a displacement sensor, an acceleration sensor, or the like. Note that in place of the vibration sensor 21, a vibration state may be detected using a bridge circuit, as described in European Patent Application Publication No. 0 332 053. The amplifier unit 3 comprises the power amplifier circuit 31, a negative feedback circuit 32', and a transfer function control circuit 33. The negative feedback circuit 32' amplifies the detection output of the vibration sensor 21 or the vibration state detection bridge circuit with a predetermined transfer function β, and inputs the amplified output to the inverting input terminal of the power amplifier circuit 31.
In the acoustic apparatus shown in Fig. 8, the amplifier unit 3 cooperates with the general-purpose power amplifier 5, and the same MFB driving as in the acoustic apparatus disclosed in European Patent Application Publication No. 0 332 053 is performed as a whole.

Claims

1. An acoustic apparatus for driving a loudspeaker unit (2) having two input terminals (P3, P4) in cooperation with an external power amplifier having two output terminals (P1, P2), which is adapted to constant-voltage-drive a loudspeaker, comprising:
   - a power amplifier unit (3), for generating an electric energy corresponding to an increase in energy compared to the energy of a constant-voltage-driving state, comprising a power amplifier circuit (31) for receiving a signal from the one output terminal (P1) of said external power amplifier (5) via a transfer function circuit (33) and for using the other output terminal (P2) of said external power amplifier as an operation reference potential point, amplifying the received signal with a predetermined transfer function and for driving one input terminal (P3) of said loudspeaker unit (2), the apparatus further comprising a connection circuit for connecting the one output terminal (P1) of said external power amplifier to the other input terminal (P3) of said loudspeaker unit (2).
   - an operation reference potential point, amplifying the received signal with a predetermined transfer function and for driving one input terminal (P3) of said loudspeaker unit (2), the apparatus further comprising a connection circuit for connecting the one output terminal (P1) of said external power amplifier (5) to the other input terminal (P3) of said loudspeaker unit (2).

2. An apparatus according to claim 1, characterized in that the characteristic improving driving operation is a negative impedance driving operation.

3. An apparatus according to claim 1, characterized in that the characteristic improving driving operation is a motional feedback driving operation.

4. An apparatus as claimed in any of the preceding claims, characterized by a feedback circuit (32, 32′) for detecting a driving or operation state of said loudspeaker unit (2) and feeding back a detection output of said loudspeaker unit (2) to an input side of said power amplifier circuit (31).

5. An apparatus according to claim 4, characterized in that said feedback circuit (32) detects a current flowing through said loudspeaker unit (2).

6. An apparatus according to claim 4 or 5, characterized in that said feedback circuit (32) positively feeds back the current detected from said loudspeaker unit (2), and negative-impedance-drives in cooperation with said power amplifier circuit (31).

7. An apparatus according to any of the preceding claims, characterized in that said loudspeaker unit (2) comprises a vibration body and a means for detecting a vibration state of the vibration body.

8. An apparatus according to claim 4 or 7, characterized in that said feedback circuit (32′) detects a vibration state of said loudspeaker unit (2), negatively feeds back a detection signal, and motional-feedback-drives in cooperation with said power amplifier circuit (31).

9. An apparatus according to any of the claims 4, 7 or 8, characterized by a negative feedback circuit (32′) for negatively feeding back a detection output of the vibration state of the vibration body to an input side of said power amplifier circuit (31).

10. An apparatus according to any of the preceding claims, characterized by a cabinet (1) for storing said loudspeaker unit (2), and said power amplifier unit (3).

11. An apparatus according to claim 10, characterized in that said power amplifier unit (3) comprises said power amplifier circuit (31), said positive feedback circuit (32), and/or said transfer function circuit (33).

12. An apparatus according to claim 10, characterized in that said cabinet (1) has a resonator structure.

13. An apparatus according to claims 10 or 11, characterized in that said cabinet (1) has a resonance duct port (11).

Patentansprüche

1. Akustikvorrichtung zum Treiben einer Lautsprechereinheit (2) mit zwei Eingangsanschlüssen (P3, P4), wobei ein Zusammenwirken mit einem externen Leistungsverstärker mit zwei Ausgangsanschlüssen (P1, P2) vorgesehen ist, welche für ein Konstantspannungs-Treiben eines Lautsprechers ausgelegt ist und folgendes aufweist:
   - eine Leistungsverstärkereinheit (3), um eine elektrische Energie entsprechend eines Anstiegs der Energie im Vergleich zu der Energie eines Konstantspannungs-Treiber-Zustands zu erzeugen, welche eine Leistungsverstärkereinheit (3) zum Empfang eines Signals von einem Ausgangsanschluß (P1) des externen Leistungsverstärkers (5) über eine Übertragungsfunktionschaltung (33) aufweist und um den anderen Ausgangsanschluß (P2) des externen Leistungsverstärkers als ein Betriebsspannungsbezugspunkt zu verwenden, wobei das empfangene Signal mit einer vorbestimmten Übertragungsfunktion verstärkt wird, und um einen Eingangsanschluß (P4) der Lautsprechereinheit (2) zu treiben, wobei die Vorrichtung ferner eine
Verbindungsschaltung aufweist, um den einen Ausgangsanschluß (P1) des externen Leistungsverstärkers mit dem anderen Eingangsanschluß (P3) der Lautsprechereinheit (2) zu verbinden.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß der die Charakteristik verbessernde Treiberbetrieb ein Treiberbetrieb mit negativer Impedanz ist.

3. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß der die Charakteristik verbessernde Treiberbetrieb ein Treiberbetrieb mit Bewegungsrückkopplung ist.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, gekennzeichnet durch eine Rückkopplungsschaltung (32, 32') zur Ermittlung eines Treiber- oder Betriebszustands der Lautsprechereinheit (2) und zur Rückkopplung eines Detektionsausgangssignals an eine Eingangssseite der Leistungsverstärkerschaltung (31).

5. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, daß die Rückkopplungsschaltung (32) einen Strom ermittelt, der durch die Lautsprechereinheit (2) fließt.

6. Vorrichtung nach Anspruch 4 oder 5, dadurch gekennzeichnet, daß die Rückkopplungsschaltung (32) den von der Lautsprechereinheit (2) ermittelten Strom positiv rückkoppelt und in Zusammenwirkung mit der Leistungsverstärkungsschaltung (31) mit negativer Impedanz antreibt.

7. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Lautsprechereinheit (2) einen Schwingungskörper und Mittel zur Ermittlung eines Schwingungszustandes des Schwingungskörpers aufweist.

8. Vorrichtung nach Anspruch 4 oder 7, dadurch gekennzeichnet, daß die Rückkopplungsschaltung (32') einen Schwingungszustand der Lautsprechereinheit (2) ermittelt, ein Detektionssignal negativ rückkoppelt und in Zusammenwirkung mit der Leistungsverstärkerschaltung (31) mit Bewegungsrückkopplung antreibt.


10. Vorrichtung nach einem der vorhergehenden An-
5. Appareil selon la revendication 4, caractérisé en ce que le circuit de réaction (32) détecte un courant circulant dans le module de haut-parleur (2).

6. Appareil selon la revendication 4 ou 5, caractérisé en ce que le circuit de réaction (32) renvoie positivement le courant détecté à partir du module de haut-parleur (2) et pilote en impédance négative en coopération avec le circuit d'amplificateur de puissance (31).

7. Appareil selon l'une quelconque des revendications précédentes, caractérisé en ce que le module de haut-parleur (2) comprend un corps vibrant et un moyen pour détecter un état de vibration du corps vibrant.

8. Appareil selon la revendication 4 ou 7, caractérisé en ce que le circuit de réaction (32') détecte un état de vibration du module de haut-parleur (2), renvoie négativement un signal de détection, et pilote à réaction de mouvement en coopération avec le circuit d'amplificateur de puissance (31).

9. Appareil selon l'une quelconque des revendications 4, 7 ou 8, caractérisé par un circuit de réaction négative (32') pour renvoyer négativement une sortie de détection de l'état de vibration du corps vibrant vers un côté entrée du circuit d'amplificateur de puissance (31).

10. Appareil selon l'une quelconque des revendications précédentes, caractérisé par une enceinte (1) pour contenir le module de haut-parleur (2) et le module d'amplificateur de puissance (3).

11. Appareil selon la revendication 10, caractérisé en ce que le module d'amplificateur de puissance (3) comprend un circuit d'amplificateur de puissance (31), le circuit de réaction positif (32) et/ou le circuit à fonction de transfert (33).

12. Appareil selon la revendication 10, caractérisé en ce que l'enceinte (1) a une structure de résonateur.

13. Appareil selon la revendication 10 ou 11, caractérisé en ce que l'enceinte (1) comporte un accès de conduit de résonance (11).
FIG. 3A

FIG. 3B  PRIOR ART

FIG. 3C  PRIOR ART
FIG. 4

FIG. 5
FIG. 9 PRIOR ART