An audio loudspeaker (11) is described which is particularly designed to act as a piece of art (15) hung on a room wall. Steps are taken to assure that the art aspects of the speaker do not interfere with the high quality reproduction of audio frequencies. The speaker (11) has several features which assure that it provides high quality audio reproduction even though it is relatively thin. Pegboard (36-39) divides the cabinet cavity into a plurality of parallel resonant cavities (26-35), as well as connecting the relatively broad front and back walls (18, 19) of the cabinet to enhance their resistance to unwanted vibration. A relatively large wofer-midrange (14) is used with the same extending through the cabinet back wall in such a manner that the cabinet thinness is not adversely affected. A bass reflex port (63) and crossover network (Fig. 7) particularly developed for the speaker is also described.
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CHANGEABLE ART LOUDSPEAKER

Background of the Invention

This invention relates to acoustic loudspeakers and, more particularly, to an acoustic loudspeaker designed to display pieces of art on a wall. The pieces of art can be changed, and the invention includes a method of displaying differing pieces of art.

Most entertainment systems for the home or the like include a plurality of audio loudspeakers, each of which includes one or more acoustic drivers (often themselves referred to as speakers) in a cabinet. Each driver has a diaphragm covered by a grille cloth at the front face of the cabinet to transmit radiant energy to the room or other space within which the speaker is housed. Grille cloths often are black or other dark color to hide the driver(s) without requiring tight weaves which will interfere with the radiation of acoustic energy. The result has been that from the decorating standpoint, speaker aesthetics is quite limiting. Those in the field have believed it necessary to have relatively unsightly
speaker constructions in order to have the high-performance acoustic characteristics required by many listeners. In other words, in the past, music lovers or other audiophiles have had little choice but to sacrifice their homes' interiors to big, free standing loudspeakers. These obtrusive objects are destructive visually, even though they may be pleasing sonically.

Efforts have been made to avoid the design limitations provided by most high-performance acoustic loudspeakers, by incorporating the speakers in the room walls of the room in which the speakers are housed. The difficulty with this, of course, is that once a speaker is located in a wall, its location is set. Thus, one is not free to change interior designs without taking into consideration the fixed speaker locations.

Summary of the Invention

The present invention relates to a method of disguising an acoustic loudspeaker, and a speaker which lends itself readily to such method and yet provides the high-quality music and other audio reproduction demanded by many. From the very broad standpoint, the method includes the steps of hanging a relatively thin cabinet loudspeaker on a wall and securing a desired piece of art over it without blocking the area of the face of the speaker from which acoustic energy is to radiate. This lack of blocking either can be provided by making an appropriate provision for the passage of the acoustic energy through the piece of art itself or by assuring that the piece of art does not cover the area in question. Most desirably, the method of the invention also includes the step of replacing the piece of art with a different piece of art when desired. In other words, the art which disguises the loudspeaker can be changed, such as for interior redecorating. Moreover, the
location of the speaker and, hence, the art within the
room likewise can be changed.

The loudspeaker of the invention has many different
features which are responsible for it providing high-
quality audio reproduction and yet enabling the cabinet
to be sufficiently thin that it easily can be disguised
with a piece of art. For one, it includes a plurality of
elongated parallel panels which extend between the
speaker cabinet back wall to its front wall, to impart
strength to the latter. These panels divide the acoustic
volume defined by the cabinet into a plurality of
elongated acoustic cavities. Most importantly, an
acoustic block is provided in each of these cavities to
absorb unwanted resonances. Each cavity becomes, in
essence, a very low Q tuned filter. Moreover, each of
the strengthening panels is provided with holes for the
flow of air or another carrier of acoustic energy between
the cavities to enable the whole cabinet volume to act as
a bass reflex acoustic cavity.

The loudspeaker construction further includes an
acoustic driver that has a diaphragm secured to the face
of the cabinet and a driving component for such diaphragm
which extends through and is tightly coupled to the
cabinet back wall. This construction has two advantages.
A large acoustic driver can be provided in view of the
extension of the same through the cabinet back wall, and
yet the cabinet can be kept relatively thin. Moreover,
the cabinet back wall acts to resist the reactive or
accelerative force imparted to the driving component upon
it vibrating the diaphragm.

Another feature of the speaker is that it includes a
crossover network designed particularly for pairs of
acoustic drivers which are concentric with one another —
drivers that have a common acoustic radiation center.
The corner frequencies provided by the crossover network, i.e., each of the frequencies at which the audio amplitude provided by the drivers with the selected values of the crossover components results in the series reactance equaling the driver impedance, are spaced from one another by one or more orders of magnitude, and the audio amplitudes of the speakers between the corner frequencies are added together.

A fourth feature of the construction is that the loudspeaker includes a frame as part of the combination adapted to hold the art over the cabinet face without blocking the area discussed above from which acoustic energy is to radiate. The frame is secured to the cabinet and held in position by frictional engagement with the cabinet, e.g., with opposed narrow edge walls of the cabinet, so that it is easily removable to change the art. The loudspeaker also includes a bass reflex port which extends through one of the narrow walls. The location of this port in a narrow edge wall of the cabinet assures that when the cabinet is hung on a room wall, the port will be adjacent such room wall to enhance amplification of bass by the wall. The port is also so located that it is not interfered with by the frame engaging the opposed narrow walls of the cabinet as discussed above. A fabric sheet typically is held by the frame and the location of the port in the narrow edge wall places it at a location at which the flow of the large volume of air required for bass will not be impeded by such cloth.

Although the individual features discussed above are important in-of-themselves, in this particular construction certain combinations of the same are particularly desirable. Moreover, there are certain other combinations which are important. For example, the combination of placing the speaker on the wall, providing
it with a larger cabinet, and selecting the inductance
for the crossover network to be particularly large
relative to the inductance typically selected.

Other features and advantages of the invention
either will become apparent or will be described in
connection with the following, more detailed description
of preferred embodiments of the invention.

Brief Description of the Drawing

With reference to the accompanying three sheets of
drawing;

FIG. 1 is an exploded view of a preferred embodiment
of the invention, showing a frame for holding a poster or
other piece of fine art, exploded from the remainder of
the loudspeaker;

FIG. 2 is a side elevation view of the preferred
embodiment illustrated in FIG. 1;

FIG. 3 is an exploded perspective view of the
interior of the loudspeaker cabinet;

FIG. 4 is a plan view of the loudspeaker cabinet
with the front wall removed;

FIG. 5 is an enlarged sectional view illustrating
the relationship of the preferred acoustic drivers of the
invention to the front and back walls of the cabinet;

FIG. 6 is an idealized graphical view of a
comparison of acoustic response obtainable with the
speaker of the invention;
FIG. 7 is an electrical schematic diagram of a crossover network, showing its electrical connection to a pair of acoustic drivers that are part of the preferred embodiment of the invention;

FIG. 8 is an idealized graphical representation of the relationship of the audio amplitude in adjacent frequency spectrum sections covered by a pair of drivers of a conventional acoustic loudspeaker; and

FIG. 9 is an idealized graphical representation similar to FIG. 8 of the audio amplitude provided between adjacent frequencies when the values of the crossover network components are selected in accordance with the invention.

Description of the Preferred Embodiments

The following relatively detailed description is provided to satisfy the patent statutes. However, it will be appreciated by those skilled in the art that various changes and modifications can be made without departing from the invention as defined by the claims and their equivalents.

FIGS. 1 and 2 illustrate an embodiment of the invention that is particularly adapted to disguise a speaker as a poster or the like piece of artwork. The speaker, generally referred to by the reference numeral 11, includes a frame 12 secured as will be described to a cabinet 13. A pair of concentric acoustic drivers 14 and 16 are located in the lower corner of such cabinet. Frame 12 circumscribes, as is conventional, a rectangular matting 17 having an exterior fabric sheet. However, as will be discussed below, the covered matting 17 itself is not entirely conventional. A rectangular transparent sheet 15 of acrylic or the like is provided as is typical
to hold a poster (not shown) in position against the
matting 17.

Cabinet 13 is made up of relatively broad
coextensive front and back walls 18 and 19, respectively,
and relatively narrow edge walls 21-24. These edge walls
are opposed top and bottom walls 22 and 24 and opposed
side walls 21 and 23. Frame 12 is secured to the cabinet
only by frictional engagement of the interior surfaces of
the exterior members of the same with the edge walls of
the cabinet. While from the broad standpoint it is only
necessary that the frame engage opposed ones of the
narrow edge walls, e.g., the opposed top and bottom edge
walls, it is preferable that it engage all four of the
edge walls 21-24 as in this embodiment. It will be
recognized that because of the frictional securance, the
frame may be easily removed manually from the cabinet in
order to change or replace the art which is held over the
face of the cabinet.

While in many situations the frictional engagement
is provided by the interior side walls of the frame
exterior members, it will be seen that a frame can
include special cross members or the like to provide such
frictional engagement. For example, in the embodiment
being described the exterior dimension of the cabinet in
the vertical direction is less than that desired for the
frame. The frictional engagement is therefore provided
by a linear cross member 25 in the frame which is
parallel to and opposed to the lower frame cross member
to provide the opposed frictional engagement.

The frame dimensions in the embodiment illustrated
are dictated by aesthetics, rather than simply the
necessity to disguise the speaker. It is necessary from
the invention standpoint to provide the "matting" 17 with
a relatively wide bottom beyond the poster in order to
allow acoustic radiation flow from the drivers as will be
described. In order to balance the same aesthetically,
an additional frame portion is provided above the top
edge wall of the cabinet as from FIG. 2. In one
implementation, the frame was about 30 inches by 39
inches, whereas the cabinet dimensions at its front face
was 22.5 inches by 29.5 inches.

A standard covered-type matting having a flexible
fabric sheet over a backing board, fits within the
remainder of the frame. In this particular instance, the
backing board is cut away at the location of the drivers
14 and 16 to permit passage to the fabric sheet of
acoustic energy radiated thereby. The material of the
fabric sheet is selected to pass the acoustic energy
frequencies provided by the drivers 14 and 16 with little
or no absorption. The result is that the piece of art
does not interfere with the radiant acoustic energy
provided by the diaphragms at the face of the cabinet.

Although this aspect of the invention has been
described in connection with a poster and matting, it
will be appreciated by those skilled in the field that
many variations are possible. For example, the piece of
art may fill the frame and itself include an area which
does not block the area of the cabinet face having the
diaphragm. Moreover, although the frame may be exterior
to the art and/or its matting as illustrated, it also can
be interior thereof. That is, the art or matting can be
stretched over the frame members which frictionally
engage the cabinet edge walls, rather than being
interiorly thereof. Also, the cabinet can be provided,
if desired, with special members rather than the edge
walls for the engagement. For example, the edge walls
may be built up or have special members secured to the
same exteriorly of the edge walls of the cabinet to
provide the frictional engagement. It also is
contemplated that a single frame be used to provide a
dpiece of art to disguise a pair of spaced apart speaker
cabinets having one or more features of the instant
invention. Such cabinets can be spaced apart by a
section which includes other electronics normally
associated with an audio or audio/visual system of which
the speakers having such cabinets may be a part. The
frame can be permanently installed on the cabinet and the
artwork screwed, glued or otherwise secured to the front
of the cabinet. These variations are not meant, of
course, to be exhaustive, but merely are some which have
occurred to the applicant and may be used in different
embodiments.

Another variation that has occurred to applicant is
to place both driver arrangements for a stereo effect
into one cabinet to which the invention is applicable.
Such single cabinet could also include the electronics
which is normally associated with an audio or
audio/visual system of which the speaker is a part.

As mentioned previously, the speaker itself is
designed to provide the high quality audio reproduction
audiophiles typically require. It is desirable in such
an arrangement having relatively broad front and back
walls for the cabinet, that means be provided to support
the integrity of the same in spite of their span, and yet
not interfere with the acoustic qualities provided by the
cavity of the cabinet. Most desirably, such means will
enhance the audio quality as an added bonus. As one of
its features, the invention includes such means. With
reference to FIGS. 3 and 4, it will be seen that the
interior of the cabinet is divided into a plurality of
cavities 26-35 by elongated, parallel panels 36-39. That
is, the panels are parallel to the cabinet side edge
walls 21 and 23, and each of the same extends between,
and is rigidly connected to, the front and back walls of
the cabinet. This extension provides supporting strength

to the front and back walls to prevent unwanted vibration

in spite of the breadth of such walls. The panels are

provided, however, with numerous holes 41 to permit

passage therebetween of air or some other carrier of

acoustic energy so that the reflex nature of the full

volume defined by the cabinet is not destroyed. (As

illustrated, some of the holes 41 are larger than

others.) It has been found that simple pegboard material

can be used to make the panels. It is desirable, though,
to provide additional holes through the same to provide

the larger apertures.

Although it is not new to provide strengthening

members extending between the front and back walls of a

speaker cabinet, it has been found that it is desirable
to arrange such strengthening members to provide

acoustically resonant cavities within the cabinet with

one or more acoustically absorbent blocks 42. This

results in absorption of certain high frequency

resonances, such as those which are caused by reflection

from the cabinet end walls demarcating each of the

cavities. In this connection, the location of the blocks

in each design is determined empirically with the

location halfway between the end walls being the starting

location.

It should be noted that in most instances the blocks

42 further divide each of the cavities defined by the

panels 36-39 into more than one cavity, i.e., there are

holes for passage of acoustic energy into the regions

defined by the panels on both sides of the blocks in most

instances. Each of the blocks can be said, though, to
define an acoustic length for the cavities of which it is

a part since it does absorb one or more orders of

resonant frequencies irrespective of its size and

location.
Each of the blocks is a piece, for example, of acoustical foam, such as the polyether polyurethane foam (65 ppi, 1.7 lbs./in.) sold by the trademark HYFONIC 1, manufactured by Foamex, Division of Knoll International Holdings, Inc., Eddystone, Pennsylvania. It will be recognized, however, that other materials also can be used and, in fact, in some instances it will not be desirable that a block extend fully between panels - in some instances the block simply could be a piece of strategically located sound absorptive material.

As another feature of the invention, the drivers are so connected between the front and back walls that they enhance the ability of making the cabinet thin, and the reactive force imparted to the driving components upon vibration of the diaphragms is, in turn, imparted and resisted by the cabinet back wall. FIG. 5 is an enlarged side elevational view which illustrates this construction. The driver 14 is considerably larger than the driver 16 and in essence "hides" most of such driver in such figure. Driver 14 is made up of a supporting framework 51 for a vibrating diaphragm 52. Such framework 51 includes a ring 53 which circumscribes the same and is secured in a mating ledge 54 in the cabinet front wall 18. The result is that the diaphragm is indirectly secured in mating relationship to the front wall at the face of the cabinet.

Driver 14 further includes a driving component 54 for the diaphragm. Such driving component extends through and is coupled with rigid securance to the cabinet back wall so as to enable the back and front walls of the cabinet to be spaced close to one another and to impart to the back wall, the reactive force on the driving component resulting from radiation of acoustic energy by the diaphragm. In this connection, such driving component includes, as is usual, a magnet (not
shown) for moving the diaphragm to cause it to radiate the desired acoustic energy. As illustrated, the driving component extends within a disk-shaped aperture in the back wall defined at 56, rigidly against an annular ridge 57 in the back wall. It engages the ridge 57 for the full periphery of the latter. The result of this contact is that the reactive force on the driving component is imparted to the back wall. A sealant bead 58 is provided to assure the hermetic integrity of the cavity and assure that the major contact needed to transmit the force between the driver and the back wall is provided. This construction is a major factor in the fact that the speaker (without the frame) in the implementation mentioned earlier is only 3 inches thick.

Driver 16 is mounted within the driver 14 concentric with the same, i.e., with its center of audio radiation coinciding with the center of audio radiation of the driver 14. The result is that the two drivers are, in essence, a point source of acoustic radiation. As mentioned previously, most of the driver 16 is hidden by driver 14 in FIG. 5. What is illustrated of driver 16 is a pair of terminals 59. It will be recognized, however, that the securement of such driver in driver 14 indirectly results in the cabinet back wall 19 resisting the reactive force for the driving component of driver 16.

In the implementation of the invention described above, driver 14 is a 6.5 inch polypropylene woofer-mid range with a cast magnesium frame and a 22.5 ounce (.64 Kg) magnet. The driver 16 is a one inch cloth dome tweeter with a neodymium-iron-boron magnet and ferrofluid cooling and damping.

The speaker of the invention also relies on bass reflex. As stated earlier, holes 41 assure that the full volume defined by the cabinet is utilized to generate
reflex energy. With reference FIGS. 3 and 4, a plate 61
is included to provide a small interior cavity with side
edges, one of which is denoted by reference numeral 62,
over a port 63 (FIG. 3). This port is in the bottom side
wall 24 so as to be adjacent whatever room wall the
driver is hung on. The room wall acts to amplify the
bass.

The port construction is tuned to a much lower
frequency than normal. Without the wall, there would be
inadequate bass response with a flat but lower level at
such frequency. Wall-mounted speakers have a 6 dB
advantage in bass response due to the combination of two
effects: (1) the wall reflects non-directional bass
frequencies for a 3 dB boost, and (2) the speaker's
efficiency is doubled (3 db) because the radiation angle
is halved so the diaphragm is able to get a firmer "bite"
on the air.

To get extended bass response from a small cabinet,
the design (1) takes advantage of the above bass-
reinforcing effect of the wall immediately behind it;
(2) uses a Qt of less than .3 (large magnet) driver with
a cabinet volume approximately equal to the equivalent
volume, Vas, of the driver 14; and (3) uses a large
series inductor to flatten the resulting response by
reducing output on frequencies above the bass
frequencies, e.g., 340 Hz in an implementation of the
invention. Most desirably, this inductor also acts as an
inductor for the crossover network described below and
rolls off frequencies to be handled by the tweeter.

Since the cabinet is approximately three times the
volume of a conventional bass reflex design for driver
14, and the port is tuned to a much lower frequency, the
frequency response would normally have inadequate bass
response with a flat but lower level as mentioned above.
FIG. 6 provides an idealized graphical representation of the bass response. Line 64 represents such response. If either the speaker was not adjacent the wall or a large inductor was not used as discussed above, it is expected that the response would be basically the same as that represented by the dotted line 66.

Drivers 14 and 16 are electrically connected together via a particular crossover network which cooperates with the remainder of the features of the invention to assure high quality audio output. It is particularly designed for use with drivers which are concentric with one another as are drivers 14 and 16. It is essentially similar to other crossover networks from the first order standpoint in that it is an LC design that is, in essence, a tuned filter which directs the bass power to the low frequency driver 14 and the high frequency power to the driver 16. The inductance of the circuit is represented by an inductor 71 and the capacitance is represented by capacitor 72. These components are connected between the two drivers as is illustrated. This is a typical connection except that the polarity between the connection with the two speakers is reversed to assure phase coherence. That is, since the phase at the tweeter driver 16 leads by almost 90 degrees at the tweeter and lags by 90 degrees at the woofer driver 14, the tweeter must be connected in reverse polarity compared to a conventional crossover, even though its acoustic center closely matches that of the woofer.

It is a goal in audio loudspeaker design to have a relatively flat response, i.e., a relatively nonvariant amplitude throughout the audio frequency spectrum covered. In a normal arrangement, the values of the components of the crossover network are selected to
minimize the effect on this response of the use of two
two speakers to cover differing sections of the audio
frequency spectrum. The selection of a large inductor
flattens the bass response by reducing the output of
driver 14 at higher frequencies and also rolls off the
frequencies to be handled by the tweeter driver 16. By
using a much smaller than normal capacitor in series with
the tweeter, the tweeter's output is reduced to match
that of the woofer-midrange driver 16. By placing the
corner frequency of this capacitor at the point where the
tweeter response begins to fall off, the tweeter output
is also made flatter. FIG. 8 is an idealized
illustration of amplitude versus frequency that is
considered to be an ideal. In such figure, the corner
frequencies provided by the crossover network are
represented at 81 and 82. These corner frequencies are
those frequencies at which the audio amplitude provided
by the respective drivers with the selected values of the
crossover components, results in the series reactance
equalling the driver impedance.

The two sections of a frequency spectrum handled by
two drivers connected by a crossover network are
represented in FIG. 8 by 83 and 84. Most desirably, the
frequency extent of the crossover section, section 86, is
minimized. (It is recognized, though, that relatively
complicated arrangements have been provided in the past
which do not necessarily minimize such area.) In any
event, the ideal situation would be one in which there
is, in essence, no crossover section, with the result
that a truly flat response would be provided.

In keeping with the invention, the components of the
crossover network are selected so that the corner
frequencies of the two drivers are separated by one or
more orders of magnitude. Corner frequency 81 is the
frequency at which the audio amplitude output of driver
14 begins to decrease, whereas corner frequency 82' is
the frequency at which the audio amplitude output of
driver 16 reaches steady-state operation. For example,
in the implementation of the invention mentioned above,
the corner frequency 81' was at 340 Hz, whereas the
corner frequency 82' was at 12,000 Hz. The invention
relies on the addition of the audio output of the two
drivers to provide a flat response in section 86'. This
sum is represented by line 87. In an implementation of
the instant invention utilizing the driver components
mentioned above, the value of the capacitor 72 is
selected to be 2 microfarad, and the value of inductor 71
selected to be 2 mH. A normal first-order crossover
network design for a 8 ohm woofer and a 6 ohm tweeter
would use a capacitor approximately five times larger and
an inductor about 3-1/2 times smaller for a 2,200 Hz
crossover frequency.

The exact values of the crossover components will be
determined by the response of the specific drivers. In
fact, it has been found that some drivers have required
that the 2 microfarad series capacitor be replaced by a
1 microfarad capacitor in parallel with a series
connected 1 microfarad capacitor and 22 ohm resistor.
Note also that this arrangement works best when the two
drivers are concentric with one another.

As mentioned at the beginning of the detailed
description, Applicant is not limited to the specific
embodiment(s) described above. Various changes and
modifications can be made. The claims, their equivalents
and their equivalent language define the scope of
protection.
What is claimed is:

1. In a method of disguising an acoustic loudspeaker, the steps of:
   (a) providing an acoustic loudspeaker having a cabinet made up of relatively broad front and back walls and a plurality of narrow edge walls which are opposed to one another, said front wall providing a face for said system from which acoustic energy is to radiate;
   (b) providing means for securing a piece of art over said face without blocking an area thereof from which acoustic energy radiates;
   (c) securing a piece of art over said face without blocking said area thereof; and
   (d) hanging said cabinet on a wall of a room with said piece of art displayed.

2. The method of claim 1 further including the step of replacing the piece of art with a different piece of art.

3. The method of claim 1 further including the step of providing a port through one of said narrow edge walls from the interior of said cabinet to the exterior thereof for the passage of a carrier of acoustic energy therethrough.

4. The method of claim 1 wherein said step of providing means for securing a piece of art over said face includes providing a frame which frictionally engages said cabinet to be held and positioned by the same.
5. The method of claim 4 wherein said step of
providing a frame which frictionally engages said cabinet
includes providing such a frame which is secured and held
in position only by said frictional engagement.

6. An acoustic loudspeaker for practicing the
method of claim 1.

7. An acoustic loudspeaker comprising:
   (a) a cabinet having a face and a plurality of edge
   walls;
   (b) an acoustic driver in said cabinet having a
diaphragm terminating at said face which radiates
   acoustic energy;
   (c) means for securing said cabinet to a wall of a
   room; and
   (d) a frame for a selected piece of art to
frictionally engage said cabinet so as to be held in
position thereby, said frame being adapted to hold said
art over said face without blocking an area thereof from
which acoustic energy from said diaphragm radiates.

8. The acoustic loudspeaker of claim 7 wherein
said frame is secured to said cabinet and held in
position only by said frictional engagement with said
cabinet, whereby said frame is easily removable from said
cabinet to change the art held over said face.

9. The acoustic loudspeaker of claim 7 wherein
said cabinet has a back wall, further including means
securing said driver to said cabinet back wall so as to
impart to said back wall, the reactive force on said
driver resulting from radiation of acoustic energy by
said diaphragm.
10. The acoustic loudspeaker of claim 7 wherein said cabinet has a front wall defining said face, further including a plurality of panels within said cabinet connected between said front and back walls dividing the acoustic volume defined by the same into a plurality of acoustic cavities.

11. The acoustic loudspeaker of claim 7 further including a fabric sheet through which acoustic energy can pass to be held by said frame over said area when said frame engages said cabinet.

12. The acoustic loudspeaker of claim 11 wherein said fabric sheet is in addition to said piece of art.

13. The acoustic loudspeaker of claim 7 wherein there are a pair of said acoustic drivers associated with said cabinet, each of which is designed to radiate acoustic energy at a section of the frequency spectrum different than that for which the other is designed.

14. The acoustic loudspeaker of claim 13 wherein said drivers are concentric with one another and further including a speaker crossover network providing a pair of corner frequencies for said drivers which are separated from one another by one or more orders of magnitude.
15. An acoustic loudspeaker comprising:
   (a) a cabinet having both a front wall defining a face and a back wall;
   (b) an acoustic driver in said cabinet having a diaphragm terminating at said face to radiate acoustic energy;
   (c) means for securing said cabinet to a wall of a room;
   (d) a plurality of panels within a volume defined by said cabinet, adjacent pairs of which are generally parallel to one another, extend between said front and back walls, and define acoustic cavities within said volume; and
   (e) an acoustic absorption block in at least one of said cavities to define an acoustic length for the same.

16. The acoustic loudspeaker of claim 15 wherein each of said panels is provided with a plurality of holes extending therethrough for the flow of a carrier of acoustic energy through the same.

17. The acoustic loudspeaker of claim 15 further including means for securing a piece of art over said face without blocking an area thereof from which acoustic energy from said diaphragm radiates.

18. The acoustic loudspeaker of claim 15 further including means securing said driver to said cabinet back wall so as to impart to said back wall, the reactive force on said driver resulting from radiation of acoustic energy by said diaphragm.
19. The acoustic loudspeaker of claim 15 wherein there are a pair of said acoustic drivers associated with said cabinet, each of which is designed to radiate acoustic energy at a section of the frequency spectrum different than that for which the other is designed, further including a speaker crossover network providing a pair of corner frequencies for said drivers which are separated from one another by one or more orders of magnitude.

20. The acoustic loudspeaker of claim 19 wherein said drivers are concentric with one another.

21. An acoustic loudspeaker comprising:
   (a) a cabinet having a back wall and a front wall defining a face;
   (b) means for securing said cabinet to a wall of a room; and
   (c) an acoustic driver in said cabinet having both a diaphragm to radiate acoustic energy secured to said front wall, and a driving component for said diaphragm extending through and matingly secured to said cabinet back wall so as to enable said back wall and front walls to be spaced close to one another and to impart to said back wall, the reactive force on said driving component resulting from radiation of acoustic energy by said diaphragm.

22. The acoustic loudspeaker of claim 21 wherein said driving component includes a magnet for moving said diaphragm to cause the latter to radiate said acoustic energy.

23. The acoustic loudspeaker of claim 21 further including means for securing a piece of art over said face without blocking an area thereof from which acoustic energy from said diaphragm radiates.
24. The acoustic loudspeaker of claim 21 wherein there are a pair of said drivers concentric with one another and further including a speaker crossover network providing a pair of corner frequencies for said drivers which are separated from one another by one or more orders of magnitude.

25. An acoustic loudspeaker comprising:
(a) a cabinet having a broad face and a plurality of narrow edge walls, which cabinet defines an acoustic volume;
(b) an acoustic driver in said cabinet having a diaphragm which radiates acoustic energy terminating at said face;
(c) means for securing said cabinet to a wall of a room; and
(d) a port extending through one of said narrow edge walls for passage of a carrier of acoustic energy from said volume.

26. The acoustic loudspeaker of claim 25 further including a frame for securing a piece of art over said face without blocking an area thereof from which acoustic energy from said diaphragm radiates, which frame is adapted to engage a plurality of said cabinet edge walls to be held in position thereby without blocking said port.

27. The acoustic loudspeaker of claim 25 wherein there are a pair of said drivers concentric with one another and further including a speaker crossover network providing a pair of corner frequencies for said drivers which are separated from one another by one or more orders of magnitude.
28. An acoustic loudspeaker comprising:
   (a) a cabinet having a broad front wall defining a face, a broad back wall, and a plurality of narrow edge walls connecting said front and back walls, which cabinet defines an acoustic volume;
   (b) an acoustic driver in said cabinet having a diaphragm which radiates acoustic energy terminating at said face;
   (c) means for securing said cabinet to a wall of a room;
   (d) means for securing a piece of art over said face without blocking an area thereof from which acoustic energy from said diaphragm radiates;
   (e) means securing said driver to said cabinet back wall so as to impart to said back wall, the reactive force on said driver resulting from radiation of acoustic energy by said diaphragm; and
   (f) a plurality of panels within the volume defined by said cabinet, adjacent pairs of which are generally parallel to one another, extend between said front and back walls, and define acoustic cavities within said volume.

29. The acoustic loudspeaker of claim 28 wherein there are a pair of said drivers concentric with one another and further including a speaker crossover network providing a pair of corner frequencies for said drivers which are separated from one another by one or more orders of magnitude.

30. The acoustic loudspeaker of claim 28 wherein there are a pair of said acoustic drivers concentric with one another and said means securing said driver to said cabinet back wall secures the drivers of both of said speakers to said back wall.
31. The acoustic loudspeaker of claim 28 wherein said means for securing a piece of art over said face includes a frame for said art which frictionally engages said cabinet to be held in position thereby.

32. The acoustic loudspeaker of claim 31 wherein said frame is secured to said cabinet and held in position only by said frictional engagement, whereby said frame is easily removable from said cabinet to change the art held by the same over said face.

33. The acoustic loudspeaker system of claim 28 further including a port extending through one of said narrow edge walls for passage of a carrier of acoustic energy from said volume.

34. The acoustic loudspeaker system of claim 28, further including an acoustic block in at least one of said cavities to damp specific frequencies.

35. In an acoustic loudspeaker system having a cabinet defining an acoustic volume and a pair of speaker drivers, each of which is designed to radiate acoustic energy at a section of the frequency spectrum different than that for which the other is designed, a speaker crossover network providing a pair of corner frequencies for said drivers which are separated from one another by one or more orders of magnitude.

36. The acoustic loudspeaker system of claim 35 wherein the frequency spectrum sections of said drivers are adjacent one another, and one of said corner frequencies is the frequency at which the audio amplitude output of one of said drivers begins to decrease and the other of said corner frequencies is the frequency at which the audio amplitude output of the other of said drivers reaches steady-state operation.
37. The acoustic loudspeaker system of claim 35 wherein said drivers are concentric with one another.

38. The acoustic loudspeaker system of claim 37 wherein said crossover network electrically connects said pair of drivers to one another in a polarity providing audio phase coherency in that portion of the frequency spectrum between said corner frequencies.

39. The acoustic loudspeaker system of claim 35 wherein said crossover network electrically connects said pair of drivers to add together the audio output of said drivers between said corner frequencies.

40. The acoustic loudspeaker system of claim 35 wherein the acoustic volume provided by said cabinet is generally equal to the equivalent volume of the one of said drivers having the corner frequency at which its audio amplitude begins to decrease.
FIG. 1

FIG. 2

FIG. 3
FIG. 8
(PRIOR ART)

FIG. 9
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
   IPC(5) : H05K 5/00; A47B 81/06; H04R 1/02; H03G 5/00; H04R 25/00
   US CL : 181/150, 152, 156, 199; 381/88, 89, 90, 99, 100, 188, 205
   According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
   Minimum documentation searched (classification system followed by classification symbols)
   U.S. : 181/150, 152, 156, 199; 381/88, 89, 90, 99, 100, 188, 205
   Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
   Electronic database consulted during the international search (name of database and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
<tr>
<td>X</td>
<td>US, A, 4,923,032 (NUERNBERGER) 08 May 1990, See entire document.</td>
<td>1,2,4-8,11-14</td>
</tr>
<tr>
<td>X</td>
<td>US, A, 3,160,225 (SECHRIST) 08 December 1964, See entire document.</td>
<td>1,2,4-8,11,12</td>
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<tr>
<td>X</td>
<td>US, A, 4,244,096 (KASHICHI) 13 January 1981, See entire document.</td>
<td>1,2,4-8,11,12</td>
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<td>X</td>
<td>US, A, 3,941,638 (HORKY ET AL.) 02 March 1976, See entire document.</td>
<td>1,2,4-8,11,12</td>
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<td>X</td>
<td>US, A, 4,164,988 (VIRVA) 21 August 1979, See entire document.</td>
<td>1,2,4-8,11,12</td>
</tr>
</tbody>
</table>

[X] Further documents are listed in the continuation of Box C.  [ ] See patent family annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be part of particular relevance
  "E" earlier document published on or after the international filing date
  "L" document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  "O" document referring to an oral disclosure, use, exhibition or other means
  "P" document published prior to the international filing date but later than the priority date claimed

** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  "Z" document member of the same patent family

Date of the actual completion of the international search
07 APRIL 1993

Date of mailing of the international search report
28 APR 1993

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
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Form PCT/ISA/210 (second sheet)(July 1992)
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<th>Relevant to claim No.</th>
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<tbody>
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<td>X,P</td>
<td>US, A, 5,109,422 (FURUKAWA) 28 April 1992.</td>
<td>1,2,4-8, 11,12</td>
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<tr>
<td>Y</td>
<td>US, A, 4,903,300 (POLK) 20 February 1990, See entire document.</td>
<td>1-14,28-34</td>
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<tr>
<td>Y,E</td>
<td>US, A, 5,197,103 (HAYAKAWA) 23 March 1993, See entire document.</td>
<td>1-14,28-34</td>
</tr>
<tr>
<td>Y</td>
<td>US, A, 4,926,962 (GRAHAM ET AL.) 22 May 1990, See entire document.</td>
<td>1-14,28-34</td>
</tr>
</tbody>
</table>
### Box I  Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box II  Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

   Please See Extra Sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☑ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
   1-14, 28-34

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant’s protest.

☐ No protest accompanied the payment of additional search fees.
BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

1) Group I, claims 1-14, 28-34 are drawn to a method and apparatus of disguising an acoustic loudspeaker with a piece of art classified in class 181, subclass 150.

2) Group II, claims 15-20 are drawn to an acoustic loudspeaker cabinet having a plurality of panels within a volume defined by the cabinet and an acoustic absorption block, classified in class 181, subclass 199.

3) Group III, claims 21-24 are drawn to an acoustic loudspeaker cabinet comprising back and front walls having an acoustic driver mounted thereon. The diaphragm of the acoustic driver is secured to the front wall and the driving component of the acoustic driver is secured to the back wall, classified in class 181, subclass 171.

4) Group IV, claims 25-27 are, drawn to an acoustic loudspeaker cabinet comprising a plurality of narrow edge walls having a port extending through one of the narrow edge wall, classified in class 181, subclass 152.

5) Claims 35-40 are drawn to an acoustic loudspeaker system having a cross over network, classified in class 381, subclass 99.