

Title of the Invention

Speaker System

Field of the Invention

The present invention relates to a speaker system comprising an acoustic duct for guiding sound wave generated by a speaker disposed at the rear part of an equipment to the front among various visual appliances such as television receivers, and audio instruments for use in the fields of automobile, information processing, communication, etc.

Background of the Invention

Coupling a horn or an acoustic duct to the front of a speaker unit in order to guide sound wave generated by the speaker unit to the opening of said acoustic duct is a method which has advantages over a case without a horn or an acoustic duct, in that, for example, the sound can be conveyed to a specific direction, an output of larger sound pressure is obtainable, etc. Because of these features, the method has been widely used in many applications.

FIG.10 shows a conceptual construction of a television receiver set comprising said speaker system. Where, numeral 1 denotes an acoustic duct, 2 a speaker unit, 3 a cabinet of television set, 4 a cathode ray tube, 5 a back cabinet, symbol a a radiation sound wave of front side, B a radiation sound wave of back side.

With a television receiver set having the above described constitution, its operation is described hereunder.

A sound wave generated by speaker unit 2 goes to acoustic duct 1 which is coupled to the front of the speaker unit and having an oblong shaped, approximately rectangle, opening; the entire speaker system is constructed to take a shape running along cathode ray tube 4 and cabinet 3 of television set within the inside of the television receiver; the sound wave is guided to the front through the narrow space to be radiated as the radiation sound wave of front side A from an opening of cabinet 3 of television set, at the same time a sound wave is radiated at the back of speaker unit 2 as the radiation sound wave of back side B to the inside of back cabinet 5. The above described constitution enabled to make a television receiver set small and slim.

Now in the following, said speaker system comprising speaker unit 2 and acoustic duct 1 is described in detail referring to FIG.11 and FIG.12.

FIG.11 shows a perspective view of prior art speaker system, FIG.12 a cross sectional side-view of the speaker system.

In the FIGs, numeral 6 denotes a sound path through which a sound wave generated by speaker unit 2 proceeds, 7 a hole for absorption sound facing sound path 6, 10 a resonance absorption section comprising a tube 8 with the hole 7 as its one end and a cavity 9 which is coupled through with the other end of tube 8, 11 an opening through which a sound wave is radiated.

With the above described constitution, the operation of a prior art speaker system is described in the following.

When an input signal reaches speaker unit 2, a sound wave proceeds sound path 6 of acoustic duct 1 to be radiated through opening 11 of acoustic duct 1.

In the mean time, however, because of a substantial shift in the acoustic impedance caused at the opening 11 of acoustic duct 1, a part of the sound wave is reflected and returned to sound path 6 to create a standing wave in accordance with the length of acoustic duct 1, which makes the response frequency characteristics to have their peak at the mid-range frequency.

In order to remove the peak in mid-range frequency caused by the standing wave, the above described prior art constitution tried to absorb the peak part with the resonance absorption section 10 comprising the tube 8 with hole 7 facing sound path 6 as its one end and the cavity 9 coupled through with the other end of tube 8.

The resonance absorption section 10 has a sealed structure except that it is coupled with tube 8.

FIG.13 and FIG.14 illustrate other prior art speaker system intended to absorb said standing wave; FIG.13 is a cross sectional side view, FIG.14 a perspective view exploded.

In the FIGs, numeral 15 denotes a speaker unit for generating sound wave, 16 an acoustic duct coupled in the front of speaker unit 15, 17a a screw for coupling and fixing speaker unit 15 and acoustic duct 16 together, 17 a sound path within acoustic duct through which the sound wave proceeds, 18 a reflector board provided at both sides for guiding a sound wave generated by speaker unit 15 to an opening 16a of acoustic duct 16, 19 an absorber disposed within a throat section 22, 20 an absorber inserted from opening 16a, 21 a bonding agent for fixing the absorber inserted from said opening 16a to acoustic duct 16, symbol A indicates radiation sound wave of front side radiated from opening 16a of acoustic duct 16, B radiation sound wave of back side radiated from the back of speaker unit 15, numeral 22 denotes a throat section having its opening facing to sound path 17 along which said absorber 20 is to be inserted, 23 an absorber cover for sealing throat section 22 after disposing absorber 19, and 24 a screw for fixing the cover.

The speaker system as described above operates in the same way as the prior art shown in FIG.11, therefore the description of which operation is eliminated here. In the following, description is made on the operation for absorbing different standing waves.

The standing wave, which arises according to a length specific to the acoustic duct 16 out of sound wave generated from speaker unit 15 and renders the speaker system to be a one having

frequency characteristics of turbulent peaks and dips, can be absorbed and suppressed by the absorber 19 of throat section 22 and the absorber 20 inserted from opening 16a within acoustic duct 16; thus, flat frequency characteristics are obtainable.

In order to bring the absorber 19 of throat section 22 to the full functioning, the throat section 22 is sealed with absorber cover 23 and fixed with screw 24. Further, the reflector board 18 disposed at both sides in order for a sound wave not to be directly absorbed and damped at throat section 22 functions to a certain extent to control and guide the sound wave, which works for the compensation of, among others, mid-range frequency characteristics. Taking advantage of which, the reproduction of a natural sound is made possible even in a speaker system comprising an acoustic duct 16 constituted to have an opening of oblong, approximately rectangle, shape, and in a television receiver set employing the same speaker system.

However, in a prior art speaker system constituted in a way as shown in FIG.11 and FIG.12, where the peak at mid-range frequency is removed by providing the resonance absorption section 10 for absorbing the peak part, the absorbed part turns out to be a big dip making the response frequency characteristics curve to have turbulent peaks and dips as indicated with numeral 53 in FIG.4, and as a result the speech articulation deteriorates.

In a prior art constitution as shown in FIG.13 and FIG.14, the sound wave is absorbed and damped by absorber 19 of throat section 22 and by absorber 20 inserted from opening 16a to the extent more than what is needed, and the level of frequency characteristics substantially drops to a level as indicated with numeral 51 in FIG.7. As a result, the radiation volume of radiation sound wave of back side B becomes even larger than that of radiation sound wave of front side a, in FIG.13, bringing about a deteriorated speech articulation.

Summary of the Invention

The present invention solves the above described drawbacks the prior arts have, and aims to improve the speech articulation and offer a speaker system of excellent sound reproduction with flat response frequency characteristics.

In order to solve these tasks, a speaker system according to the present invention comprises an acoustic duct for guiding sound wave, coupled to the front of a speaker unit, the opening of which duct has an oblong, approximately rectangle, shape, which duct forms a sound path within the duct for guiding a sound wave radiated from said speaker to the opening, a resonance absorption section comprised of a tube with a hole for absorption sound as its one end and a cavity coupled through with the other end of the tube, and a cover for covering the resonance absorption section while providing a small gap linking the inside/outside of the acoustic duct through.

With the above described constitution, an excellent speaker system having improved speech articulation with flat response frequency characteristics is implemented by making use of the small gap formed in the cavity of resonance absorption section, even among the speaker system comprising a horn or an acoustic duct whose opening is constituted to have an oblong rectangle shape to be suitable for installation in equipments, suppressing the peaks and dips through the control of the width of the band to be absorbed and the Q of dip.

Brief Description of the Drawings

- FIG.1 Cross sectional side view of a speaker system according to an embodiment of the present invention
- FIG.2 Perspective view of the speaker system of FIG.1
- FIG.3 A - A Cross sectional view of FIG.1

- FIG.4 Response frequency characteristics chart of a speaker system according to an embodiment of the present invention
- FIG.5 Cross sectional side view of a speaker system according to other embodiment of the present invention
- FIG.6 Perspective view of FIG.5 exploded
- FIG.7 Response frequency characteristics chart of a speaker system according to other embodiment of the present invention
- FIG.8 Cross sectional side view of a speaker system according to other embodiment of the present invention
- FIG.9 Cross sectional side view of a speaker system according to other embodiment of the present invention
- FIG.10 Conceptual structure of a television receiver using a prior art speaker system
- FIG.11 Perspective view of the prior art speaker system
- FIG.12 Cross sectional side view of the prior art speaker system
- FIG.13 Cross sectional side view of other prior art speaker system
- FIG.14 Perspective view of FIG.13 exploded

Detailed Description of the Invention

In the following, various embodiments of the present invention are described referring to FIG.1 through FIG.9.

(Embodiment 1)

FIG.1 is cross sectional side view of a speaker system according to the present invention, FIG.2 is perspective view of the speaker system in the Embodiment 1 ; the external appearance remains the same as that of prior art as shown in FIG.11. FIG.3 is cross section at A-A in FIG.1, showing details of a resonance absorption section. Those constituent components which have the same function as those of the prior art speaker system described in FIG.11 and FIG.12 are given with the same symbols or numerals,

and explanation to which is omitted.

In the FIGs, numeral 1 denotes an acoustic duct coupled to the front of a speaker unit 2; inside the acoustic duct 1, a sound path 6 is formed for guiding sound wave radiated from speaker unit 2 to an opening 11, and a resonance absorption section 10a is formed by a tube 8 with a hole for absorption sound 7 as its one end and a cavity 9 which is coupled through with the other end of the tube 8.

As shown in FIG.2, the resonance absorption section 10a is constituted by coupling with a cover 10b for resonance absorption section.

FIG.3 is cross section at A-A in FIG.1, showing said resonance absorption section 10a in detail; where, 10c indicates a small gap having approximately 0.1mm clearance disposed along the edge of cover 10b for resonance absorption section for linking the cavity 9 to the outside of acoustic duct 1, therefore the cavity 9 is in a state not completely sealed with cover 10b. The small gap 10c may be provided for a desired length along the edge of cover 10b, relating to the gap clearance. Instead of disposing the small gap along the edge of cover 10b, a same effect is obtainable by providing a slit or a small hole in the cover 10b.

Now in the following, description is made on the operation of a speaker system of the present invention constituted as above.

When an input signal is applied to speaker unit 2, sound wave proceeds through the sound path inside of acoustic duct 1 to be radiated from opening 11 of acoustic duct 1. Meanwhile, the standing wave created in the inside of acoustic duct 1 is taken into cavity 9 from hole for absorption sound 7 via tube 8, when, the width of the band to be absorbed and the Q of dip can be controlled by adjusting the air pressure within cavity 9 making use of the air escaping through small gap 10c of approximately 0.1mm clearance disposed along the edge of cavity 9; in this way the peaks and dips are suppressed to the response frequency characteristics curve as indicated by numeral 52 in FIG.4.

As seen from FIG.4, a constitution according to the present Embodiment is capable of suppressing the peaks and dips of mid-range frequency to improve the speech articulation; thus, enables to present a speaker system having excellent sound reproduction of flat response frequency characteristics.

By assembling a visual equipment with a speaker system of the present invention, the size of visual equipment can be made small and slim, furthermore, to a one that have high performance and quality sound.

A same effect is of course obtained when a back cabinet, a bass reflector, a port, etc. is additionally provided to a speaker system of the present invention constituted with the acoustic duct 1.

Although in the above described Embodiment the gap 10c is made to have approximately 0.1mm clearance, any small gap is acceptable in so far as it serves for suppressing the peaks/dips; the clearance may be increased or decreased depending on the needs, or may be determined in relation to the gap length and the effects.

The above description has been made on an assumption that there is only one resonance absorption section 10a, however if more than two of such sections, each having different length of tube 8, different cavity 9, are provided a flatter response frequency characteristics curve is obtainable.

(Embodiment 2)

FIG.5 is cross sectional side view of a speaker system according to embodiment 2 of the present invention, FIG.6 is perspective view exploded of the same. Those constituent components which have the same function as those of the the prior art speaker system described in FIG.13 and FIG.14 are given with the same symbols or numerals, and explanation to which is omitted.

What is different from the prior art technology as illustrated in FIG.13 and FIG.14 is that in a constitution where an acoustic duct 16 for guiding sound wave the opening of which duct has an oblong, approximately rectangle, shape is coupled to the front of a speaker unit 15, a first inserting partition 30 which can be

inserted to acoustic duct 16 from opening 16a is provided. In the FIGs, numeral 30 denotes a first inserting partition, 31 a port section of the first inserting partition 30, and 33 a cavity of the first inserting partition.

With a speaker system constituted according to the Embodiment, the operation is described hereunder.

When an electric signal is applied to speaker unit 15 the signal is converted to sound signal and a sound wave is generated, which sound wave is guided to opening 16a through sound path 17 by acoustic duct 16 coupled to the front of speaker system 15, to be radiated as radiation sound wave of front side A.

As a result of disposing the first inserting partition 30, which can be inserted from opening 16a of acoustic duct 16, in the inside of acoustic duct 16, the first inserting partition 30 and the acoustic duct 16 are integrated to form a structure as if they are mono-structured; furthermore, the port section of first inserting partition 31 provided in the first inserting partition 30 works as a short tube, which, together with the cavity of the first inserting partition 33 formed by the first inserting partition 30 and the acoustic duct 16, plays a role of Helmholtz resonator in acoustic duct 16 and the cavity of first inserting partition 33 causes the cavity resonance on a standing wave created in the inside of acoustic duct 16; thereby a sound wave, which was in a conventional setup absorbed/damped more than actually necessary by an absorber, is not reduced to a loss any more, and radiated as radiation sound wave of front side A, therefore the sound pressure can be maintained at high level, without causing the deterioration in the level of response frequency characteristics, which was a drawback pertinent to this type of acoustic duct and the horn; and as the radiation sound wave of front side A is radiated without loss and maintained without being set off by the radiation sound wave of back side b, the speech articulation is not ill-affected; thus the present invention realizes for the first time the improved speech articulation, which any prior art technology could not.

The frequency characteristics of a speaker system according to this Embodiment 50 and the frequency characteristics of a prior art speaker system 51 are compared in FIG.7.

As FIG.7 indicates, the frequency characteristics 50 has a flatter curve with the turbulent peak/dip at the vicinity of 500Hz caused by the primary resonance suppressed by the cavity of first inserting partition 33 formed by first inserting partition 30 and acoustic duct 16, furthermore because of the eliminated absorber, which used to be inserted from the front, the level of entire frequency curve is raised, making it possible to reproduce a sound of rich frequency characteristics with the feeling of abundant sound pressure.

As described above, the constitution, wherein the first inserting partition 30 is separated from acoustic duct 16 to be an independent piece and insertable from the front of opening 16a of acoustic duct 16, allows a complete freedom in designing the shapes of first inserting partition 30 and port section of first inserting partition 31, which makes it possible to put the turbulent peaks and dips caused by the actions of resonance occurring in number of orders, which the prior art technology is unable to remove, under full control, making it possible to freely modify the response frequency characteristics.

Further, as the radiation sound wave of front side A is radiated without loss, it is maintained without being set off by the radiation sound wave of back side b and without causing a decreased level, which enables to reproduce a sound rich in low-region. In addition, as the volume of radiation sound wave of back side radiated in the inside of a back cabinet(not shown) decreases, the L-side radiation sound wave of back side and the R-side radiation sound wave of back side neither interfere to each other, nor affect the frequency characteristics; and favorable response frequency characteristics are realized.

Furthermore, introduction of the structure which allows insertion from the front of opening 16a of acoustic duct 16 gives influence on the resin mold component constituting conventional acoustic duct 1. Namely, as a result, polystyrene material material of high flowability and low tenacity, with which material the shaping of a hinge structure is impossible, becomes usable, in addition to the widely-used polypropylene material capable of shaping a hinge structure which is an indispensable structure for housing and sealing-in an absorber; the selection range of materials is thus widened, the designing freedom in designing the structure of an acoustic duct is increased, which in turn increases the margin and the freedom of designing the sound quality for a speaker system.

By incorporating a speaker system according to the Embodiment in a television receiver set, the television receiver set can be made small and slim-shaped, which enables to offer a high performance television receiver set with quality sound.

(Embodiment 3)

FIG.8 is cross sectional side view of a speaker system according to Embodiment 3 of the present invention. In FIG.8, numeral 30 denotes a first inserting partition, 31 a port section of the first inserting partition, 33 a cavity of the first inserting partition, 34 a second inserting partition, 35 a port section of the second inserting partition, 36 a cavity of the second inserting partition; what is different from the constitution of Embodiment 2 is that there are two inserting partitions 30 and 34 disposed in the inside of acoustic duct 16.

In the above described constitution, the turbulent peaks/dips of resonance in the frequency characteristics are divided into finer sections so as to be able to distinguish the resonance of even-numbered order and that of odd-numbered order, and the resonance of even-numbered order is assigned to the left inserting partition, for example, and that of odd-numbered order to the right inserting partition to be suppressed separately by each of the Helmholtz resonators formed by the cavities of inserting partitions; wherein by controlling the frequency of

Helmholtz resonator the turbulent peaks and dips can be suppressed by the two inserting partitions upto the high orders of resonance. In this way, the present invention implements the flatter frequency characteristics that has never been before.

(Embodiment 4)

FIG.9 is cross sectional side view of a speaker system according to Embodiment 4 of the present invention. In FIG.9, numeral 37 denotes an absorber disposed in a cavity 33 of a first inserting partition, 38 an absorber disposed in a cavity 36 of a second inserting partition, what is different from the constitution of Embodiment 3 is that there are very small amount of absorbers 37 and 38 disposed in cavities 33 and 36.

In the above described constitution, by disposing very small amount of absorbers 37 and 38 in the inside of first cavity 33 of inserting partition and second cavity 36 of inserting partition, even a small and sharp peak/dip caused by the standing wave and or cavity resonance is absorbed, making it possible to subtly control or give flavor to what has never been represented in the response frequency characteristics before. Further, the constitution of the present Embodiment radiates a sound wave as the radiation sound wave of front side A from opening 16a of acoustic duct without causing any absorption/damping, because the absorber is disposed in the inside of inserting partition, not exposed to sound path 17 through which the sound wave proceeds, while in general the use of absorber deteriorates the level of sound pressure.

Also the cavity in which an absorber 19 of throat section 22 is to be disposed as illustrated in FIG.5 may be constituted with the same concept, inserting a partition from the back of acoustic duct 16, or from the side of speaker unit 15; by which constitution an equivalent performance is obtainable.

As described above, a speaker system according to the present invention implements the flat response frequency characteristics where the peaks and dips are least contained in

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the mid-range frequency, which is an important range for reproducing the human voice. In this way, the present invention realizes an excellent speech articulation with favorable acoustic characteristics which the prior art technology could not attain.



What is claimed:

(claim 1) A speaker system comprising an acoustic duct for guiding sound wave having an oblong, approximately rectangle shape opening, coupled to the front of a speaker unit, wherein
a sound path is formed in the inside of the acoustic duct to guide a sound wave radiated from said speaker unit to the opening;

a resonance absorption section is comprised of a tube, one end of which is a hole for absorption sound disposed facing to the sound path, and a cavity, which is coupled through with the other end of the tube; and

a cover for covering the resonance absorption section is coupled providing a small gap linking the inside/outside of the acoustic duct.

(claim 2) A speaker system according to claim 1, wherein at least two resonance absorption sections, the tube length and the cavity volume of each are different, are comprised.

(claim 3) A speaker system according to either claim 1 or claim 2, wherein the clearance of small gap provided along the edge of cover for resonance absorption section is approximately 0.1mm.

(claim 4) A speaker system comprising an acoustic duct for guiding sound wave having an oblong, approximately rectangle shape opening, coupled to the front of a speaker unit, wherein

a partition shape reflector board is disposed in the inside of the acoustic duct along the sound path for guiding the sound wave of a speaker unit; and

a partition board having a port section is inserted to be coupled from the opening of the acoustic duct.

(claim 5) A speaker system according to claim 4, wherein a pair of partition boards having port section are inserted from the opening to be coupled with the both ends of the opening.

(claim 6) A speaker system according to either claim 4 or claim 5, wherein an absorber is disposed in a cavity formed by the partition board having a port section and the side wall of the acoustic duct.