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54 **Loudspeaker cabinets.**

57 A loudspeaker cabinet has walls (10,12,16,18) made of a material having a high stiffness-to-mass ratio, for example a metal honeycomb structure material, and the enclosure is filled or partially filled with a sound-absorbing material (30) which has different sound-absorbing properties as one moves further away from the drive unit (29). This graded absorbing material (30) can be layers or blocks of foam plastics material, fiberglass, etc. Preferably, it is lightly absorbent adjacent to the drive unit (29) and strongly absorbent nearer the walls.

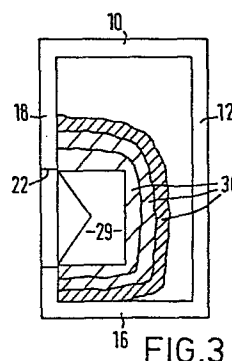


FIG.3

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LOUDSPEAKER CABINETS

SPECIFICATION

5 This invention relates to loudspeaker cabinets.

Many different designs of loudspeaker cabinet have been proposed with a view to reducing the effect of resonances. It is known for example that when considering the rigidity of a speaker cabinet one must
10 take into account bending resonances and also resonance effects resulting from the interaction of the mass of the panels and the compliance of the enclosed volume of air. It is known that one way to raise this resonance in frequency is to reduce the mass of the
15 panels from which the cabinet is made. Attempts have been made to find panels which are both lighter and stiffer than wood. One proposal which has been made, as mentioned for example in "Hi-Fi Answers", July 1982, is to use panels of a sandwich construction, similar to
20 that used for aircraft panels. Such sandwiches

comprise two thin sheets of aluminium or aluminium alloy separated by an aluminium or aluminium alloy honeycomb structure. Panels made from such sandwich material have an extremely high stiffness to mass ratio, and in
5 theory are therefore well-suited for use as panels for a loudspeaker cabinet. However, it has previously been considered that sandwich-type material, although having a high stiffness to mass ratio, performs less well than chipboard panels when one considers the effect known as
10 critical frequency. Above a particular frequency, known as the critical frequency, a panel becomes substantially transparent to sound, and at frequencies above this critical frequency the panels of the loudspeaker cabinet allow sound to escape through the panels. This can
15 cause colouration of the sound for example. Consequently, because of this lowering of the critical frequency, and also because of the considerable cost of the basic sandwich material, the use of such material for the panels of loudspeaker cabinets has been effectively
20 dismissed.

The present invention is based upon the discovery that the problem of critical frequency can be overcome, using panel material having a high stiffness to mass ratio, if one includes acoustic absorbing means arranged
25 appropriately within the cabinet.

It is of course well-known to provide sound-absorbing material within a loudspeaker cabinet. Conventionally, this is achieved by filling the cabinet enclosure with fibreglass for example, or by lining the
30 cabinet walls.

In accordance with the present invention there is provided a loudspeaker cabinet comprising walls of a material having a high stiffness to mass ratio, at least one drive unit, and sound-absorbing means within the
35 enclosure defined by the walls, said sound-absorbing

means being of a composition and/or so arranged that its sound-absorbing properties differ in dependence on its position in the cabinet.

The effect of the sound-absorbing means is to
5 overcome, or at least substantially reduce, the adverse effect of critical frequency, and to balance the effects of reflection and absorption of sound and thus avoid or reduce the transparency of the cabinet to sound.

Preferably, the sound-absorbing means comprises
10 foam material positioned within the cabinet. The sound-absorbing means may be positioned simply around the drive unit or drive units, or alternatively, may be designed substantially to fill the cabinet enclosure.

The absorbing material forms an acoustic "wedge",
15 i.e. is acoustically graded so that its frequency absorption characteristics gradually change as one moves further away from the drive unit or units.

Various alternative embodiments of loudspeaker cabinet construction in accordance with the invention
20 will now be described by way of example, and with reference to the accompanying drawings, in which:

Fig. 1 is a longitudinal view, partly in section, taken down through the centre of a loudspeaker cabinet, illustrating the use of a honeycomb sandwich structure
25 for the panels, but not showing the internal sound-absorbing means;

Fig. 2 is a schematic side view of a loudspeaker cabinet, partly in section, and showing one configuration of sound-absorbing material within the cabinet enclosure;

30 Fig. 3 shows an alternative disposition of the sound-absorbing material around a drive unit within the cabinet enclosure; and,

Fig. 4 shows a further alternative configuration of sound-absorbing material for use within the cabinet
35 enclosure.

Referring first to Fig. 1, the loudspeaker cabinet is shown as comprising a top panel 10, a rear panel 12, two side panels (one of which is shown at 14), a base 16 and a front panel 18. As is indicated at 20, all the panels are made of a sandwich material having a high stiffness to mass ratio. One such material which is suitable for use is a sandwich comprising two sheets of aluminium or aluminium alloy filled with a honeycomb of aluminium or aluminium alloy foil. A typical material is that sold by Ciba-Geigy and known by the trademark "Aeroweb". Such a sandwich has a honeycomb core made by fastening ribbons of foil together in a layered slab by suitably spaced adhesive stripes perpendicular to the long axis of the ribbons and then expanding the slab to produce a hexagonal cell structure, as indicated at 20 in Fig. 1. The sandwich is notably stiffer along the long axis of the ribbons than perpendicular thereto. Preferably, the panel material is arranged so that the ribbons of the honeycomb structure run parallel to the longer sides of each panel. In the embodiment shown, the line of the ribbons runs vertically for the two side panels 14, and for the front panel 18 and rear panel 12, and from side to side of the cabinet for the top panel 10 and base 16. Preferably, the base 16 of the cabinet is formed in two pieces, joined at the centre of the base, with each base portion being a continuation of the respective side panel. The top panel 10, the two side panels 14 and the two portions of the base 16 can be machined, folded and wrapped around to form the desired rectangular configuration. The front panel 18 and the rear panel 12 can then be fitted into the open-ended box defined by the other panels, and can be suitably secured in place, for example by adhesive.

As shown in Fig. 1, the front panel 18 has cut-

outs 22 to receive the loudspeaker drive units (not shown). A rebated panel 24 is laminated to the front panel 18 to enable flush mounting of the drive units.

Although reference is made herein to the use of
5 an aluminium sandwich/honeycomb material, it should be clearly understood that the invention is not limited to the use of such a material. The advantage of such a sandwich material is that it has a very low mass per unit area, and a very high stiffness to mass ratio.
10 Any material having comparable parameters, or indeed better performance in terms of stiffness to mass ratio, could equally well be used as a panel material for the cabinet.

A particularly preferred "Aeroweb" material is
15 that known as Type 3003. This has a minimum compression strength of 2.76 MN/m^2 , a nominal longitudinal beam shear strength of 2.2 MN/m^2 , a nominal transverse beam shear strength of 1.6 MN/m^2 , a nominal thickness of 12.5mm. and an average weight of 4.6 Kg/m^2 .

20 The essence of the present invention lies in the appreciation that, coupled with the use of such materials for the cabinet shell, one can achieve vastly improved performance by incorporating within the cabinet appropriately arranged sound-absorbing means which will raise the
25 critical frequency, or even substantially eliminate critical frequency as a phenomenon which has to be catered for.

Fig. 2 illustrates one way in which a sound-absorbing means can be incorporated within the cabinet
30 enclosure. Here, a plurality of blocks 28 of sound-absorbent material, preferably a foam material, are positioned around the drive unit 29 and are appropriately secured in place. Depending upon the degree of sound absorption which one wishes to achieve within the cabinet
35 enclosure, one can provide the blocks either just around

the drive unit itself, or alternatively to fill the whole cabinet enclosure.

Fig. 3 shows an alternative arrangement in which layers 30 of flexible sound-absorbing material are wrapped around the drive unit 29. Again, the layers 30 may be provided only in the immediate vicinity of the drive unit, or can be arranged substantially to fill the cabinet enclosure.

Fig. 4 shows yet another way of providing a sound-absorbing means within the cabinet shell. Here, the sound-absorbing material comprises a plurality of generally triangular cross-section pieces 32 of sound-absorbing material, such as a foamed material, formed as wedges or prisms and suitably arrayed to form a sound-absorbing barrier. These triangular cross-section elements 32 need not necessarily all be of the same material or all have the same sound-absorbing characteristics. For example, one could make up the barrier from two different materials, designed to absorb different frequency ranges, and positioned alternately, as indicated for example by the cross-hatching in Fig. 4. The individual blocks or wedges 32 could either be fitted piece-by-piece into the cabinet enclosure, or alternatively the pieces could be glued on to a fabric backing in an appropriate configuration so that the fabric with the pieces glued thereon could then simply be folded and inserted as a unit into the cabinet enclosure.

It is necessary, whatever the actual form of the sound-absorbing material, to arrange it in the form of an acoustic "wedge" or transmission line. In other words, the sound-absorbing material is appropriately graded in relation to its position within the cabinet enclosure so that there is a change in its sound-absorbing properties as one moves away from the drive unit towards the cabinet panels.

Absorbent materials which have low sound-absorbing properties are also substantially non-reflective of sound waves, i.e. the sound waves pass easily through them. Similarly, highly absorbent materials are more reflective of sound waves. In accordance with the present invention the absorbing material within the enclosure is graded so that the material nearer to the drive unit is lightly absorbent and therefore substantially non-reflective, while the material most remote from the drive unit is strongly absorbent and therefore more reflective. This has the advantageous result that the sound waves within the enclosure are not reflected back to the drive unit by the first absorbing material which they encounter, and additionally the subsequent absorbing material absorbs most of the waves, thereby to prevent them reaching the cabinet walls. In other words both the drive unit and the cabinet walls are substantially freed from direct or reflected sound waves.

If an air space is left within the cabinet, this is preferably adjacent to the walls, not next to the drive unit.

Although in the embodiment described above one is working with a panel-form cabinet shell which is then filled or partially filled with a sound-absorbing material, one could, within the scope of the present invention, construct a cabinet in the reverse sense. In other words, one could start from a block for example of foamed material, and then enclose this sound-absorbing material within an outer shell or skin which could be formed by panels, moulding, spray-coating, etc., provided that the outer shell has the high stiffness to mass ratio characteristics discussed earlier. More generally, although a panel-form construction has been referred to above in relation to the presently preferred embodiment, any other

method of or materials for producing a "shell" having a high stiffness to mass ratio could alternatively be used.

Also, although panels of metal honeycomb structure
5 have been described as advantageous, other panel structures having a high stiffness to mass ratio could alternatively be used, for example sandwich panels of porous or cellular material between strong skins. The core material could be stiff foam plastics, cellulose fibre,
10 paper, etc., and the skins could be of metal, plastics or hardboard for example.

Furthermore, although it is conventional to make loudspeaker cabinets of box shape, the present invention is also applicable to cabinets having alternative configurations. One could for example construct a shell of
15 spherical or cylindrical configuration from a high stiffness to mass ratio material, and then incorporate appropriate sound-absorbing material within the shell to achieve the object of the present invention. As yet a
20 further alternative configuration one could have a shell structure of upright generally cylindrical form, with the wall of the cylinder being inwardly concave and with an inwardly concave top and bottom to the enclosure.
If this is not considered aesthetically attractive then
25 such a structure could be incorporated within a conventional box-shaped outer enclosure.

CLAIMS :

1. A loudspeaker cabinet comprising walls of a material having a high stiffness to mass ratio, at least
5 one drive unit, and sound-absorbing means within the enclosure defined by the walls, said sound-absorbing means being of a composition and/or so arranged that its sound-absorbing properties differ in dependence on its position in the cabinet.
- 10 2. A loudspeaker cabinet according to claim 1, in which the sound-absorbing means is graded in relation to its distance from said drive unit or units, being more lightly absorbent of sound waves adjacent to the drive unit or units and more strongly absorbent of sound
15 waves remote from the drive unit or units.
3. A loudspeaker cabinet according to claim 1 or 2, in which the sound-absorbing means comprises layers of material having different acoustic absorbing properties.
- 20 4. A loudspeaker cabinet according to claim 3, in which the layers are of a foam plastics material.
5. A loudspeaker cabinet according to any preceding claim, in which the walls comprise a metal sandwich structure comprising two skins with a honeycomb
25 cellular array therebetween.
6. A loudspeaker cabinet according to claim 5, made of rectangular wall panels, in which the honeycomb cells are made by securing elongate ribbons of foil together in a layered slab and expanding the slab, and
30 wherein the walls of the cabinet are arranged so that the ribbons of the honeycomb structure run parallel to the longer sides of the side panels.
7. A loudspeaker cabinet according to claim 6, in which the ribbons of the honeycomb structure also run
35 parallel to the longer sides of the rear panel.

8. A loudspeaker cabinet according to claim 6 or 7, in which the cabinet has two side walls, a top wall and a base all formed from one piece of material with the ends joined at the centre of the base.

- 5 9. A loudspeaker cabinet according to any preceding claim, in which the sound-absorbing means only partially fills the cabinet enclosure, with an air gap between the sound-absorbing means and at least the rear wall of the cabinet.

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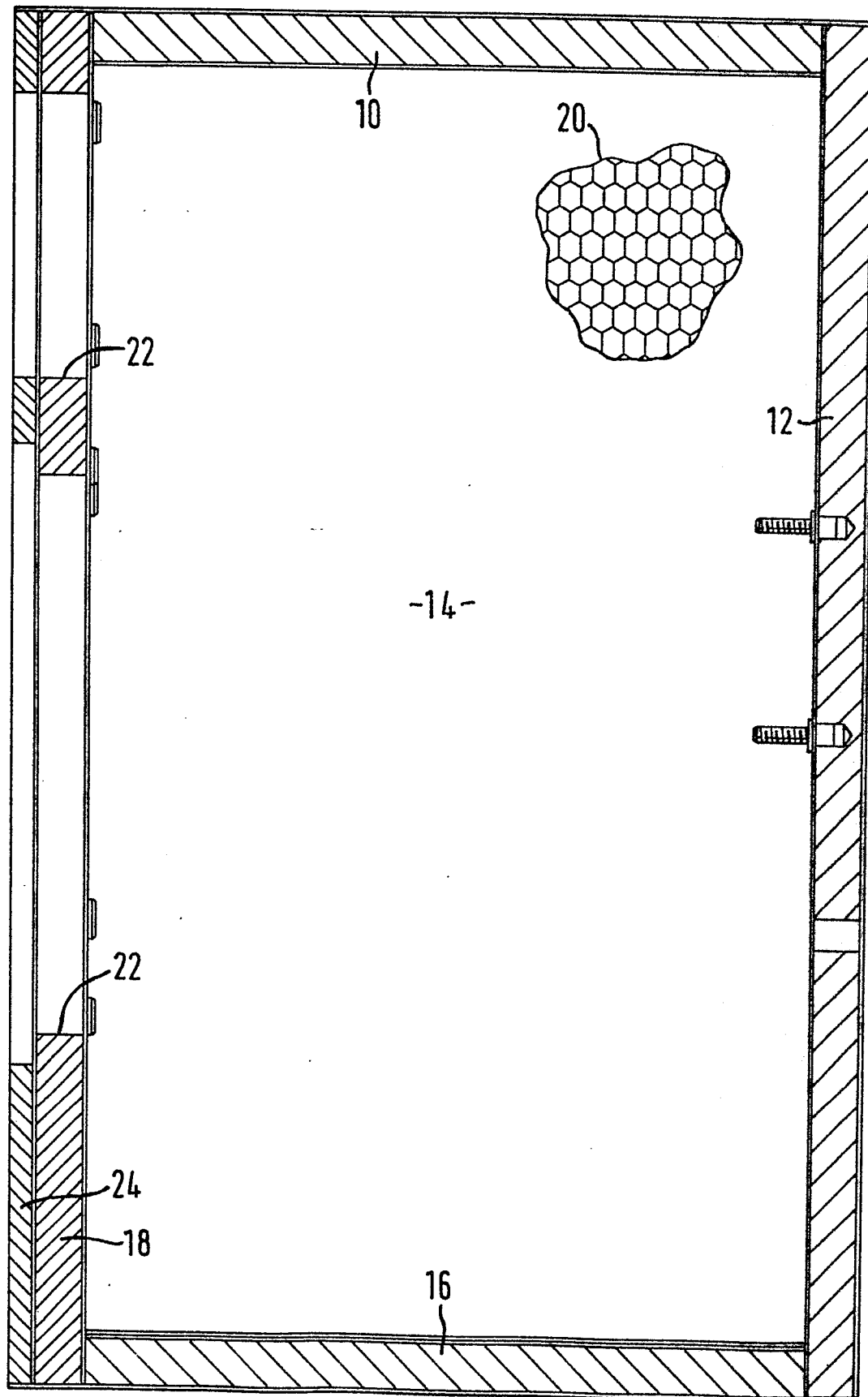


FIG. 1

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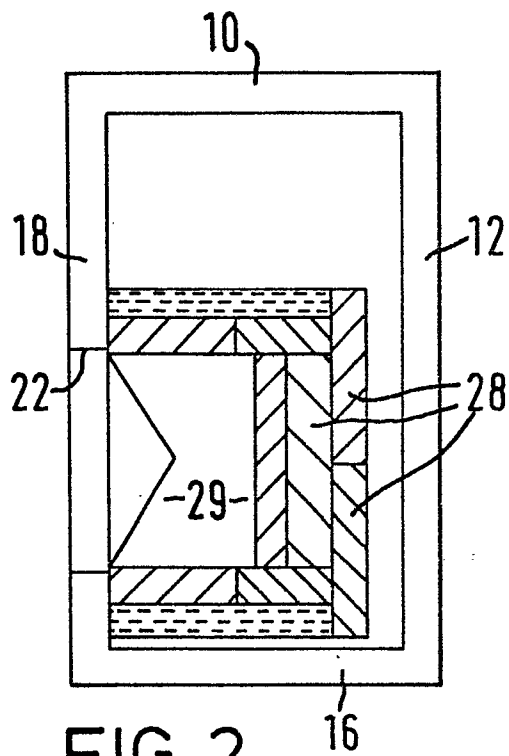


FIG. 2

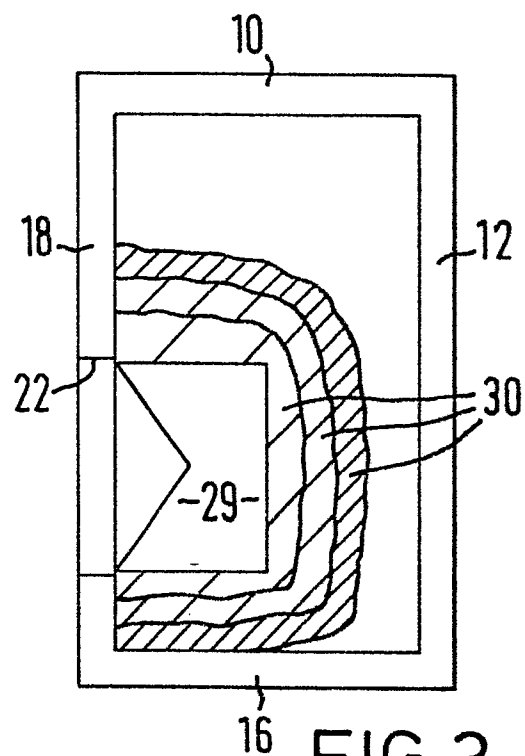


FIG. 3

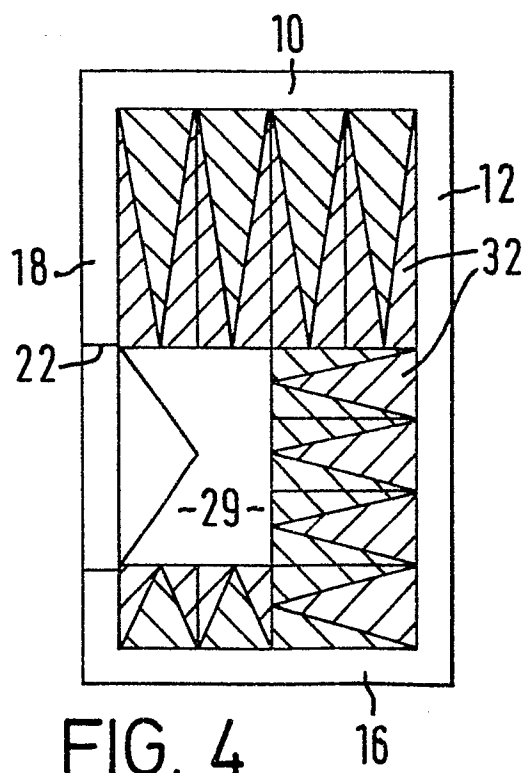


FIG. 4



European Patent
Office

EUROPEAN SEARCH REPORT

0111408

Application number

EP 83 30 7326

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. 3)
X	US-A-4 127 751 (SHOUZO KINOSHITA) * Figures 4-6; column 2, lines 31-63; column 3, lines 45-59; column 4, lines 11-16 *	1-4	H 04 R 1/28
Y	---	5,9	
X	US-A-4 044 855 (FUMIO KOBAYASHI) * Figures 5-7; column 1, line 7 - column 2, line 15; column 4, line 54 - column 5, line 45; claims 1,3,4-8 *	1-3	
Y	---	5,9	
Y	PATENTS ABSTRACTS OF JAPAN, vol. 6, no. 222 (E-140)[1100], 6th November 1982 & JP - A - 57 127 396 (SANYO DENKI K.K.) 07-08-1982	5	TECHNICAL FIELDS SEARCHED (Int. Cl. 3) H 04 R
A	PATENTS ABSTRACTS OF JAPAN	6,7	
Y	FR-A-2 334 259 (ART ET ACOUSTIQUE APPLIQUEE) * page 3, lines 5-28; claims 1,2,7,8,9,10; figures 1,2 * -/-	9	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 24-02-1984	Examiner MINNOYE G.W.
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 L : document cited for other reasons & : member of the same patent family, corresponding document			



DOCUMENTS CONSIDERED TO BE RELEVANT			Page 2
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
A	-----	1-3	
			TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 24-02-1984	Examiner MINNOYE G. W.
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 L : document cited for other reasons & : member of the same patent family, corresponding document	