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(54) **Asymmetrical transducing.**

(57) A symmetrical electroacoustical transducing apparatus includes a first electroacoustical transducing system (11,12,13,33) having first electroacoustical transducing structure (33) constructed and arranged to transduce spectral components in substantially the full range of audio frequencies. A second electroacoustical transducing system (14,15,31) has a second electroacoustical transducing structure (31) constructed and arranged to transduce spectral components only in the upper range of audio frequencies. The first and second electroacoustical transducing structures (33,31) are relatively displaced and coact to be capable of radiating a composite stereo sound signal when the first electrical transducing structure (33) receives a first electrical signal representative of a first stereo signal with spectral components in the upper frequency range and the second electroacoustical transducing structure (31) receives a second electrical signal representative of a second stereo signal with spectral components in the upper frequency range.

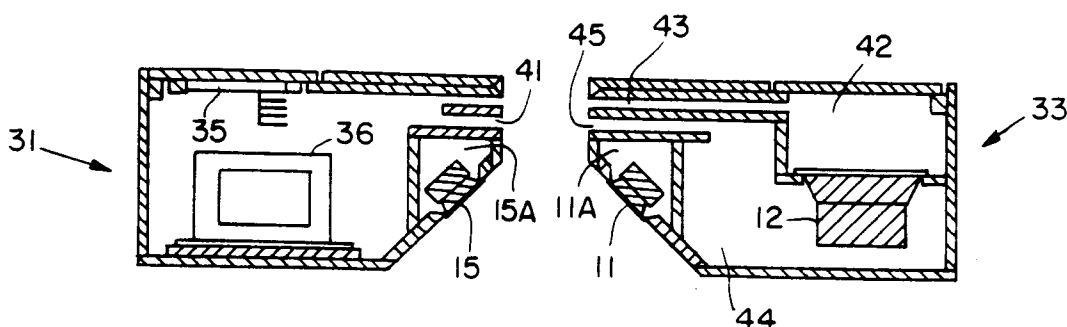


FIG. 2B

The present invention relates in general to electroacoustical transducing and more particularly concerns novel apparatus and techniques for stereo electroacoustical transducing.

According to the invention, there are first and second transducing systems. The first electroacoustical transducing system is operative over substantially the full audio frequency range and is constructed and arranged to electroacoustically transduce input electrical signal spectral components in the upper frequency range of only a first stereo signal. The second electroacoustical transducing system is constructed and arranged to electroacoustically transduce spectral components in the upper frequency range only and representative of only those spectral components of the second of first and second stereo signals. The first electroacoustical transducing system preferably includes a first electroacoustical transducing structure for also transducing spectral components in the bass frequency range, preferably representing the sum of bass frequency spectral components in both the first and second stereo signals. The first and second stereo signals are typically left and right signals.

According to one aspect of the invention, the first electroacoustical transducing system radiates only spectral components in the bass frequency range sufficiently low so that the source thereof is nonlocalizable.

Typically the first electroacoustical transducing system includes a summer having a first input connected to a first stereo signal input terminal and a second input coupled to a lowpass filter having its input coupled to a second stereo input terminal. The first stereo electroacoustical transducing system typically includes a first equalizer and first amplifier intercoupling the output of the summer and the first electroacoustical transducing structure. The first electroacoustical transducing structure typically includes a woofer and upper frequency driver with a capacitor coupling the output of the first amplifier to the upper frequency driver. Alternatively, there may be a full range driver coupled to the amplifier. The second electroacoustical transducing system typically includes a second equalizer, a second amplifier and an upper frequency driver.

According to one form of the invention, there are first and second enclosures. The first enclosure includes a woofer driver mounted between first and second subchambers ported to the outside embodying the principles of Bose U.S. Patent No. 4,549,631 with an angled panel carrying an upper frequency driver. The second enclosure carries the second electroacoustical transducing system upper frequency driver on an angled panel and houses amplifiers and equalizers for both electroacoustical transducing systems.

According to a specific form of the invention, the

first electroacoustical system comprises an acoustic waveguide embodying the principles of Bose U.S. Patent No. 4,628,528. In a specific form of the invention, the first and second electroacoustical transducing systems are carried within a single stereo receiver cabinet.

Numerous other features, objects and advantages of the invention will become apparent from the following detailed description when read in connection with the accompanying drawing in which:

FIG. 1 is a block-schematic diagram illustrating the logical arrangement of a system according to the invention;

FIG. 2A is a front view of a stereo system according to the invention having left and right cabinets; FIG. 2B is a plan sectional view through section 2B-2B of FIG. 2A; and

FIG. 3 is a perspective pictorial view with bounding surface transparencized to illustrate internal construction of an embodiment of the invention in a stereo receiver cabinet.

With reference now to the drawings and more particularly FIG. 1 thereof, there is shown a block-schematic diagram of an exemplary embodiment of the invention. A first electroacoustical transducing system comprises left upper frequency driver 11 and woofer 12 that receive energy from power amplifier 13. Capacitor 14 couples the output of power amplifier 13 to left upper frequency driver 11.

A second electroacoustical transducing system comprises right upper frequency driver 15 which receives energy from power amplifier 14. Equalizer 16 couples right input terminal 17 to power amplifier 14. Summer 21 and equalizer 22 couple left input terminal 23 to power amplifier 13. Low pass filter 24 couples right input terminal 17 to a second input of summer 21 so that the output of summer 21 includes spectral components within the full audio frequency range of the left input signal incident upon left input terminal 23 and bass frequency spectral components of the right input signal incident upon right input terminal 17 so that woofer 12 electroacoustically transduces the sum of bass frequency spectral components incident upon left input terminal 23 and right input terminal 17 while capacitor 14 selectively transmits upper frequency spectral components, typically above a frequency of the order of 200 Hz, present in the left signal incident upon left input terminal 23 transduced by upper frequency driver 11. Alternatively, the first electroacoustical transducing system may comprise a single full-range driver, such as a driver of the type used in the commercially available BOSE 901 loudspeaker system with equalizers 16 and 22 coacting with transducers 12 and 15 to provide substantially uniform radiated power as a function of frequency over substantially the full audio frequency range.

Amplifier 13 typically has a higher maximum output power capability than amplifier 14 because there

is usually more power radiated over the wider frequency range. By using equalization in both channels with equalizers 16 and 22, the effective frequency response of drivers 11 and 15 may be substantially the same without a capacitor coupling the output of amplifier 14 to right upper frequency driver 15. Woofer 12 may be supported in a suitable enclosure to provide a desired system response. A preferred form of enclosure is of the type described in Bose U.S. Patent No. 4,549,631 characterized by lowpass filtering characteristics so that the connection between power amplifier 13 and woofer 12 is free of costly passive components.

It is to be understood that principles of the invention may be embodied in passive structures. For example, the woofer may comprise a dual-voicecoil driver with one voicecoil receiving left bass spectral components and the other voicecoil receiving right bass spectral components. It is also possible to couple the woofer to only one of the input terminals so that it radiates bass spectral components in the signal on that input terminal.

Referring to FIG. 2A, there is shown a front view of left and right enclosures 33 and 31 in an exemplary embodiment of the invention. Right enclosure 31 supports right upper frequency driver 15 on angled panel 32. Left enclosure 33 supports left upper frequency driver 11 on angled panel 34.

Referring to FIG. 2B, there is shown a plan view through section 2B-2B of FIG. 2A. Right enclosure 31 includes a low power equalizer-amplifier 35 for energizing right upper frequency driver 15 and a higher power equalizer-amplifier 36 for energizing woofer 12 and left upper frequency driver 11. Right enclosure 31 is formed with a front opening 37 (FIG. 2A) and side openings 41 for allowing air circulation. Upper frequency drivers 11 and 15 reside in like enclosures 11A and 15A, respectively.

Right enclosure 31 may also house a component such as a CD player, that may be adversely affected by vibration. The absence of bass radiation from this enclosure results in reduced mechanical vibration. The enclosure may be visually symmetrical while being acoustically asymmetrical.

Woofer 12 resides in a multi-chambered enclosure having a first subchamber 42 coupled to the outside through port 43 and a second subchamber 44 coupled to the outside through port 45.

Referring to FIG. 3, there is shown another embodiment of drivers in a stereo receiver enclosure 51 partially transparentized to show internal structure. In this embodiment the first or left electroacoustical transducing system includes a full-range driver 52 at the front of an acoustic waveguide 53 that extends along the indicated dotted path to a far end opening 54 at the right of the enclosure. The second or right electroacoustical transducing system comprises an upper frequency driver 55. Preferably the channel

53A to the rear of driver 52 is filled with polyester that helps reduce resonant peaks. This embodiment of the invention is used in the BOSE ACOUSTIC WAVE stereo receiver commercially available shortly after the filing date of this application. This embodiment of the invention incorporates principles disclosed in Bose U.S. Patent No. 4,628,528 and described in the co-pending application filed on the same day as this application and claiming priority from US application No. 058478 filed on 6 May 1994.

Claims

1. Asymmetrical electroacoustical transducing apparatus comprising:
 - a first electroacoustical transducing system (11,12,13,33) having a first electroacoustical transducing structure (33) constructed and arranged to transduce spectral components in substantially the full range of audio frequencies; and
 - a second electroacoustical transducing system (14,15,31) having a second electroacoustical transducing structure (31) constructed and arranged to transduce spectral components only in the upper range of audio frequencies, the first and second electroacoustical transducing structures relatively displaced and coacting to be capable of radiating a composite stereo sound signal when the first electrical transducing structure receives a first electrical signal representative of a first stereo signal with spectral components in the upper frequency range and the second electroacoustical transducer receives a second electrical signal representative of a second stereo signal with spectral components in the upper frequency range.
2. Apparatus in accordance with claim 1, wherein the first electroacoustical transducing system (11,12,13,33) further comprises a first input terminal (23) for receiving a first stereo signal coupled to the first electroacoustical transducing structure (33), and
 - the second electroacoustical transducing system (14,15,31) further comprises a second input terminal (17) coupled to the second electroacoustical transducing structure (31).
3. Apparatus in accordance with claim 2, wherein the first electroacoustical transducing system (11,12,13,33) further comprises a first equalizer (22), and the second electroacoustical transducing system (14,15,31) further comprises a second equalizer (16), the first and second equalizers constructed and arranged to coact with the first and second electroacoustical transducing structures (33,31) to establish a predetermined

radiated power response from the first and second electroacoustical transducing structures over substantially the full operating audio frequency range of the apparatus.

4. Apparatus in accordance with claim 2 or claim 3, wherein the first electroacoustical transducing system (11,12,13,33) further comprises a first power amplifier (13) having an input and an output coupled to the first electroacoustical transducing structure, a summer (21) having an output coupled to the input of the first power amplifier, a first input coupled to the first input terminal (23) and a second input, and further comprising a low-pass filter (24) coupling the second input terminal (17) to the second input of the summer. 5
5. Apparatus in accordance with claim 1, wherein the first electroacoustical transducing structure (11,12,13,33) comprises a woofer (12) and an upper frequency driver structure (11) and the second electroacoustical transducing structure (14,15,31) comprises only an upper frequency driver structure (15). 10 20 25
6. Apparatus in accordance with claim 1, wherein the first electroacoustical transducing structure (11,12,13,33) comprises a fullrange driver and the second electroacoustical structure (14,15,31) comprises only an upper frequency driver structure (15). 30
7. Apparatus in accordance with claim 5, wherein the first electroacoustical structure (33) comprises an acoustic waveguide. 35
8. Apparatus in accordance with claim 1, wherein the first electroacoustical transducing structure (33) comprises a first cabinet (33) and the second electroacoustical transducing structure (31) comprises a second cabinet (31) separate from the first cabinet. 40
9. Apparatus in accordance with claim 1 and further comprising a cabinet (51) carrying the first and second electroacoustical transducing structures (33,31). 45
10. Apparatus in accordance with claim 2 or claim 3 and further comprising: 50
 - a summer (21) having an output coupled to the first electroacoustical transducing system (11,12,13,33);
 - a first input coupled to the first input terminal (23) and a second input; and
 - a lowpass filter coupling (24) the second input terminal (17) to the second input of the summer. 55

11. Apparatus in accordance with claim 2 and further comprising:

a bass summer (21) coupled to the first input terminal (23) and the second input terminal (17) constructed and arranged to cause the first electroacoustical transducing structure (33) to transduce the sum of bass spectral components in signals on the first and second input terminals.

12. Apparatus in accordance with claim 9, wherein the cabinet (51) is a receiver cabinet.

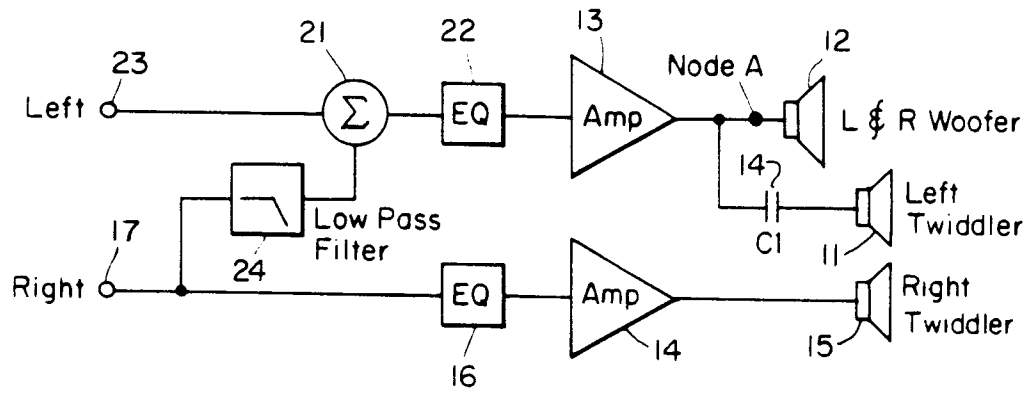


FIG. 1

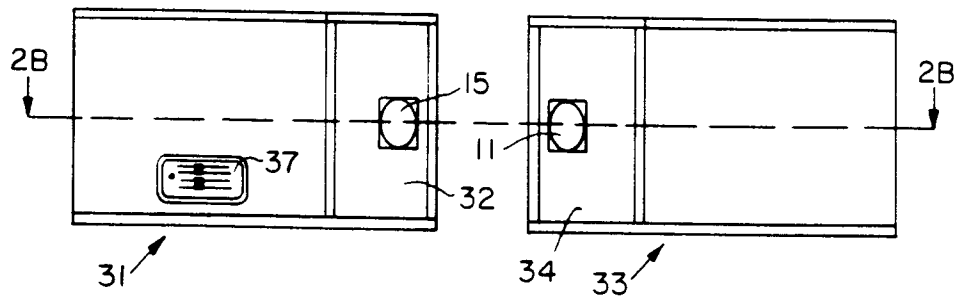


FIG. 2A

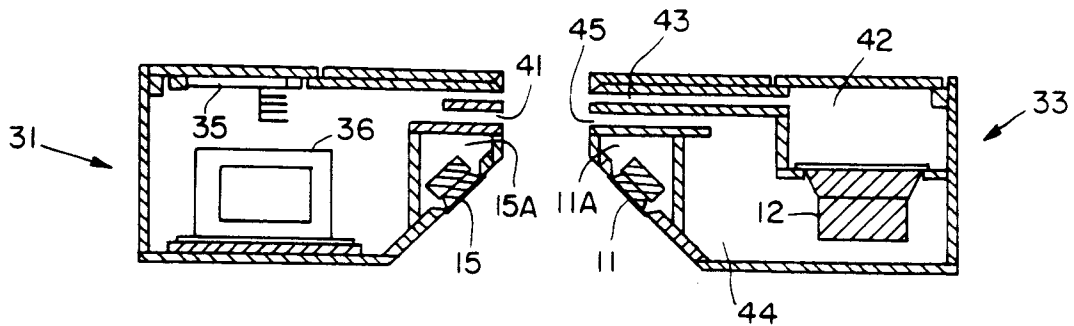


FIG. 2B

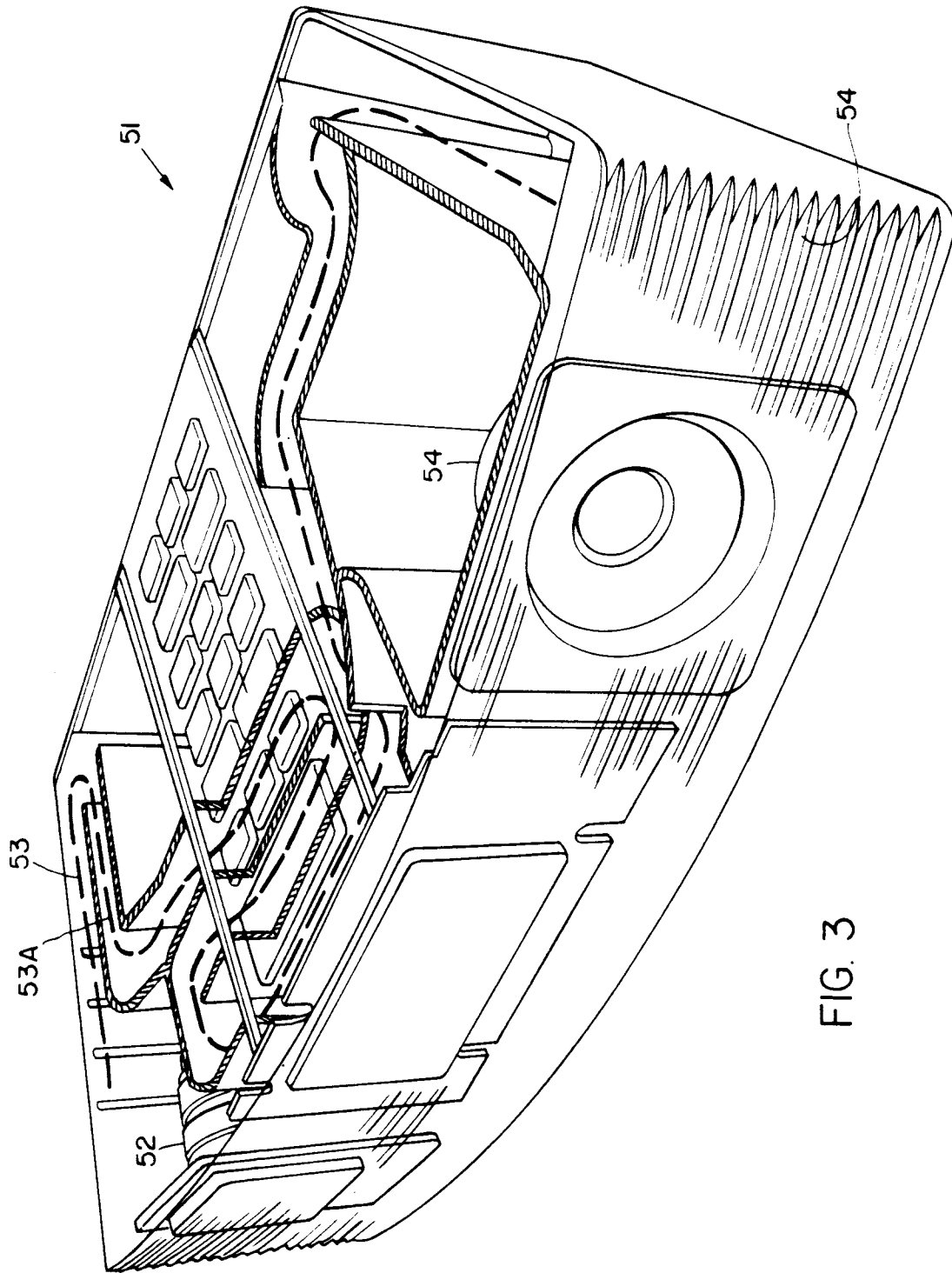


FIG. 3



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 3191

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
Y	EP-A-0 370 619 (BOSE) * column 1, line 27 - column 2, line 20 * * column 4, line 12 - column 6, line 52 * ---	1-6, 10-12	H04R5/02 H04S1/00
Y	US-A-4 243 840 (KATES) * column 4, line 5 - column 5, line 35 * ---	1-6, 10-12	
A	US-E-RE31228 (BOSE) * column 1, line 26 - column 2, line 45 * * column 2, line 55 - column 3, line 23 * * column 3, line 52 - column 5, line 33 * ---	1,5-8,12	
A	US-A-3 582 553 (BOSE) * column 3, line 54 - column 4, line 21 * * column 4, line 72 - column 6, line 7 * abstract. ---	1,2,5-8, 12	
A	US-A-4 424 416 (FUKUOKA) * column 1, line 6-10 * * column 3, line 67 - column 5, line 46 * -----	1,2,4,9, 10,12	TECHNICAL FIELDS SEARCHED (Int.Cl.5) H04R H04S
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 2 August 1994	Examiner Zanti, P
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons ----- & : member of the same patent family, corresponding document			

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