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(62) Divisional of:
199725158

(71) Applicant(s)
Dubois Limited

(72) Inventor(s)
Stefan Alexander Pijanowski; Anthony Henry Joseph Fraser; Peter Antony Farrar

(74) Agent/Attorney
PATENT ATTORNEY SERVICES,26 Ellingworth Parade,BOX HILL VIC 3128

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ABSTRACT

APPARATUS FOR HOLDING A COMPACT DISK

The apparatus comprises: a base portion (12, 102), disk-engaging means (15,16, 104) extending from the base portion (12, 102) for releasably engaging the central hole of the disk. The compact disk is urged out of engagement with the disk-engaging means when the disk-engaging means is released. The disk-engaging means comprises resilient inwardly extending radial arms (15, 101), cantilevered from the base portion (12, 102). Pressure applied to the inner ends of the arms flexes the arms towards the base portion to move the inner ends of the arms towards each other sufficiently to release their engagement with the disk. An upstand (106) surrounds the disk and is positioned close thereto so as to restrict movement of the disk within its own plane. Finger recesses (106A) in the upstand may be formed so as to inhibit access to the edge of a disk whilst held by the apparatus but provide access thereto once the disk has been released. 3-arm release mechanisms are also described. The apparatus may be formed as a one-piece plastics moulding as a tray for insertion in a box or as part of a wall of a video-style library box.

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COMPLETE SPECIFICATION

FOR A STANDARD PATENT

ORIGINAL

Applicant(s): DUBOIS LIMITED

Actual Inventor(s): Stefan Alexander Pijanowski
Anthony Henry Joseph Fraser
Peter Antony Farrar

Address for Service: **PATENT ATTORNEY SERVICES**
26 Ellingworth Parade
Box Hill Victoria 3128
Australia

Title: APPARATUS FOR HOLDING A COMPACT DISK

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

APPARATUS FOR HOLDING A COMPACT DISK

TECHNICAL FIELD

This invention relates to apparatus for holding a compact disk. By "compact disk", in the context of this specification, is meant not only the relatively common standard 120mm diameter laser-readable disk such as are currently sold carrying, for example, pre-recorded music, computer software and data, and similar recordable disks, but also similar disks of various sizes such as are known or proposed for recording video, films, interactive games and other information or data.

BACKGROUND ART

Conventionally, when not in use, such compact disks are stored in clear polystyrene boxes, known as "jewel cases", wherein the disk is held on a separate tray fitted in the case and having seven or eight tines arranged to form a boss or "rosette" with which the aperture in the centre of a compact disk may be releasably engaged.

The legs or tines of the rosette are shaped such that they extend upwardly from the tray, curve outwardly, such that they can grip a compact disk, and then, towards their ends, curve inwardly to provide a boss over which the hole in the compact disk may be manually pushed.

It has long been recognised that such apparatus for holding a compact disk is not very satisfactory because it requires two hands to release a disk and lift it from the rosette; consequently many people do not attempt to push the centre of the rosette but instead use just one hand to grasp an outer edge of a compact disk and wrench it off the rosette thereby bending the disk, sometimes scoring the recorded surface of the disk on the tines, and eventually distorting or even breaking the tines. Such scoring of the disk can be especially critical when, as is now often the case, the disk carries compressed, or "stacked", computer software, or computer readable data.

Such apparatus also does not retain the disk securely in that the disk can be released by lifting an edge thereof and may also be released due to shock loads, e.g. during transport, rough handling or if the apparatus is dropped or is subjected to an impact.

There have been many attempts and theoretical proposals to overcome such problems and provide a more reliable and readily releasable disk-holding apparatus.

For example, EPA-0356539 proposed apparatus in which the rosette was provided with a central pushing part having cranked flap pieces arranged such that pressing down the pushing part would cause the cranked flap pieces to push a disk up and off the disk-engagement tines. EPA-0429195 proposed the use of resilient means to urge the disk out of engagement with the central boss. PCT WO-A-93/01598 proposed a release button arranged to engage all the inner ends of the legs of the rosette and a spring designed to remain with no tension during disk storage but to "pop-up" the disk should the button be pressed. US-A-5,251,750 proposes linking the inner ends of all the tines by a "live" or "living" hinge produced by a reduced thickness in the moulded material whilst also suggesting linking the button to four cranked ejection arms arranged such that depressing the button causes the ejection arms to push a compact disk off the rosette.

DE-A-3425579 discloses a disk storage cassette having a spigot arrangement for holding a disk. The spigot arrangement comprises spigot tongues which are connected by a pressure plate so that the spigot reduces in diameter when a load is applied to the pressure plate. The spigot tongues are provided with retaining or locking cams for engaging the central hole of the disk. The disk is held by the spigot in contact with a raised support on the base of the cassette.

Such prior art is of relatively complex construction so is difficult and hence expensive to manufacture and/or does not operate as easily or as reliably as may be desired. The disclosures in these prior publications, although discussed here as background to the present invention, are not necessarily commonly known in the field or industry of the invention in Australia prior to the present invention.

An object of this invention is to provide apparatus for holding a compact disk, which can be suitable for incorporating in a tray of a disk storage container and in a video style library box, which can be reliable to hold a disk and can be easily operable to release a compact disk stored thereon.

DISCLOSURE OF INVENTION

According to a one aspect of the invention there is provided apparatus for holding a compact disk having a central hole, the apparatus including: a base portion, disk-engaging means extending from the base portion for releasably engaging the central hole of the disk and arranged to support the centre of the disk away from the base portion, and disk support means on the base portion for supporting the disk at positions away from the central hole, arranged such that, when the disk engages the disk support means, the centre of the disk can be flexed towards the base portion so that, upon release of the engagement of the disk engaging means with the central hole, the disk is able to revert to its unflexed state so the centre of the disk moves out of engagement with the disk engaging means.

According to another aspect of the invention there is provided apparatus for holding a compact disk having a central hole, the apparatus including:

a base portion,

disk-engaging means extending from the base portion for releasably engaging the central hole of the disk and arranged to support the centre of the disk above the base portion, said disk-engaging means including at least two resilient arms radially extending inwardly from the base portion, each of said resilient arms having a rim or lip at its inner end arranged to engage on the upwardly facing surface of the compact disk held by the disk engaging means, and

disk support means on the base portion for supporting the disk at positions away from the central hole,

the arrangement being such that, when the disk is engaged by the disk support means, pressure applied to the inner ends of the resilient arms causes the rims or lips to depress the centre of the disk by flexing the disk downwardly until the resulting movement of the inner ends of the resilient arms towards each other is sufficient to release the engagement of the rims or lips on the upwardly facing surface of the disk, whereupon the disk reverts towards its unflexed state enabling the centre of the disk to move out of engagement with the disk engaging means.

It should be understood that apparatus according to the invention can be incorporated into a tray for fitting into a conventional "jewel case" compact disk container, or can be incorporated in a video style library box, and in either case, with the obvious exception of any separate second button and/or separate resilient ejection means of compressible material which are described later in relation to apparatus illustrated in the drawings, the tray or the box may be formed as an integral one-piece, one shot, injection moulding of a plastics material such as polypropylene or a copolymer of butadene and styrene.

Other features of this invention will be apparent from the following description and from the subsidiary claims of the specification.

BRIEF DESCRIPTION OF DRAWINGS

The various aspects of the invention will now be further described, merely by way of example, with reference to the following drawings, in which:

Figure 1 is a perspective view of a video style library box incorporating apparatus for holding a compact disk and having features which are incorporated in the embodiments of the invention;

Figure 2 is a plan view of the box shown in Figure 1;

Figures 3, 4 and 5 show a side view, underneath plan view and end view, respectively, of the box shown in Figure 1;

Figure 6 is a cross-sectional view taken on the line 6-6 in Figure 2 showing a compact disk held in the apparatus;

Figure 7 is a similar view to Figure 6 but showing the apparatus in the disk-release position;

Figure 8 is a schematic cross-sectional view of the apparatus as illustrated in the previous Figures taken partially on line 6-6 in Figure 2 and partially on line 8-8 in Figure 2 and showing a compact disk in position to be engaged with the apparatus;

Figure 9 is a perspective view of a tray incorporating apparatus for holding a compact disk fitted in a jewel-case;

Figure 10 is a cross-sectional view, corresponding to that of Figure 6, of an embodiment of the invention;

Figure 11 is a schematic magnified plan view of the release mechanism as described in relation to the apparatus of Figure 1;

Figure 12 is a plan view of another embodiment of apparatus according to the present invention;

Figure 13 is a side cross-sectional view through the apparatus of Figure 12 with a disk shown held thereon;

Figures 14A - 14D are schematic plan views of alternative forms of release mechanism which may be used in place of that shown in Figure 12;

Figure 15 is a schematic plan view of part of apparatus such as that shown in Figure 12 showing a modification thereof;

Figures 16A and 16B are sectional views taken along line A-A of Figure 15;

Figure 17 is a plan view of apparatus similar to that shown in Figure 12 but with the modification illustrated in Figure 15;

Figure 18 is a plan view of another embodiment of apparatus according to the present invention;

Figure 19 is a perspective view of the apparatus shown in Figure 18;

Figure 20 is a plan view of a further embodiment of apparatus according to the present invention;

Figure 21 is a perspective view of the apparatus shown in Figure 20;

Figure 22 is a plan view of an alternative form of release mechanism which may be used in the apparatus shown in the preceding figures;

Figure 23A is a perspective view of the release mechanism of Figure 22; and

[the next page is numbered 10]

Figure 23B is a similar view but with some parts omitted so as to reveal other parts which are concealed in Figure 23A.

BEST MODE OF CARRYING OUT THE INVENTION

The video style library box shown in Figures 1 to 8 comprises a lid portion 11, a base portion 12 and a spine portion 13, which is connected to the lid portion 11 and to the base portion 12 by living hinges 14.

Within the lid portion 11 moulded, spring clip-like, devices 11A are provided for holding a printed booklet or leaflet to be included with the disk, and within the base portion 12 is moulded a partially annular rim 12A that protects the disk should any loose booklet or the like be left in the box and also constitutes an aesthetic frame around the disk held in the box. When the box is closed, male parts 11B of a closure clip on the lid portion 11 engage with female parts 12B of the clip provided on the base portion 12.

Moulded integrally in the base portion 12 is the apparatus for holding a compact disk (a disk being shown only in Figures 6, 7 and 8), the apparatus comprising the base portion 12 of the box, two resilient inwardly extending radial arms 15 each cantilevered from the base portion 12 and interconnected at their inner ends, the inner ends being formed to provide a disk-engaging button-like member indicated generally as 16 and described in more detail hereinafter with reference to Figures 6 and 7; and four resilient inwardly extending disk ejection arms 17 also cantilevered from the base portion 12 as described in more detail hereinafter with reference to Figure 8.

The box is injection moulded in polypropylene or a copolymer of butadene and styrene, and the base portion 12 is apertured, with "cut aways", below the arms 15 and the arms 17 (as shown in Figure 4) to allow the complete box to be formed in a one-shot, one-piece, moulding; subsequently (as in conventional library style video boxes) a clear plastic sheet 18 (see Figures 3 and 4) may be welded across the outside of box, and a descriptive paper jacket or the like (not shown) may be inserted between the box and the sheet 18 to identify the contents of the box and also hide any cutaways in the base 12 of the box that might otherwise be deemed unsightly.

Referring now to Figures 6 and 7, where the two inwardly extending radial arms 15 are cantilevered from the base portion 12, the base portion 12 may, if desired, be reinforced by a thickening 19 of the moulding. The disk-engaging button-like member identified generally

as 16 is moulded as two substantially semi-circular segments 20, interconnected by an integral living hinge 21 to ensure that if either segment is depressed the other segment will also move.

Although it is preferable for the segments 20 to form together a button-like member 16, it should be understood that in some cases the segments 20 can be mechanically interconnected by, for example, a separate second button-like member (not shown).

Moreover, the outer surface of the button-like member 16 may be formed with a generally concave outer surface as indicated by the dotted line 22 such that any accidental contact on the button-like member 16 is unlikely to act against the inner ends of either of the arms 15.

The semi-circular segments 20 are preferably each moulded with a disk-retaining capping rim, or lip, 23, which overlies an aperture or cut-away 24 in the respective arm 15 to allow the capping rims, or lips, 23 to be formed during the one-shot moulding operation.

To engage a compact disk 25 on the apparatus, it is laid with its central aperture resting over the segments 20. The disk is then manually pressed towards the base portion 12 whereupon the edges of the central aperture ride over chamfered edges 20A of the segments 20. The downward pressure thus applied by the disk 25 to the segments 20 flexes the arms 15 towards the base portion 12 causing the segments 20 to move towards each other until they are able to pass through the central aperture so the arms 15 can revert to their unflexed, or substantially unflexed, positions.

As will be seen in Figure 6, the segments 20 are adapted to engage within the central aperture of a compact disk, such as shown at 25, with the capping rims, or lips, 23 securely retaining the disk 25 by engaging the upper surface thereof adjacent the central hole. To release the disk from the apparatus, pressure, such as indicated by the arrow "P" in Figure 7, is applied to depress the segments 20 and hence the arms 15 towards the base portion 12, thereby disengaging the capping rims, or lips 23 from the upper surface of the disk 25 and so allowing the disk to be disengaged from the segments 20. Due to the mechanical interconnection provided between the segments 20, it will be appreciated that even if pressure is not applied centrally to the button-like member 16, the segments will still all move so as to disengage from the central hole of the disk 25.

It will also be appreciated that in order to allow the capping rims, or lips 23 to disengage from the disk 25 without damaging the edge of the central hole thereof, at least the centre of the disk 25 must be allowed to move to some extent towards the base portion 12 as the pressure P is applied. The resilient ejection arms 17 also allow the centre of the disk 25 to be pressed towards the base portion 12 as the disk 25 is being engaged on the apparatus.

Disengagement of the disk 25 from the segments 20 is effected by the four resilient inwardly extending disk ejection arms 17 which act to move the disk 25 away from the base portion 12 when the engagement of the capping rims or lips 23 with the disk is released. The disk 25 thus "pops up" ready for removal from the apparatus. The arms 15 may also help lift the disk 25 as they revert to their unflexed positions when pressure P is removed.

As will be seen in Figure 8, the disk ejection arms 17, which are shown on the section line 8-8 in Figure 2, are cantilevered from the base portion 12 at a distance "x" at least 20mm radially outward from the centre and preferably at least 30mm therefrom, and at an angle "A" in the range 10 to 40 degrees and preferably in the range 20 to 30 degrees with respect to the base portion 12 when in the unstressed state, such that when the disk 25 is engaged by the segments 20, the arms 17 are flexed through an angle of only 5 to 20 degrees and preferably only 10 to 15 degrees and therefore are not unduly stressed and hence can reliably function over a long period. The arms 17 are each moulded with a pad-like end portion 26 adapted to engage on the annular inner area of the disk 25 that does not carry recorded information.

The ends of the arms 17 are preferably arranged to engage an area of the disk 25 approximately 5-10mm radially outward of the edge of the central hole thereof.

It will thus be appreciated that the disk 25 can be reliably and easily removed from the apparatus by simply pressing the button-like member 16 whereupon the disk 25 is released from engagement therewith and the resilient arms 17 act to lift the disk 25 a few millimetres so the disk 25 can be easily gripped by its outer edge and removed from the apparatus. The button-like member 16 is designed such that finger pressure on either part thereof will reliably release the disk 25 from engagement with the rim, or lip, 23 thereof.

The ejection arms 17 are flexed as a disk 25 is engaged on the apparatus so whilst the compact disk 25 is held in the apparatus it is resiliently supported against the underside of

the capping rims or lips 23 and away from the base portion 12 by the resilient arms 17. The disk 25 is thereby protected from undue shock loads during handling or transit. The resilient ejection means 17 also serve to support the disk 25 when pressure P is applied to the button-like member 16 and so reduce flexure of the disk whilst the capping rims or lips 23 are disengaging from the disk.

Whereas the apparatus illustrated in the drawings includes four resilient arms 17, the apparatus should include at least two and preferably at least three such arms 17 in order to provide stable support and ejection of a disk 15, and the apparatus may include more than four arms 17 although spatial limitation may restrict the number of arms 17 that can be accommodated without unduly weakening the base 12 and/or compromising the reliability of the arms 17.

Moreover, the resilient arms 17 may be omitted, and the resilient disk ejection means may comprise one or more pieces of compressible material, e.g. foam, located in a position such as that shown by the dotted circle 17A in Figure 2, to act between the base 12 and the disk 25.

As will also be seen in Figure 8, the two resilient disk-engaging arms 15, which are shown as taken on the section line 6-6 in Figure 2, are cantilevered from the base portion 12 at a distance "y" radially outward from the centre, which is preferably at least 10mm and more preferably at least 15mm, and at an angle "B" in the range 5 to 30 degrees, and preferably in the range 10-20 degrees, with respect to the base portion 12 when in the unstressed state, so that the arrangement is such that with a disk 25 engaged thereon, as shown in Figure 6, the arms 15 are flexed through an angle of 10 degrees or less and preferably 5 degrees or less thereby ensuring that the apparatus can be repeatedly and reliably operated over a very long period.

As shown in Figure 8, the arms 15, including the segments 20, have a length substantially similar to the distance "y" as the spacing between the segments 20 is typically less than 5mm. The arms preferably have a width of at least 5mm, and more preferably of 10 to 15mm, and a thickness of 1 to 2mm.

It will be appreciated that the arms 15 may have other shapes, eg they may be inclined to the base portion 12 where they are cantilevered thereto and then extend substantially parallel to the base portion 12 where they join with the segments 20.

Although the apparatus described has two arms 15, in a modified form of the apparatus (not shown) it may include three such arms each having its inner end moulded as a segment of a composite button-like disk-engaging member: and whereas even more than three such arms may be provided, it is considered that spatial limitations would prevent four or more such arms from being sufficiently sturdy to reliably withstand repeated use and would increase the difficulty of providing reliable mechanical interconnection between the ends of each of the arms.

The apparatus described above in relation to Figures 1 to 8 may also, as shown in Figure 9, be incorporated in a disk-holding tray for fitting in an otherwise conventional jewel-case. In figure 9, the jewel-case includes a conventional box portion 27 and lid portion 28 hinged together at 29 in known manner. Within the box portion 27 is inserted the apparatus for holding a compact disk, in the form of a tray, shown generally at 30, which comprises a partially annular rim 30A (of slightly different shape to that of Figure 1), a base portion 31, two resilient inwardly extending arms 32 cantilevered from the base portion 31 and interconnected at their inner ends, with the inner ends being formed to provide a disk-engaging button 33 in similar manner to the button-like member 16 of the apparatus described with reference to the previous Figures. Moreover, the jewel-case tray 30 shown in Figure 9 also includes four resilient inwardly extending disk ejection arms 34 similar to the arms 17 shown in Figure 1. Thus it should be understood that the apparatus of Figure 9 is operated and functions in similar manner to that of the previous Figures and therefore does not require further description.

In an embodiment according to the invention, the separate resilient ejection means may be dispensed with and the resilience of the disk itself used to permit the required movement for engagement of the disk with the engagement means and, on removal of the disk, to lift the disk clear of the engagement means once their engagement with the central hole of the disk as been released. This embodiment will be described with reference to Figure 10.

The apparatus shown in Figure 10 has resilient arms 15 and a button-like member 16 etc similar to those of the apparatus described above so will not be described further. Disk support means 35 are, however, provided on the base portion 12 for supporting the disk, when pressure P is applied to the button-like member 16 as described above, the support being provided at positions away from the central hole of the disk 25, and preferably at the outer edge of the disk 25 as shown in Figure 10.

The disk support means 35 are preferably arranged so that the disk 25 is held just clear of the support means 35 when the arms 15 are in their substantially unflexed positions whilst a disk 25 is held in the apparatus as shown in Figure 10. When pressure P is applied to the button-like member 16, the disk 25 is moved towards the base portion 12 until its edges engage the support means 35. Further depression of the

button-like member then presses the centre of the disk 25 towards the base portion 12 so the centre of the disk is flexed downwards until the capping rims or lips 23 release their engagement with the disk 25 and the disk is free to revert to its unstressed state whereupon the centre of the disk is able to move away from the base portion 12 and the disks 25 "pops up" ready from removal from the apparatus. As in the apparatus described above, the arms 15 also help lift the disk 25 once the button-like member 16 has been pushed through the central aperture to the underside of the disk and the pressure P removed.

If the disk is supported at at least three, and preferably six, locations around its periphery, the flexure is distributed around the entire disk so that it flexes in a substantially similar manner to the flexing of a diaphragm.

Figure 11 shows a plan view of two disk engaging arms 101 such as that disclosed in GB-A-2291640, cantilevered from a base portion 102 and connected thereto at hinge lines 103. The inner end of each arm is provided with a semi-circular contact portion 104 which together form a substantially circular button-like member over which the central aperture of a disk (not shown) is fitted. Each contact portion 104 carries a lip or projection 104A for securely retaining a disk by engaging on an outwardly facing surface thereof. The disk is released by depressing the button-like member towards the base portion which causes the contact portions 104 and hence the projections 104A to move towards each other until the engagement of the projections 104A on the disk is released.

Although this release mechanism functions satisfactorily, it can be improved in a number of ways, particularly to reduce the risk of accidental release of the disk therefrom.

One problem with the apparatus shown in Figure 11 is that if a force is applied in the plane of the disk in the direction A, i.e. perpendicular to the arms 101, this force causes the disk to engage both contact portions and apply forces to them as illustrated by the arrows B. Such forces tend to push both contact portions 104 inwardly, i.e. towards each other, and downwardly (towards the base portion 102) with the result that the disk can be released. In the example shown in Figure 11, the gap between the contact portions is relatively small but in real life the gap may be much wider so making this problem worse. This is a significant disadvantage as forces can be applied in the direction A due to mishandling of the disk or shock loads, e.g. if the apparatus is dropped or receives a blow on the side.

It should be noted that references in this specification to forces applied to a disk include not only forces applied directly to the disk but also inertial forces which cause the disk to move in a similar way, e.g. when the apparatus is subjected to an impact.

It has been discovered that one way of reducing the possibility of the disk being released in this way is to arrange the contact portions 104 so that at least the majority of any force applied in the direction A is transmitted by the disk to only one of the contact portions 104.

This can be achieved by arranging the contact portions 104 so that the ends of the gap between them lie away from the perpendicular to the length of the arms 101. Figures 12 and 14 show various possible shapes of the contact portion 104 which achieve this.

There are a number of reasons why such an arrangement of the contact portions helps reduce the risk of the disk being released by forces applied within the plane of the disk and, in particular, in a direction perpendicular to the length of the arms 101. Firstly, as the force (or at least a majority of the force) A acts on only one of the contact portions, the tendency for the contact portions to be squeezed together is avoided or reduced. Also, as the gap between the contact portions 104 does not lie on this perpendicular, the contact portions can be formed to be a very close fit within the disk aperture in this direction so as to reduce the scope for lateral movement of the disk in this direction to a minimum.

Furthermore, if a force is applied in direction C shown in Figure 104A, i.e. at the end of the gap between the contact portions 104, the tendency for such a force to cause the disk to release compared with a force in direction A acting on the arrangement shown in Figure 11 is much reduced. Again, there are a number of reasons for this. As the gap between the

contact portions is no longer perpendicular to the length of the arms 101, the width of the gap can be reduced as the inward movement of the contact portions 104 when the button-like member is depressed will be in a direction at an angle across the gap. The consequent reduction in the width of the end of the gap where the force C may be applied reduces the pinching effect of such a force as well as reducing the scope for movement of the disk perpendicular to the gap. Furthermore, a force in direction C will have a much reduced tendency to deflect the arm 101 as it is no longer perpendicular to the length of the arm 101. A force in direction C is resisted by the arm 101 as one component of the force is trying to stretch the arm. Furthermore, a force in direction C also acts to hold the disk more tightly under the projection 104A on that side of the button-like member and so the disk is retained more securely rather than having a tendency to be released.

It will be appreciated that the projections 104A are only provided on the side of the contact portion 104 in line with the arms 101 so they move inwardly when the button-like member is depressed to release the disk. For this reason, the prior art arrangement shown in Figure 11 is particularly vulnerable to a force applied in the direction A as such a force has no component which acts to hold the disk under either of the projections 104A.

As mentioned above, the contact portions 104A can have a variety of shapes to achieve the above advantages. The gap between the contact portions may be a simple straight line at, for example, approximately 45-70 degrees to the length of the arms 101 as shown in Figure 14A. Alternatively, the dividing line between the contact portions 104 may have a curved or sinusoidal shape. Figures 12 and 14B show examples of the latter where the contact portions 104 have a shape resembling the "yin-yang" symbol. The ends of these dividing lines still lie away from the perpendicular to the length of the arms 101 and are preferably positioned as close as possible to the arms 101.

Figure 14C shows a further arrangement in which the dividing line is substantially V or U-shaped and Figure 14D shows a further variant of this in which the dividing line follows a more curved form.

The width of the gap between the contact portions 104 is preferably 1.5mm or less and most preferably 1.0mm or less.

A further advantage of the arrangements described above is that the contact portions can be arranged to increase the likelihood that both portions are contacted when the

button-like member is engaged by a finger tip (and so give more reliable operation of the disk release mechanism). If the diagonal dividing line shown in Figure 14A is arranged in the orientation shown so that it extends from the top left to the bottom right when a case incorporating the apparatus is open in the orientation shown in Figure 12, a right-handed person tends to extend their right index finger in a similar direction to this diagonal line so their finger tip will usually bridge the dividing line.

The other shape contact portions 104 shown in Figures 12 and 14B-14D are also designed so that, with a typical adult finger, it is difficult to press the button-like member without engaging both contact portions.

A yet further advantage of the arrangements described above, is that the dividing line between the contact portions, particularly in the central region of the button-like member, is no longer perpendicular to the length of the arms 101 so any tendency for a finger pressing the button-like member to be pinched by the gap as the contact portions 104 move towards each other is reduced. It will be appreciated that in the arrangements shown in Figures 14C and 14D, the dividing line does not pass across the central region of the button-like member so the possibility of the finger being pinched in this way is further reduced.

In addition to the above features, it is important to accurately form the button-like member so that it is a close fit within the central aperture of the disk (which has a 15mm diameter in the conventional 120mm diameter disk) in order to minimise the scope for movement of the disk within the plane of the disk whilst it is held on the apparatus. To this end, in the direction parallel to the length of the arms 101, the diameter of the button-like member immediately beneath the projection 104A when the disk is held thereon is preferably as close a match as possible to the diameter of the disk's aperture (which is typically 15mm) so as to avoid or minimise any play therebetween and avoid or minimise any stress applied to the aperture. Preferably the disk is free to rotate on the button-like member although lateral movement of the disk, i.e. within the plane of the disk, on the button is prevented or minimised.

In the direction perpendicular to the length of the arms 101, the contact portions 104 are again sized to be as close a fit as possible within the aperture of the disk so as to avoid or minimise the scope for movement of the disk in this direction and avoid or minimise any stress applied to the aperture.

The projections 104A preferably project from the sides of the contact portions and preferably project therefrom by between 0.5 and 1.0mm. Each projection also preferably extends around an arc on the edge of the respective contact portion so as to subtend an angle of between 30 and 90 degrees at the centre of apparatus.

The apparatus described herein in relation to Figure 11 onwards has a number of other important differences over the apparatus described in relation to Figures 11 to 20.

Figures 11 to 20 relate to the use of resilient ejection means for urging the disk out of engagement with the disk engaging means when the rims or lips release their engagement on the disk, for example, further arms resiliently cantilevered from the base portion or one or more pieces of compressible material.

Such resilient ejection means may be used in the apparatus described herein in relation to Figure 11 onwards. However, instead of or in addition to such resilient means, it has been discovered that the resilience of other parts of the apparatus, e.g. the arms 101 or the base portion 102, and, in particular, the resilience of the disk itself can be used to provide a similar ejection function. The apparatus is thus preferably arranged so that as the button-like member is depressed to release the disk, part of the apparatus and/or the disk is flexed so that elastic energy is stored therein and, when the engagement of the projections 104A is released, the said part and/or disk reverts to its unstressed state and causes at least the central portion of the disk to move so the projections 104A pass through the central aperture of the disk.

One simple way of achieving this is to provide supports 105 adjacent the periphery of the disk so that when the button-like member is depressed, the disk is moved towards the base portion 102 until its periphery engages the supports 105. Further depression of the button-like member to release the disk thus presses the centre of the disk towards the base portion 102 relative to the periphery of the disk whereby the disk undergoes elastic deformation. Once the projections 104A have moved inwardly sufficient to release their engagement on the outwardly facing surface of the disk, the disk is free to revert to its unstressed, flat shape whereupon the central portion of the disk moves, or "pops up", so it is not re-engaged by the projections 104A or button-like member when the user's finger is removed.

In the embodiment shown in Figure 12, support is provided at the periphery of the disk by raised surfaces 105 formed on the base portion 102.

The arrangement is preferably such that when a disk is held in the apparatus, the arms 102 support the disk clear of the support 105. The disk is thus held in an unstressed state and is free to rotate on the button-like member. Alternatively, the arrangement may be such that when a disk is held in the apparatus, the periphery of the disk is or is almost in contact with the support 105. It is also possible for the arrangement to be such that when a disk is installed on the apparatus it is held in a slightly flexed state and reverts to a flat shape when its engagement with the projections 104A is released.

Figure 13 shows a cross-sectional view of the apparatus shown in Figure 12 and shows a disk 110 held on the apparatus. This Figure shows the disk being held so that its periphery rests lightly on the supports 105 and the centre of the disk 110 is supported clear of the base portion 102 by the arms 101, preferably 2-3mm clear of the base portion 102.

The supports 105 also limit the extent by which the peripheral portion of the disk can be pressed towards the base portion. A further problem of the apparatus described in relation to Figures 11 to 20 is that by pressing the edge of the disk towards the base portion it is sometimes possible to prise the disk off the apparatus even though the button-like member has not been fully depressed. Accordingly, by limiting the scope for movement of the periphery of the disk towards the base portion, preferably in combination with an upstand (described further below) which limits the scope for lateral movement of the disk, this problem can be overcome or at least minimised.

The contact portions 104 may be mechanically interconnected, e.g. by a "living hinge" or a further button-like member. However, although this can be advantageous in some circumstances, it is not always possible or desirable. A living hinge can be formed between the contact portions if the apparatus is made of a resilient (typically crystalline) plastics material such as polypropylene and, indeed, this material is used to form apparatus as described herein when the apparatus is formed as an integral part of an enclosure for housing the disk. In some cases, such apparatus may, if desired, be provided with a mechanical interconnection between the contact portions, e.g. in the form of a living hinge, but in other cases no such interconnection is provided so the contact portions are separate from each other.

It is also desirable to form the apparatus described herein as an insert or "tray" for inserting within a separate casing. The conventional "jewel box" mentioned above comprises a clear plastics casing with the disk-holding rosette formed on a tray inserted therein. The apparatus described herein may also be formed on a similar type of tray for inserting in a conventional clear plastics casing. Such inserts or trays are preferably made of an amorphous plastics material, such as styrene, as this has the required rigidity to hold its shape when formed into a relatively flat, tray-like article and is capable of being formed into more precise and intricate shapes. However, it is not always possible to form a living hinge that will survive repeated use in such a rigid material.

Accordingly, the apparatus described herein may also be provided in the form of an insert or tray formed from an amorphous plastics material with the respective contact portions 104 separate from each other but together forming a button-like member suitable for engagement by a finger tip. Nevertheless, in some circumstances, it is possible to form living hinges between the contact portions of apparatus formed of an amorphous plastics material.

An advantage of using contact portions 104 which are not interconnected, is that any tendency for one portion to pull the other one down if one portion is subjected to a lateral force such as A or C described above, is also avoided.

In such an arrangement, the contact portions 104 are also preferably shaped so as to increase the likelihood that both portions are contacted when the button-like member is depressed by a finger tip (as described above) to help ensure the release mechanism operates easily and reliably.

Another way of reducing the risk of accidental release of a disk due to forces applied in the plane of the disk, is to provide an upstand 106 surrounding or partially surrounding the disk when it is held in the apparatus so as to restrict access to the peripheral edge of the disk. The upstand 106 thus forms a "nest" in which the disk is held. The upstand 106 thus acts to obstruct access to much of the edge of the disk (except at finger cut-outs 106A which are provided to assist in lifting a disk out of the apparatus once it has been released) in order to further reduce the risk of forces being applied to the disk within the plane thereof. The upstand 106 is positioned close to the periphery of the disk (e.g. with a clearance of 0.5mm

or less) so as to provide further restriction on the scope for movement of the disk within its own plane.

Such an upstand may be used in apparatus having any form of release mechanism, e.g. any of the forms illustrated in Figures 11 - 44 or described below with reference to Figures 18 - 23. The support 105 described above may be formed as a step in the side of the upstand 106.

In the arrangement shown in Figure 12, there is a gap in the upstand 106 at either side of the apparatus, each gap extending through about 40 degrees around the periphery of the disk. These gaps are provided to reduce the width of the apparatus. This is, for example, required so the apparatus made in the form of an insert or tray can be fitted into an enclosure of conventional size. The disk is clearly more vulnerable to lateral forces in the area of these gaps. However, it will be appreciated that by shaping the contact portions 104 so that the ends of the gap between the contact portions fall on a line which does not coincide with the gaps in the upstand 106, this potential problem can be avoided. These gaps may also be closed by the sides of the container or its lid when this is closed. As the upstand 106 surrounds the majority of the disk and is positioned close thereto, it is still effective in reducing the scope for movement of the disk within its own plane despite the presence of these gaps.

The apparatus described herein thus enables a disk to be securely held by simply placing the disk on the apparatus so that its aperture lies over the button-like member. The disk is then pressed towards the base portion 102 whereupon the button-like member is depressed causing the contact portions 104 and the projections 104A to move towards each other until the button-like member is able to pass through the aperture. Once the projections 104A have passed through the aperture, the arms 101 revert to or towards their unstressed position so that the projections 104A engage upon the outwardly facing surface of the disk and thus securely retain the disk on the apparatus.

The apparatus is designed so that the disk can be easily released by depressing the button-like member but is otherwise very difficult to remove other than by forcing it to the extent that the apparatus and/or the disk is damaged.

Whilst held by the apparatus, the disk is supported away from the base portion 102 by the arms 101 and/or the button-like member. As the arms flex principally about the hinge

lines 103 which are at a greater radius from the centre of the apparatus than the projections 104A, any attempt to prise or wrench the disk off the apparatus will cause the arms 101 to flex further from the base portion about the hinge lines 103 and thus tighten their engagement with the disk.

The arms 101 themselves are preferably relatively stiff so movement thereof occurs principally by means of flexing about the hinge lines 103 rather than flexing of the arm itself or of the contact portions 104 relative to the arm 101.

As indicated above, the disk is released by simply depressing the button-like member whereby the arms 101 flex towards the base portion 102. The disk itself must also be allowed to move towards the base portion 102 with the arms until the projections 104A have moved inwards sufficiently to release their engagement on the outwardly facing surface of the disk.

As described above, the shape of the contact portions 104 of the button-like member and/or the provision of an upstand immediately adjacent the edge of the disk help to reduce the risk of the disk being accidentally released by forces applied in the plane of the disk.

The apparatus shown in Figure 12 is preferably formed as an integral, one-shot plastics moulding.

Further improvements and features of the upstand 106 will now be described.

As indicated above, the apparatus is provided with an upstand 106 for surrounding or partially surrounding a disk held in the apparatus so as to restrict access to the peripheral edge of the disk. The upstand 106 thus acts to obstruct access to much of the edge of the disk, except at finger cut-outs 106A which are provided to assist in lifting a disk out of the apparatus when it has been released, to reduce the risk of forces being applied to the disk within the plane thereof. The upstand 106 is preferably positioned close to the periphery of the disk (eg with a clearance of 0.5mm or less) so as to restrict the scope for movement of the disk within its own plane.

A potential problem with apparatus such as that shown in Figure 12 is that users unfamiliar with the apparatus may be tempted to use the finger recesses 106A to try to grip the edge of the disk and attempt to wrench the disk off the button-like member without depressing the button-like member 104 and in doing so they are likely to damage the disk and/or the apparatus.

Figure 15 is a schematic plan view of a finger recess 106A similar to those shown in Figure 12 but which is formed such that when a disk 110 is held in the apparatus a part 106B of the upstand 106 extending across the finger recess 106A prevents or inhibits access to the edge of the disk 110 so that a user cannot use the finger recess to attempt to grip the disk by its edges.

Figure 16A is a cross-sectional view of the finger recess 106A shown in Figure 15 and shows the position of the disk when it is held by the disk-engaging means. As shown, the disk is preferably held just clear of the step or support 105 provided on the inner side of the upstand 106 but is at a position level with or beneath the top of the part 106B. The upstand 106, and the parts 106B thereof across the recesses 106A thus prevent access to the edge of the disk.

However, after the disk has been released from the disk-engaging means by depression of the button-like member 104, an ejection mechanism (as described above) causes the disk to be lifted so it is supported on or slightly above the button-like member 104 so that the periphery of the disk stands proud of the upstanding portion 106B as shown in Figure 16B. The user can then make use of the finger recesses 106A to grip the edge of the disk 110 in order to lift it from the apparatus.

It will be appreciated that, compared to the arrangement shown in Figure 12, the finger recesses shown in Figure 15 are modified so that they do not extend through to the inner side of the upstand 106 so the upstand 106 is not interrupted by the recesses. This is achieved by providing a relatively thin wall or upstand 106B across the inner end of each finger recess 106A as shown in Figure 15.

Figure 17 is a plan view of apparatus similar to that shown in Figure 12 but with the addition of walls 106B across the inner ends of the finger recesses 106A to prevent access to the periphery of the disk until the disk is lifted clear of the walls 106B following release of the disk-engaging means.

As described above, to enable the disk 110 to be lifted from the apparatus it must be moved to a raised position following its release so that it stands proud of the part 106B of the upstand 106. It is found that access to the edge of the disk is sufficient to enable it to be lifted, it not being necessary for the user's fingers to engage the underside of the disk. Thus, to enable the disk to be lifted away from the apparatus it is merely necessary for the disk to

be moved, following its release from the disk-engaging means, to a position where it stands just clear of the top of parts 106B of the upstand 106, preferably with the underside of the disk 110 just clear of the top of parts 106B.

The top of the parts 106B of the upstand may be at the same level as the top of the remainder of the upstand 106 or may be at a slightly lower position than the top of the remainder of the upstand 106.

When the disk 118 is held by the disk-engaging means, the upper surface of the disk 110 preferably lies at substantially the same level as the top of the parts 106B or may lie slightly below the level of the top of the remainder of the upstand 106 to prevent access to the edge of the disk 110. However, in other arrangements, when the disk 110 is held by the disk-engaging means, its upper surface may lie at a higher level than the top of the parts 106B as the form of the upstand 106 and/or recesses 106A may be such as to prevent a user's finger from being able to grip the edge of the disk as only the upper corner at the periphery of the disk can be touched. However, following release of the disk 110, it is lifted so the bottom surface of the disk 110 lies at a similar level to or above the level of the top of the parts 106B so the edge of the disk 110 can be gripped by a user's fingers.

Figures 18 and 19 show a further embodiment of apparatus for holding a compact disk. This embodiment is designed for holding a digital video disc (DVD) and the base portion 102 thus has a shape and size similar to that of a conventional video box.

The disk release mechanism illustrated in Figures 18 and 19 is similar to that described in relation to Figures 11 to 20. The two halves of the button-like member may be joined by a living hinge as shown or may be unconnected.

The upstand 101-106 shown in Figures 18 and 19 is similar to that of Figure 12 except that it is continuous, i.e. it extends the full 360 degrees around the periphery of the disk and, in the arrangement shown, no finger recesses are provided.

A support 105 is provided in the form of a step on the inner edge of the upstand 106 as in Figure 12 except this is also continuous, i.e. extends the full 360 degrees around the periphery of the disk.

The apparatus shown in Figures 18 and 19 functions in a manner similar to that shown in Figure 12. When a disk is held on the apparatus, the upstand, being positioned immediately adjacent the periphery of the disk, obstructs access to the edge of the disk to

prevent forces being applied to the disk in the plane thereof and to inhibit finger access to the edge of the disk and also serves to restrict scope for movement of the disk within the plane of the disk. It is therefore very difficult for the disk to be released from the mechanism either accidentally or intentionally other than by depressing the button-like member 104 at the centre of the disk.

When the button-like member 104 is depressed, the centre of the disk is flexed downwards by the action of the projections 104A of the button-like member 104 as the periphery of the disk is supported on the support 105 until the engagement of the projections 104A on the disk are released and the button-like member is able to pass through the central hole of the disk. The centre of the disk then "pops up" as the disk reverts to its flat, unflexed state whereby the centre of the disk is raised to prevent it being re-engaged by the button-like member when the user's finger is removed therefrom. The disk then rest lightly on the top of the button-like member 104 and its projections 104A and in this position its edges are held clear of the upstand 106 so a user's fingers can engage the edges of the disk to lift it away from the apparatus.

Figures 20 and 21 show another embodiment of apparatus for holding a compact disk similar to that shown in Figures 18 and 19 but with a 3-arm release mechanism instead of a 2-arm release mechanism, and mounted on a substantially square base portion 102 rather than a rectangular base portion. As shown, the three arms 101 are equi-angularly spaced from each other.

Each of the three arms 101 is cantilevered from the base portion 102 and connected thereto at a hinge line 103. The inner ends of the three arms 101 together form a button-like member comprising a triangular portion 120 each side of which is connected to a segment-shaped portion 121 by a living hinge 122. The three segment-shaped portions 121 together form a substantially complete circular shape over which the central hole of a disk 110 can be fitted. A lip or projection 121A for engaging on the outwardly facing surface of the disk 110 projects from the curved side of each segment-shaped portion 121. The lips 121A preferably project 0.5 - 1.0mm from the portions 121.

Depression of the triangular portion 120 towards the base portion 102 causes the three segment-shaped portions 121 to move towards each other, i.e. towards the centre of the triangular portion 120, until the projections 104A are moved out of engagement with the

outwardly facing surface of the disk 110 so as to release their engagement with the disk. In all other respects, this apparatus functions in a similar manner to that shown in Figures 18 and 19.

The base portions 102 shown in Figures 18 - 21 may form part of a casing or may form a tray for insertion into a casing. In a further arrangement, the base portion 102 may be affixed, e.g. by adhesive, to one half of a folded cover (not shown) e.g. formed of cardboard, the other half being arranged, when folded over, to cover a disk held on the apparatus.

For the latter arrangement, the rear side of the base portion 102 is preferably substantially flat so as to facilitate its adhesion to the folded cover. The rear sides of the base portions shown in Figures 18 - 12 may be formed flat apart from a circular recess corresponding to the circular upstand 106 and a central cut-out where the release mechanism is formed.

A further upstand in the form of a wall 123 is provided around the periphery of the base portion 102. The wall 123 is preferably slightly higher than the upstand 106 so when the folded cover mentioned above is closed, the cover does not lie in contact with the disk. As shown in Figure 12, the wall 123 may form part of the upstand 106 where the upstand 106 meets the wall at the edge of the base portion.

Figure 22 is a plan view of another version of a 3-arm release mechanism which may be used in any of the other embodiments described above. In this case, the inner ends of the arms 101 are each provided with a sector-shaped portion 125 which together form a circular button-like member. The three sector-shaped portions 125 are separate from each other, i.e. they are not connected by living hinges. Each of the sector-shaped portions 125 has a projection 125A for engaging a disk.

Figure 23A is a perspective view of the 3-arm release mechanism shown in Figure 12.

Figure 23B is a similar view but with the arms 101 and sector-shaped portions 125 omitted so as to more clearly show a three-armed re-inforcing portion 126 provided across the cut-out in the base portion 102 underneath the release mechanism.

The apparatus shown in Figures 20 and 21 is suitable for making in a resilient crystalline plastics material and the apparatus shown in Figures 22 and 23 is suitable for making in an amorphous plastics material.

In each of the embodiments described in relation to Figures 18 - 21, the upstand 106 is again preferably positioned so as to be immediately adjacent the edge of a disk held on the apparatus so as to prevent movement of the disk in its own plane and to provide the other functions described above.

Figures 18 - 21 show a continuous upstand 106 without finger recesses. However, in other arrangements (not shown) some areas of the upstand may be of slightly reduced height to facilitate finger access to the edge of the disk once it has been released so making it easier to grip the disk to lift it clear of the apparatus. Four localised areas of reduced height may, for instance, be provided in the upstand, each extending over a length of upstand subtending an angle of about 20 degrees at the centre of the apparatus. These areas are preferably equi-angularly spaced from each other and preferably located in areas of the upstand nearest the corners of the base portion 102.

In the apparatus described in relation to Figures 18 - 21, the support 105 preferably comprises a raised surface substantially parallel to the base portion (and to the plane of a disk held thereon). The raised surface may, for instance, be at a level 2 - 3mm above the base portion 102 and have a width of about 2mm. The upstand 106 extends about 0.5 to 1.5mm, and preferably about 1mm, above the raised surface 105 (a compact disk typically has a thickness of about 1mm).

It should be noted that the degree of flexing of a disk required to cause the centre of the disk to rise or "pop up" sufficiently on release of the disk to prevent re-engagement thereof by the disk engaging mechanism may be relatively small. In some embodiments with a typical disk having a diameter of approximately 120mm the centre may be flexed approximately 0.5 - 1.0mm relative to the periphery thereof whereas in other embodiments the centre may flex 1.0 - 3.0mm. Similarly, the periphery of the disk need be raised by only a relatively small amount to lift it sufficiently relative to the upstand to enable the edges of the disk to be grasped. In some embodiments, this movement may be as small as 0.5 - 1.0mm whereas in other embodiments it may be 1 - 5mm.

As mentioned above in the description of various Figures, at least the base portion, the ejection arms (when provided) and the radial arms, may be formed as an integral plastics moulding and preferably the entire disk-holding tray or the video style library box is formed as a one-shot, integral moulding.

It will also be appreciated from the above that the apparatus for holding a disk may be provided in a video-style library box, preferably integrally moulded with a wall thereof as illustrated, or may be provided in some other form of box or enclosure either integrally moulded therewith or as an insert or tray installed therein.

The claims defining the invention are as follows:

1. Apparatus for holding a compact disk having a central hole, the apparatus including: a base portion, disk-engaging means extending from the base portion for releasably engaging the central hole of the disk and arranged to support the centre of the disk away from the base portion, and disk support means on the base portion for supporting the disk at positions away from the central hole, arranged such that, when the disk engages the disk support means, the centre of the disk can be flexed towards the base portion so that, upon release of the engagement of the disk engaging means with the central hole, the disk is able to revert to its unflexed state so the centre of the disk moves out of engagement with the disk engaging means.

2. Apparatus as claimed in claim 1, wherein said disk-engaging means includes at least two resilient arms radially extending inwardly from the base portion.

3. Apparatus as claimed in claim 2, wherein the at least two resilient arms, in their unflexed states, extend in cantilevered manner away from the base portion such that the disk engaged by said disk-engaging means is supported away from the base portion.

4. Apparatus as claimed in claim 2 or 3 wherein said disk-engaging means includes three resilient arms radially extending inwardly from the base portion.

5. Apparatus as claimed in any preceding claim further including rims or lips provided by said disk-engaging means, wherein upon depression of said disk-engaging means, the rims or lips press the centre of the disk towards the base portion so the centre of the disk is moved downwards until the rims or lips release their engagement with the disk.

6. Apparatus as claimed in claim 5, wherein said rims or lips in use securely retain the disk by engaging on the upwardly facing surface of the compact disk held by the disk engaging means.

7. Apparatus as claimed in claim 2, 3 or 4 wherein each of said resilient arms has a rim or lip at its inner end arranged to engage on the upwardly facing surface of the compact disk held by the disk engaging means such that pressure applied to the inner ends of the resilient arms causes the rims or lips to depress the centre of the disk until the resulting movement of the inner ends of the resilient arms towards each other is sufficient to release the engagement of the rims or lips on the upwardly facing surface of the disk.

8. Apparatus for holding a compact disk having a central hole, the apparatus including:

a base portion,

disk-engaging means extending from the base portion for releasably engaging the central hole of the disk and arranged to support the centre of the disk above the base portion, said disk-engaging means including at least two resilient arms radially extending inwardly from the base portion, each of said resilient arms having a rim or lip at its inner end arranged to engage on the upwardly facing surface of the compact disk held by the disk engaging means, and

disk support means on the base portion for supporting the disk at positions away from the central hole,

the arrangement being such that, when the disk is engaged by the disk support means, pressure applied to the inner ends of the resilient arms causes the rims or lips to depress the centre of the disk by flexing the disk downwardly until the resulting movement of the inner ends of the resilient arms towards each other is sufficient to release the engagement of the rims or lips on the upwardly facing surface of the disk, whereupon the disk reverts towards its unflexed state enabling the centre of the disk to move out of engagement with the disk engaging means.

9. Apparatus as claimed in any preceding claim in which the disk support means is arranged to support the disk at a plurality of locations around the outer edge thereof when pressure is applied to the centre of the disk.

10. Apparatus as claimed in claim 9 in which the disk support means extends 360 degrees around the disk-engaging means.

11. Apparatus as claimed in claim 9 or 10 in which the disk support means is at a level 2 to 3 mm above the base portion.

12. Apparatus as claimed in any one of claims 9 to 11 having an upstand extending around the outer edge of the disk support means so as to at least partially surround the peripheral edge of the disk whilst it is held in the apparatus, the upstand being positioned sufficiently close to the periphery of the disk as to restrict the scope for movement of the disk within its own plane.

13. Apparatus as claimed in claim 12 in which the disk support means comprises a step on the inner side of the upstand.

14. Apparatus as claimed in any preceding claim in which the disk-engaging means holds the disk clear of the disk support means when engaged with the central hole of the disk.

Dated this 15th day of June 2004
PATENT ATTORNEY SERVICES
Attorneys for
DUBOIS LIMITED

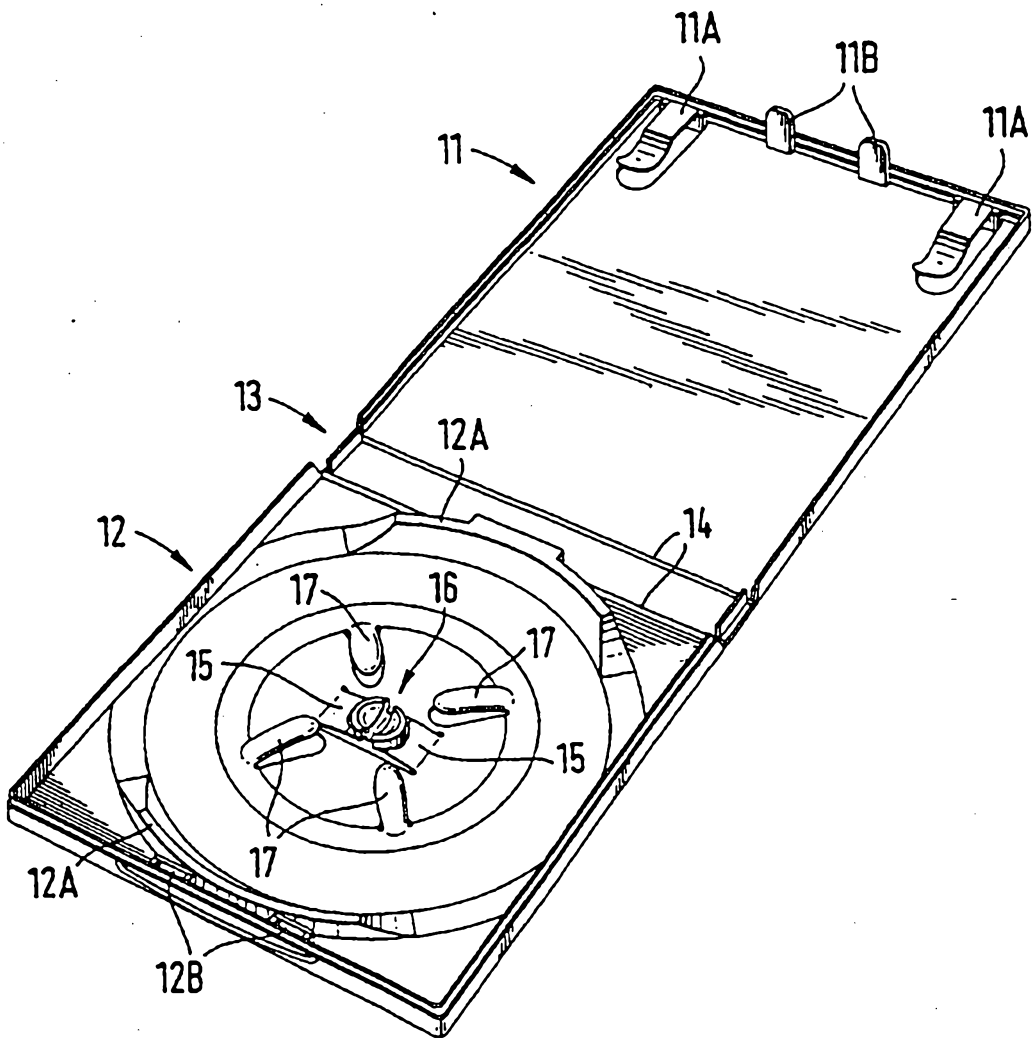


Fig. 1

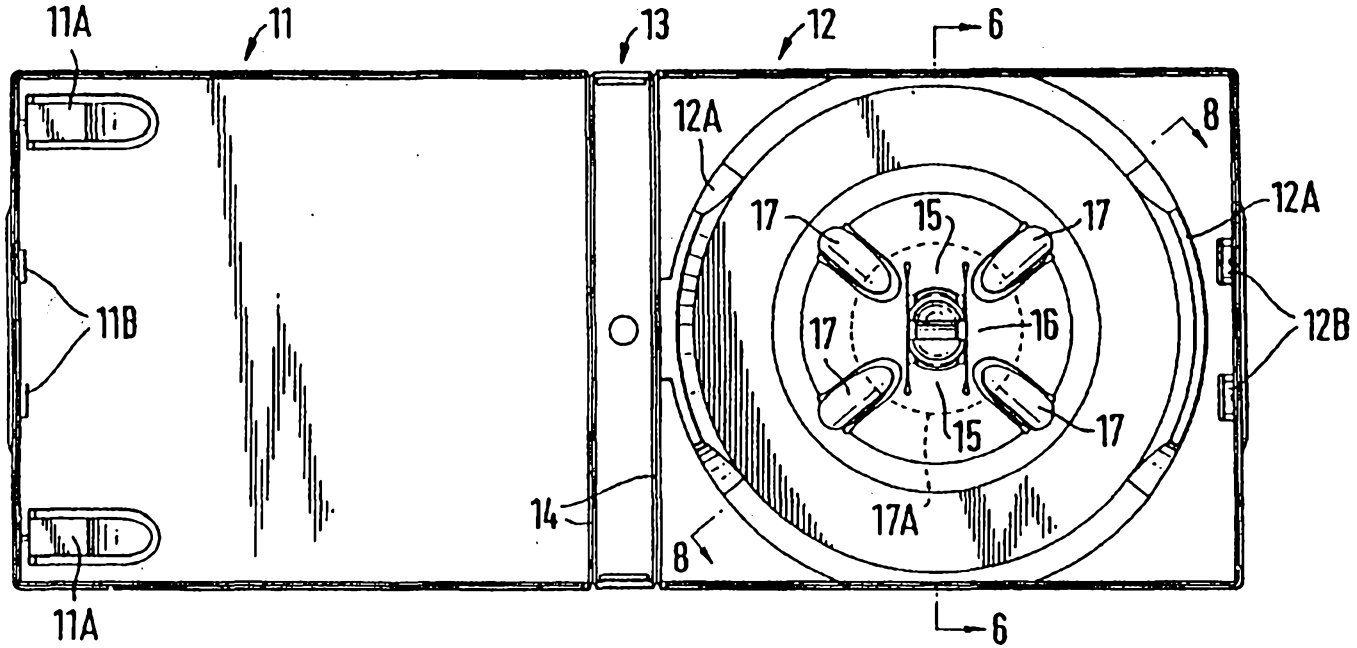


Fig. 2

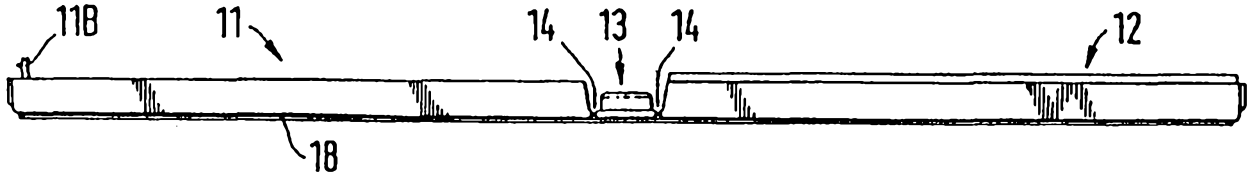


Fig. 3

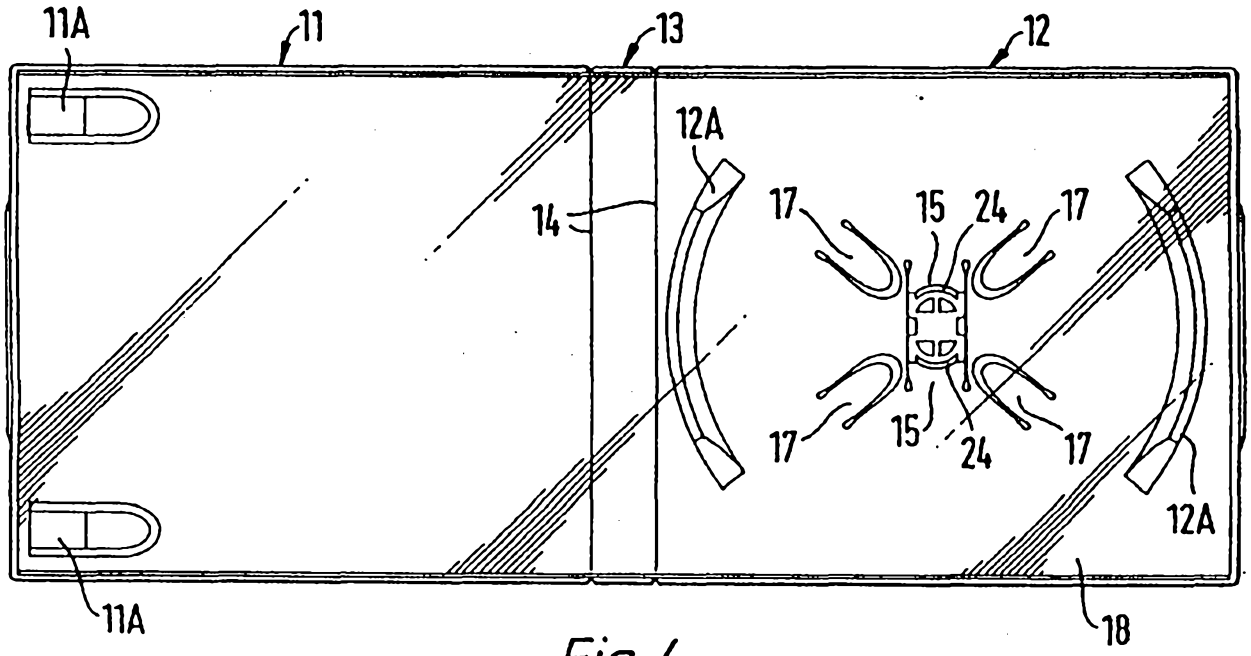


Fig. 4

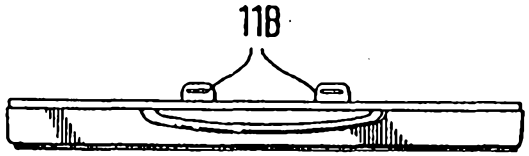


Fig. 5

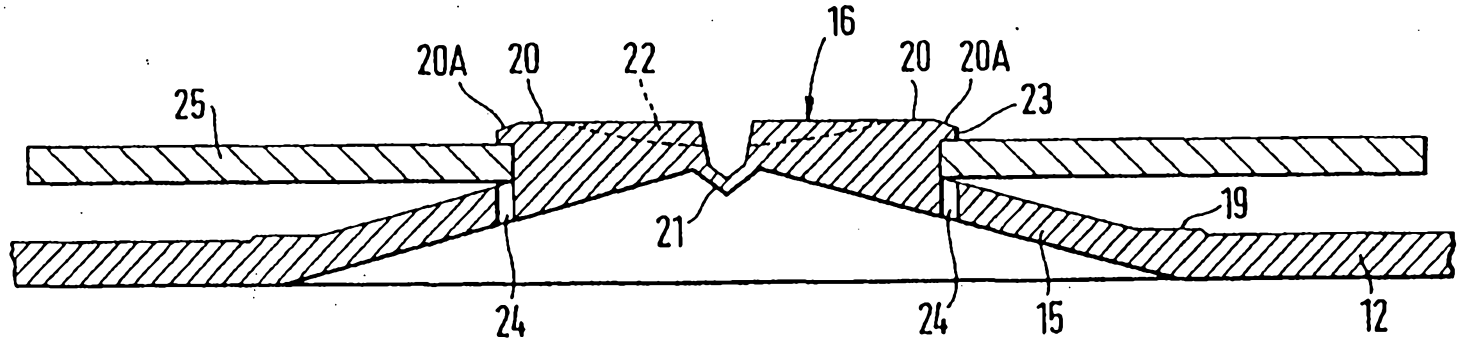


Fig.6

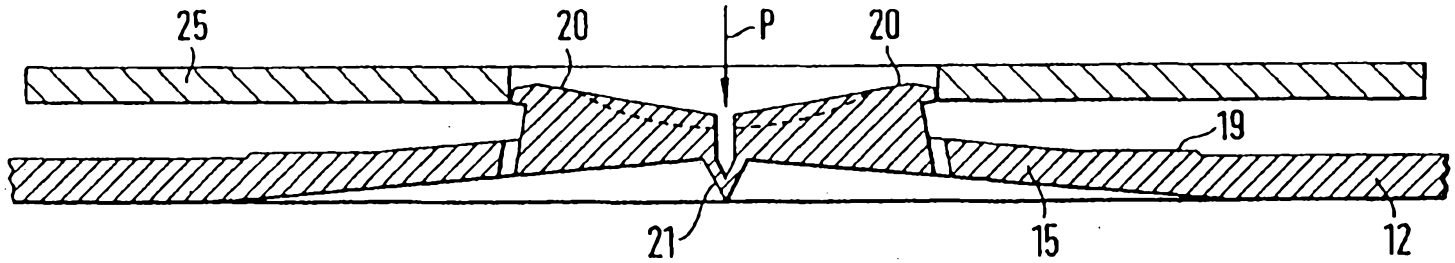


Fig.7

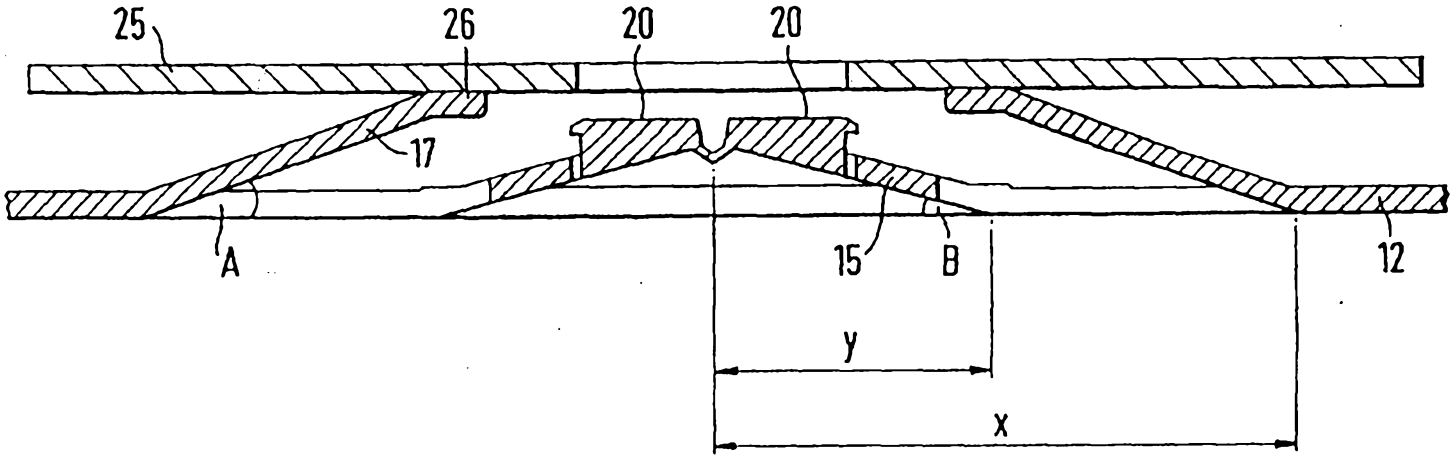


Fig.8

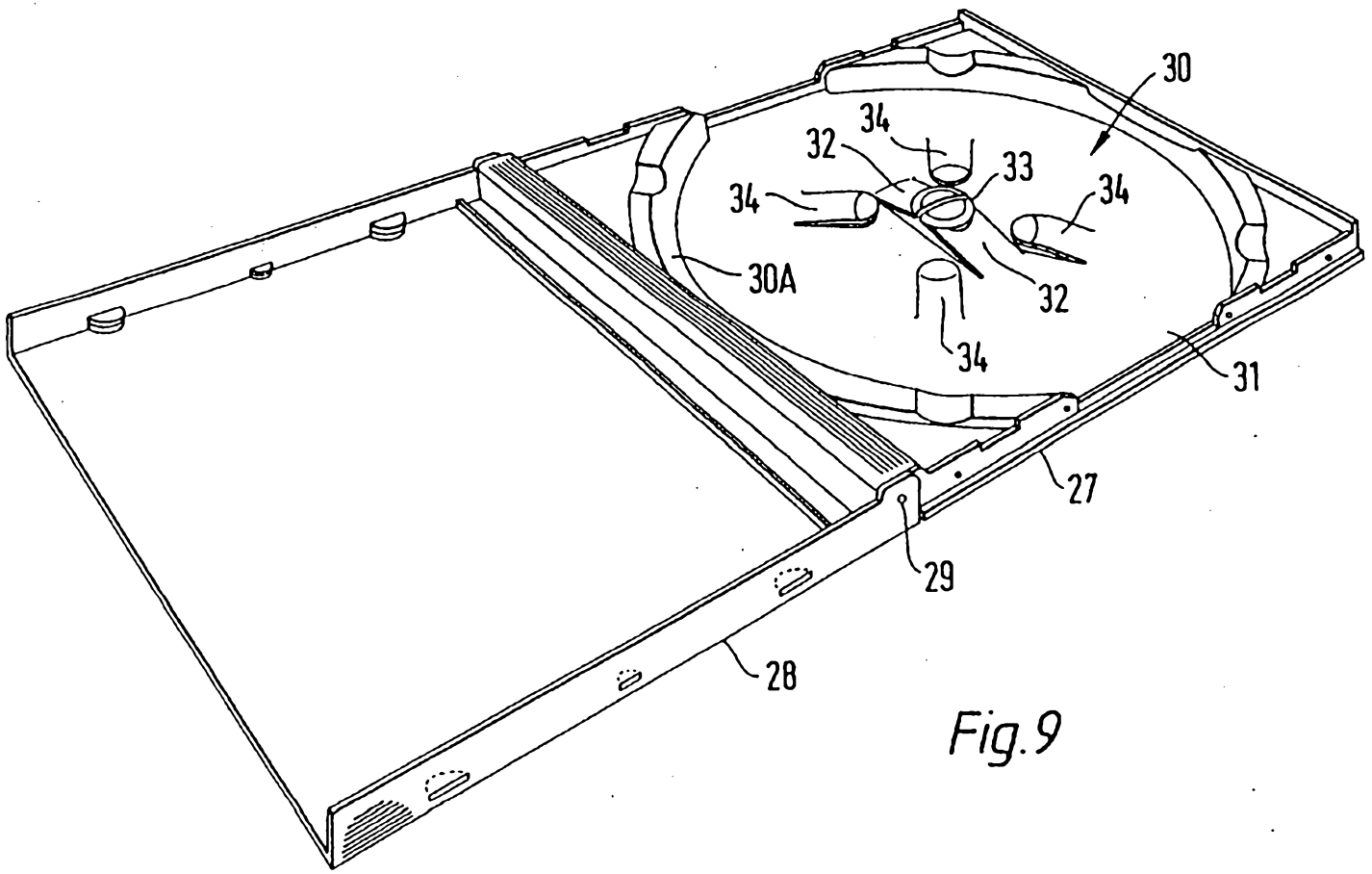


Fig.9

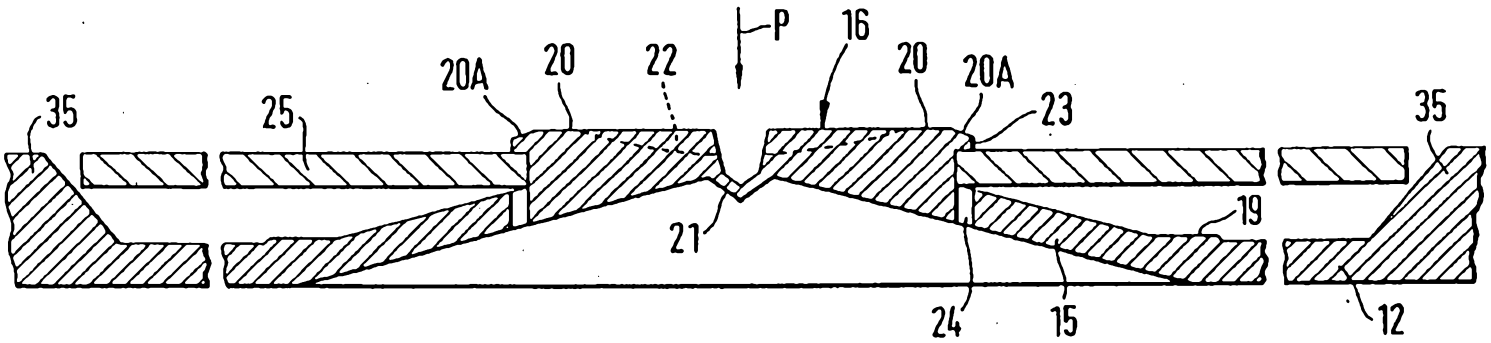


Fig. 10

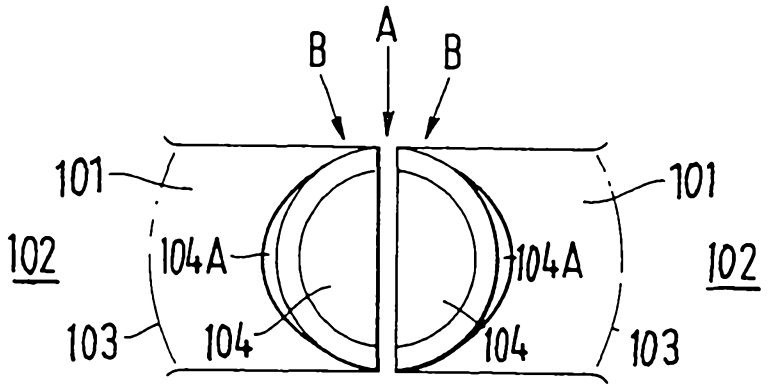


Fig. 11

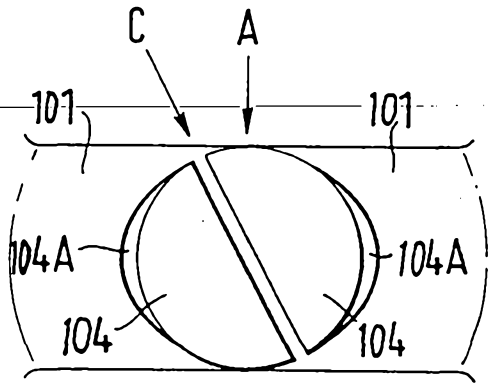


Fig. 14A

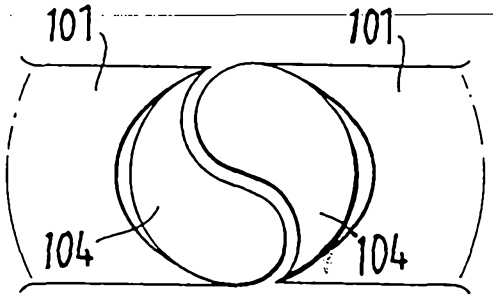


Fig. 14B

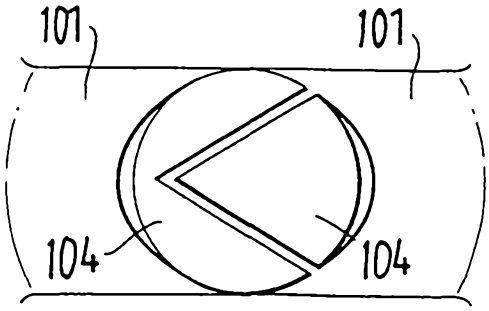


Fig. 14C

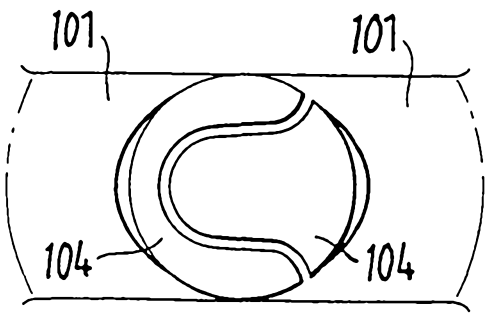


Fig. 14D

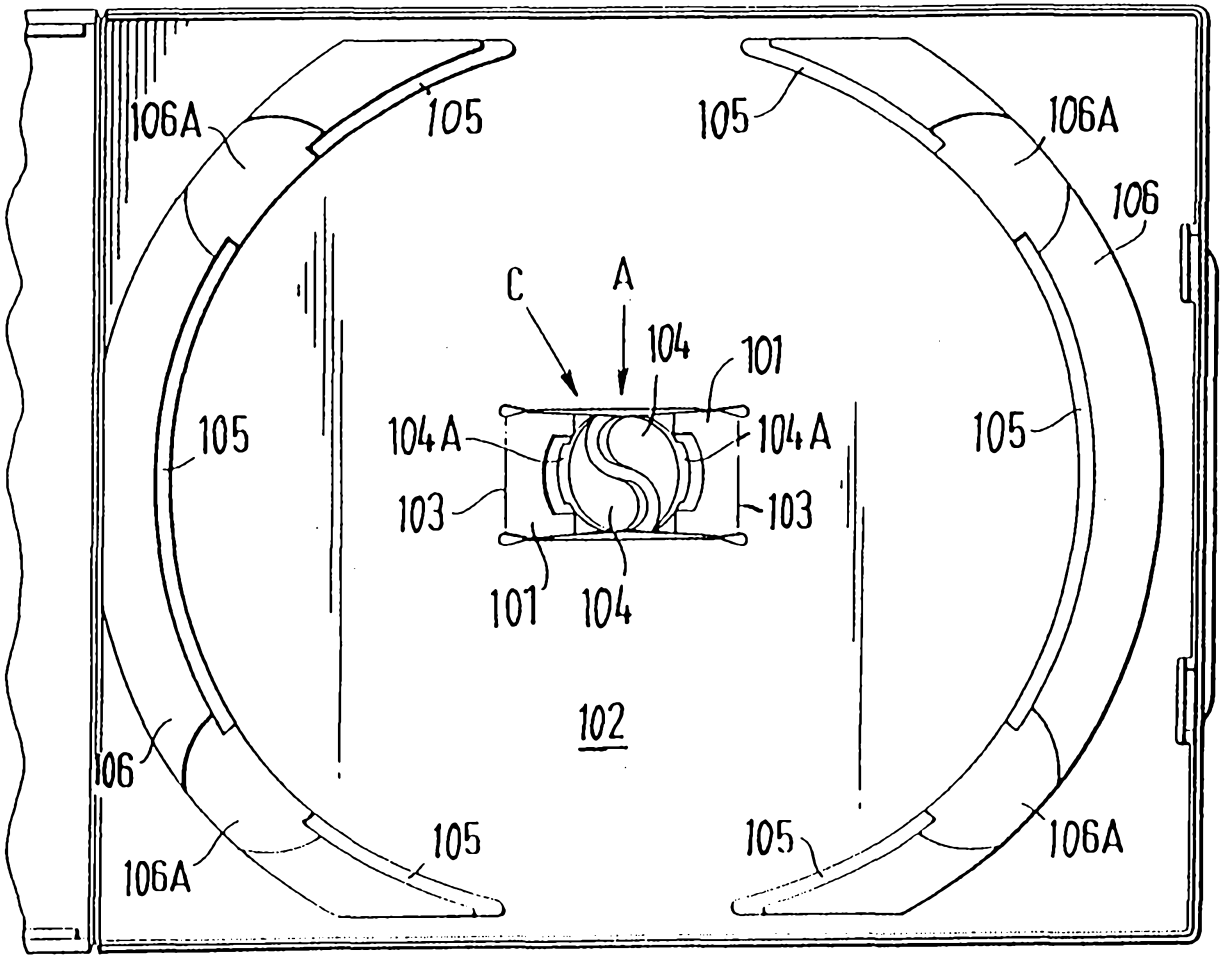


Fig. 12

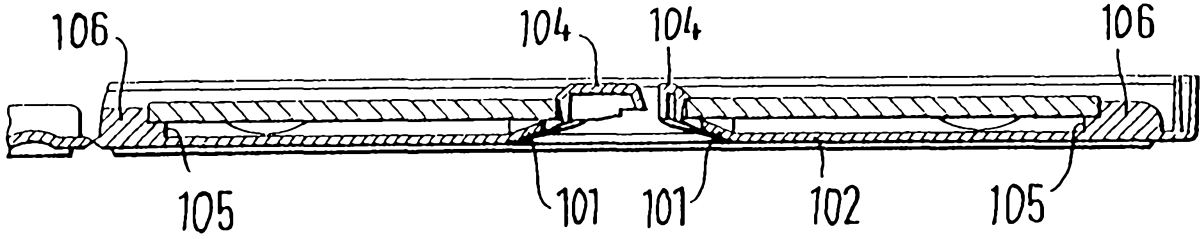


Fig.13

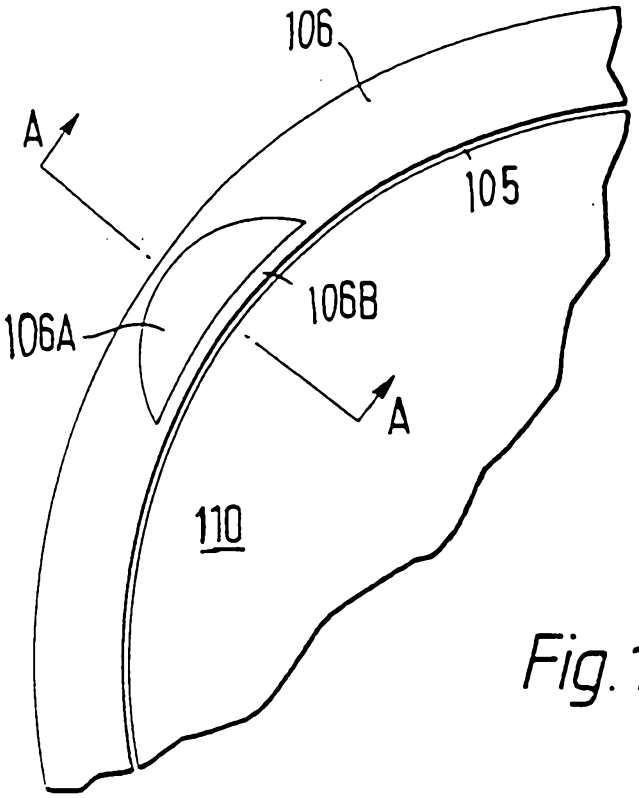


Fig.15

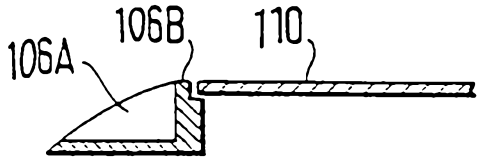


Fig.16A

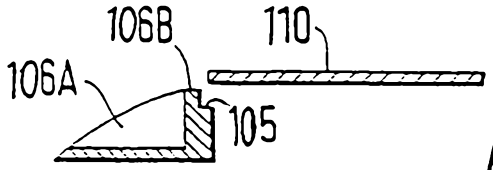
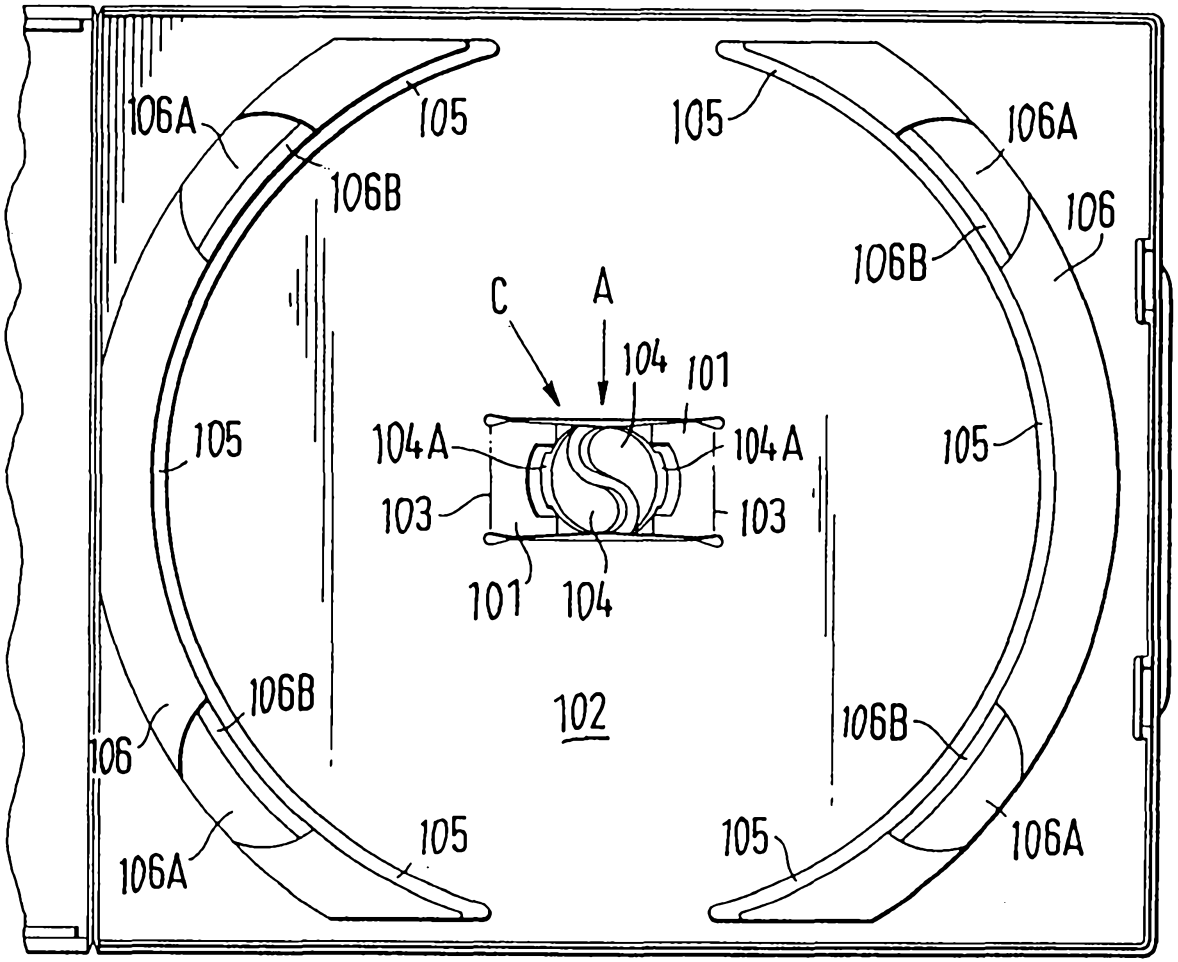


Fig.16B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106A

Fig.17

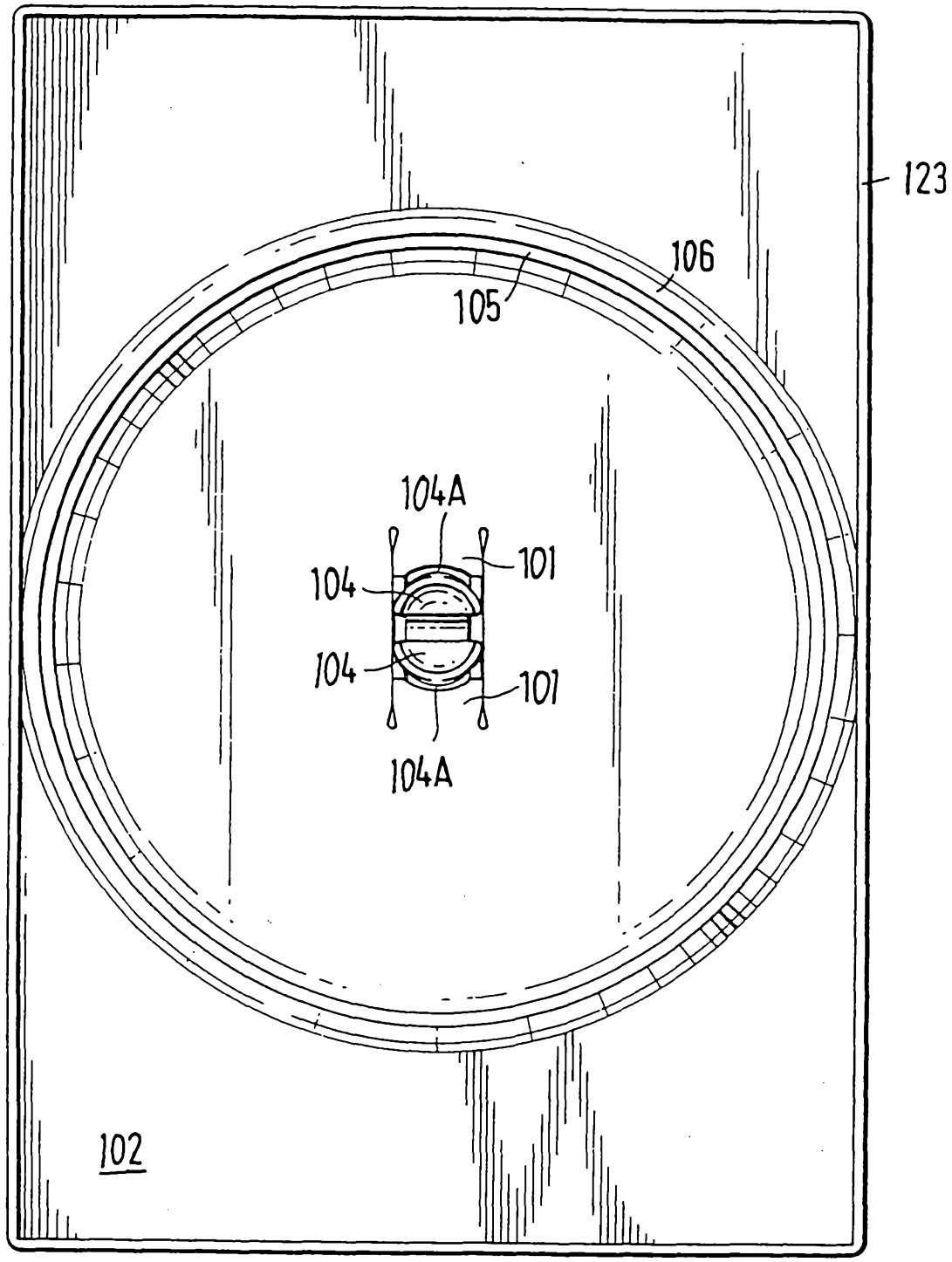


Fig.18

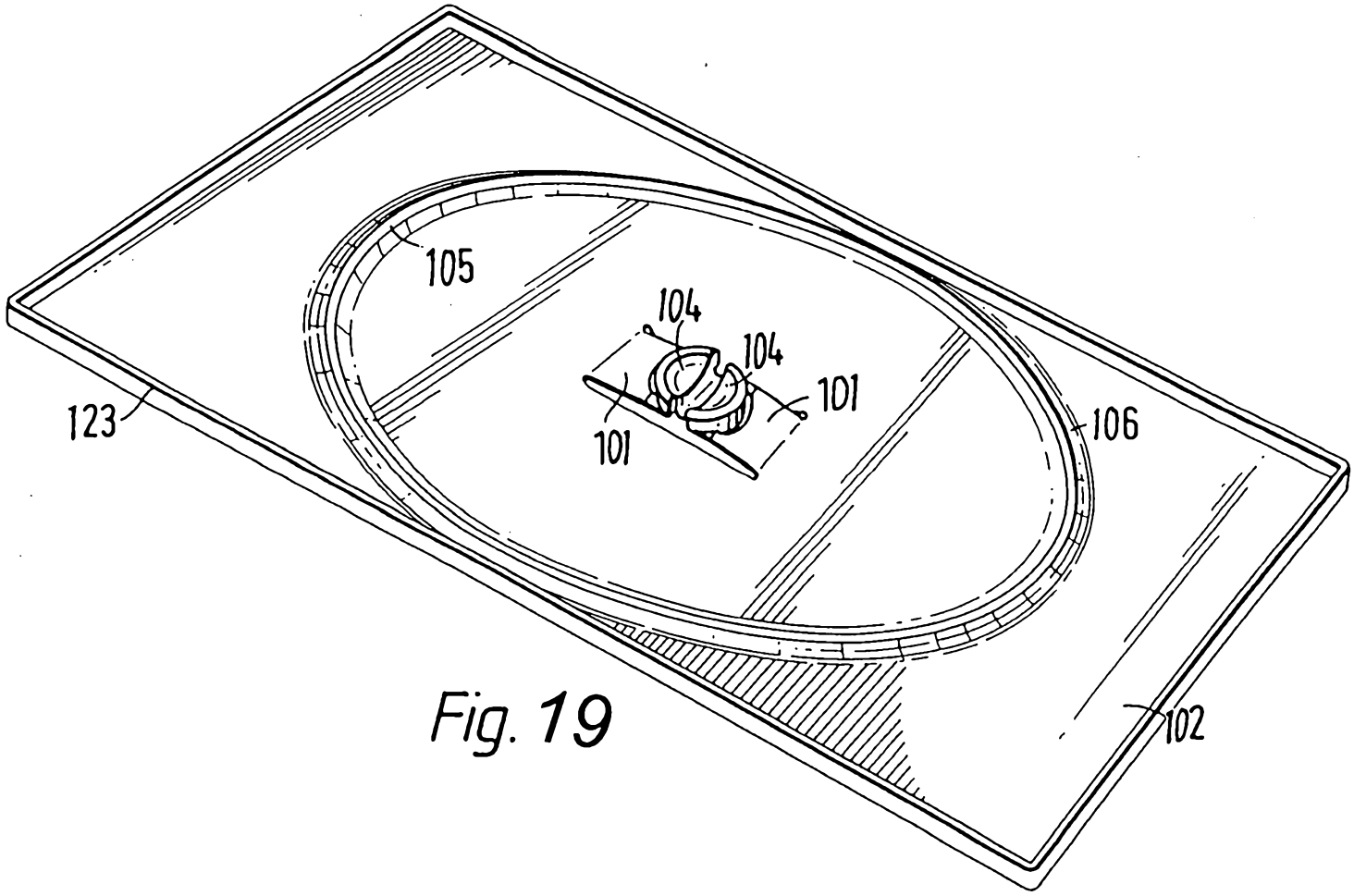
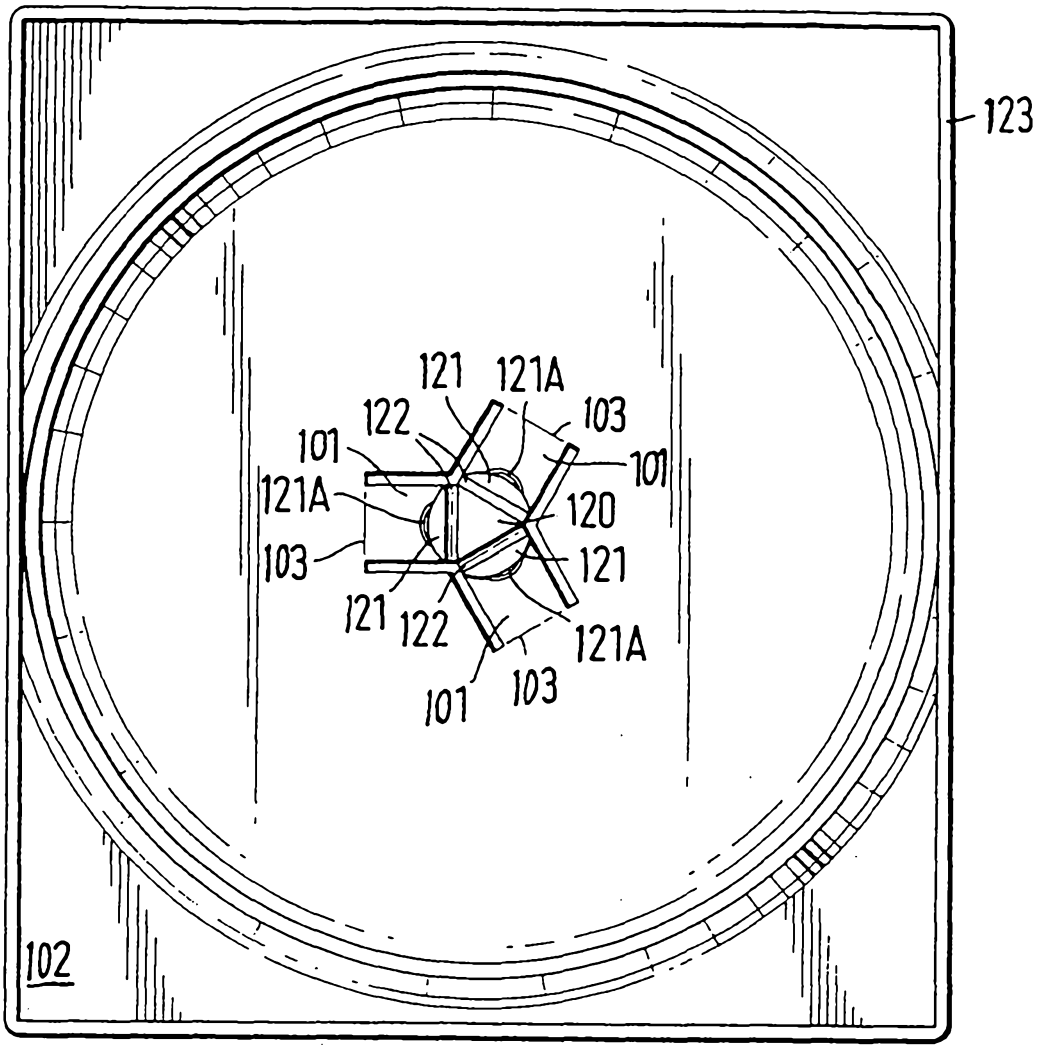


Fig. 19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121A
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Fig. 20

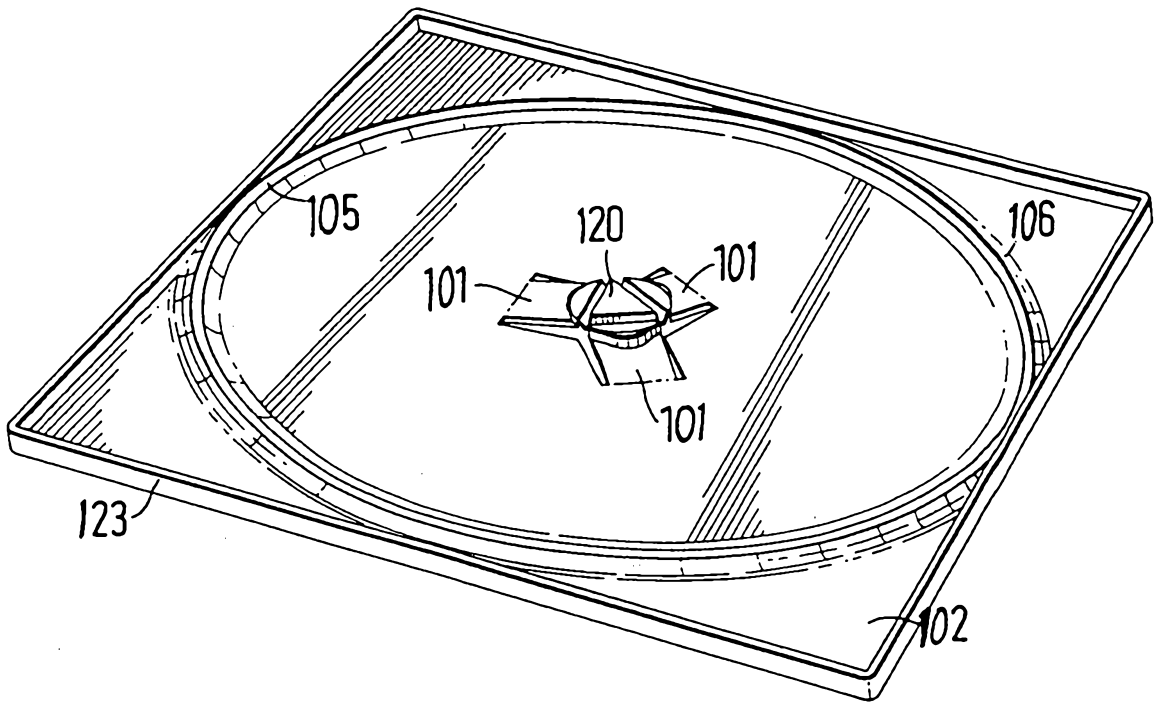

Fig. 21

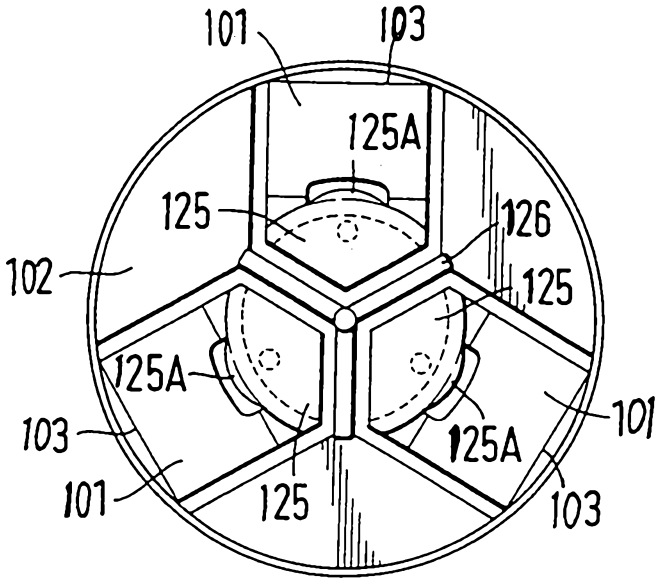

Fig. 22

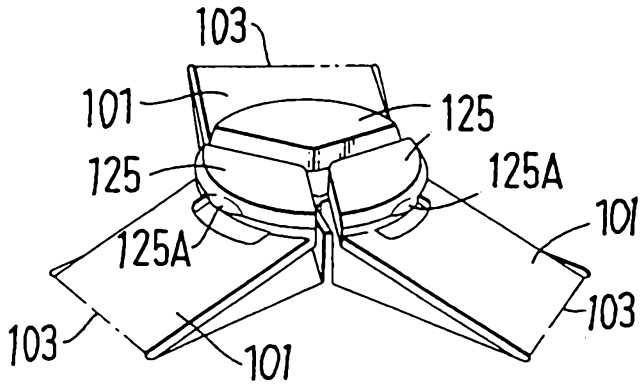

Fig. 23A

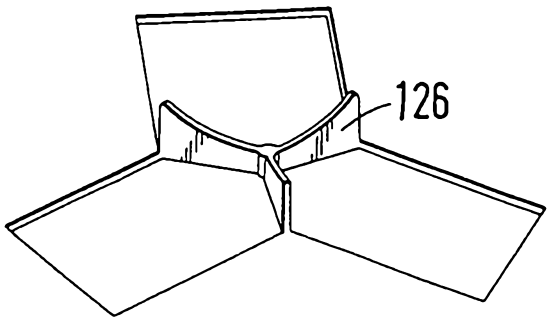

Fig. 23B