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(54) Mechanical filter for acoustic systems and television set equipped with sunch filters

(57) The invention relates to a mechanical filter for acoustic systems comprising at least one loudspeaker (6) and an acoustic horn (5) associated with the loudspeaker, the one open end (7) of the horn being secured to the edge (8) of the diaphragm (9) of the loudspeaker and the other open end (4) of the horn constituting the acoustic output. The horn exhibits rigid walls of which a part (10, 11) is rendered flexible, the flexible part of the horn being able to vibrate under the acoustic pressure inside the horn so as to filter or absorb the resonant peak(s) in the acoustic response of the rigid horn.

The invention is particularly beneficial in improving the acoustic system for television sets.

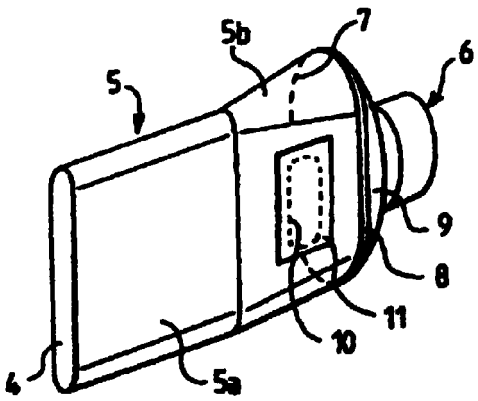

FIG.3

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Description

[0001] The present invention relates to a mechanical filter for acoustic systems. Among the possible applications of such a filter, the case of television sets may be cited.

[0002] Nowadays, consumers are evermore demanding regarding the criteria for choosing television sets: on the one hand, the technical quality of the pictures and sound, and on the hand, the aesthetic visual appearance of the television set. To ensure good sound quality, especially in the middle frequency range (between 300 Hz and 5 kHz) and low frequency range (between 20 Hz and 300 Hz), one requires loudspeakers whose diaphragm is of large size, implying a fair degree of bulkiness. To ensure functional aesthetic appearance, one reduces the dimensions of the part surrounding the screen of the television set on the front face. Such a demand requires the sound columns at each side of the screen to be discreet and narrow, especially for 16/9 format television sets.

[0003] As a result, one is compelled to site the loudspeakers somewhat behind the front face so as to profit from the spaces available between the electron tube and the side walls of the cabinet of the television set. Since the sound in the middle and high frequencies propagates by following a directional mode, it is preferable for the sound issuing from the loudspeakers to emerge into the sound columns on the front face of the television set. To satisfy these constraints, sound guides are used, these being ducts linking the loudspeakers and the sound columns. The ducts have a "horn" shape with one open end which is more flared than the other open end, and which will be called the "acoustic horn" hereinafter.

[0004] The acoustic horn is in general made by moulding a rigid plastic. The flared end of the horn is secured to the edge of the diaphragm of a loudspeaker, by mechanical fastening, and the other end of the horn is of oblong cross section parallel to a sound column at the front face of the television set and emerging into this column.

[0005] Such acoustic horns are certainly satisfactory from the mechanical and aesthetic standpoint, but exhibit distortions in the sound rendition which are perceptible to the listener.

[0006] The object of the present invention is to reduce such distortions by virtue of a simple and effective solution.

[0007] The object of the invention is also a mechanical filter for acoustic systems which eliminates the resonant peak(s) without introducing perturbation into the acoustic response of the system in the remainder of the acoustic frequency spectrum.

[0008] The mechanical filter for acoustic systems, according to the invention, satisfies the following conditions. The acoustic system comprises at least one loudspeaker and an acoustic horn associated with the loudspeaker, the one open end of the horn being secured to the edge of the diaphragm of the loudspeaker and the other open part of the horn constituting the acoustic output. The horn exhibits rigid walls of which a part is rendered flexible. The flexible part of the horn can vibrate under the acoustic pressure inside the horn so as to filter or absorb the resonant peak(s) in the acoustic response of the rigid horn.

[0009] The invention will be better understood and advantages of the invention will become apparent on studying the detailed description of an embodiment taken by way of purely non-limiting example and illustrated in the appended drawings, in which:

- Figure 1 is a diagrammatic representation of a television set as environment for application of the invention,
- Figure 2 is a rigid acoustic horn,
- Figure 3 is a rigid acoustic horn, a part of whose walls is rendered flexible according to the invention, and
- Figure 4 is a comparison of the acoustic response curves of the horns illustrated in Figures 2 and 3 respectively.

[0010] Figure 1 shows a television set with a cabinet or box 1, enclosing an electron tube (not represented) whose display screen (not represented) emerges into the opening 2 of the front face or façade of the television set. On either side of the opening 2 are two sound or acoustic columns 3 into each of which emerges the oblong open end 4 of an acoustic horn 5. The other flared open end of the horn 5 is fastened to a loudspeaker 6. The role of the horn 5 is to guide the sound produced by the loudspeaker 6 towards the corresponding sound column 3.

[0011] The acoustic horn 5, as shown in greater detail in Figure 2, exhibits a part with constant oblong cross section 5a and a flared part 5b. The flared open end 7 of the flared part 5b is mounted on the edge or rim 8 of the diaphragm 9 of the loudspeaker 6, with the aid of screws or mechanical clips. The horn 5 is made by moulding of plastics, for example, polystyrene, with a thickness of walls of the order of 2.5 mm to 3 mm. The horn structure thus obtained is rigid.

[0012] The inventor has noted distortions in the acoustic response curve of a rigid horn 5 of this type. Indeed, for a horn length of around 180 mm, the acoustic response curve exhibits a resonant peak at roundabout 440 Hz (see Figure 4, curve A). This signifies that at the open end 4 of the acoustic horn 5, the sound around the frequency 440 Hz is excessively amplified to the detriment of the surrounding frequencies (150 Hz-300 Hz and 600 Hz-1 kHz). This creates acoustic distortion perceptible to the listener who may also be a television viewer. This inevitable defect is due to the acoustic resonance of the "organ pipe" formed by the horn 5 according to which the resonant peak corresponds to a wavelength which equals four times the length of the pipe (or the length of the pipe is equal to a quarter of the wave-

length).

[0013] After numerous tests and numerous possible envisaged solutions, the inventor has arrived at a very simple and effective solution, which will be explained with the aid of Figures 3 and 4.

[0014] The invention uses a mechanical vibrational phenomenon, obtained by exciting a slender plate via the acoustic pressure present in the horn 5 and generated by the loudspeaker 6, in such a way as to profit from its first few mechanical natural modes so as to absorb the unwanted peak of the acoustic response of the horn and improve its acoustic performance. The invention can be applied to any acoustic system (sealed or bass-reflex enclosures, labyrinths, other acoustic guides, etc.), since it uses the overpressure created inside a volume (closed or otherwise) by a loudspeaker.

[0015] An embodiment of the invention (Fig. 3), which gives a satisfactory solution, consists in making an opening 10 in the rigid walls of the flared part 5b of the horn 5 and in covering the opening 10 with a slender or flexible plate 11, in such a way that the first natural mode of mechanical vibration of this plate 11 (regarded as built in at the boundaries of the opening 10) is adjusted to the resonant frequency to be attenuated. Thus, the desired filtering is carried out but without modifying the acoustic response of the system within the remainder of the acoustic frequency spectrum. By playing around with the material of the plate 11 (stiffness, damping coefficient, thickness, etc.), with the dimensions, the shape and the position of the opening 10 with respect of the loudspeaker 6, it is possible to optimize this vibro-acoustic phenomenon but without generating noise from parasitic mechanical vibrations.

[0016] To determine the dimensions of the opening 10 and the characteristics of the plate 11, the following formulae may be used:

$$F_o = \frac{35{,}99}{2\pi} \times \sqrt{\frac{D\left(\frac{3}{a^4} + \frac{2}{a^2 b^2} + \frac{3}{b^4}\right)}{8\rho h}} \qquad (1)$$

$$D = \frac{Eh^3}{12(1-\mu^2)} \qquad (2)$$

where

F_0 is the frequency of the first natural mode of vibration of the plate,
D is the stiffness factor of the plate,
E is Young's modulus for the material,
ρ is the density of the material,
μ is Poisson's ratio,
h is the thickness of the plate,
a and b are the sides of the rectangle formed by the plate.

[0017] From formulae (1) and (2) above, it is possible to calculate the frequency of the first natural mode of vibration F_0 of a polystyrene plate 0.5 mm thick and of dimensions 57 mm × 33 mm. The result gives a value F_0 of around 457 Hz. Curve B of Figure 4 shows the result on the acoustic response of the horn 5 with an opening 10 covered by a flexible plate 11 with the above characteristics. It is observed that the resonant peak is greatly diminished, this being manifested through better quality sound rendition, having as it does less distortion, relative to curve A.

[0018] A simple embodiment consists in making the opening 10 on the horn 5 directly when moulding this component and using polystyrene plates provided with adhesives. The vibrating function of the plate 11 is ensured by the polystyrene plate and the adhesive serves to fasten the plate to the horn 5 and to add damping to the plate, in such a way as to reduce any undesirable effects of the harmonics and other modes of vibration of the plate 11.

[0019] According to the dimensions of the opening 10 and the thickness of the plate 11 and in the case of acoustic systems manufactured by injection moulding (like the horn 5); the plate 11 or vibrating diaphragm can be included directly in the component when moulding.

[0020] The dimensions of the system to be dealt with and the significance of defects to be eliminated may necessitate the multiplicity of this type of system, that is to say several openings 10 covered by several flexible plates 11. These flexible plates may have the same dimensions so as to reinforce the filtering within a narrow band of frequencies, or different dimensions so as to broaden the frequency band to be filtered.

[0021] In a general manner, when the flexible plate 11 is made from the same material as the rigid horn 5, the thickness of the plate is preferably chosen between 10% and 30% of the thickness of the rigid walls surrounding the corresponding opening 10.

Claims

1. Mechanical filter for acoustic systems comprising at least one loudspeaker (6) and an acoustic horn (5) associated with the loudspeaker, the one open end (7) of the horn being secured to the edge (8) of the diaphragm (9) of the loudspeaker and the other open end (4) of the horn constituting the acoustic output, characterized in that the horn (5) exhibits rigid walls of which a part (10, 11) is rendered flexible, the flexible part of the horn being able to vibrate under the acoustic pressure inside the horn so as to filter or absorb the resonant peak(s) in the acoustic response of the rigid horn.

2. Mechanical filter for acoustic systems according to Claim 1, characterized in that the flexible part of the horn is formed by at least one opening (10) in the rigid walls of the horn (5), the opening being covered by a flexible plate (11).

3. Mechanical filter for acoustic systems according to Claim 2, characterized in that the flexible plate (11) is glued to the rigid walls of the horn.

4. Mechanical filter for acoustic systems according to Claim 2, characterized in that the flexible plate (11) is obtained directly by moulding the horn.

5. Mechanical filter for acoustic systems according to one of Claims 2 to 4, characterized in that the flexible plate (11) exhibits a thickness of between 10% and 30% of the thickness of the rigid walls surrounding the opening (10).

6. Television set comprising a cabinet (1) enframing a display screen, at least one acoustic column (3) adjacent to the screen, and at least one mechanical filter according to one of the preceding claims, the acoustic output (4) of the horn (5) emerging into the acoustic column.

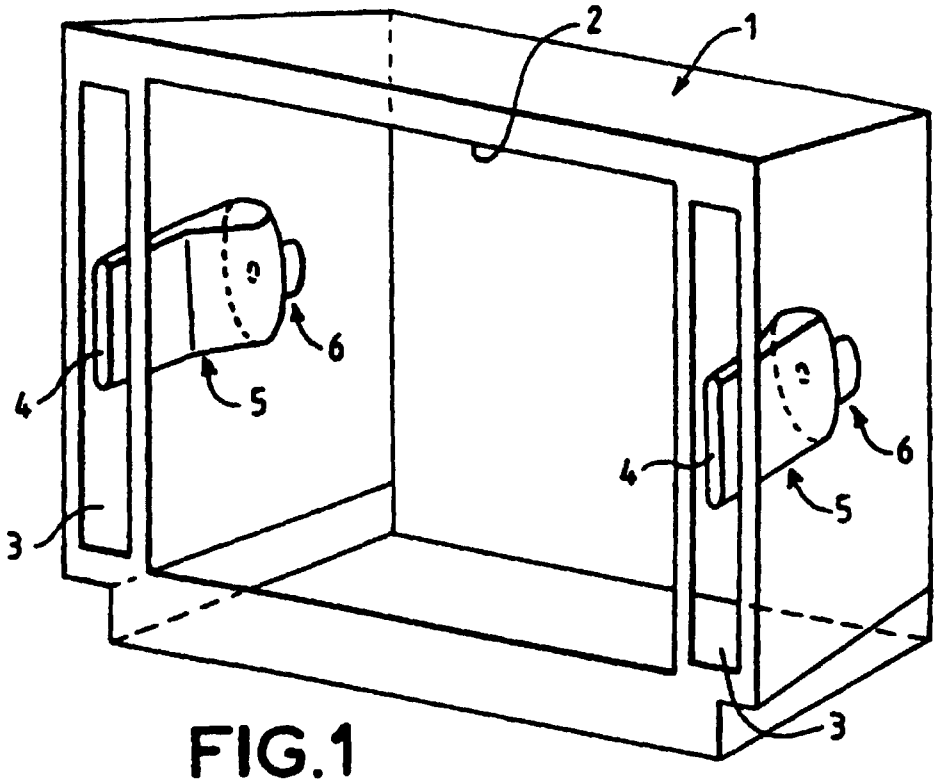

FIG.1

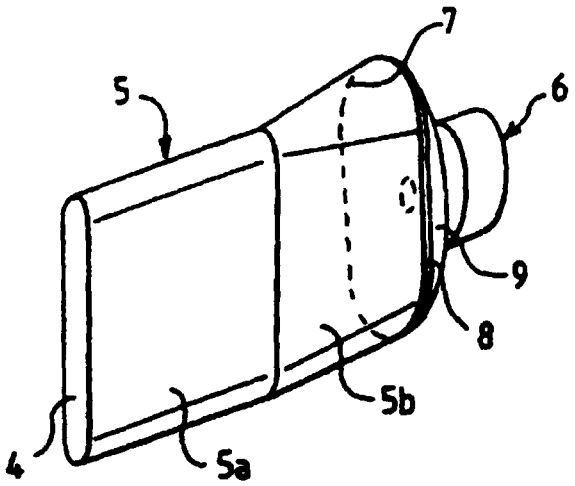

FIG.2

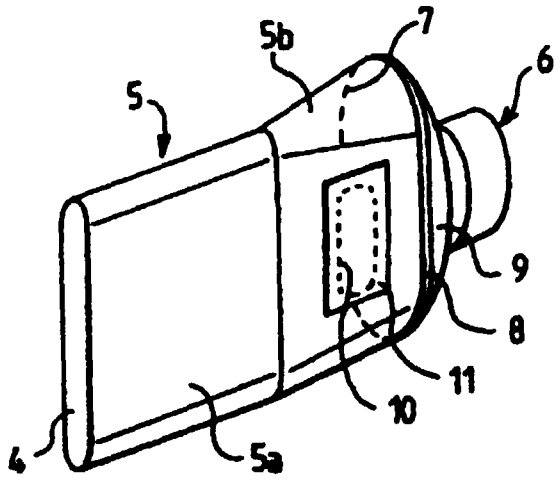

FIG.3

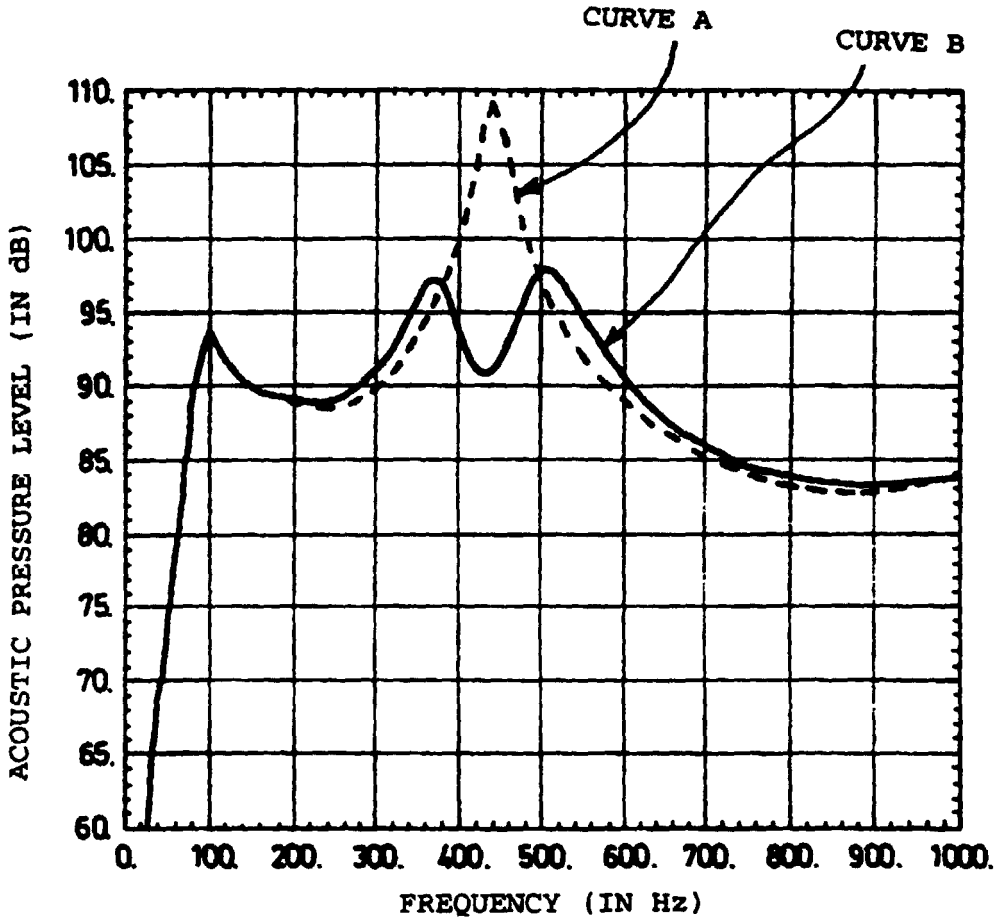
CURVE A
CURVE B
110.
105.
100.
95.
90.
85.
80.
75.
70.
65.
60.
ACOUSTIC PRESSURE LEVEL (IN dB)
0.
100.
200.
300.
400.
500.
600.
700.
800.
900.
1000.
FREQUENCY (IN Hz)

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 00 20 1058

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.7)
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

G10K
H04R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 April 2000	Swartjes, H

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