June 9, 1964 H. J. HOPKINS 3,136,383

DUPLEX LOUD SPEAKER SOUND BOX SYSTEM

Filed March 15, 1963

Fig. 1.

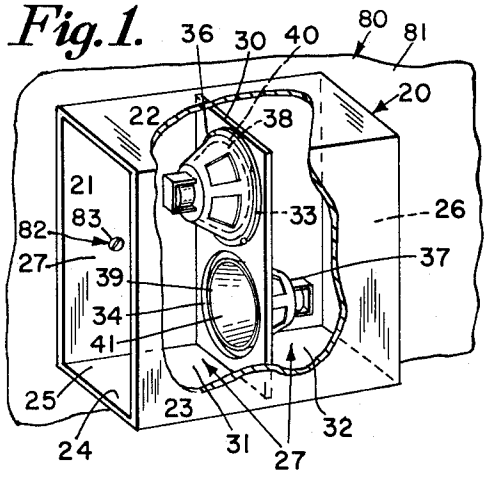
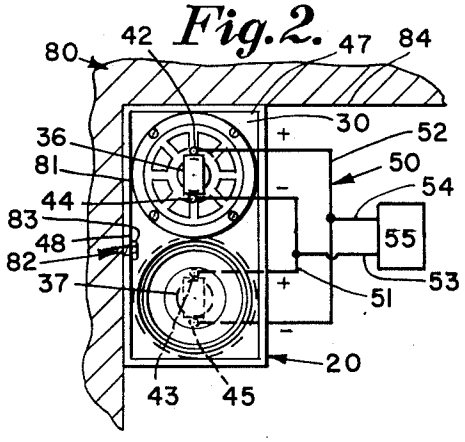


Fig. 2.



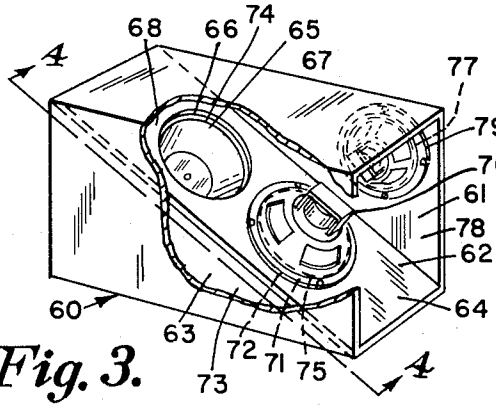


Fig. 3.

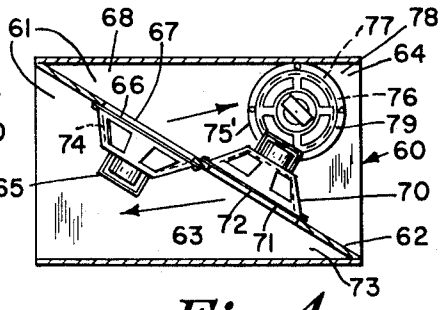


Fig. 4.

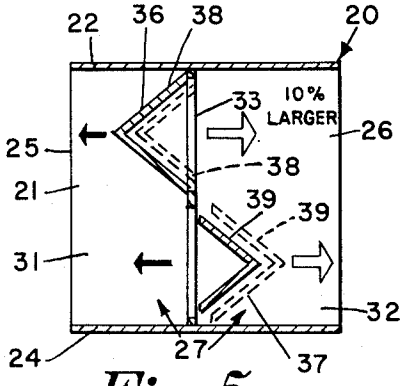


Fig. 5.

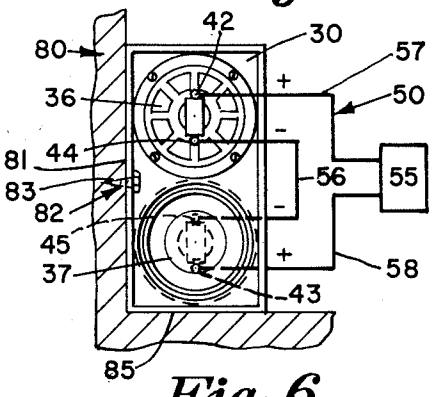


Fig. 6.

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DUPLEX LOUD SPEAKER SOUND BOX SYSTEM

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This invention relates to an improved loud speaker sound box for achieving predetermined acoustic loading on each opposite side thereof without distortion of the reproduced sound waves, the sound box being especially adapted for mounting alongside a central portion of the wall of a room.

This application is a continuation-in-part of my application Serial No. 199,223 filed May 28, 1962, entitled, Duplex Sound Box for Sound Wave Reproduction, now abandoned.

I have discovered that the reception of any radio program may be greatly enriched by providing a tubular sound box with a baffle disposed intermediate of the ends of the sound box, on which two loud speakers are mounted, each in an opposite chamber, to discharge sound waves into the opposite chamber.

A loud speaker mounted on an infinite baffle radiates sound waves equally from both sides of its own diaphragm into a spherical space bisected by the plane of the baffle. The sound energy on each side of the baffle is 180 degrees out of phase. A baffle of this type may be considered infinite if the acoustic path length at the lowest frequency to be produced is sufficient to prevent destructive cancellation of the front wave from the loud speaker diaphragm by its own back wave. This dictates that the baffle be very large in order to fulfill its designed function.

A finite baffle is a compromise attempt to obtain satisfactory sound reproduction with a baffle of reasonable or convenient size from a user's standpoint, and under conditions of small rooms or restricted areas of service use.

An open-back box baffle or sound box is an attempt to make a relatively large finite baffle occupy less space by folding it back upon itself to form the sides of the box. With loud speakers having a low natural resonant frequency, the open-back baffle may perform quite well. However, due to the rather poor coupling of the loud speaker diaphragm to the air in the room, the efficiency of this type of baffle is rather low. There is also frequently undesirable resonant effects due to the air contained within the box. This type of baffle is also of the dipole radiator type, but of rather impure form.

The closed-back box baffle attempts to nullify the detrimental effects of the back wave cancelling the front wave at the lower audio frequencies, but accomplishes this only at the expense of greatly reduced acoustic efficiency. Furthermore, in the closed-back box baffle, the acoustic air loading on both sides of the speaker diaphragm is not the same. This unequal loading on the two sides of the loud speaker diaphragm is considered by many to be a cause of distortion, while equal acoustic loading on both sides of the diaphragm is a very desirable condition.

Considering the open-back box baffle as a flat finite baffle, with its edges folded back and directed rearwards, consider the case now in which the front panel supporting the load speaker unit has been moved back into the box to a depth equal to one half the depth of the sides of the box. This baffle now consists of two open-ended boxes joined together at their closed ends, which then becomes the loud speaker mounting panel.

The internal air mass resonance will, in this type of baffle, be much less than that in a conventional box baffle of similar dimensions, because the volume of air contained in the cavities of air chambers of the unit is now

divided into two more or less equal air chambers or spaces, and these air masses can only communicate via the loud speaker diaphragm, which is ordinarily a cone or horn and damped by its electromagnetic structures and its associated circuitry. This permits the acoustic path length from the front to the rear of the loud speaker diaphragm to be conveniently increased without significant interference by internal air resonance. This also permits very good low frequency reproduction to be easily obtained from the duplex sound box loud speaker baffle unit.

This duplex baffle and sound box unit also has a considerable advantage in that the acoustic air loading on both sides of the loud speaker diaphragm is substantially identical, or equal. Also the acoustic loading is considerably increased by the presence of the sides of the sound box projecting both forwardly and rearwardly, from the loud speaker mounting panel. This balanced loading of the duplex baffle and sound box minimizes tonal distortion in the reproduced sound waves.

In general, the object of my invention is to provide a combined loud speaker and sound box construction, or unit, which will occupy a minimum of space, and will deliver reproduced musical and other compositions in more pleasing tones, to arrest attention and please the listeners.

With the above and other objects in view, the invention comprises certain new and useful constructions, combinations and arrangements of parts, clearly shown in the accompanying drawing, and fully described in the accompanying specification thereof, in which:

FIG. 1 is a perspective view of a sound box constructed in accordance with the invention, with parts broken away to show the oppositely disposed loud speakers on the transverse baffle;

FIG. 2 is an end elevation of the sound box shown in FIG. 1 with circuitry shown diagrammatically thereon; the sound box being mounted centrally of a wall at ceiling level;

FIG. 3 is a perspective view of another embodiment of the invention in which the baffle is diagonal, with parts broken away;

FIG. 4 is a side elevation of the sound box shown in FIG. 3 in section on line 4—4 of FIG. 3;

FIG. 5 is a diagrammatic side elevation of the sound box shown in FIG. 1, illustrating in dotted lines the mechanical in phase, movement of the speaker cones, and

FIG. 6 is an end elevation similar to FIG. 2, showing other circuitry diagrammatically, the sound box being mounted centrally of a wall at floor level.

As shown in FIGURES 1 and 2, a loud speaker sound box **20**, constructed in accordance with the invention, preferably includes four elongated side walls **21**, **22**, **23** and **24** forming a tube with open ends **25** and **26**. The elongated, tubular, sound box **20** thus forms a main sound chamber **27** which preferably is of rectangular cross section.

A baffle **30** is mounted transversely of main sound chamber **27**, preferably substantially midway of the open ends **25** and **26** and normal to the side walls **21**, **22**, **23** and **24**. The baffle **30** thus divides the main sound chamber into two opposed sub chambers **31** and **32**, each substantially equal in volume and sound reproductive capacity and each of uniform rectangular cross section. A pair of loud speaker openings **33** and **34** are juxtaposed in baffle **30** to occupy a major portion of the rectangular area thereof.

A pair of identical low frequency loud speakers **36** and **37** are each oppositely disposed on baffle **30**, each having a loud speaker cone **38** or **39**, a mouth **40** or **41**, plus terminals **42** or **43** and minus terminals **44** or **45**. Preferably the short side **47** of the rectangular baffle **30** is

substantially equal to the diameter of the mouth 40 or 41 of one loud speaker 36 or 37 and the long side 48 of baffle 30 is substantially equal to twice the diameter of the mouth 40, or 41, of one loud speaker 36 or 37. Preferably also the depth of each sub chamber, from the baffle 30 to the open end 25 or 26 of the sub chamber is substantially equal to the diameter of the mouth 40, or 41 of one of the loud speakers 36 or 37, and therefore approximately equal to the width of the short side of baffle 30.

The duplex sound box 20 is thus arranged to permit the loud speaker 36 located in sub chamber 31, to radiate sound waves rearwardly into sub chamber 31 while also radiating sound waves forwardly into the opposite sub chamber 32. Similarly the loud speaker 37, located in sub chamber 32, radiates sound waves rearwardly into sub chamber 32 while also radiating sound waves forwardly into the opposite sub chamber 31. Thus substantially balanced acoustic loading is achieved on each opposite side of the baffle 30 and at each opposite open end 25 and 26 of the sound box 20.

Circuit means 50 is provided to connect the terminals of loud speakers 36 and 37 in such a way that the cones 38 and 39 are mechanically in phase to move in unison first in one direction and then in the opposite direction. The loud speakers are thus electrically out of phase. As shown in FIG. 2 circuit means 50 may be in parallel wherein a conductor 51 connects plus terminal 43 and minus terminal 44'', a conductor 52 connects minus terminal 45 and plus treminal 42'' and conductors 53 and 54 place the conductors 51 and 52 in circuit with the amplified signal source 55. As shown in FIGURE 6 the circuit means 50 may be in series wherein conductor 56 connects the minus terminals 44 and 45, and conductors 57 and 58 connect the plus terminals in series with the amplified signal source 55.

As best shown in FIGURE 5, the cone 38 of speaker 36 moves to the right to direct sound through the opening 33 into sub chamber 32 in unison with the movement of the cone 39 of speaker 37 to the right to also direct sound into sub chamber 32. The air within the main chamber 27 thus is not compressed but bodily urged in the direction of the open arrows. Upon the return movement, in unison, of the cones 38 and 39 in the opposite direction the air is moved in the direction of the closed arrows, also without compression or expansion of the air within sound box 20.

Preferably, as shown in FIGURE 5, the volume of the sub chambers 31 and 32 is not exactly equal but only substantially equal. The baffle 30 is offset slightly from a position midway of the ends 25 and 26 so that the volume of one sub chamber is 5–10% greater than the volume of the other chamber to prevent the resonating of the sub chambers at the same frequency.

Another embodiment of the invention is shown in FIGURES 3 and 4 wherein a sound box 60 having a main sound chamber 61 is divided by a diagonal baffle 62 into two flared horn-like sub chambers 63 and 64. A low frequency loud speaker 65 is mounted on baffle 62 in sub chamber 63 with its mouth 66 spanning the opening 67 in the baffle and directing sound waves forwardly into the small end 68 of the opposite sub chamber 64. Similarly an identical low frequency loud speaker 70 is mounted on baffle 62 in sub chamber 64 with its mouth 71 spanning the juxtaposed opening 72 in the baffle and directing sound waves forwardly into the small end 73 of the opposite sub chamber 63. The sub chambers 63 and 64 constitute oppositely directed horns and the cones 74 and 75 of the speakers 65 and 70 are mechanically in phase and electrically out of phase as before mentioned.

The sub chambers 63 and 64 may vary slightly in volume to avoid resonating at the same frequency or they may be identical in volume with a high frequency speaker 75' located within one sub chamber such as 64 and having its mouth 76 spanning an opening 77 in one of the side walls 78. The volume of the speaker 75' reduces the air space within the sub chamber 64 as compared to the air space within sub chamber 63 and tends to avoid resonance of both sub chambers at the same frequency.

While conventional speaker systems are usually mounted in an upper corner of a room to enable the adjacent walls and ceiling to serve as a horn, in this invention the sound boxes 20 and 60 are mounted alongside a wall 80 of a room 81, midway of the corners of the room. Acoustic balance is thus maintained and sound emitted from the opposite ends of the box is equal in reproduction throughout the room. As shown in FIGURES 1 and 2, suitable support means 82 such as the screws 83 are provided to mount the sound boxes 20 or 60 midway of the wall 81, proximate the level of ceiling 84 so that the equally spaced corners of the room will each act as a horn. The sound boxes 20 or 60 may also be mounted midway of a room side wall 89, proximate the level of the floor 85 with similar sound reproduction effect.

The internal air mass resonance will, in my improved loud speaker sound box construction and baffle, be much less than that of a conventional box baffle, of similar dimensions because the volume of air virtually contained in the sound chambers or cavities on the opposite sides of the baffle, is now divided into two substantially equal masses or volumes of air and these divided air masses can only communicate with each other via the loud speaker cones, or diaphragms, which are fairly heavily damped by electromagnetic properties and associated circuitry. This permits the acoustic path length from the front to the rear of the loud speaker cone to be conveniently increased, without being modified by internal air resonance. This permits very good low frequency sound reproduction to be easily obtained from the duplex loud speaker sound box.

The duplex baffle also has a considerable advantage in that the acoustic loading of both sides of the loud speaker diaphragm is substantially identical. Also, the acoustic loading is considerably increased by the presence of the sides of the sound box projecting forwards and rearwardly from the speaker baffle or panel. This balanced acoustic loading of the duplex or two-way baffle minimizes distortion of the reproduced sound waves and thus greatly improves the pleasure of listening.

A loud speaker mounted in a wall at the junction of another wall, will radiate two times the acoustic power at low frequencies, than will the same loud speaker mounted in the middle of a wall. The same loud speaker mounted on a wall at the junction of another wall, and near the ceiling or the floor of the room, will radiate four times the acoustic power at low frequencies than it will if mounted in the middle of the wall.

In this invention, the sound box is located along the wall of the room, so the loud speakers will radiate their sound waves as if the radiation came from a double corner, such as is formed by the junction of the floor and the wall of the room. The presence of a corner on each side of the duplex sound box provides for remarkable efficiency in low frequency sound wave reproduction. A loud speaker sound box of this type designed for along-the-wall placement, greatly simplifies the domestic problem of getting the best entertainment from a loud speaker unit.

In the embodiment of the duplex loud speaker sound box and two way baffle of FIGURES 3 and 4, a duplex horn unit is provided. This has the same inherent advantages and properties as the duplex baffle of the first illustrated embodiment of my invention, but the additional advantage of still greater efficiency, due to the duplex horn loading function or feature. This gain in efficiency is in addition to that obtained by the double corner effect obtained by the along-the-wall placement of the duplex or two-way baffle and sound box.

I claim:

1. In a loud speaker sound box of the type having four elongated side walls defining a horizontal, tubular, main sound chamber with opposite open ends and having a baffle extending transversely of said main chamber to divide the same into two opposite sub chambers, substantially equal in volume, the combination of

a pair of juxtaposed, identical loud speaker openings in said baffle, and

a pair of identical, loud speakers oppositely disposed on said baffle, each located in one of said opposite sub chambers and having its mouth spanning one of said openings to radiate sound waves rearwardly into said one sub chamber and forwardly into the other said sub chamber.

2. A sound box as specified in claim 1 wherein said baffle is normal to said side walls and substantially midway between the open ends of said main sound chamber.

3. A sound box as specified in claim 1 wherein said baffle is mounted diagonally of said main chamber to form identical, flared, horn-like sub chambers and each said loud speaker is located in the large end of one said sub chambers to radiate sound waves forwardly into the small end of the opposite sub chamber.

4. A sound box as specified in claim 1 wherein said baffle is rectangular, the short side thereof being substantially equal to the diameter of the mouth of one said loud speaker and the long side thereof being substantially equal to twice the diameter of said mouth.

5. A sound box as specified in claim 1 wherein each said sub chamber is of uniform rectangular cross section and the depth of each said sub chamber, from said baffle to said open end, is substantially equal to the diameter of one said loud speaker.

6. A sound box as specified in claim 1 wherein said baffle is mounted slightly off centre relative to said main chamber and one said sub chamber differs in volume from the other said sub chamber by about ten percent whereby said sub chambers will not be resonant at the same frequency.

7. A sound box as specified in claim 1 plus a loud speaker opening in one of said side walls and a high frequency loud speaker mounted within one of said sub chambers with its mouth spanning said opening;

the volume of said high frequency loud speaker in said sub chamber reducing the volume of said sub chamber relative to the other said sub chamber to avoid resonance of said sub chambers at the same frequency.

8. A sound box as specified in claim 1 plus circuit means connecting said speakers out of phase electrically to cause said speakers to be in phase mechanically,

whereby the cones of said speakers move in unison, first in one direction and then in the opposite direction.

9. In combination with a room having a floor, a ceiling and side walls,

a tubular, open ended, loud speaker sound box having a transverse baffle dividing said box into opposed, open ended sub chambers,

a pair of identical, loud speakers oppositely disposed on said baffle, each located in one said sub chamber and having its mouth directed into the other said sub chamber,

circuit means connecting said speakers electrically out of phase, to cause said speakers to be mechanically in phase, and

means supporting said sound box alongside one wall of said room, midway from the adjacent corners thereof,

whereby the acoustic loading at each opposite open end of said sound box is substantially balanced.

10. In combination,

a tubular sound box having elongated side walls and opposite open ends;

a baffle disposed substantially midway of the ends of said sound box, normal to said side walls, said baffle having juxtaposed loud speaker openings therein and dividing said box into outwardly opened sub chambers of substantially equal acoustical capacity;

a pair of low frequency loud speakers, equal in sound wave reproduction capacity, oppositely disposed on said baffle, each loud speaker being located in one said sub chamber and having its mouth spanning one of said openings to radiate sound waves into the other said sub chamber, and

circuit means connecting said loud speakers for moving the cones thereof in unison first in one direction and then in the opposite direction.

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