(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 100 287 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
16.05.2001 Bulletin 2001/20

(51) Int Cl.[7]: **H04R 7/06**

(21) Application number: **99402807.4**

(22) Date of filing: **10.11.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

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(54) Loudspeaker

(57) A rectangular, polymorphous or elliptical loudspeaker which is flat and has one or more flat diaphragms 14, 15 made of paper, double skinned fluted polypropylene copolymer, corrugated cardboard, layers of EVA (Ethlene-Vinylacetate), EPS (Polyform), PVC (Polyvinyl Chloride). The panel has a longitudinal bending strength greater than the transverse bending strength. The diaphragm is vibrated by a driver unit 16 which comprises a magnet 17 and voice coil 18. Magnet 17 can be mounted on the rear panel 15 and the voice coil 18 is mounted on the front diaphragm 14. An alternative is to mount magnet 17 on the rear diaphragm instead of panel. The diaphragm 14 is mounted at its edges to a frame 11 with the driver unit 16 mounted in the space enclosed by the frame and the panel 15.

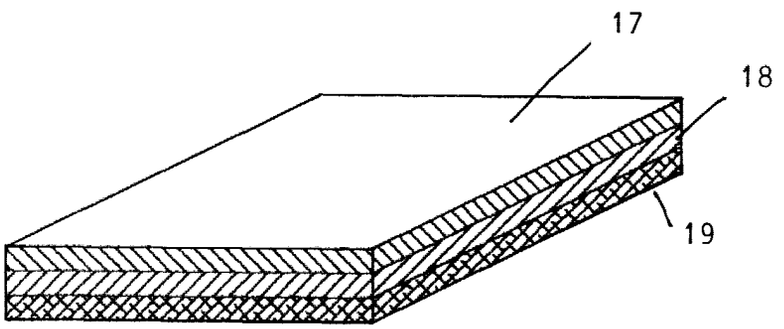

Fig.3

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Description

FIELD OF THE INVENTION

[0001] This invention relates to loudspeakers, and is applicable particularly on multi media and all speakers related applications, including hi fi system, television and car stereo.

BACKGROUND

[0002] The free-standing electrostatic flat loudspeakers have been around for many years. These speakers are large and expensive. They have had a less than desirable sound frequency response and sound distribution pattern. Our aim is to develop a cheaper and better performance flat speakers.

STATEMENT OF THE INVENTION

[0003] The aspect of the invention is provided a loudspeaker includes a planer diaphragm which can be vibrated so as to radiate sound from at least from one face. A driver unit operable by a varying electric current to generate a varying force on this diaphragm. The force varying in a manner related to the varying electric current, characterized by the driver unit being connected to the diaphragm at one or more selected positions or mounted to structure which is in turn connected to the diaphragm at one or more selected positions.

[0004] The diaphragm should have a bending strength in a single plans along a first axis which is greater than along a second axis which is perpendicular to the first axis. The material of the diaphragm has a bending strength in one direction of the plane of the material which is significantly greater than the bending strength along a line in the plane of the material at right angles to the first direction.

[0005] Preferably it has a longitudinal bending strength which is more than twice of its transverse bending strength, which is particularly suitable to panels which are rectangular or elliptical.

[0006] Preferably the loudspeaker includes a frame having at least one face, said the diaphragm extending right across the face and perhaps a rear diaphragm extending right across the rear face whereby the interior space of the loudspeaker is substantially enclosed.

[0007] The driver unit is located remote from the frame. Advantageously the driver unit is located outside from the frame. The driver unit is connected to the diaphragm whereby the driver unit will apply varying force, corresponding to the varying electric current and cause the diaphragm to flex and emit an acoustic signal from the face of the diaphragm exterior of the loudspeaker.

[0008] The diaphragm should be flexible and the diver operates the diaphragm in polar mode. Conveniently the driver unit is mounted to the diaphragm at said one or more selected positions which is remote from the peripheral edge of the diaphragm.

[0009] Preferably said positions are selected so that flexure of the diaphragm in one or more of its natural modes of vibration is not impeded. The diaphragm may be of double skinned polypropylene copolymer, and may be approximately 3mm thick. The surface of each diaphragm is treated with a corona discharge to assist adhesion of paint etc, or of the diaphragm to the frame.

[0010] Conveniently each diaphragm is approximately 600 grams or less per square meter, and may have a tensile strength of around 25 MPa or more and may have a Shore hardness of 60 or more.

[0011] Conveniently each diaphragm is slightly fluted or corrugated or slightly curved, so as to provide a modified acoustic performance of the loudspeaker.

[0012] The interior of the loudspeaker may be a sealed box, with or without one or more ports or vents provided through the frame or through the diaphragm.

[0013] Preferably the diaphragm is made of a sheet of extruded plastics material having integral front and skins joined by closely spaced parallel walls normal to said skins. The diaphragm can also made from different layers of material adhesive together to form a combination of frequency response. The preferable material for this combination is PVC, EVA and EPS.

[0014] Preferably the diaphragm is of double skinned polypropylene co-polymer and the walls are substantially normal to said parallel sheets. Alternatively, the diaphragm is of paper or cardboard, said walls being of substantially corrugated form and being fastened by adhesive to the inner opposing faces of the parallel sheets. Other aspect of development indicate that the sandwich like structure of EVA, EPS and PVC also provide a good material for flat panel.

[0015] Conveniently the driver unit includes a magnet, one pole of which is in magnetic continuity with a yoke and the other pole of which is positioned from the yoke by an air gap through which gap a voice coil is operable, the voice coil being attached to drive the diaphragm.

[0016] Conveniently a sheet of damping material is connected from a stationary part of the loudspeaker to said part of the diaphragm adjacent the panel or to the panel. The damping material may be cloth.

[0017] Preferably the damping material is porous or perforated so as to allow the passage of air there through.

BRIEF DESCRIPTION OF THE DRAWING

[0018] One embodiment of the invention is described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a front view of a loudspeaker, including different shape and size, according to the invention, and

Figure 2 is a cross-section in a vertical plane along the line II-II in Figure 1, and

Figure 3 is a partial perspective view of a component of the loudspeaker,
Figure 4 is a partial perspective view of a component of the loudspeaker of another design,
Figure 5 is a cross-section of a further embodiment,
Figure 6 is a first rear view of the embodiment shown in Figure 5, and
Figure 7 is a second modified rear view of the component shown in Figure 4,
Figure 8 is a transverse section through another embodiment.
Figure 9 is a side view of a voice coil shown in section in Figure 8.

DESCRIPTION

EXAMPLE 1

[0019] In figure 1, we can see several design for the flat panel. Basically, the panel can be any shape. It can be rectangular, polymorphous or elliptical. A flat loudspeaker 10 includes a square peripheral frame 11 conveniently made of ABS plastic board. Each external edge of the frame 11 is conveniently 150mm long. The flame is suspended by wire of cords 12 attached to loops or other fasteners 13 at the top of the frame 11.

[0020] In Figure 2, the front of the loudspeaker 10 is covered by a front diaphragm 14 which is attached and sealed around the edges thereof by a suitable adhesive to the front face of the frame 11. The rear of the loudspeaker 10 is covered by a rear panel 15 which are directly connected to the frame 11. Thus the interior of the loudspeaker 10 constitute a sealed box. The thickness between the front diaphragm and rear panel are 120 millimeters for a 150 millimeters square loudspeaker.

[0021] A driver unit 16 is positioned adjacent the center of the diaphragms 14. The driver unit is the same as to those used in conventional cone-type loudspeakers and includes a magnet 17, which can be a permanent magnet or an electromagnet, and a voice coil 18. The voice coil 18 carries the usual winding connected by leads 19 to terminals 20 on the rear of the loudspeaker 10. The magnet 17 is fastened, for example, by an adhesive to the interior surface of the rear panel 15 and the voice coil 18 is fastened to the interior surface of the front diaphragm 14. The dimensions of the driver unit 16 and the spacing of the front diaphragm 14 and rear panel 15, are arranged so that the voice coil 18 is in the correct operative position relative to the magnet 17, and properly centered therein.

[0022] The surface of the diaphragm 14 may be slightly fluted and instead of either diaphragm being flat, it could be corrugated, sandwich like so as to provide a modified acoustic performance of the loudspeaker 10.

EXAMPLE 2

[0023] Figure 3 shows a preferred construction for the front diaphragm 14. It has a sandwich like structure and made from two more layers. The combination of the layer material should have different density and all less than 200 GSM. The total density of the panel should less than 600 GSM. The panel should be around 2 to 5 mm thick. Preferably the EVA layer (17) , the EPS layer (18) and PVC layer (19) stick together with adhesive are the best choice. The EVA has the better response to low frequency vibration. The EPC has better performance in middle frequency vibration. The PVC give better result in high. The combination of sandwich like structure give very well result for flat panel.

[0024] The structure can be modified to have only two layers with this three material. The base layer is the PVC layer and will connect to the voice coil in some way. The face layer will be the combination of EVA and EPS pieces to achieve different sound response.

[0025] Figure 4 shows a preferred construction for the front diaphragm 14, It comprises an integral extrusion of polyethylene around 3-5mm thick and having front and rear skins
25, 26 joined by continuous longitudinal walls 27 with air spaces there between. By this construction, the material of the diaphragm 14 is acoustic and has a longitudinal bending strength which may typically be around twice the transverse bending strength. Thus, this material is particularly useful in the construction of rectangular loudspeakers, for example those having sides of 200mm x100mm long. Larger or smaller panels can be made using this type of material.

EXAMPLE 3

[0026] Figure 5 shows a loudspeaker having a rigid rear panel 28 of AVB plastic around 3mm thick, with the magnet 17 fastened in the center thereof. The frame 11 holds the front diaphragm 14 at a distance of around 3-5mm from the front face of the panel 28. The voice coil 18 is held in the gap in the magnet 17 by being fastened in a central hole in the diaphragm 14. A hole is made at the center of the diaphragm and fastened to the voice coil 18 by adhesive.

[0027] To allow desired motion of the diaphragm 14, the panel 28(shown in figure 6) has an array of gaps 30. The sizes and locations of the gaps 30 are carefully chosen to achieve a smooth frequency response from the loudspeaker 10.

[0028] Alternative, or additional modification of the frequency response curve is achieved by using sandwich like diaphragm as in figure 7. Two different material are adhered to PVC base layer to achieve different frequency response. EPS 31 are placed close to the voice coil to achieve better high and the EVA 32 are responsible for the low.

EXAMPLE 4

[0029] In Figures 8 and 9, a loudspeaker 110, includes

a diaphragm 111, to be described later. The outer edge of the diaphragm 111 is connected to plastics dish 112 by adhesive. For this purpose, the dish is provided with a flat 113 on which the diaphragm 111 rests. The cylindrical yoke 117 is located the center portion of the dish 112.

[0030] Since the yoke 117 forms part of a magnetic circuit, it is preferably made of low oxygen pure iron which has been annealed slowly in hydrogen. A permanent magnet 118 is held coaxial with the yoke 117 by adhesive. A circular diaphragm 118 is attached to the frame of the yoke. The other end is attached to the diaphragm 111 by adhesive. There is a hole at the center of the diaphragm, the voice coil is secured in this hole by adhesive and a diaphragm 118 are placed on top of the voice coil.

[0031] It has been found that a suitable material for the diaphragms 111 is a double skinned sheet made from a polypropylene co-polymer approximately 3 millimeters thick and approximately 600 grams per square matte or less. Preferably the diaphragm 111 has a tensile strength of around 23 MPa or more and shore hardness of 60 or more. The material preferably has a corona discharge treated surface to assist adhesion ot paint, wallpaper etc to the diaphragms 111. The diaphragm 111 is preferably a laminate having a core of foam, or has ribs, tubes, corrugated sheet or the like. If it has a foam core it preferable that the foam is not uniform (or the cover sheets are shaped or reinforced). Another alternative is to use a sandwich like structure with a combination of PVC, EVA and EPS layers.

[0032] The diaphragm 111 may comprise an integral extrusion of polyethylene around 3 to 5mm thick and having front and rear skins 130, 131 joined by continuous longitudinal walls 132 with air spaces in between . By this construction, the material of the diaphragm 111 has a longitudinal bending strength which may typically be around twice the transverse bending strength. Thus , this material is particularly useful in the construction of rectangular loudspeakers, for example those having sides of 200mmx100mm long.

[0033] Figure 9 shows the possible structure of the voice coil that can be used. The voice coil can be single (linear) or double layer (non-linear) as shown in the figure.

ADVANTAGES OF THE PREFERRED EMBODIMENTS

Ease of manufacture.

[0034] The manufacturing of flat panel is very similar to the traditional drivers. This will provide a very easy way to assemble the panel.

[0035] Lightweight diaphragm material particularly suite to rectangular or elliptical panels. Scalability

[0036] Loudspeakers or diaphragms can be made in many different sizes or shapes..

VARIATIONS!

[0037] One or more drivers may be used depending upon the size of the diaphragm. The loudspeakers may be tuned by porting or by adding weights.

[0038] The diaphragms can be made of any shape.

[0039] They need not be flat although this is preferred.

[0040] Different materials can be used. Preferably the material is light weight and stiff but flexible.

[0041] Larger panels may require more drivers and a thicker core flute diaphragm. Finally various other alterations or modifications may be made to the foregoing without departing from the scope of this invention as set forth in the following claims.

Claims

1. A loudspeaker including at least one diaphragm which can be vibrated to radiate sound from at least one face, and one or more driver unit operable by a varying electric current in order to generate a varying force on the one or more diaphragm. The force varying in a manner retards to the varying electric current. The diaphragm has a bending strength in a single plan along a first axis which is greater than along a second axis which is perpendicular to the first axis. The driver unit is connected to the diaphragm at one or more selected positions or mounted to a structure which is in turn connected to the diaphragm at one or more selected positions.

2. A loudspeaker as claimed in claim 1 characterized by connecting to the peripheral frame, which is connected to a plastic panel at rear. The diaphragm extending right across the face the interior space of the loudspeaker is substantially enclosed.

3. A loudspeaker as claimed in claim 2, characterized by the driver unit being connected to both of said diaphragms whereby the driver unit will apply varying force, corresponding to the varying electric current, to said diaphragms and cause the diaphragm to flex and emit an acoustic signal from the face of the diaphragm exterior and interior of the loudspeaker.

4. A loudspeaker as claimed in claim 1, characterized in that said the diaphragm is made of double skinned polypropylene copolymer.

5. A loudspeaker as claimed in claim 1, characterized is that the first diaphragm is made of a sheet of extruded plastics material having integral front and rear skins joined by closely spaced parallel walls normal to said skins.

6. A loudspeaker as claimed in claim 1, characterized

in that said the diaphragm is made of paper or corrugated cardboard.

7. A loudspeaker as claimed in claim 1, characterized in that said the diaphragm is made of combination of layers with different density of material.

8. A loudspeaker as claimed in claim 1, characterized in that said the diaphragm is make of material which includes PVC, EVA and EPS.

9. A loudspeaker as claimed in any preceding claim characterized in that each diaphragm is approximately 600grams or less per squats meters

10. A loudspeaker as claimed in any preceding claim characterized in that each diaphragm has a tensile strength of around 25 MPa or more.

11. A loudspeaker as claimed in any preceding claim characterized in that each diaphragm has a shore hardness of 60 or more.

12. A loudspeaker as claimed in any preceding claim characterized in that the surface of the or each diaphragm is treated wish a corona discharge to assist adhesion of paint or paper thereto, or of the diaphragm to the frame.

13. A loudspeaker as claimed in any preceding claim characterized in that the driver unit includes one coaxial voice coil, which fastened to a diaphragm.

14. A loudspeaker as claimed in claim 1 in which the driver unit includes a magnet, one pole of which is in magnetic continuity with a yoke and the other pole of which is positioned from the yoke by an air gap through which gap a voice coil is operable, the voice coil being attached to drive the diaphragm, characterized in that the yoke is made from low oxygen pure iron annealed very slowly in hydrogen.

15. A loudspeaker as claimed in claim 14 characterized in that a member made of the same material as the yoke is in magnetic continuity with said other pole of the magnet, the air gap being formed between a peripheral portion of said member and an opposing part of the yoke .

16. A loudspeaker as claimed in claim 1 characterized in that the voice coil has more windings per unit length thereof away from that axial part of the voice coil which is in said air gap when no electric current is passed through the windings.

17. A loudspeaker as claimed in claim 16 characterized in that the voice coil winding is a single layer or double layer, with the windings spaced apart in the region of said axial pair.

18. A loudspeaker as claimed in claim 16 characterized in that more than said single layer is wound at regions of the voice coil furthermore said axial part.

19. A loudspeaker as claimed in claim 1 characterized in that a sheet of damping material is connected from a stationary part of the loudspeaker to said part of the diaphragm adjacent the panel or to the panel and in which the damping material is cloth so as to allow the passage of air through.

20. A loudspeaker substantially as herein described with reference to any one of the accompanying drawings.

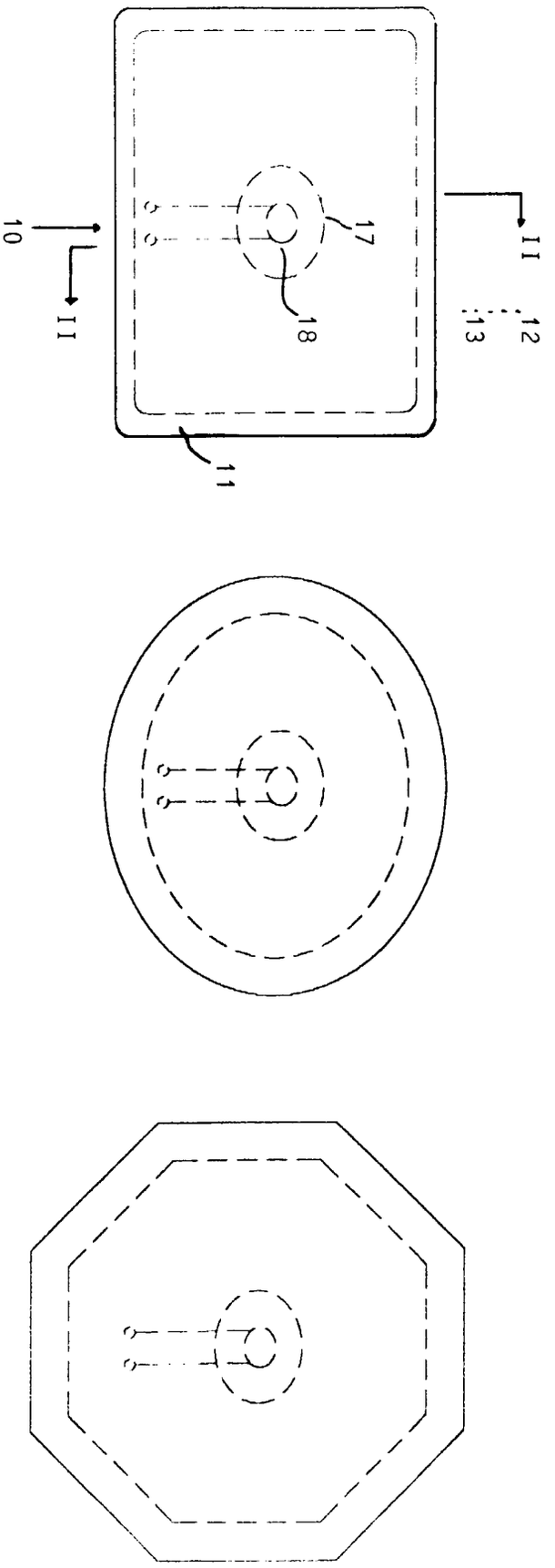


Fig.1

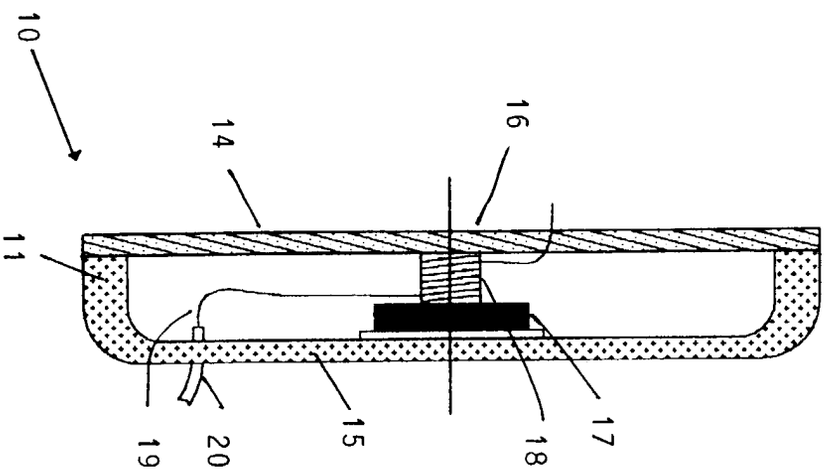


FIG.2

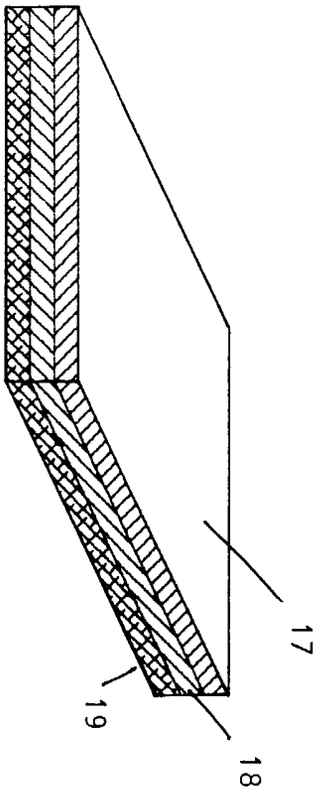


Fig.3

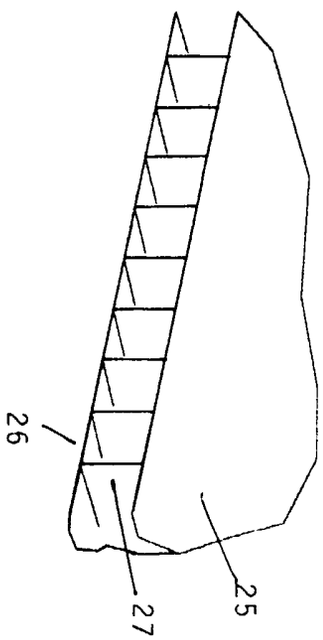


Fig.4

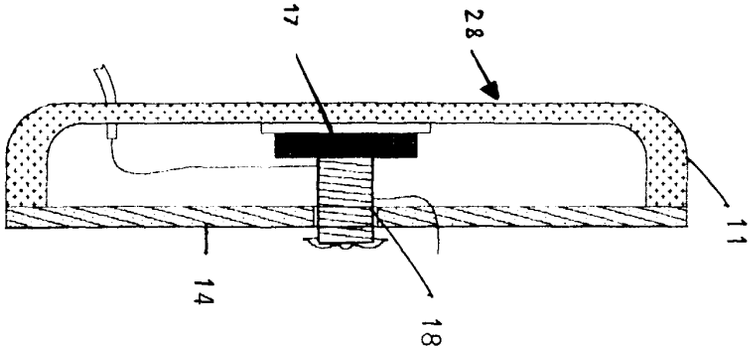


Fig.5

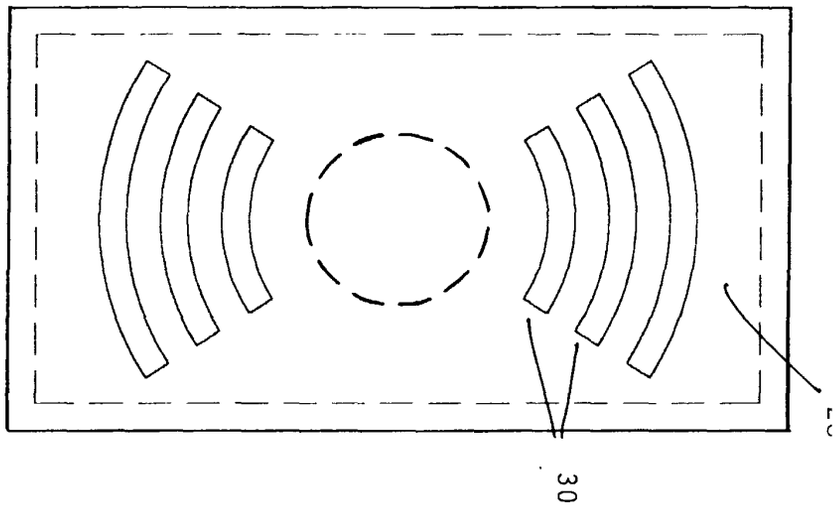


Fig.6

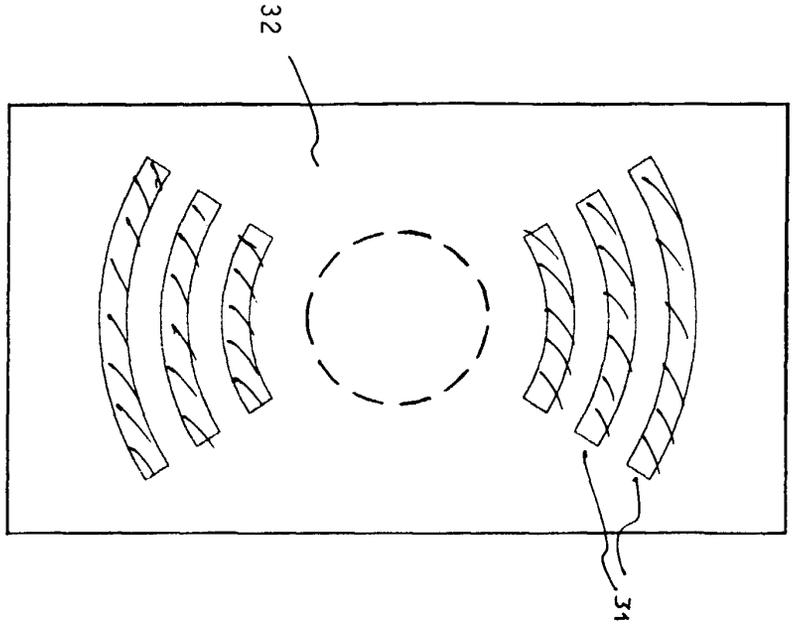


Fig.7

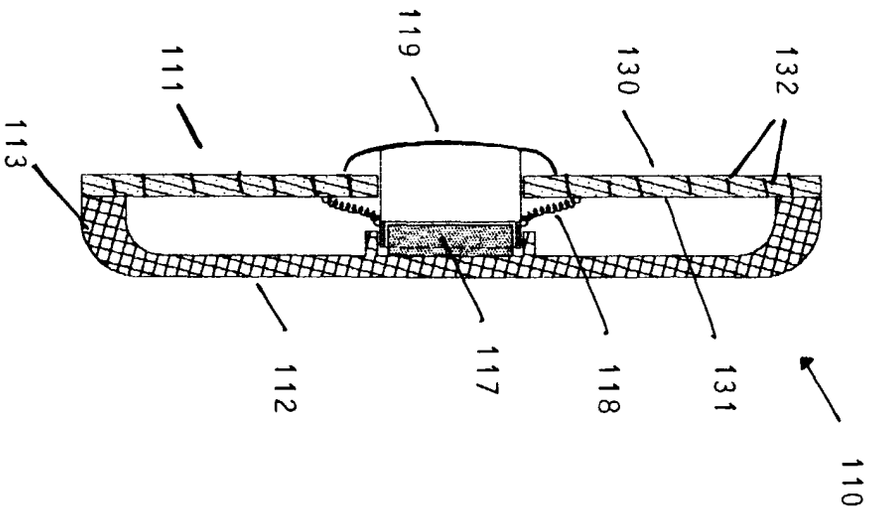


Fig.8

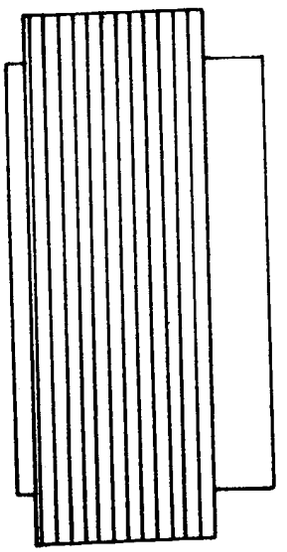
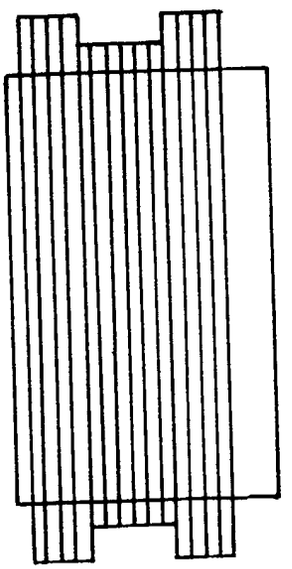


Fig.9



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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 April 2000	Zanti, P

CATEGORY OF CITED DOCUMENTS

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