**Amendments**

The preamble of claim 1 has been amended to clarify the invention relates to the modular speaker component for retrofitting to different rigid containers of different volumes, to form a speaker assembly. In claim 1, it indicates clearly that fixed part 10 (now clarified to read “fixed support member”) together with sealed connection part 11 (now clarified as read “sealable connector member”), are secured to the opening 31 of rigid container 30.

It is submitted that the amended preamble of claim 1 improves the overall clarity of the claim and no new matters has been introduced

The phrase “a fixed part, wherein the fixed part has a thin-walled structure” in previously filed claim 1 is considered to be unclear using relative terms such as “thin”, it has not been amended to read “a fixed support member”.

Claim 1 has also been amended to clarify the positions of the active loudspeaker unit 1 and the passive diaphragm units 20. The fixed support member is now specified to have at least two installations ports where the active loudspeaker unit and at least one passive diaphragm unit are respectively installed at the installation ports are effectively the “installation portion” of the fixed support member as originally claimed in claim 1.

The term fixed part and sealed connection part is clarified as read “fixed support member” and “sealable connector member” respective throughout the whole claims of 1 to 13 and specifications.

No new matters has been inserted.

# MODULAR SPEAKER COMPONENT

## FIELD OF THE INVENTION

**[0001]** This invention involves the modular component of a kind of modular speaker.

## BACKGROUND OF THE INVENTION

**[0002]** As a piece of electric-acoustic conversion equipment the speaker has a wide variety of forms. Particularly for some special venues, the speaker cannot be made too big after taking into consideration factors such as structure and appearance. Further, due to constraints, it cannot simply be placed in the environment to stick out all alone. And so, the form of the speaker body should be made such that it is similar to the environmental elements. Such special venues are very varied and they can range from e.g. museums to exhibition halls to bedrooms to retail stores. The styles are diverse and the differences are obvious. A very large proportion of speakers have custom structures so uniformity is hard. It is difficult to satisfy modular application for batch production and standardization.

**[0003]** The easiest way to handle this is to simply load the loudspeakers in several sealed rigid containers. These rigid containers would be the environmental elements themselves and they would allow the actual speaker body to be concealed. The drawback of this method is the difficulty in ensuring the sound quality of the 20 speaker, particularly at medium and low frequencies. And so, the challenge is to design the speaker in a modular manner while ensuring that it has considerable versatility and high quality sound effects.

## SUMMARY OF THE INVENTION

**[0004]** In view of the above problem of ensuring both versatility and high quality sound effects for the speaker, this invention proposes a kind of universal modular speaker component. The technical plan is as follows:

**[0005]** The modular speaker component for retrofitting to different rigid containers (30) having different volumes to form a speaker assembly, the component includes:

a fixed support member having at least to installation ports therethrough,

an active loudspeaker unit and at least one passive diaphragm units installed at their respective installation ports of the fixed support member and sealingly engaged with the fixed support member; and

a sealable connector member attached to an extending from a perimeter of the fixed support member, wherein a continuous outer surface of the sealable connector member defines a seal therealong for sealingly engaging with an opening of a rigid container to form an airtight resonant space therein

**[0006]** Below are several preferred improvements for this technical plan.

**[0007]** In a preferred embodiment, the said sealable connector member uses the seal to align, connect and secure the said fixed part to the opening of a rigid container. This causes this said fixed support member and the rigid container to jointly form the resonant space. On this basis, there can be three improvements: For the first improvement, the projection locations of the said active loudspeaker unit and the or each passive diaphragm units on the opening of the said rigid container are entirely located within the largest outer diameter of the sealable connector member. For the second improvement, the said active loudspeaker unit has a back loaded form relative to the said resonant space. For the third improvement, the said rigid container is a sealed speaker with a phase inversion device. The said phase inversion device refers to any phase inverter tube, labyrinth path, horn path or arbitrary combination of the three.

**[0008]** In a preferred embodiment, the or each said passive diaphragm unit and the said active loudspeaker unit are oriented the same direction. Further, the or each said passive diaphragm unit is distributed at a periphery of the said active loudspeaker unit. Following

improvement can be made on the basis of this plan: The said passive diaphragm unit uses at least one ring-shaped structure at the said fixed support member, wherein an inner part of the ring-shaped structure is filled by the said active loudspeaker unit; and an outer part of the ring-shaped structure reaches the sealable connector member.

**[0009]** In a preferred embodiment, the vibration directions of the said passive diaphragm units all intersect a central axis of the said fixed support member; the said active loudspeaker unit and the said passive diaphragm units are all rotationally symmetric around the central axis of the said fixed support member; the said passive diaphragm units are distributed at a periphery of the said active loudspeaker unit. Further, in another preferred embodiment, the said passive diaphragm units are entirely rotationally symmetric. They also take up a side area of the said fixed support member.

**[00010]** In a preferred embodiment, the said fixed support member, the sealable connector member and the or each passive diaphragm unit have an integrated molded structure.

**[00011]** In a preferred embodiment, the said sealable connector member is fixed on the rigid container with an adjustable volume using the said seal.

**[00012]** In a preferred embodiment, the said seal forms a flat surface. Through a weight of the entire component itself: it is placed on a horizontal surface to form a sealed form.

**[00013]** In a preferred embodiment, the said active loudspeaker unit, the or each passive diaphragm unit, sealable connector member and seal are all located on the same flat surface; further, the said seal is fitted tightly to an installation hole of a sealed container. The entire component thus constitutes an embedded form.

**[00014]** The beneficial effects of this invention are:

**[00015]** 1. The fixed support member integrates the active loudspeaker unit and the or each passive diaphragm units on top and combines with the sealable connector member fixed on it to form overall a universal high sound quality module that is unaffected by the rigid container. In a plan based on a small volume, it can also exhibit outstanding performance at medium and low frequencies; it can very conveniently form a complete high performance speaker with the rigid container, and satisfy the shape constraint requirements for the speaker in various application environments with different styles.

**[00016]** 2. The central axis of the active loudspeaker unit is preferably located in the axis of the fixed support member. The passive diaphragms are rotationally symmetric around this central axis. This allows the entire modular speaker component to maintain stability along the central axis the fixed support member, particularly when the central axis of the fixed support member is perpendicular to the rigid container.

**[00017]** 3. The vibration directions of the passive diaphragm units adopt the method of preferably all having the same direction as the central axis of the fixed part. This causes the coloration to be relatively low for the entire fixed support member. There are also fewer harmonic waves and the sound quality is purer. At the same time, this method reduces the additional vibration caused by the form change of the air within the resonant space. On the one hand, it can prevent as much as possible the damage caused too much tangential vibration. The modular speaker component will then not require too many securing mechanisms and securing can be done by means of simple placement. Therefore, the modular speaker component will be even less constrained by external air form, structure, securing, etc.

**[00018]** 4. The active loudspeaker unit preferably uses the back loading method relative to the resonant space. This allows the loudspeaker frame and other components to be concealed and protected.

**[00019]** 5. The projection locations of the active loudspeaker unit and the or each passive diaphragm unit on the opening of the rigid container are preferably entirely located within the largest outer diameter of the sealed connection part. This allows the fixed support member, as well as all the above components, to fit within the opening of the rigid container. Based on requirements, concealment can be done for the necessary depth. These parts can be made more concealed and unexposed, and the appearance will be unaffected.

**[00020]** 6. The vibration directions of all the passive diaphragm units preferably intersect the central axis of the fixed support member. Further, the sum of all the passive diaphragm units perpendicular to the central axis of the fixed support member is preferably zero; this setup causes the tangential vibration for the entire modular speaker component in the horizontal direction to achieve balance during operation. This greatly weakens the horizontal shifting of the speaker body, i.e. the rigid container, during large movements. It makes the speaker body more stable and also lowers the coloration.

**[00021]** 7. The form of the passive diaphragm unit is preferably a ring-shaped structure. An inner part of the ring-shaped structure is filled by the active loudspeaker unit; an outer part of the ring-shaped structure reaches the sealable connector member. Such a form allows the entire fixed support member to obtain maximum use, such that its effective vibration area is the largest. It has outstanding performance at low frequencies and the coloration is minimized at the same time too.

BRIEF DESCRIPTION OF THE DRAWINGS

**[00022]** The following figures and embodiments provide further explanation for this invention.

**[00023]** Figure 1 is the side cutaway view diagram for the use of embodiment 1 of this invention on a groove-shaped container.

**[00024]** Figure 2 is the schematic top view diagram for the embodiment shown in Figure 1,

**[00025]** Figure 3 is the side cutaway view diagram for embodiment 2 of this invention.

**[00026]** Figure 4 is the schematic top view diagram for the embodiment shown in Figure 3.

**[00027]** Figure 5 is the schematic cutaway view diagram for the use of the embodiment shown in Figure 3 on a standard glass jar.

**[00028]** Figure 6 is the side cutaway view diagram for embodiment 3 of this invention.

**[00029]** Figure 7 is the top view diagram for the embodiment shown in Figure 6.

**[00030]** Figure 8 is the schematic top view diagram for embodiment 4 of this invention.

**[00031]** Figure 9 is the schematic side view diagram for the use of the embodiment shown in Figure 8 on a glass jar.

**[00032]** Figure 10 is the schematic top view diagram for embodiment 5 of this invention.

**[00033]** Figure 11 is the schematic side view diagram for the use of the embodiment shown in Figure 10 on a glass jar.

**[00034]** Figure 12 is the sectional schematic side view diagram for embodiment 6 of this invention.

**[00035]** Figure 13 is the side cutaway view diagram for embodiment 7 of this invention.

**[00036]** Figure 14 is the top view diagram for embodiment 7 shown in Figure 13.

**[00037]** Figure 15 is the impedance curve diagram for the use of the embodiment shown in Figure 14 on four kinds of rigid containers with different volumes.

## DETAILED DESCRIPTION OF THE INVENTION

**Embodiment 1:**

**[00038]** As per Figure 1, the side cutaway view diagram for the use of embodiment 1 of this invention on a ceramic groove-shaped container; Figure 2 is the schematic top view diagram for the embodiment shown in Figure 1; the following explanation for embodiment 1 of this invention is with reference to these two diagrams.

**[00039]** Fixed part or fixed support member 10 has a disc-shaped thin-walled structure. A moving coil type active loudspeaker unit 1 is loaded at its center. Its cone hole faces upward; four passive diaphragm units 20 are distributed at the periphery of active loudspeaker unit 1 which is on top of fixed part 10. Fixed part 10 forms a circle together with sealed connection part or sealable connector member 11 at its periphery. Using the plugging method, it is secured within opening 31 of rigid container 30. Further, the central axis of fixed part 10 and the central axis of active loudspeaker unit 1 are the same; also, the four passive diaphragm units 20 are rotationally symmetric around the aforementioned central axis. In particular, the vibration directions n of the four passive diaphragm units 20 is the same as the direction of this central axis. Sealed connection part 11 is located at the outermost edge of fixed part 10. There is sealing material where it comes in contact with opening 31. The entire fixed part 10 and rigid container 30 together form an airtight resonant space 32.

**[00040]** When active loudspeaker unit 1 starts to operate, its cone will drive the air within resonant space 32 to change its form. This will thus cause diaphragms 21 on passive diaphragm units 20 to resonate such that all the audio frequency vibration is generated from active loudspeaker unit 1 and the four passive diaphragm units. An improved sound quality is thus obtained.

**[00041]** As can be seen, fixed part or fixed support member 10 integrates active loudspeaker unit 1 and passive diaphragm units 20, and combines with the sealed connection part or sealable connector member11 fixed on it to form overall a universal high sound quality module that is unaffected by rigid container 30. In a plan based on a small volume, it can also exhibit outstanding performance at medium and low frequencies; it can very conveniently form a complete high performance speaker with rigid container 30, and satisfy the shape constraint requirements for the speaker in various application environments with different styles. This presents an updated design method: Active loudspeaker unit 1 and passive diaphragm units 20 can be individually designed and tuned to form a modular component. This will greatly reduce the constraints for the speaker body (rigid container portion). In so doing, the structural design and appearance design can also be more proactive, and the sound quality effect will also not be lowered. By providing post-tuning module data, it can become a kind of universal module. This allows a greater degree of freedom within a certain range for the design of the speaker 20 body. This is different from the traditional design method where priority must be given to the design of the speaker body.

**[00042]** On the other hand, the central axis of active loudspeaker unit 1 is located in the central axis of fixed part 10. The passive diaphragms 20 are rotationally symmetric around this central axis. This allows the entire speaker to maintain stability along the central axis of fixed part or fixed support member 10, particularly when the central axis of fixed part or fixed support member 10 is perpendicular to the device. The vibration directions of passive diaphragm units 20 adopt the method of all having the same direction as the central axis of fixed part or fixed support member 10. This causes the coloration to be relatively low for the entire fixed part or fixed support member10. There are also fewer harmonic waves and the sound quality is purer. At the same time, this method reduces the additional vibration caused by the form change of the air within resonant space 32. On the one hand, it can prevent as much as possible the damage caused

by the unbalanced vibration of the rigid container. On the other hand, it will not cause too much tangential vibration. The speaker will then not require too many securing mechanisms and securing can be done by means of simple placement. Therefore, the speaker will be even less constrained by external air form, structure, securing, etc.

**[00043]** Active loudspeaker unit 1 in this embodiment 1 uses the back loading method relative to resonant space 32. This allows the loudspeaker frame and other components to be concealed and protected. At the same time, the projection locations of active loudspeaker unit 1 and passive diaphragm units 20 on the opening of rigid container 30 are entirely located within the largest outer diameter of sealed connection part or sealable connector member 11. This allows fixed part or fixed support member 10, as well as all the above components, to fit within the opening of rigid container 30. Based on requirements, concealment can be done for the necessary depth. These parts can be made more concealed and unexposed, and the appearance will be unaffected.

**Embodiment 2:**

**[00044]** As per Figure 3, the side cutaway view diagram for embodiment 2 of this invention; Figure 4 is the schematic top view diagram for the embodiment shown in Figure 3; Figure 5 is the schematic cutaway view diagram for the use of the embodiment shown Figure 3 on a standard glass jar; the following explanation for this embodiment 2 is with reference to these three diagrams.

**[00045]** In this embodiment 2, there are three passive diaphragm units 20. Like embodiment 1, they are rotationally symmetric relative to active loudspeaker unit 1 that has the same central axis as fixed part or fixed support member 10; the vibration directions of all the passive diaphragm units 20 intersect the central axis of fixed part or fixed support member 10; further, the sum of all the passive diaphragm 20 components perpendicular to the central axis of fixed part or fixed support member 10 is zero; this setup causes the tangential vibration for the entire speaker in the horizontal direction to achieve balance during operation. This greatly weakens the horizontal shifting of the speaker body during large movements. It makes the speaker body more stable and also lowers the coloration. For this embodiment 2, the sealed connection part or sealable connector member 11 can fit within rigid container 30 that is an 86mm glass jar. This is a relatively universal plan.

**[00046]** There are three passive diaphragm units 20. This allows sufficiently uniform vibration for the vibration-capable surface of the entire fixed part or fixed support member 10. The complexity will also not be too high.

**Embodiment 3:**

**[00047]** As per Figure 6, the side cutaway view diagram for embodiment 3 of this invention; Figure 7 is the top view diagram for the embodiment shown in Figure 6; the following explanation for embodiment 3 is with reference to these two diagrams.

**[00048]** The form of fixed part 10 for this embodiment 3 is similar to that for embodiment 2. It is an upward protruding structure; active loudspeaker unit 1 is still located at the central axis of fixed part or fixed support member 10 and the back loading method is used. The difference is that the form of passive diaphragm unit 20 is a ring-shaped structure. The part within the inner ring is filled by active loudspeaker unit 1; the outer ring reaches sealed connection part or sealable connector member 11. Such a form allows the entire fixed part 10 to obtain maximum use, such that its effective vibration area is the largest. It has outstanding performance at low frequencies and the coloration is minimized at the same time too. In particular, a plan using such kind of ring-shaped passive diaphragm unit 20 allows the utilization of thinner loudspeakers. It is suitable to be used for environments where the space thickness is relatively small. To achieve this form, fixed part or fixed support member 10 requires a support frame 13 to properly secure active loudspeaker unit 1 and passive diaphragm unit 20.

**Embodiment 4:**

**[00049]** As per Figure 8, the schematic top view diagram for embodiment 4 of this invention; Figure 9 is the schematic side view diagram for the use of the embodiment shown in Figure 8 on a glass jar; the following explanation for embodiment 4 of this invention is with reference to these two diagrams.

**[00050]** In this embodiment 4, fixed part or fixed support member 10 is a spherical shape overall. As for active loudspeaker unit 1 and the two passive diaphragm units 20 with the same appearance, they are distributed around the central axis of fixed part or fixed support member l0 in a rotationally symmetric manner. Further, the vibration directions of active loudspeaker unit 1 and passive diaphragm units 20 intersect the central axis of fixed part or fixed support member

10. This method allows the form of the fixed part to be simple. It also causes the vibration to be balanced. Through sealed connection part or sealable connector member 11, fixed part or fixed support member 10 is plugged and secured to opening 31 of glass jar 30.

**Embodiment 5:**

**[00051]** As per Figure 10, the schematic top view diagram for embodiment 5 of this invention; as per Figure 11, the schematic side view diagram for the use of the embodiment shown in Figure l0 on a glass jar. The following explanation is with reference to these two diagrams.

**[00052]** Active loudspeaker unit 1 occupies the top area of fixed part or fixed support member 10. At the same time, passive diaphragm units 20 are distributed at the side of fixed part or fixed support member 10 while being rotationally symmetric around the central axis of active loudspeaker unit 1; sealed connection part or sealable connector member 11 is located at the opposite end of active loudspeaker unit 1. At the same time, all the passive diaphragm units 20 are rotationally symmetric and they occupy the side area of fixed part 10. This kind of method also fully utilizes the surface area of fixed part or fixed support member 10 and maximizes the vibration-capable portion. This substantially improves the sound effect at medium and low frequencies, and it further prevents coloration. In particular, it is easy to make components of such form into standard parts for production and popularization. Due to the sealing material of the rigid container, it has a flat opening form. This allows the entire component to be placed flat on a level surface such that sealing is sufficient and normal usage is possible; similarly, sealed connection part or sealable connector member 11 is secured on a rigid container with adjustable volume. Convenience can be achieved and the effect of rigid container 30 is almost negligible. There is thus good applicability. For this type of embodiment, its sealed connection part or sealed connector member 11 can be adjusted for the corresponding audio effects at low frequencies to satisfy different requirements.

**Embodiment 6:**

**[00053]** As per Figure 12, the sectional schematic side view diagram for embodiment 6 of this invention. Compared with embodiment 5, the module's fixed part or fixed support member 10, active loudspeaker unit 1 and passive diaphragm units 20 are similar. The difference is that this

embodiment is used on a rigid container 30 with phase inverter tube 32; coupled with this phase inverter tube 32 the performance for the entire speaker at low frequencies can be significantly improved. The original lower limit for low frequencies was 70-80Hz. Now, it can be as low as around 50Hz. This is a preferred embodiment. In particular, fixed part 10 and passive diaphragm units 20 of this embodiment use an integrated molded structure. This makes processing simple for the components and provides good airtightness too; the diaphragms of the passive diaphragm units 20 as well as the elastic medium all use rubber material. Treatment is done for their thicknesses and surfaces such that they can be integrated. During actual debugging, various matching weights can also be added onto the passive diaphragm units 20 to achieve different resonance effects.

**Embodiment 7:**

**[00054]** Figure 13 is the side cutaway view diagram for embodiment 7 of this invention; Figure 14 is the top view diagram for embodiment 7 shown in Figure 13; there are similarities between this embodiment and embodiment 3: The form of passive diaphragm units 20 and their diaphragms 21 is a ring-shaped structure. The part within the inner ring is filled by active loudspeaker unit 1; the outer ring reaches sealed connection part or sealable connector member 11. In particular, passive diaphragms 20 have a flat form and they jointly form an embedded type module with active loudspeaker unit 1. Their sealed connection part or sealable connector member 11 and fixed part or fixed support member l0 use the same material. Sealed connection part or sealable connector member 11 has sealing effect itself and it possesses the same capability as the sealing material. It is used in conjunction with the similar sealing material on the rigid container. The cone diameter of active loudspeaker unit 1 is 5 inches and the outer diameter of the diaphragms 21 is 10 inches.

**[00055]** Figure 15 is the impedance curve diagram for the use of the embodiment shown in Figure 14 on four kinds of rigid containers with different volumes.

**[00056]** For the use of this embodiment on four different rigid containers, the containers are represented on the impedance curve diagram as the four curves of A, B, C and D: These four curves correspond to the four rigid containers of respective volumes 18122,5263,3649 and 2197cm3. As can be seen, no matter how the volume changes, the peak value can be maintained near the frequencies of 50Hz and 100Hz. At these frequencies, there is more stable impedance.

The change in volume causes slight displacement for the peak value. However, it is a stable trend within 30-200Hz;

on the other hand, when the volume is relatively large, such as the state for A, the peak value is relatively concentrated and obvious. There is good performance at low frequencies. As can be seen, the performance of the module at low frequencies is not constrained by the rigid container. It is not much constrained by the speaker body and 5 this greatly facilitates the design of the speaker body.

**[00057]** The description above only covers the preferred embodiments of this invention and it is not meant to limit its implementation scope i.e. any equivalent changes or modifications made within the patent scope of this invention or based on its specification content should all fall within the scope of this invention.

## Claims

1. A modular speaker component for retrofitting to different rigid containers (30) having different volumes and having an opening symmetrical in two mutually perpendicular axis to form a speaker assembly, the component compromising:

    a fixed support member (10) having at least two installation ports therethrough,

    an active loudspeaker unit (1) and at least one passive diaphragm unit (20) installed at their respective installation ports of the fixed support member (10) and sealingly engaged with the fixed support member (10); and

    a sealable connector member (11) attached to an extending from a perimeter of the fixed support member (10), wherein a continuous outer surface of the sealable connector member defines a seal therealong for sealingly engaging with an opening (31) of a rigid container (30) without the use of further fasteners to form an airtight resonant space (32) therein.

2. The modular speaker component of claim 1, wherein the sealable connector member (11) uses the seal to align, connect and secure the fixed support member (10) to opening (31) of the rigid container (30) to cause the fixed support member (10) and the rigid container (30) to jointly form the resonant space (32).

3. The modular speaker component of claim 1 wherein the rigid container (30) is a sealed speaker with a phase inversion device, and wherein the phase inversion device refers to any phase inverter tube (32), labyrinth path, horn path or arbitrary combination of the three.

4. The modular speaker component of claim 1, wherein the or each passive diaphragm unit (20) and the active loudspeaker unit (1) are oriented the same direction, and wherein the or each passive diaphragm unit (20) is distributed at a periphery of the active loudspeaker unit (1).

5. The modular speaker component of claim 4, wherein the passive diaphragm units (20) uses at least one ring-shaped structure at the fixed support member (10), wherein an inner part of the ring-shaped structure is filled by the loudspeaker unit (1), and wherein an outer part of the ring-shaped structure reaches the sealable connector member (11).

6. The modular speaker component of claim 1, wherein the vibration directions of the passive diaphragm units (20) all intersect a central axis of the fixed support member (10) wherein the active loudspeaker unit (1) and the passive diaphragm units (20) are all rotationally symmetric around the central axis of the fixed support member (10); and wherein the passive diaphragm units (20) are distributed at a periphery of the active loudspeaker unit (1).

7. The modular speaker component of claim 6, wherein the passive diaphragm units (20) are entirely rotationally symmetric, and wherein the passive diaphragm units (20) take up a side area of the fixed support member (10).

8. The modular speaker component of claim 2, wherein a projection locations of the active loudspeaker unit (1) and the or each passive diaphragm unit (20) on the opening (31) of the rigid container (30) are entirely located within a largest outer diameter of the sealable connector member (11).

9. The modular speaker component of claim 2 wherein the active loudspeaker unit (1) has a back loaded form relative to the resonant space (32).

10. The modular speaker component of claim 1, where in the fixed support member (10) the sealable connector member (11) and the or each passive diaphragm unit (20) have an integrated molded structure.

11. The modular speaker component of claim 1, wherein the sealable connector member (11) is fixed on the rigid container (30) with an adjustable volume using the said seal.

12. The modular speaker component of claim 1, wherein the seal forms a flat surface, and wherein through a weight of the entire component itself, the seal is placed on a horizontal surface to form a sealed form.

13. The modular speaker component of claim 1, wherein the active loudspeaker unit (1), the or each passive diaphragm unit (20) the sealable connector member (11) and the seal are all located on the same flat surface, wherein the seal is fitted tightly to an installation

hole of a sealed container, and wherein the entire component thus constitutes an embedded form.