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(54) **LOUDSPEAKER**
LAUTSPRECHER
HAUT-PARLEUR

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Description

FIELD OF INVENTION

[0001] The present invention relates to a loudspeaker, particularly but not exclusively a portable loudspeaker for use with personal CD players (e.g. Sony DISCMAN CD players), personal mini disc players, and personal stereo cassette players (e.g. Sony WALKMAN tape cassette players). For the purposes of the present specification, such CD/mini disc/cassette players are defined as personal players.

BACKGROUND ART

[0002] Personal players are primarily intended to produce sound for one listener at a time. For this reason, personal players are supplied with headphones. Nevertheless, portable loudspeakers are available on the market and are intended for occasions when the personal players are used to reproduce sound for more than one person at a time. The portable loudspeakers must be compact and lightweight in order to meet user requirements.

[0003] The present applicant has appreciated that existing portable loudspeakers for personal players are perhaps not as compact as the user would like, so much so that storage is sometimes a problem. Therefore, an object of the present invention is to provide a portable loudspeaker which is more readily accepted by the user.

DISCLOSURE OF INVENTION

[0004] According to an aspect of the present invention, there is provided a portable loudspeaker for use with a personal player, comprising a housing having an outer periphery in the shape of a storage device selected from the group consisting of a CD box, a tape cassette box, and a mini disc box.

[0005] CDs, mini discs and audio tape cassettes are traditionally sold in standard-sized storage boxes and, as a result, there is a tendency for the users of personal players to accept readily the size of such storage boxes. Indeed, accessories such as carrying cases for personal players are sometimes designed to accommodate the standard-sized storage boxes in addition to the personal player itself. Accordingly, the present applicant has appreciated that a loudspeaker with a housing of substantially the same dimensions as one of the standard-sized storage boxes (be it single or double or otherwise) is likely to be more readily accepted by users of personal players because its size is in keeping with existing apparatus carried by users.

[0006] The housing may comprise an open-top box enclosure and a lid, with the lid being movable from a first position covering the enclosure opening to a second position upstanding from the enclosure. With the lid in the second position, projecting away from the enclosure

opening, the interior of the enclosure becomes accessible, possibly for storing an item. The lid may be connected to the open-box enclosure with a hinge.

[0007] Preferably, the sound generating unit of the portable loudspeaker is mounted on or in the lid of the portable loudspeaker. In this way, the orientation of the sound-generating element may be altered by moving the position of the lid relative to the open-box enclosure. This may be useful if the sound generating element produces a directional output, or to take advantage of beneficial reflections of sound waves, e.g. from a flat surface such as a table.

[0008] A further sound-generating unit may also be mounted in or on one side of the open-top box enclosure. The said one side may be movable relative to the other sides of the open-box enclosure. In this way, the lid and the said one side may be orientated to face in the same direction, perhaps for stereo sound reproduction, whilst the other sides of the open-box enclosure may project outwards to stabilise the portable loudspeaker. The outer periphery of the portable loudspeaker housing may be in the shape of a double CD, tape cassette or mini disc box, in which the said one side forms the second lid which faces the aforementioned lid when closed.

[0009] The dimensions of a CD box, particularly a double CD box, are well suited to producing a portable loudspeaker embodying the present invention.

[0010] The sound-generating unit of the portable loudspeaker may comprise a flat panel acoustic radiator and a transducer positioned to excite bending waves in the acoustic radiator and thereby radiate sound energy by flexural vibrations. The flat panel acoustic radiator may be a distributed mode acoustic radiator as disclosed in International patent application published under number WO97/09842 in the name New Transducers Limited, the whole content of which is incorporated herein by reference. With the distributed mode acoustic radiator, the transducer would be mounted in or on the panel at a preferred location to excite distributed modes of vibration in the panel.

[0011] The housing may house a battery for energising the sound generating element of the portable loudspeaker. The housing may also house a radio receiver for receiving radio signal broadcasts and subsequently reproducing sound through the portable loudspeaker. The radio receiver may include an aerial which is embedded in the housing.

[0012] According to an embodiment of the present invention, the sound generating unit comprises a loudspeaker comprising an acoustic radiator and a transducer mounted on or in the acoustic radiator to excite bending waves in the acoustic radiator for producing an acoustic output, the acoustic radiator comprising a first region and a second region surrounding the first region, the first region being stiffer than the second region and having the transducer mounted on or in it.

[0013] The first region may be regarded as a "stiff" is-

land surrounded by the second region which may be regarded as a flexible diaphragm. The first region may have a first uniform stiffness, and the second region may have a second uniform stiffness - the first uniform stiffness being greater than the second. The first and second uniform stiffnesses may be achieved by increasing the thickness of the acoustic radiator across the first region. The first region may be at least 25% thicker than the second region. The transition between the different thicknesses of the first and second regions may be tapered to avoid a sharp step.

[0014] The amplitude of displacements in the acoustic radiator may be greater (perhaps at least five times greater) at frequencies below 300Hz than those at frequencies above 300Hz. Both the first and second regions may be sufficiently stiff to support the propagation of bending waves across the acoustic radiator, at least at high frequencies. However, by providing a peripheral region which is more readily able to flex than the island region, it is believed that the second region may support a degree of pistonic movement in the loudspeaker, thus enabling sound to be produced both pistonic and vibrationally, especially at low frequencies. This may be significant at frequencies up to about 300Hz, where the pistonic contribution to the sound output may provide an important supplement to the vibrational component, especially in compact portable loudspeakers of the present invention.

BRIEF DESCRIPTION OF DRAWINGS

[0015] Embodiments of the invention will now be described by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows schematically a first embodiment of a portable loudspeaker embodying the present invention;

Figure 2 shows schematically a second embodiment of a portable loudspeaker embodying the present invention;

Figure 3 shows schematically a third embodiment of a portable loudspeaker embodying the present invention;

Figure 4 shows lid detail of the portable loudspeaker of Figure 3;

Figure 5 shows a partial cross-sectional view along line XX of Figure 4; and

Figure 6a and 6b shows laservibrometry results illustrating acoustic behaviour at 250 Hz of the portable loudspeaker of Figure 3.

MODES OF CARRYING OUT THE INVENTION

[0016] Figure 1 shows a portable loudspeaker (10) resembling a double CD case, and comprising left- and right-hand lids (12,14) pivotally coupled about parallel axes AA and BB to side walling (16). The side walling

(16) forms an open box like enclosure, with the left- and right-hand lids (12,14) acting as the top and bottom surfaces to complete the enclosure. The portable loudspeaker (10) is illustrated in the "open" configuration to facilitate a description of the internal components; in the "closed" configuration (not shown), the portable loudspeaker (10) is the same shape and size as a conventional double CD case, and thus has the outward appearance thereof. In the "open" configuration, the side walling (16) acts as a support stand for the portable loudspeaker (10). Rubber feet may be provided on the bottom surface of side walling (16) to improve grip on smooth surfaces.

[0017] Each lid (12,14) comprises a sound generating unit in the form of a distributed mode acoustic radiator (20) mounted in a frame (22) with a compliant foam surround (not shown) sandwiched therebetween to isolate the frame (22) from unwanted vibrations. The acoustic radiator (20) comprises a stiff, lightweight panel (24) and an exciter (26), positioned to excite distributed mode bending waves in the panel (24). The acoustic radiator (20) works in accordance with the teachings of the disclosure of WO97/09842, the whole contents of which are incorporated herein by reference, and accordingly further explanation is unnecessary. The exciter (26) in the left-hand lid (12) is offset relative to the one in the right-hand lid (14) to avoid fouling when the portable loudspeaker (10) is in the closed configuration.

[0018] The side walling (16) acts as a spacer between the left- and right-hand lids (12,14), providing storage space for certain components. An amplifier (30) including a volume control (32) is mounted towards one corner of the side walling (16). The amplifier (30) is coupled to input connector (34) for receiving an output setting from a personal player such as a personal cassette player (36). The input connector (34) could be replaced with a receiver for receiving infra-red output signals from a transmitter coupled to the personal player. The amplifier (30) sends electrical signals to the exciters (26) via wiring (not shown) in order to generate sound. A battery (40) supplying power for the amplifier (30) is located in the corner of the side walling (16) opposite the amplifier (30); by locating the amplifier (30) and battery (40) in opposing corners, space is left available to accommodate the exciters (26) when the loudspeaker (10) is in the closed configuration. A 12 volt d.c. input socket may be provided so that power may be introduced from a mains supply (via a transformer) as an alternative to the battery (40).

[0019] The amplifier (30) has incorporated with it a radio receiver (38) for receiving radio wave broadcasts to enable radio broadcasts to be heard using the portable loudspeaker (10). The radio receiver (38) has an aerial (39) embedded in side walling (16). An MP3 or mini-disc player may also be incorporated in the assembly, perhaps alongside the amplifier.

[0020] Despite the presence of compliant foam isolating the acoustic radiator (20) from the frame (22), some

vibrations may still be conveyed through the frame to the side walling (16). Vibrations induced in the side walling (16) may be undesirable, and may be reduced by placing compliant foam absorbers (not shown) where the frames (22) may otherwise be in contact with the side walling (16).

[0021] Figure 2 shows a portable loudspeaker (50) resembling a single CD case, and comprising a lid (52) pivotally coupled about axis A¹A¹ to open-top box enclosure (54). open-top box enclosure (54) consists of sides (56) with an acoustic radiator (24, 26) coupled thereto. The portable loudspeaker (50) is illustrated in the "open" configuration to show the internal components.

[0022] Where there are features in common with the embodiment of Figure 1, the same reference numerals have been used. A slimline battery arrangement (58) is illustrated, and the amplifier omitted for convenience. In any event, a miniature digital amplifier could be used in place of the somewhat larger analogue amplifier illustrated in Figure 1. A key difference between the Figure 1 and 2 embodiments is the fact that there is no independent side walling so that the lid (52) is hinged direct to the sides (56) defining with a base the open-top box enclosure (54). The acoustic radiator (24, 26) in the open-top box enclosure (56) is optional and if only one acoustic radiator is required in the portable loudspeaker (50), a standard panel (60) would be used as the base of the enclosure. A stereo signal could still be reproduced by using a pair of such loudspeakers.

[0023] Figure 3 shows a portable loudspeaker (70) resembling a double CD case. Where there are features in common with the embodiment of Figure 1, the same reference numerals have been used. Each lid (12, 14) comprises a sound-generating unit comprising an acoustic radiator (72) which comprises a two-region panel (74) and an exciter (76), positioned to excite bending waves in the acoustic radiator for producing sound. Each acoustic radiator is integrally formed with the respective lid, being moulded from polycarbonate. Thus, there is no compliant foam isolating the acoustic radiator from the rest of the lid.

[0024] Figures 4 and 5 shows detail of lid (14) - including the position (78) for the corresponding transducer (equivalent to that of lid (12) when rotated through 180°). The position (78) may not be the optimised position for locating the transducer. The two-region panel (74) comprises a first region (80) of thickness t_1 , and a second region (82) of thickness t_2 . The second region (82) surrounds the first region (80) which may thus be regarded as an "island". The two-regional panel (74) is such that $t_1 > t_2$, and in the present case t_1 is 2.0mm and t_2 is 1.2mm. This means that the first region (80) is stiffer than the second region (84).

[0025] In use, a transducer (76) positioned on site (78) will produce bending waves across the panel (74). The first region (80) - being relatively stiff and lightweight - is particularly suited to propagating such bending

waves. At frequencies below 300 Hz - say 250 Hz - the second region (82) allows for some pistonic movement in a direction perpendicular to the panel surface by virtue of the fact that it is less stiff than the first region (80).

[0026] Figures 6a and 6b are based on stills taken from laservibrometry experiments at an operating frequency of 250 Hz and give amplitude plots at two phases, 180° apart. On the left hand side of each Figure, results are shown for the two-region panel (74) of Figure 4 with the amplitude readings taken along a line passing through an exciter. For comparison, on the right hand side of each Figure, results are plotted for an equivalent uniform (distributed mode) panel made from polycarbonate sheet 2mm thick. The amplitude displacements are greatest for the two-region panel (74) where the transducer/exciter (76) is located; the maximum amplitude is perhaps seven times or more greater than that of conventional panel provided for comparison. The increased, pistonic-type displacements at frequencies below about 300Hz provide an enhanced bass response.

Claims

1. A portable loudspeaker (10) for use with a personal player (36), comprising a sound generating unit (20) in a housing (12, 14, 16) having an outer periphery in the shape of a storage device selected from the group consisting of a CD box, a tape cassette box, and a mini disc box.
2. A portable loudspeaker according to claim 1, in which the housing comprises an open-top box enclosure and a lid.
3. A portable loudspeaker according to claim 2, in which the lid is movable from a first position covering the enclosure opening to a second position uncovering the enclosure opening.
4. A portable loudspeaker according to claim 3, in which the lid is attached to the open-top box enclosure with a hinge.
5. A portable loudspeaker according to claim 2, 3 or 4, in which the sound generating unit is attached to or mounted in the lid.
6. A portable loudspeaker according to any one of claims 2 to 5, further comprising a further sound generating element attached to or mounted in one side of the open-top box enclosure.
7. A portable loudspeaker according to claim 6, in which the said one side opposes the enclosure opening.
8. A portable loudspeaker according to claim 6 or 7, in

which the said one side is movable relative to other sides of the open-top box enclosure.

9. A portable loudspeaker according to claim 6, 7 or 8, in which the said one side is a second lid, with the housing being in the shape of a storage device selected from the group consisting of, a double CD box, a double tape cassette box and a double mini disc box. 5
10. A portable loudspeaker according to any one of the preceding claims, in which the sound generating unit comprises an acoustic radiator and a transducer mounted on or in the acoustic radiator to excite bending waves in the acoustic radiator for producing an acoustic output. 10
11. A portable loudspeaker according to any one of the preceding claims, in which the housing includes a radio receiver for receiving radio signal broadcasts and means for reproducing sound according to received radio signal broadcasts using the sound generating unit. 15
12. A portable loudspeaker according to claim 11, in which the radio receiver includes an aerial embedded in the housing. 20
13. A portable loudspeaker according to any one of the preceding claims, in which the sound generating unit comprises a loudspeaker comprising an acoustic radiator and a transducer mounted on or in the acoustic radiator to excite bending waves in the acoustic radiator for producing an acoustic output, the acoustic radiator comprising a first region and a second region surrounding the first region, the first region being stiffer than the second region and having the transducer mounted on or in it. 25
14. A portable loudspeaker according to claim 13, in which the first region has a first uniform stiffness. 30
15. A portable loudspeaker according to claim 13 or 14, in which the second region has a second uniform stiffness. 35
16. A portable loudspeaker according to claim 13, 14 or 15, in which the stiffness variation is provided by the first region being thicker than the second region. 40
17. A portable loudspeaker according to claim 16, in which the first region is at least 25% thicker than the second region. 45
18. A portable loudspeaker according to any one of claims 13 to 17, in which the amplitude of displacements in the acoustic radiator are greater at frequencies below 300Hz than they are above 300Hz. 50

19. A portable loudspeaker according to any one of claims 13 to 18, in which the acoustic radiator provides an acoustic output at least in part through piston movement at frequencies below 300Hz.

20. A portable loudspeaker according to any one of claims 13 to 19 in which the acoustic radiator is integrally moulded in the housing.

Patentansprüche

1. Tragbarer Lautsprecher (10) für den Einsatz mit einem personengebundenen Abspielgerät (36), aufweisend eine Klangerzeugungseinheit (20) in einem Gehäuse (12, 14, 16) mit einem Außenumfang in Form einer Aufbewahrungsvorrichtung, ausgewählt aus der Gruppe bestehend aus einer CD-Box, einer Tonbandkassettenbox und einer Minidisc-Box.
2. Tragbarer Lautsprecher nach Anspruch 1, **dadurch gekennzeichnet, dass** das Gehäuse eine oben offene kastenförmige Hülle und einen Deckel aufweist.
3. Tragbarer Lautsprecher nach Anspruch 2, **dadurch gekennzeichnet, dass** der Deckel von einer ersten Stellung, in der die Gehäuseöffnung abgedeckt ist, in eine zweite Stellung, in der die Gehäuseöffnung nicht abgedeckt ist, bewegbar ist.
4. Tragbarer Lautsprecher nach Anspruch 3, **dadurch gekennzeichnet, dass** der Deckel mittels eines Scharniers an der oben offenen kastenförmigen Hülle angebracht ist.
5. Tragbarer Lautsprecher nach Anspruch 2, 3 oder 4, **dadurch gekennzeichnet, dass** die Klangerzeugungseinheit am Deckel angebracht oder im Deckel montiert ist.
6. Tragbarer Lautsprecher nach einem der Ansprüche 2 bis 5, weiterhin aufweisend ein weiteres Klangerzeugungselement, das an einer Seite der oben offenen kastenförmigen Hülle angebracht oder in dieser Seite montiert ist.
7. Tragbarer Lautsprecher nach Anspruch 6, **dadurch gekennzeichnet, dass** die genannte eine Seite der Öffnung der Hülle gegenüber liegt.
8. Tragbarer Lautsprecher nach Anspruch 6 oder 7, **dadurch gekennzeichnet, dass** die genannte eine Seite relativ zu anderen Seiten der oben offenen kastenförmigen Hülle bewegbar ist.
9. Tragbarer Lautsprecher nach Anspruch 6, 7 oder 8,

dadurch gekennzeichnet, dass die genannte eine Seite ein zweiter Deckel ist, wobei das Gehäuse die Form einer Aufbewahrungsvorrichtung aufweist, ausgewählt aus der Gruppe bestehend aus einer Doppel-CD-Box, einer Doppel-Tonbandkassettenbox und einer Doppel-Minidisc-Box.

10. Tragbarer Lautsprecher nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Klangerzeugungseinheit einen akustischen Strahler und einen Wandler aufweist, der an oder in dem akustischen Strahler montiert ist, um in dem akustischen Strahler Biegewellen für die Erzeugung einer akustischen Ausgabe zu erregen. 5
11. Tragbarer Lautsprecher nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Gehäuse einen Rundfunkempfänger zum Empfangen von Rundfunksendungen und Mittel für die Wiedergabe von Klängen gemäß den empfangenen Rundfunksignalen mit Hilfe der Klangerzeugungseinheit aufweist. 10
12. Tragbarer Lautsprecher nach Anspruch 11, **dadurch gekennzeichnet, dass** der Rundfunkempfänger eine in das Gehäuse eingebettete Antenne aufweist. 15
13. Tragbarer Lautsprecher nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Klangerzeugungseinheit einen Lautsprecher aufweist, der einen akustischen Strahler und einen Wandler aufweist, der an oder in dem akustischen Strahler montiert ist, um in dem akustischen Strahler Biegewellen zum Erzeugen einer akustischen Ausgabe zu erregen, wobei der akustische Strahler einen ersten Bereich und einen zweiten, den ersten Bereich umgebenden Bereich aufweist, wobei der erste Bereich steifer als der zweite Bereich ist und der Wandler an oder in ihm montiert ist. 20
14. Tragbarer Lautsprecher nach Anspruch 13, **dadurch gekennzeichnet, dass** der erste Bereich eine erste gleichmäßige Steifigkeit aufweist. 25
15. Tragbarer Lautsprecher nach Anspruch 13 oder 14, **dadurch gekennzeichnet, dass** der zweite Bereich eine zweite gleichmäßige Steifigkeit aufweist. 30
16. Tragbarer Lautsprecher nach Anspruch 13, 14 oder 15, **dadurch gekennzeichnet, dass** der Steifigkeitsunterschied dadurch bewirkt wird, dass der erste Bereich dicker ist als der zweite Bereich. 35
17. Tragbarer Lautsprecher nach Anspruch 16, **dadurch gekennzeichnet, dass** der erste Bereich mindestens 25 Prozent dicker ist als der zweite Bereich. 40

18. Tragbarer Lautsprecher nach einem der Ansprüche 13 bis 17, **dadurch gekennzeichnet, dass** die Amplitude der Verlagerungen in dem akustischen Strahler bei Frequenzen unterhalb 300 Hz größer ist als bei Frequenzen oberhalb 300 Hz. 45

19. Tragbarer Lautsprecher nach einem der Ansprüche 13 bis 18, **dadurch gekennzeichnet, dass** der akustische Strahler eine akustische Ausgabe zumindest teilweise durch kolbenartige Bewegung mit Frequenzen unterhalb 300 Hz erzeugt. 50

20. Tragbarer Lautsprecher nach einem der Ansprüche 13 bis 19, **dadurch gekennzeichnet, dass** der akustische Strahler einstückig in dem Gehäuse ausgebildet ist. 55

Revendications

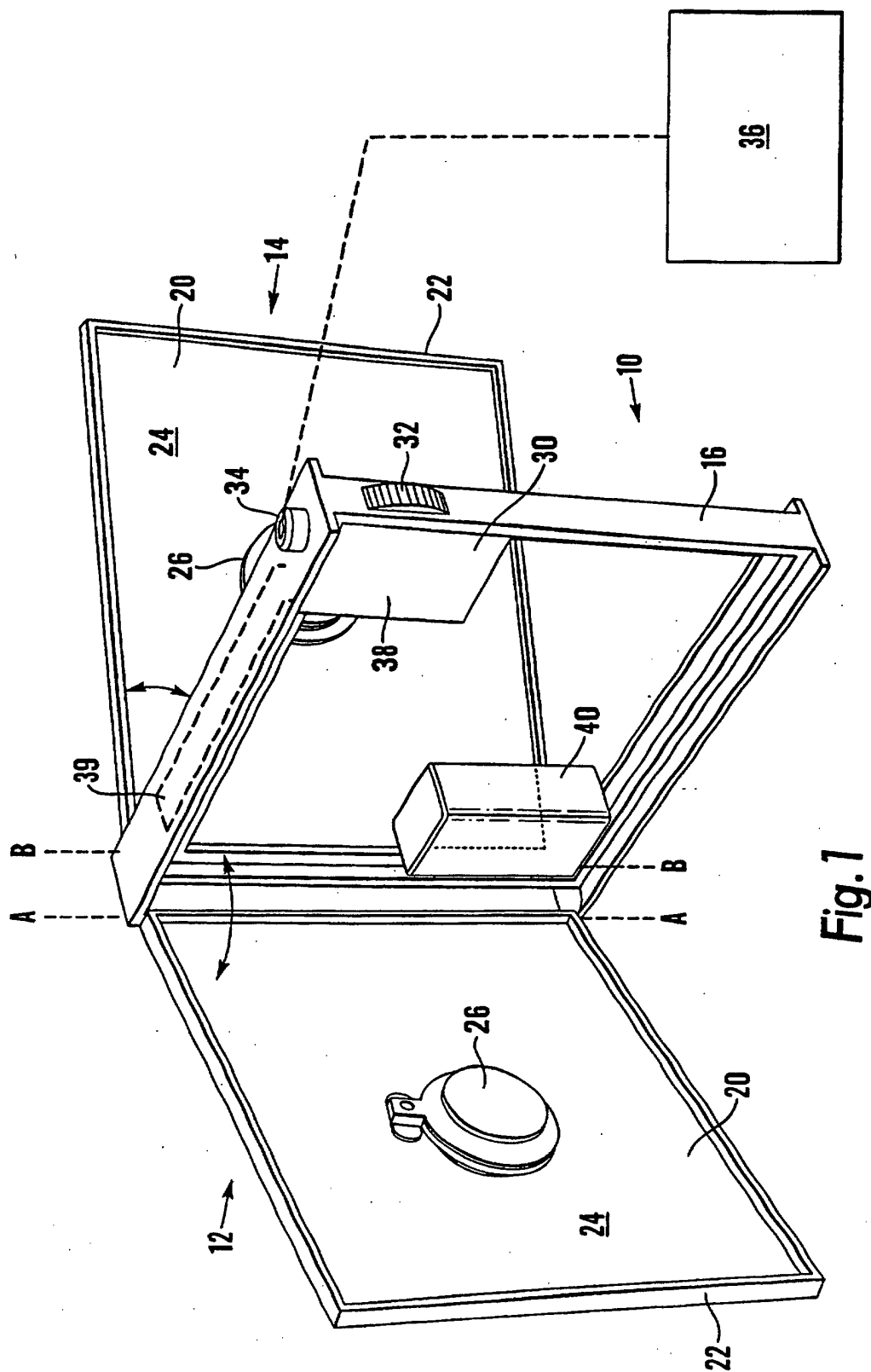
1. Haut-parleur portatif (10) destiné à être utilisé avec un lecteur personnel (36), comprenant une unité de génération de sons (20) dans un boîtier (12, 14, 16) ayant une périphérie extérieure sous la forme d'un dispositif de rangement sélectionné dans le groupe consistant en une boîte pour CD, une boîte pour cassettes et une boîte pour mini-disques.
2. Haut-parleur portatif selon la revendication 1, dans lequel le boîtier comprend une enceinte en forme de boîte ouverte sur le dessus et un couvercle.
3. Haut-parleur portatif selon la revendication 2, dans lequel le couvercle est mobile d'une première position recouvrant l'ouverture de l'enceinte vers une deuxième position ne recouvrant pas l'ouverture de l'enceinte.
4. Haut-parleur portatif selon la revendication 3, dans lequel le couvercle est fixé à l'enceinte en forme de boîte ouverte sur le dessus par une charnière.
5. Haut-parleur portatif selon la revendication 2, 3 ou 4, dans lequel l'unité de génération de sons est fixée au couvercle ou montée sur le couvercle.
6. Haut-parleur portatif selon l'une quelconque des revendications 2 à 5, comprenant en outre un élément de génération de sons supplémentaire fixé à un côté de l'enceinte en forme de boîte ouverte sur le dessus ou monté sur celui-ci.
7. Haut-parleur portatif selon la revendication 6, dans lequel ledit un côté fait face à l'ouverture de l'enceinte.
8. Haut-parleur portatif selon la revendication 6 ou 7, dans lequel ledit un côté est mobile par rapport aux

autres côtés de l'enceinte en forme de boîte ouverte sur le dessus.

9. Haut-parleur portatif selon la revendication 6, 7 ou 8, dans lequel ledit un côté est un deuxième couvercle, le boîtier présentant la forme d'un dispositif de rangement sélectionné dans le groupe consistant en une boîte pour deux CD, une boîte pour deux cassettes et une boîte pour deux mini-disques. 5
10. Haut-parleur portatif selon l'une quelconque des revendications précédentes, dans lequel l'unité de génération de sons comprend un émetteur acoustique et un transducteur monté sur ou dans l'émetteur acoustique pour exciter des ondes de flexion dans l'émetteur acoustique pour produire une sortie acoustique. 10
11. Haut-parleur portatif selon l'une quelconque des revendications précédentes, dans lequel le boîtier comprend un récepteur radio pour recevoir des émissions de signaux radio et des moyens pour reproduire un son conformément à des émissions de signaux radio en utilisant l'unité de génération de sons. 15
12. Haut-parleur portatif selon la revendication 11, dans lequel le récepteur radio comprend une antenne intégrée dans le boîtier. 20
13. Haut-parleur portatif selon l'une quelconque des revendications précédentes, dans lequel l'unité de génération de sons comprend un haut-parleur comprenant un émetteur acoustique et un transducteur monté sur ou dans l'émetteur acoustique afin d'exciter des ondes de flexion dans l'émetteur acoustique pour produire une sortie acoustique, l'émetteur acoustique comprenant une première région et une deuxième région entourant la première région, la première région étant plus rigide que la deuxième région et le transducteur étant monté sur ou dans celle-ci. 25
14. Haut-parleur portatif selon la revendication 13, dans lequel la première région présente une première rigidité uniforme. 30
15. Haut-parleur portatif selon la revendication 13 ou 14, dans lequel la deuxième région présente une deuxième rigidité uniforme. 35
16. Haut-parleur portatif selon la revendication 13, 14 ou 15, dans lequel la variation de rigidité est obtenue par le fait que la première région est plus épaisse que la deuxième région. 40
17. Haut-parleur portatif selon la revendication 16, 45

dans lequel la première région est plus épaisse d'au moins 25 % que la deuxième région.

18. Haut-parleur portatif selon l'une quelconque des revendications 13 à 17, dans lequel les amplitudes des déplacements dans l'émetteur acoustique sont plus importantes aux fréquences inférieures à 300 Hz qu'aux fréquences supérieures à 300 Hz. 5
19. Haut-parleur portatif selon l'une quelconque des revendications 13 à 18, dans lequel l'émetteur acoustique fournit une sortie acoustique au moins en partie par l'intermédiaire d'un mouvement de piston aux fréquences inférieures à 300 Hz. 10
20. Haut-parleur portatif selon l'une quelconque des revendications 13 à 19, dans lequel l'émetteur acoustique est moulé intégralement dans le boîtier. 15



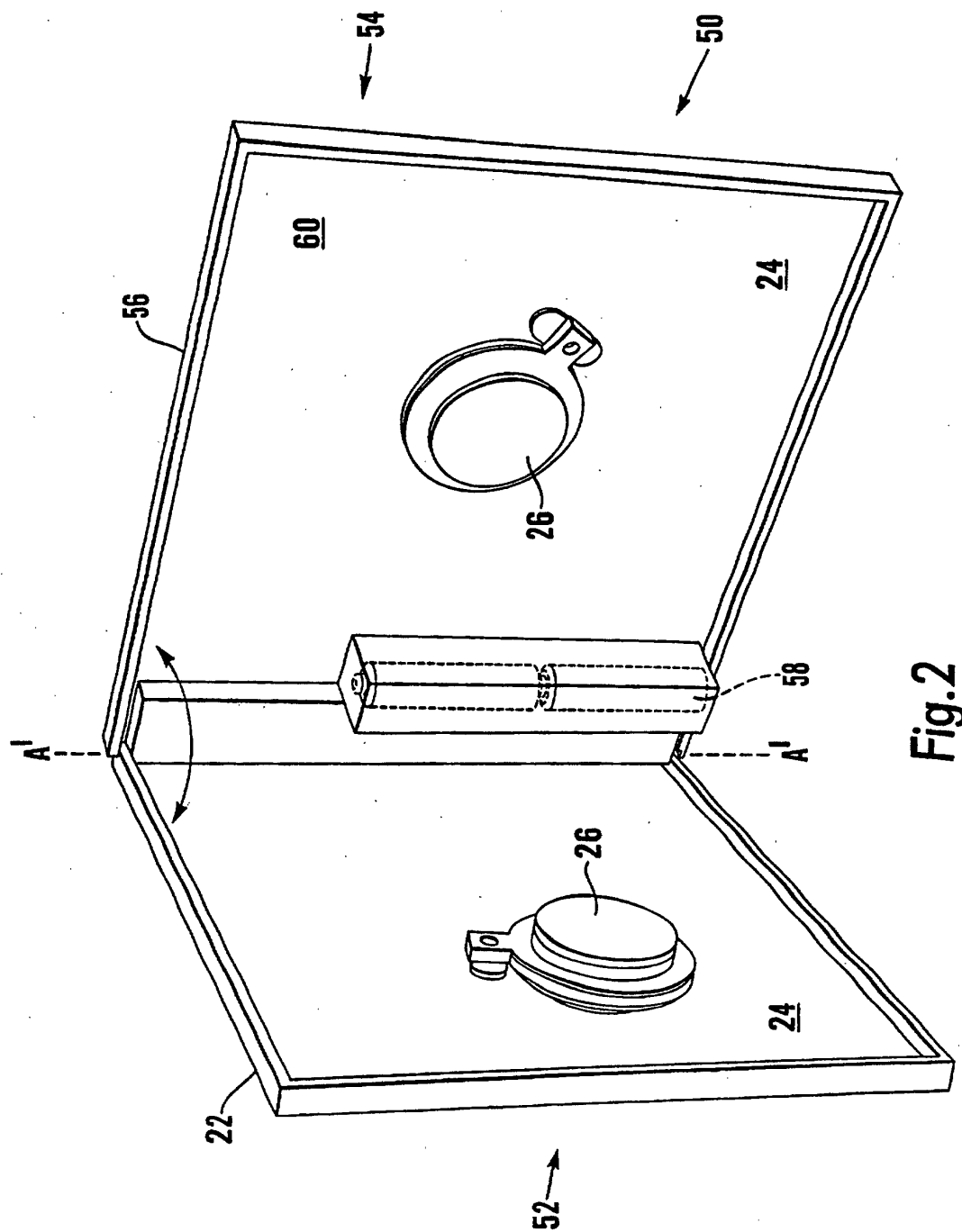


Fig. 2

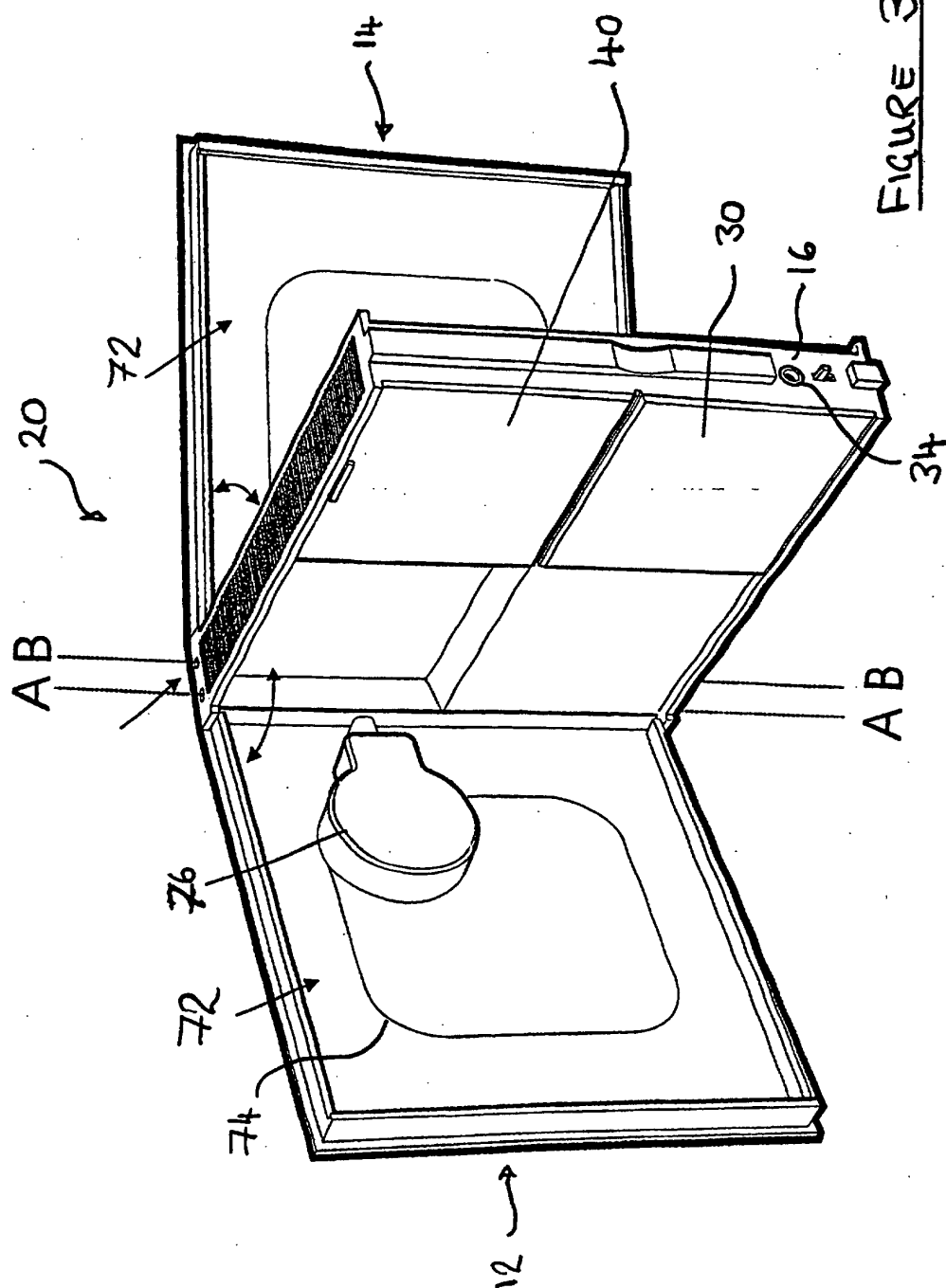
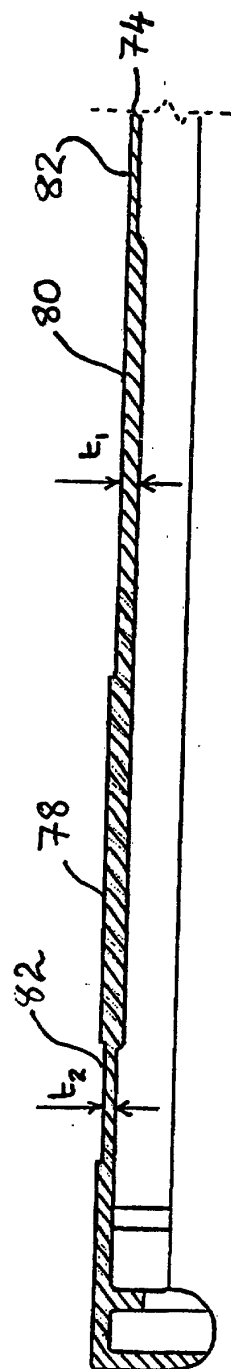
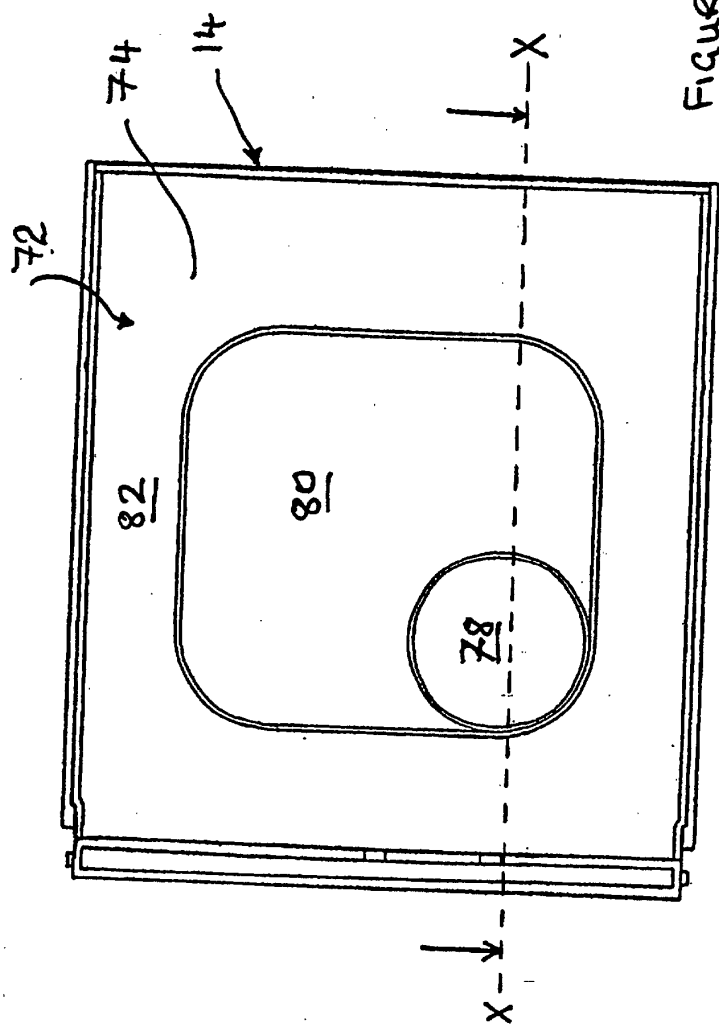


FIGURE 3



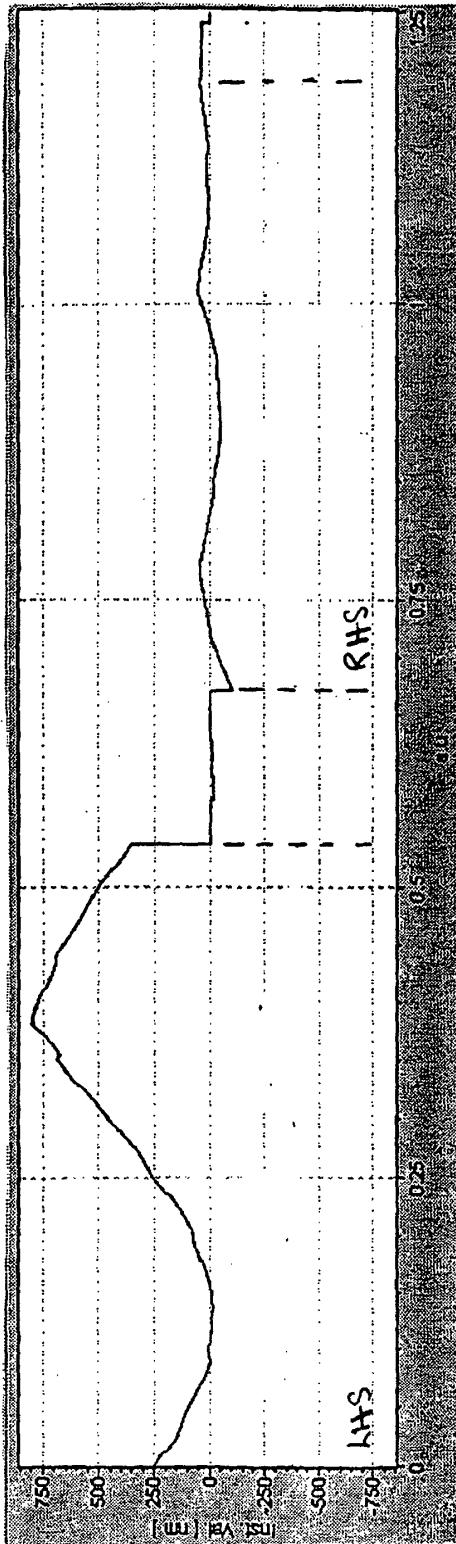


FIGURE 6a
RHS = CONTROL (UNIFORM PANEL)

LHS = FIGURE 4 GEOMETRY

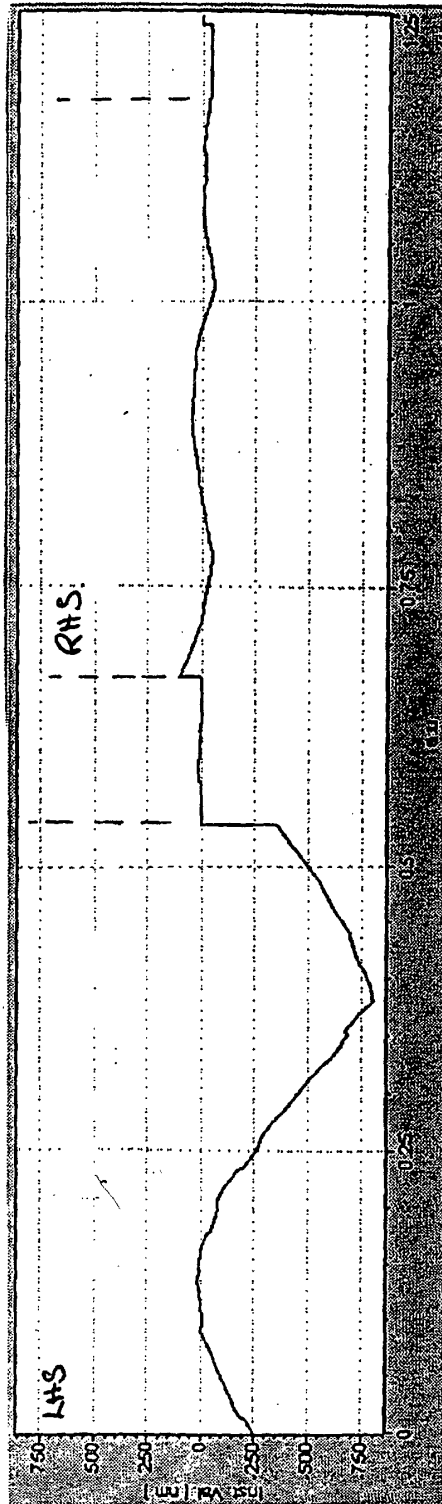


FIGURE 6b