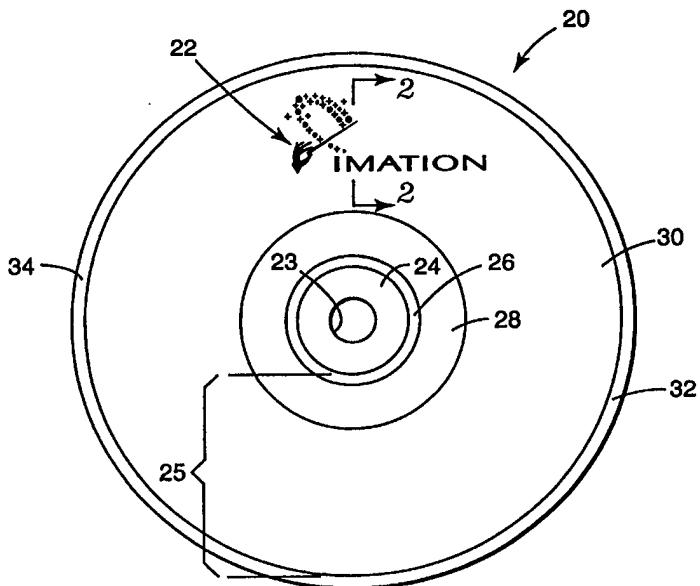




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(54) Title: CUSTOMIZED GRAPHICS FOR DUAL LAYER OPTICAL DISCS



(57) Abstract

A dual layer optical disc (20) having images (22) encoded therein. The dual layer optical disc includes a first data layer (44) and a second data layer (48) coupled to the first data layer. An optically viewable image is encoded within the first data layer or the second data layer. The viewable image may be a light contrast, medium contrast, or high contrast image. The first data layer and the second data layer may have a balanced reflectivity rating. In another embodiment, the first data layer and the second data layer have an unbalanced reflectivity rating, for varying the visibility of images encoded therein. The dual layer optical disc may further include a second side, having a third data layer (44b) and a fourth data layer (44a) having an optically viewable image encoded within the third data layer or the fourth data layer. The optically viewable image may be a holographic image.

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CUSTOMIZED GRAPHICS FOR DUAL LAYER OPTICAL DISCSTechnical Field

The present invention relates generally to 5 optical discs. In particular, the present invention includes a dual layer optical disc having images within a diffraction pattern encoded in one or more layers in the disc.

10

Background of the Invention

Optical discs, such as CD-ROM (Compact Disc-Read Only Memory) or DVD (Digital Versatile Disc or Digital Video Disc) media have data stored as a series of lower reflectance "pits" formed within a plane of 15 higher reflectance "lands". The pits may be coated with the same material as the lands, but due to pit geometry, will diffract more light than the flatter lands, and therefore return less light to the reading sensor. The pits bottoms may be illuminated and read 20 resembling bumps, which also diffract more light than the flatter lands. The pits are arranged in a spiral track originating at the disc center hub and ending at the disc outer rim. The data may be considered to lie in a series of tracks spaced radially from the center 25 hub. Disc layers having no data thereon may contain a spiral groove or a series of concentric grooves, creating a diffraction pattern. Whether a spiral or a series of concentric grooves, the resulting grooves are substantially circular.

30

The track typically begins in a "pre-user data" area near the center hub. The pre-user area contains descriptor information of the disc itself. A "user-data" area follows the pre-user data area, and contains the data of the disc. A "lead-out" area

follows the user-data area, lying closer to the outer edge of the disc. The lead-out area contains no user data, but may contain a pattern of pits which can be a repeating pattern or a random pattern having no data 5 readout value or information content. The pre-user data area, user-data area, and lead-out area collectively comprise the "information area" of the disc.

The information content is encoded in the length 10 of the slightly arcuate, circumferential pits.

Microscopically, the track consists of a series of pits. When viewed with the naked eye, the aligned pits appear to form a continual groove, with the spiral groove forming a diffraction pattern. The 15 diffraction pattern reflects light of varying colors, as described by Bragg's law.

In the lead-out area, the spiral track may be a continuous spiral groove, having a very long pit, formed not for information content but for appearance.

20 Thus, while the optical disc may contain a spiral pattern to the outer rim, there may be very little user-data present, with the lead-out area comprising a majority of the disc surface in a sparsely populated disc. In even a fully populated disc, the lead-out 25 area comprises a few millimeters near the outer rim.

A master optical disc is typically manufactured by coating a glass substrate with a positive photosensitive layer, followed by baking the coated substrate. A laser is thereafter used to expose 30 portions of the photoresist in a spiral pattern of circumferential arcs of varying length, corresponding to the later formed pits. The master disc is thereafter developed, with the exposed areas being washed away, forming pits. The unexposed areas

remain, forming a plane of higher "lands." As such, the master disc is said to be "pre-recorded" optical disc.

The master disc is used as a mold to form one or 5 more harder, metallised, "stampers", having bumps corresponding to the pits in the master disc. The stampers are used to form the optical discs via injection molding, the final discs having pits corresponding to the bumps in the stampers 10 corresponding to the pits in the master disc.

In CD-ROMs, the readable side includes a transparent polycarbonate bottom layer having the reflective layer thereover, which in turn has a protective "lacquer" layer thereover, which can 15 include a label. The readable side is typically placed face down over a laser reader which penetrates the transparent layer to the single reflective layer having pits. As an example, in pre-recorded media, pits are formed in such a way to give a high contrast 20 signal relative to the land.

DVDs are an optical disc having increased capacity relative to CD-ROMs. In one example, this is achieved in part by having double sided discs. Double sided DVDs have two reflective layers, each facing 25 outward, requiring flipping the disc to read both sides or an additional device to read the second side.

Double sided DVDs require each side to be transparent, and thus have a special labelling requirement, as covering one side with lacquer and 30 label is no longer possible. Any label or image on the disc must be both visible, and transparent to a laser in the region containing data. Double sided discs consist of two single sided discs bonded back to back with an adhesive.

Another example of an optical disc having increased capacity relative to CD-ROMs is a dual layer disc. Dual layer discs include an innermost data layer having a reflective layer thereon, and an 5 outermost data layer having a reflective layer thereon. The outermost reflective layer is sometimes referred to as the "semi-reflective layer" and the innermost reflective layer as the "fully reflective layer". The outermost reflective layer has optically 10 readable differences in reflectivity between lands and pits, yet being sufficiently transparent to allow reading of the innermost reflective layer below. The desired innermost or outermost layer is optically read by focusing the optical disc reader at the proper 15 depth for the layer of interest. For increased optical disc capacity, dual layer optical discs may also be double sided. A double-sided, dual layer optical disc includes two optically readable layers on each side of the disc.

20 Labelling of the previously described optical discs is important. Labelling can operate as a deterrent to piracy. The data on optical discs, being digital, can be read perfectly, and reproduced perfectly, in unlimited quantities. Standard labels 25 on the lacquer side of CD-ROMs can also easily be reproduced, using techniques similar to those used to produce the original labels. Labelling requiring the creation of art-work on the master discs or stampers themselves would require significantly more effort 30 and/or specialized equipment to produce copies capable of passing as the original discs.

One known method of labeling optical discs is described in U.S. Patent No. 5,607,188, issued March 4, 1997, entitled "Marking of Optical Disc for

Customized Identification". This patent includes an optical disc which is labeled by incorporating a low contrast image, such as a "watermark", into the optical disc substrate. The image is a low contrast 5 image which is located in the user-data area of the disc and includes optically readable data encoded therein.

It would be desirable to mark a dual sided disc in a way that would identify a disc as being 10 authentic, that is, as having been manufactured by an authorized source. It is desirable to have a dual layer optical disc with images on one layer but not another. Further, it is desirable to have a dual layer optical disc having an image front visible on 15 one side with the image back visible on the other side. Finally, it is desirable to create images for dual layer discs at the master disc level.

#### Summary of the Invention

20 The present invention is a dual layer optical disc having optically viewable images encoded on selected layers of the disc. The invention may include a double sided disc, where each side can have images encoded therein.

25 In one embodiment, the present invention includes a dual layer optical disc having images encoded therein. The dual layer optical disc includes a first data layer and a second data layer coupled to the first data layer. An optically viewable image is 30 encoded within the first data layer. Further, a second optically viewable image may be encoded within the second data layer.

The first data layer, having an optically viewable image therein, may include a data region and

an image region, each region having a plurality of lands and pits. The lands in the image region may have a height less than the height of the lands located within the data region relative to the pits.

5 The dual layer optical disc may further include optically readable data encoded within the second layer and/or first layer.

The optically viewable image may be a light contrast image, a medium contrast image, or heavy 10 contrast image. If the optically viewable image is a light contrast image, the optically viewable image may further include optically readable data encoded therein. The optically viewable image may be a holographic image.

15 The first data layer and the second data layer may have a balanced reflectivity value. In another application, the first data layer and the second data layer may have an unbalanced reflectivity value. In one preferred embodiment, the first data layer is 20 semi-reflective and the second data layer is reflective.

The dual layer optical disc may further include a second side, having a third data layer and a fourth data layer. The third data layer or the fourth data 25 layer may also include an optically viewable image encoded therein.

In another embodiment, the present invention includes a dual layer optical disc having an image encoded therein. The dual layer optical disc includes 30 a first protective layer and a first layer, the first layer including a first data layer having a first reflective layer formed thereover. A second layer is interposed between the first protective layer and the first layer, including a second data layer having a

second reflective layer formed thereover. An optically viewable image may be encoded within the first layer or the second layer.

5 The first layer and the second layer may have a balanced reflectivity value. In another application, the first layer and the second layer may have an unbalanced reflectivity value. In one embodiment, the first reflective layer is semi-reflective and the second reflective layer is reflective.

10 The dual layer optical disc in accordance with the present invention may further include a third layer including a third data layer having a third reflective layer formed thereover, wherein the first protective layer is formed of an adhesive and couples 15 the second layer to the third layer. An optically viewable image may be encoded within the third layer.

Further, a fourth layer may be coupled to the third layer, the fourth layer including a fourth data layer having a fourth reflective layer formed thereover.

20

#### Brief Description of the Drawings

Figure 1 is a top view of a dual layer optical disc having an image encoded therein in accordance with the present invention;

25 Figure 2 is a partial cross-sectional view taken along line 2-2 of Figure 1, showing one embodiment of the dual layer optical disc in accordance with the present invention;

30 Figure 3 is a plan view of the optical disc of the embodiment of Figure 2, as viewed from the non-read side;

Figure 4 is a plan view of the optical disc of Figure 2, as viewed from the read side;

Figure 5 is a partial cross-sectional view of

another embodiment of the dual layer optical disc in accordance with the present invention;

Figure 6 is a plan view of the optical disc of Figure 5, as viewed from the non-read side;

5 Figure 7 is a plan view of the optical disc of Figure 5, as viewed from the read side;

Figure 8 is a partial cross-sectional view of another embodiment of a dual-layer optical disc in accordance with the present invention;

10 Figure 9 is a plan view of the optical disc of Figure 8, as viewed from the non-read side;

Figure 10 is a plan view of the optical disc of Figure 8, as viewed from the read side;

15 Figure 11 is a partial cross-sectional view of another embodiment of a dual-layer optical disc in accordance with the present invention;

Figure 12 is a plan view of the optical disc of Figure 11, as viewed from the second side;

20 Figure 13 is a plan view of the optical disc of Figure 11, as viewed from the first side;

Figure 14 is a partial cross-sectional view of another embodiment of a dual-layer optical disc in accordance with the present invention;

25 Figure 15 is a plan view of the optical disc of Figure 14, as viewed from the first side;

Figure 16 is a plan view of the optical disc of Figure 14, as viewed from the second side;

30 Figure 17 is a partial cross-sectional view of another embodiment of a dual-layer optical disc in accordance with the present invention;

Figure 18 is a diagram illustrating a method of creating a master disc for creating a dual layer optical disc in accordance with the present invention;

Figure 19 is a partial cross-sectional view of a

master disc in accordance with the present invention after development of low, medium, and high contrast image regions; and

5 Figure 20 is a diagram illustrating another method of creating a master disc for creating a dual layer optical disc in accordance with the present invention.

Detailed Description of the Preferred Embodiments

10 Although specific dual-layer optical discs are used in the exemplary embodiments described herein, it is recognized that the field to which this invention pertains includes all types of dual-layer optical data discs having information contained in data structures 15 therein as data features. In various formats of optical data discs, the data features may include data pits, grooves, bumps or ridges, and lands or land areas. This includes current formats of dual layer DVD, as well as future formats which use data features 20 described herein.

Figure 1 illustrates a readable side of a dual layer optical disc 20 having an image 22 located therein, in accordance with the present invention. Although the Imation logo is shown, it is recognized 25 that most any image or character may be produced within the disc substrates. The side shown is capable of being illuminated and read by an optical disc laser or reader. Disc 20 is a dual layer optical disc, such as a dual layered DVD optical disc. The opposite side 30 (not shown in Figure 1) may be either an opaque, labeled, non-read side, or a second, readable side which also may be dual layered. Disc 20 includes an inner rim 23, an inner annular ring 24, an information area 25, an outer annular ring 32, and an outer rim

34.

Although only the top layer of the dual layer optical disc 20 is shown, each layer may include an information area 25. The information area 25 is 5 defined as the area on the disc 20 capable of containing user data. In one embodiment, the information area 25 includes a pre-user area 26, a user-data area 28, and a lead-out area 30. The pre-user area 26 typically contains information about the 10 disc contents, such as descriptive information. The user-data area 28 contains the user accessible contents of the disc. The lead-out area 30 typically appears as a spiral track similar to that in the user-data area, but may contain no information readable by 15 an optical disc player.

The information area 25 is the area available for information storage, even though much of it may be taken up with the lead-out area 30 when the disc has little user-data encoded. On one of the layers, the 20 information area 25 contains image 22, such as the Imation logo shown consisting of a design and alphanumeric characters. As shown, the image 22 is located in the lead-out area 30 of the information area 25.

25 In one application, each layer of the dual layer disc has a pre-user data area 26, a user-data area 28 and a lead-out area 30. When the disc 20 is read by an optical disc player, the disc reader begins reading the first layer pre-user data area 26, then reads the 30 user-data area 28, and then travels from the lead-out area 30 to the second layer pre-user data area 26, and then reads the user-data area 28 of the second layer.

In another application, the first layer has a pre-user data area 26 and a user-data area 28, and the

second layer has a user-data area 28 and a lead-out area 30. In this application, the optical disc reader reads the first layer pre-user data area 26 and the user-data area 28, and then continues to the second 5 layer and reads the user-data area 28 and ends at the lead-out area 30.

Figures 2-17 illustrate different embodiments of a dual layer disc in accordance with the present invention having an image contained (encoded) on one 10 of the layers therein. Each of these embodiments will be discussed in detail in the following paragraphs.

In Figure 2, a partial cross-sectional view of one embodiment of the optical disc 20 (including image 22) in accordance with the present invention is shown.

15 In the exemplary embodiment shown, disc 20 is a single-sided dual layer optical disc.

Dual layer optical disc 20 includes a read side 40 and a non-read side 41. Starting at read side 40, the optical disc 20 further includes a first layer 42 20 having a first data layer 44 and a first reflective layer 46, and a second layer 43 having a second data layer (or spacer layer) 48 and a second reflective layer 50, and a protective layer 52. The first reflective layer 46 is interposed between the first data layer 44 and the second data layer 48, and the second reflective layer 50 is interposed between the second data layer 48 and the protective layer 52.

25 The first data layer 44 and the second data layer 48 are generally transparent and include a series of lands 54 and pits 56. In one embodiment, the first data layer 44 and the second data layer 48 are formed of a generally clear material. In one exemplary embodiment, the first data layer 44 may be formed of a substantially clear polycarbonate and the second data

layer 48 may be formed of a substantially clear photopolymer. The first reflective layer 46 and the second reflective layer 50 are formed of a reflective material, such as aluminum, gold, or a dielectric, 5 such as is described in U.S. Patent No. 5,540,966, entitled "Dual Layer Optical Medium Having Partially Reflecting Thin Film Layer", issued July 30, 1996, having varied degrees of reflectivity, as will be described in detail later herein. The protective 10 layer 52 may be formed of a protective material, such as lacquer, which may be opaque or clear. If the lacquer is clear, and no label is contained on non-read side 42, the reverse of image 22 may be viewed through the non-read side 42.

15 In the embodiment shown, the first layer 42 has data encoded therein, indicated by data region 58. The second layer 43 may also have data encoded therein, indicated by data region 60, but also includes image region 62. Specifically, in first 20 layer 42, the data region 58 includes a series of full height lands 54 and pits 56. Similarly, within data region 60 located on second data layer 48, the data region 60 includes full height lands 54 and pits 56. Within image region 62, the lands are reduced height 25 lands 64. If a reference plane were drawn through the bottom of the pit 56, the reduced height lands 64 appear reduced in height relative to full height lands 54. Reducing the difference in the height between reduced height lands 64 and full height lands 54, 30 disturbs the periodic diffraction grating within image region 62, creating optically viewable image 22.

The reduced height lands 64 within image region 62 produce a contrast in the diffraction grating between the image region 62 and the data region 60.

The contrast in the diffraction grating within image region 62 results in a viewable image within the disc substrate, such as image 22.

The image 22 can be a low contrast, medium  
5 contrast, or high contrast image. Whether the image  
22 is a low contrast, medium contrast or high contrast  
image depends greatly upon the height of the reduced  
height lands 64 within image region 62 relative to the  
level of the pits 56 and the (full height) lands 54  
10 within data region 58, and the reflectivity values of  
each layer (42 and 48).

For light contrast images, reduced height lands  
64 are shorter than lands 54, relative to the bottom  
of pits 56, being reduced sufficient enough to create  
15 a viewable image, but not sufficient to destroy  
optical readability. Therefore, a light contrast  
image may be located within image region 62 using  
reduced height lands 64, yet reduced height lands 64  
have a height sufficient to contain encoded data which  
20 is readable by an optical disc reader.

For heavy contrast images within image region 62,  
the lands are substantially or totally removed to the  
level of the bottom of the pits 56. The resulting  
difference in the diffraction pattern between image  
25 region 62 and data region 60 is a high contrast image  
located in image region 62. When reduced height lands  
64 are totally obliterated or substantially removed to  
form a high contrast image, no data may be encoded  
within the image region 62 which could be readable by  
30 an optical disc reader. As such, image region 62 can  
be said to be optically viewable, but not optically  
readable.

A medium contrast image is produced using reduced  
height lands 64 having a medium height (as shown in

Figure 2) within image region 62. A medium height land is a land having a height which can be defined within the range between where the height of the land is such that the image region 62 may be no longer 5 readable by an optical disc reader when data is encoded therein, down to the point where the lands are substantially or completely removed or obliterated. The resulting difference in diffraction pattern between the image region 62 and data region 60 is a 10 medium contrast image relative to the previously defined light contrast and heavy contrast images.

In one application of the above embodiment, data may be encoded within first layer 42 and images may be encoded in second layer 43. In this application, the 15 images on second layer 43 may be light contrast, medium contrast or heavy contrast images. In another application, data may be encoded within first layer 42, and data may also be encoded within data region 60 of second layer 43, with light contrast, medium 20 contrast or heavy contrast images encoded within image region 62. If the images encoded within image region 62 are light contrast images due to the height of the reduced height lands 64, then data may also be encoded within image region 62 which is not only optically 25 viewable, but optically readable by an optical disc reader.

Optical disc 20 has an effective reflectivity value, substantially caused by the reflectivity of first reflective layer 46 and second reflective layer 30 50, but also affected by the reflectivities and losses caused by the passage of light through the various substrates, including first data layer 44 and second data layer 48. First layer 42 has an effective reflectivity, indicated as R1, which is defined by the

fraction or intensity of incident light that is reflected by first reflective layer 46 to a receiver (not shown) outside of first read side 40. The second reflective layer 50 has an effective reflectivity, 5 indicated by R2, which may be defined as the fraction of incident light that is reflected by the second reflective layer 50 to a receiver (not shown) outside of first read side 40. As previously stated, the effective reflectivity values R1 and R2 are also 10 affected by the various substrates which they pass through.

In Figure 2, one exemplary embodiment of the attenuation of light (or signal) caused by first layer 42 and second layer 43 is shown. Incident light (70) 15 enters first data layer 44, becoming attenuated (at 72) by surface reflection (not shown) at first data layer 44. The light is further attenuated as it passes through first data layer 44, and is reflected on first reflective layer 46 (74). The light 20 reflected by the first reflective layer 46 again exits the first data layer 44 (76), which has been previously referred to as R1. Light which is focused on the second reflective layer 50, after passage through the first reflective layer 46, passes through 25 second data layer 48 (78), is reflected at second reflective layer 50, and again passes back through second data layer 48, first reflective layer 46, first data layer 44 (80), and exits the first data layer 44, indicated as R2.

30 The effective reflectivity of the first layer 42 and the second layer 43 (and resulting R1 and R2) may be balanced or unbalanced. In a balanced application, R1 is equal to R2. Reflectance of the disc 20 materials are selected such that the resulting signal

effective reflectivity value (or signal strength) of R1 is equal to R2. In an unbalanced application, R1 is greater than R2 or R2 is greater than R1. An unbalanced effective reflectivity value may be

5 desirable when other factors are considered, such as the desired visibility of an image encoded within one of the layers.

In one exemplary embodiment having balanced reflectivity, where R1 is substantially equal to R2,

10 the first reflective layer 46 is "semi-reflective" being formed of a metal or dielectric, such as those previously described herein, having a reflectivity rating in the range of 25 percent to 40 percent. The second reflective layer 50 is reflective, and may also

15 be formed of a metal or dielectric having a greater reflectivity than first reflective layer 46. In one embodiment, the reflective layer 50 may have a reflectivity rating of 70 percent or greater and may be aluminum.

20 In another embodiment, the effective reflectivity value of the first layer 42 is not equal to the effective reflectivity value of the second layer 43 (for example, R1 is not equal to R2). In one preferred embodiment, the effective reflectivity value

25 of the first reflective layer 46 is less than the effective reflectivity value of the second reflective layer 50, resulting in R1 less than R2. For example, the ratio of R2 to R1 may be two to one or ten to one.

It is also recognized that R1 may be greater than R2.

30

The effective reflectivity value of first layer R1 relative to second layer R2 may be varied to make images contained/encoded in one layer more visible or viewable than the other layer. For example, in the

exemplary embodiment shown, data is encoded in first layer 42 and image 22 is encoded within second layer 43. First data layer 44, second data layer 48, and protective layer 52 are substantially clear. First 5 reflective layer 46 is less reflective than second reflective layer 50, and in combination with other disc materials, results in an unbalanced reflectivity of R1 less than R2.

Figure 3 is a plan view of optical disc 20 when 10 viewed from the non-read side 41. Since protective layer 52 is substantially clear, image 22 may be viewed from the non-read side. In reference to Figure 4, a plan view of the optical disc 20 is shown, as viewed from the read side 40. Since the effective 15 reflectivity value of first layer 42 (R1) is less than the effective reflectivity value of second layer 43 (R2), the image 22 may also be viewed from the read side 40. The diffraction grating contrast of image 22 when viewed from read side 40 is dependent upon the 20 height of reduced height land 64, as previously described herein, and is further dependent upon the difference in the reflectivity of the first layer 42 and the second layer 43.

In Figure 5, a partial cross-sectional view of 25 another embodiment of dual layer optical disc 20 in accordance with the present invention is shown. First layer 42 includes data region 58 and image region 62, having reduced height lands 64 for producing image 22. Second layer 43 includes data region 60 having data 30 encoded therein. Similar to the previous embodiment, the first data layer 44, the second data layer 48, and the protective layer 52 are substantially clear. Further, the first layer 42 and the second layer 43 have an unbalanced reflectivity rating, wherein the

first reflective layer 46 is less reflective than the second reflective layer 50.

In Figure 6, a plan view of dual layer optical disc 20 is shown as viewed from the non-read side 41.

5 It is noted that since image 22 is contained within first layer 42, and the first reflective layer 46 is semi-reflective and the second reflective layer 50 is reflective, no change in diffraction grating is visible from the non-read side 41 and image 22 is not  
10 viewed. In Figure 7, a plan view of dual layer optical disc 20 is shown as viewed from the read side.

Image 22 located within first layer 42 is visible from the read side 40.

15 In Figure 8, a partial cross-sectional view of another embodiment of the dual layer optical disc 20 in accordance with the present invention is shown. In this embodiment, both first layer 42 and second layer 43 include visible (optically viewable) images thereon. Specifically, second layer 43 includes  
20 reduced height lands 64 in image region 62 to disturb the periodic diffraction grating, creating the optically viewable image 22. First layer 42 includes reduced height lands 64 within image region 62 to disturb the periodic diffraction grating, creating the  
25 optically viewable alphanumeric image 90. As previously described herein, if image 22 or image 90 are a light contrast image resulting from the height of reduced height lands 64, optically readable data may also be encoded therein.

30 Similar to the previous embodiments, first data layer 44, second data layer 48 and protective layer 52 are substantially clear. Further, the effective reflectivity of first layer 42 and second layer 43 is "unbalanced". Specifically, first layer 42 is semi-

reflective and second layer 43 is reflective.

In Figure 9, a plan view of dual layer optical disc 20 is shown as viewed from non-read side 41. Since second layer 43 is reflective, only image 22 5 contained in second layer 43 is visible from the non-read side 41. In Figure 10, a plan view of optical disc 20 is shown as viewed from the read side. In this view, alphanumeric image 90 contained within first layer 42 is visible. Further, since first layer 10 42 is semi-reflective and second layer 43 is reflective, the reverse of image 22 is also visible from the read side 40.

In Figure 11, a partial cross-sectional view of another embodiment of the dual layer optical disc 20 15 in accordance with the present invention is generally shown, wherein the dual layer optical disc 20 is a double sided optical disc. Optical disc 20 includes first side 92, as previously described in detail in the embodiment of Figure 8, and also includes a second 20 side 94. Second side 94 includes a read side 96 and a non-read side 98. In the embodiment shown, second side 94 merely consists of a substrate formed of a material which can be similar to first data 44, such as a polycarbonate. The first side non-read side 41 25 is securely coupled to the second side non-read side 98 using protective layer (or coating) 52, which in this embodiment is preferably a clear adhesive.

In Figure 12, a plan view of optical disc 20 is shown as viewed from the second side 94 read side 96. 30 Similar to Figure 9, only the diffraction grating resulting in image 22 is visible therein. In Figure 13, a plan view of optical disc 20 is shown as viewed from the first side read side 40. Similar to Figure 10, both the image 22 and the alphanumeric image 90

are visible therein.

In Figure 14, a partial cross-sectional view of another embodiment of the dual layer optical disc 20 is shown, wherein the dual layer optical disc 20 is a 5 double sided optical disc. In this embodiment, first side 92 can be similar to the dual layer optical disc 20 as previously described herein. Second side 94 has an image 22 encoded therein.

In particular, second side 94 further includes a 10 third layer 100, including a third data substrate 102 and a third reflective layer 104. The third data substrate 102 and third reflective layer 104 may be formed of materials as previously described herein for first side 92. The first side 92 is coupled to second 15 side 94 at protective layer 52, which may be an opaque adhesive.

In Figure 15, a plan view of optical disc 20 is shown as viewed from first side 92 read side 40. In this embodiment, image 22 is not visible from first 20 side 92 read side 40. In Figure 16, a plan view of optical disc 20 is shown as viewed from second side read side 96. As shown, the contrast in the diffraction grating between image region 62 and data region 106, results in an optically viewable image 22.

25 In one application, the embodiment of Figure 14 is a DVD optical disc. First side 92 functions as a data side having optically readable data encoded within first layer 42 and second layer 43. Second side 94 operates as a label side, having image 22 in 30 the form of a disc content label.

In Figure 17, a partial cross-sectional view of another embodiment of the optical disc 20 in accordance with the present invention is shown, wherein the optical disc 20 is a dual layer double-

sided disc, wherein each side includes a dual layer. As shown, the optical disc 20 includes side A and side B, wherein each side includes images and data encoded within a layer therein.

5        Each side, side A and side B, can be similar to any of the dual layer optical disc embodiments as previously described herein. In the embodiment shown, side A and side B are each similar to the embodiment of Figure 8, having both data and images encoded 10 within each layer therein. The dual layer dual-sided optical disc 20 is formed by coupling two dual layer optical discs together, back to back, with an opaque adhesive 52.

15      In Figure 18, a process of creating a master disc 100 for use in creating a dual layer optical disc 20 in accordance with the present invention is shown. The process includes providing a substrate 102 coated with a photosensitive layer 104. The photosensitive layer 104 may be secured to the substrate 102 using an 20 adhesive (not shown). The photosensitive layer 104 is responsive to a light source. In one embodiment, the substrate 102 is formed of quartz or glass and the photosensitive layer 104 is formed of photoresist.

25      A mask 106 is placed over and parallel to the plane of the photosensitive layer 104. In one embodiment, the mask 106 may include a chrome pattern on a glass substrate. The glass substrate has an absence of chrome corresponding to the desired pattern. In a preferred embodiment, the mask 106 is a 30 diffraction mask having an image pattern located therein to create a diffraction pattern disturbed in image regions within the photosensitive layer 104.

      A light source 108 is used for transferring the mask 106 pattern to the master disc 100. In one

embodiment, the light source 108 is a UV light source. The pattern mask 106 is positioned between the master disc 100 and the light source 108. In operation, the light source 108 emitting light 110 is placed over the 5 pattern mask 106, and photosensitive layer 104 is exposed to the light 110 for a period of time sufficient to create the desired reaction. The amount of exposure reaction is dependent upon the light source intensity and the duration of the exposure of 10 the photosensitive layer 104 to the light source 108.

In one preferred embodiment, the master disc 100 is a pre-recorded master, meaning it has user-data already encoded on the disc. In one method, the master disc 100 is pre-recorded using a laser beam 15 writer to record data by exposing photoresist in regions corresponding to future data pits as is well known in the art. Upon further exposure of master disc 100 in accordance with the present invention, both user-data, diffraction patterns and images may be 20 developed in a development step.

It is also recognized that master disc 100 may not be previously recorded, and may have pre-user data and user-data portions encoded using a mask similar to mask 106, but encoding data pits in addition to the 25 diffraction pattern. In this embodiment, a laser beam is not required to either write data or form images on the disc.

It is also recognized that a laser beam may be used for recording images within the photosensitive 30 layer 104 by exposing the photosensitive layer 104 in regions corresponding to the image regions. If a laser beam writer is utilized, the light source 108 and mask 106 are not necessary for forming images within photosensitive layer 104.

Referring to Figure 19, the result of light, medium and heavy exposure of photosensitive layer 64 is illustrated. At 112, light exposure region 114 is shown, which would correspond to a light contrast 5 image being formed within one layer of optical disc 20. At 116, a medium exposure is shown, resulting in a medium contrast image in optical disc 20. At 120, a heavy exposure is shown, resulting in a heavy contrast image viewable within optical disc 20.

10 The master disc 100 is used to form a metallized stamper to form a single layer of the dual layer disc in a disc molding process. The stamper will have ridges or stamper bumps corresponding to the pits within master 100. The stamper will be used to 15 produce replica discs in an injection molding process.

Once a replica disc of the first layer is formed, the replica disc may be used for making single sided dual layered discs or dual sided dual layered discs, such as shown in Figures 1-17. For example, in one 20 embodiment, to form the dual layer side of a disc, the first reflective layer 46 is deposited on the first data layer 44 to form first layer 42. The first layer 42 is coated with an embossable material, such as a photopolymer, and the data regions or image regions of 25 the second data layer 48 are embossed within the embossable material. A second reflective layer 50 is deposited on the second data layer 48 to form the second layer 43. For a single sided disc, the second layer 43 is then covered with a protective layer 52, 30 such as lacquer.

In another embodiment, once a replica disc of the first layer 42 is formed using the above-described disc molding process, a similar process is used for forming a second molded layer containing the second

data layer 48 therein. A first reflective layer 46 is deposited on the first data layer 44, and a second reflective layer 50 is deposited on a second molded data layer. The first molded layer 42 and the second 5 molded layer are secured together using a clear adhesive layer, which becomes the second data or spacer layer 48. For forming double-sided discs, individual dual layer discs or a dual layer disc and a single layer disc are coupled back to back using an 10 adhesive, as previously indicated herein.

It is also recognized that the image encoded within one of the layers of the dual layer disc may be a holographic image. The holographic image may be formed in a master disc for creating a dual layer disc 15 using methods as disclosed in U.S. Patent No. 5,607,188, previously incorporated herein by reference. In one exemplary embodiment, a holographic image is produced in a layer of a dual layer optical disc, as previously described herein, using a coherent 20 light source and a phase altering mask. In particular, in reference to Figure 18, the light source 108 is a coherent light source, such as a laser light. Mask 106 is a phase altering mask such as a holographic thin film phase grating. When laser light 25 110 passes through the phase altering mask 106, a hologram is formed on the master disc 100 when light from the phase altering mask 106 is interfered with non-defracted light that passes through the phase altering mask 106. The master disc 100 is developed 30 and processed using methods as previously described herein, and contains a holographic image therein.

In another exemplary embodiment shown in Figure 20, a reflective object 130 is used to form the holographic image in the master disc 100. In one

embodiment, a reflective hologram 132, such as a Denisyuk hologram, is placed adjacent the master 100 (containing photoresist layer 104 over substrate 102) with the reflective side of the reflective hologram 5 facing the photoresist layer 104. A coherent light source 134 such as a laser light is passed through the master 102 from the side opposite the photoresist layer 104. Laser light (indicated at 136) which passes through the master disc 100 will interfere with 10 light reflected from the hologram 132 (indicated at 138), which will duplicate the reflective hologram on the master disc 100 (photosensitive layer 106). The master disc 100 is then developed as previously described herein, and contains a holographic image 15 therein. The master disc 100 is used for making a dual layer optical disc with a holographic image encoded in at least one of the layers therein, as shown in the embodiments of Figures 1-17. Alternatively, it is also recognized that instead of using a 20 reflective hologram, any reflective object may be positioned adjacent the master disc 100 photosensitive layer 106 such that the light reflected from the object will duplicate the reflective hologram onto the master disc 100.

What is claimed:

1. A dual layer optical disc (20) having an image (22) encoded therein, the dual layer optical disc comprising:
  - a first data layer (44) including a plurality of lands (54) and a plurality of pits (56);
  - 10 a second data layer (48) coupled to the first layer, the second layer having a plurality of lands (54) and a plurality of pits (56); and
  - 15 an optically viewable image (22) encoded within the first layer, wherein the optically viewable image is defined by a region within the first layer having reduced height lands (64).
- 20 2. The disc of claim 1, further comprising a second optically viewable image encoded within the second data layer.
- 25 3. The disc of claim 1, wherein the optically viewable image is a light contrast image having optically readable data encoded therein.
- 30 4. The disc of claim 1, wherein the first layer is semi-reflective (46), and the second layer is reflective (50).
5. The disc of claim 1, further comprising a protective layer (52) coupled to the second layer.
6. The disc of claim 1, wherein the optically viewable image is a holographic image.

7. The disc of claim 1, wherein the optically viewable image may be viewed through the second layer.

8. The disc of claim 1, wherein the first layer 5 and the second layer have a balanced effective reflectivity value.

9. The disc of claim 1, wherein the first layer and the second layer have an unbalanced effective 10 reflectivity value.

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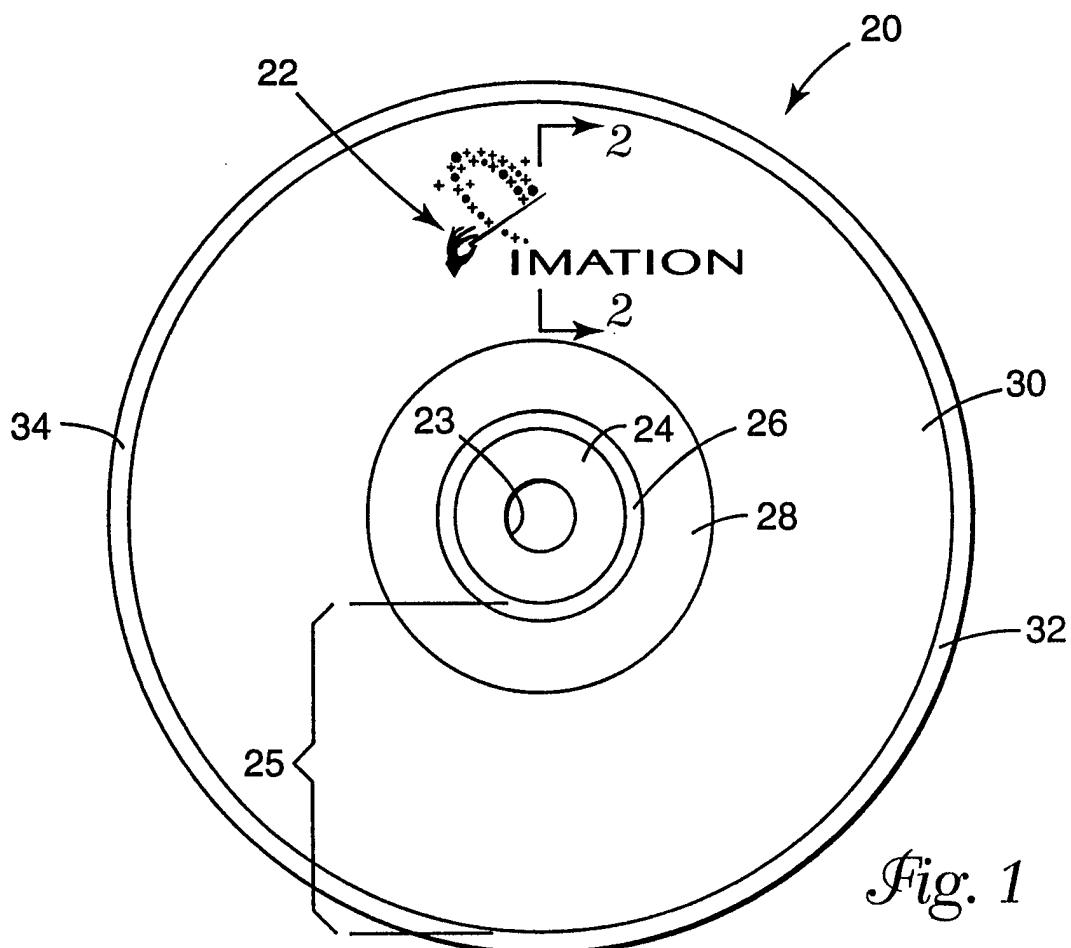
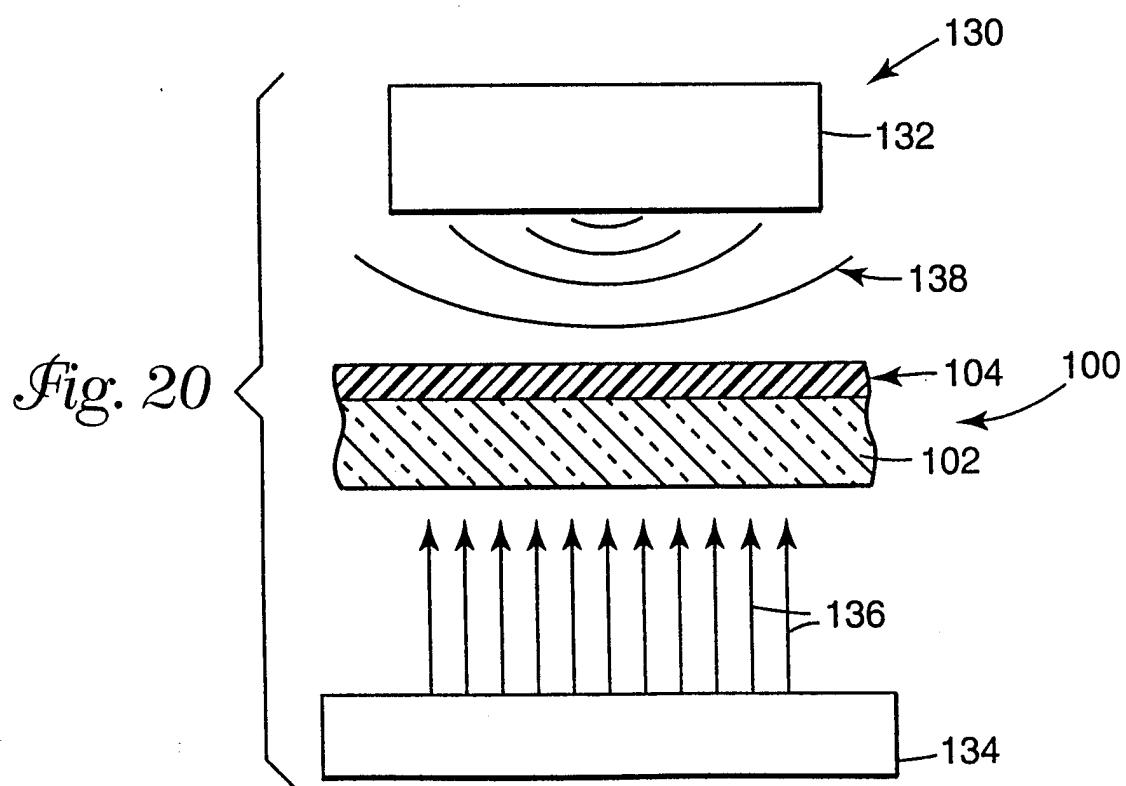


Fig. 1



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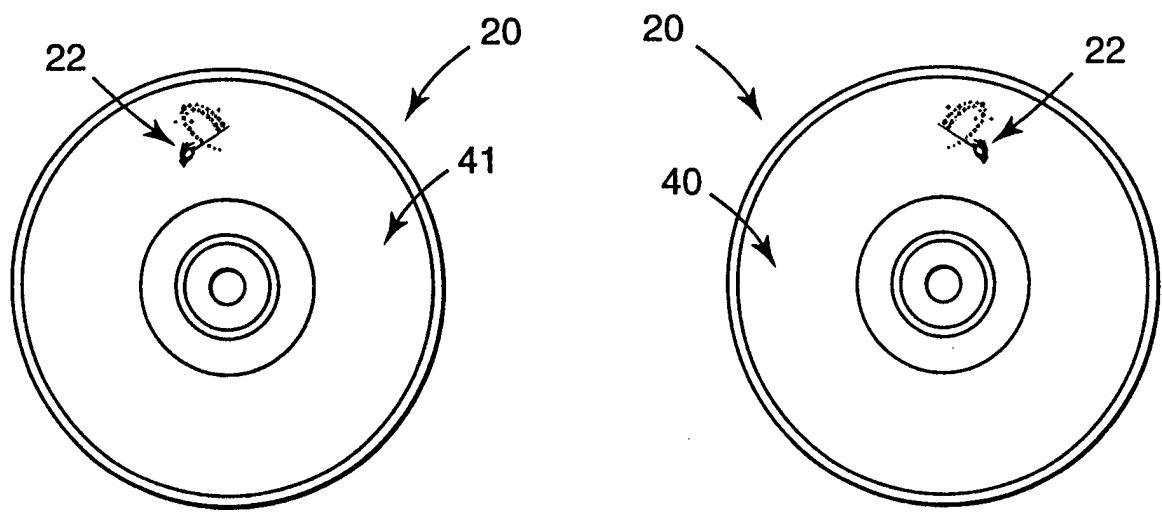
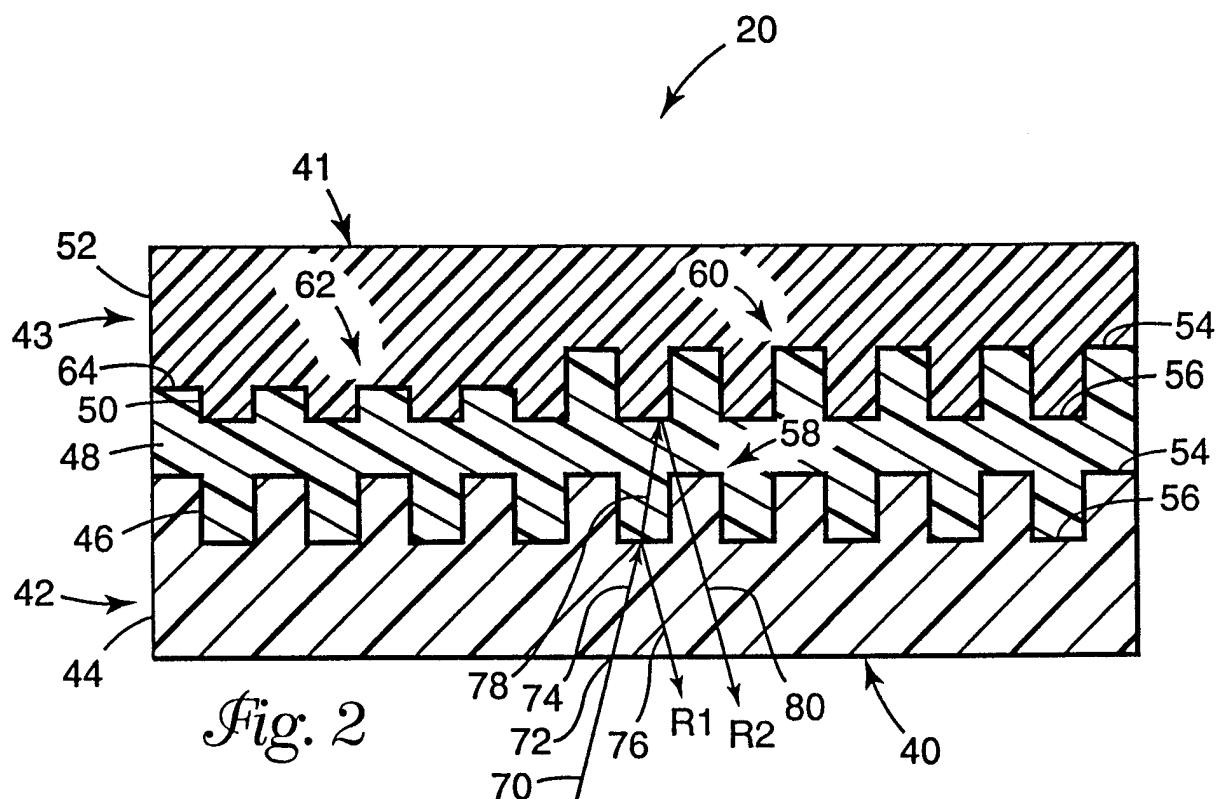
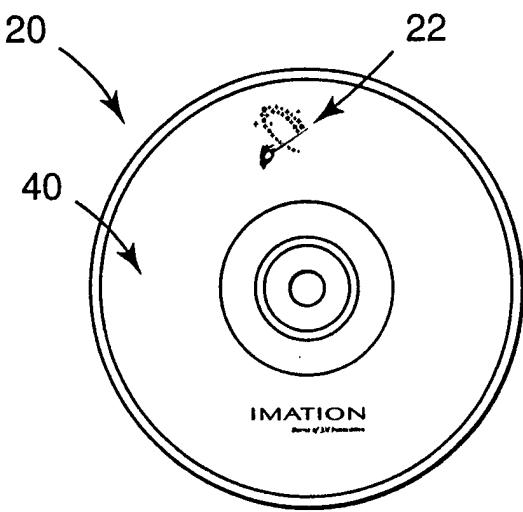
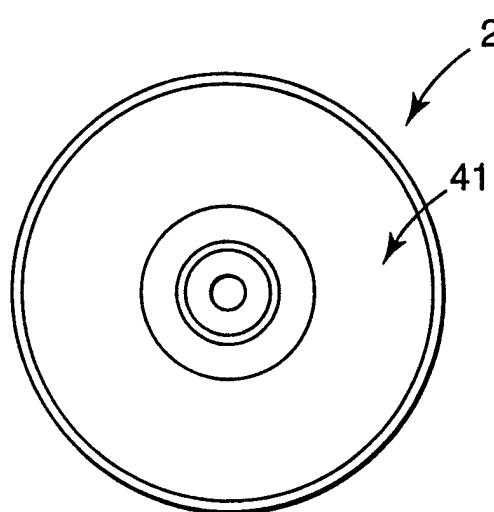
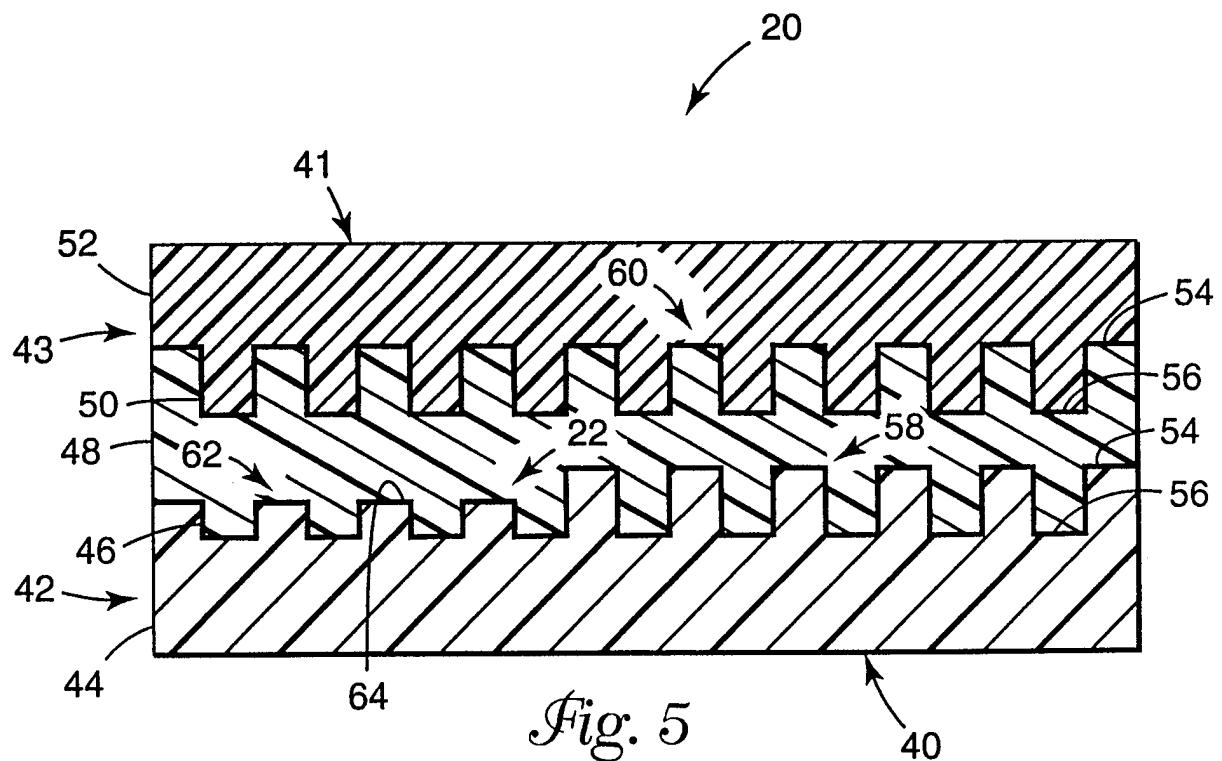


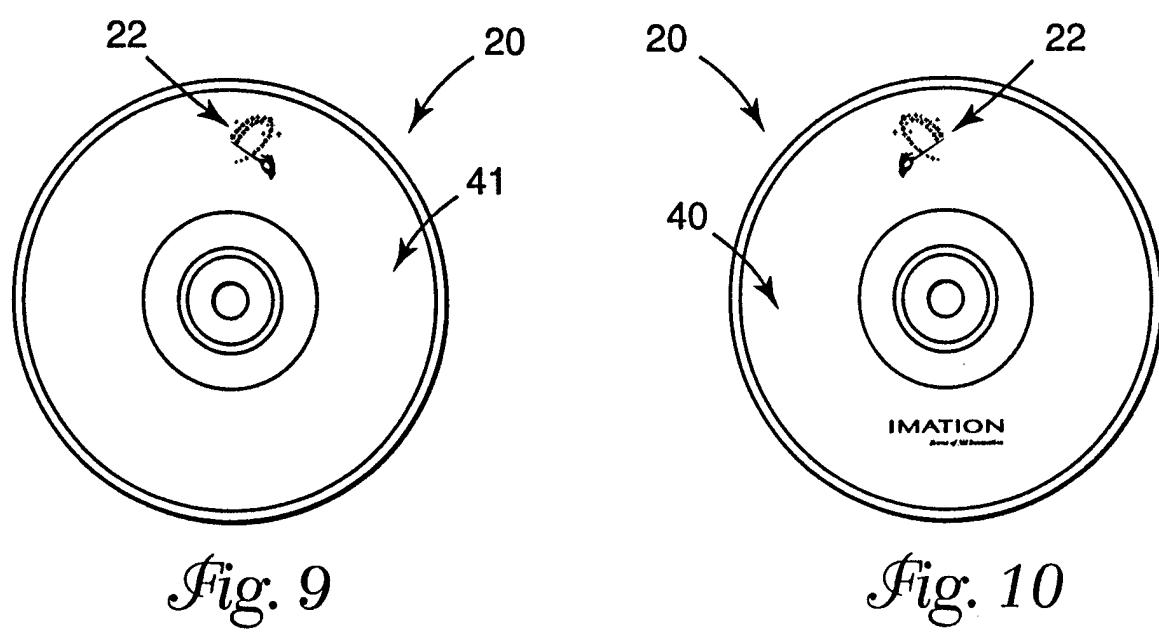
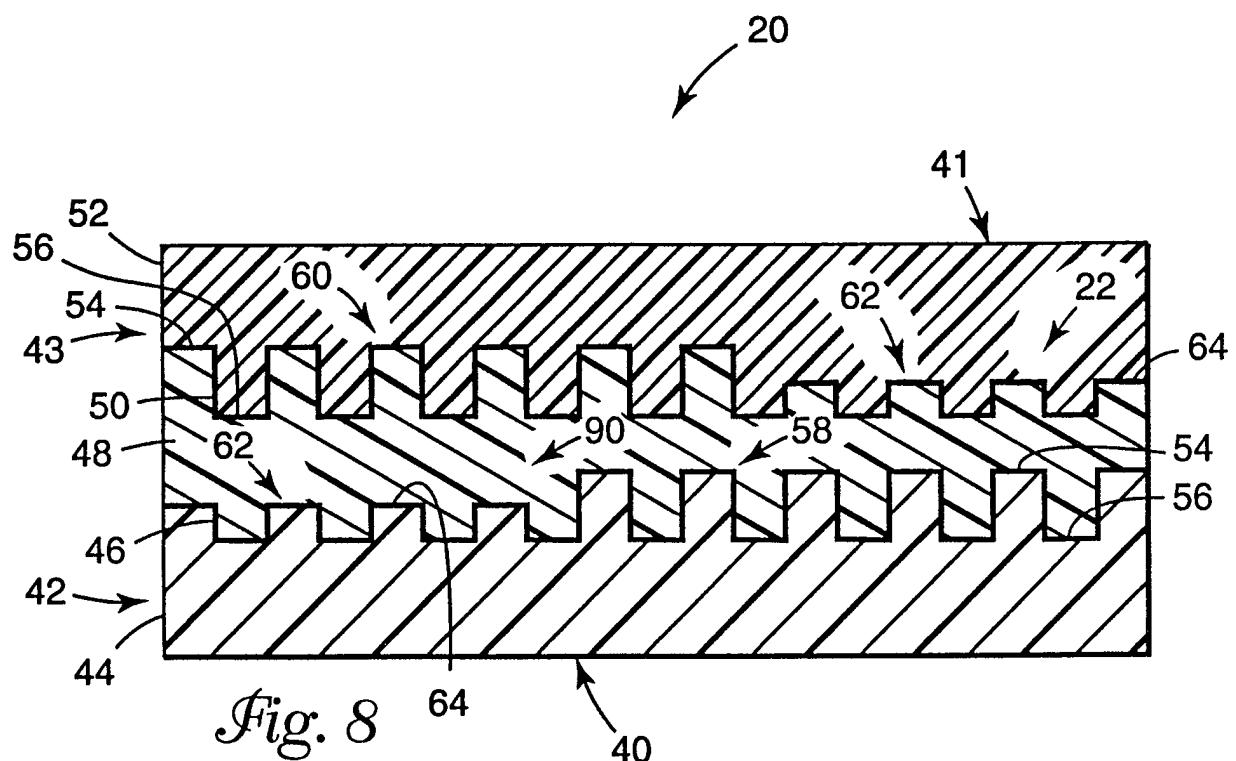
Fig. 3

Fig. 4

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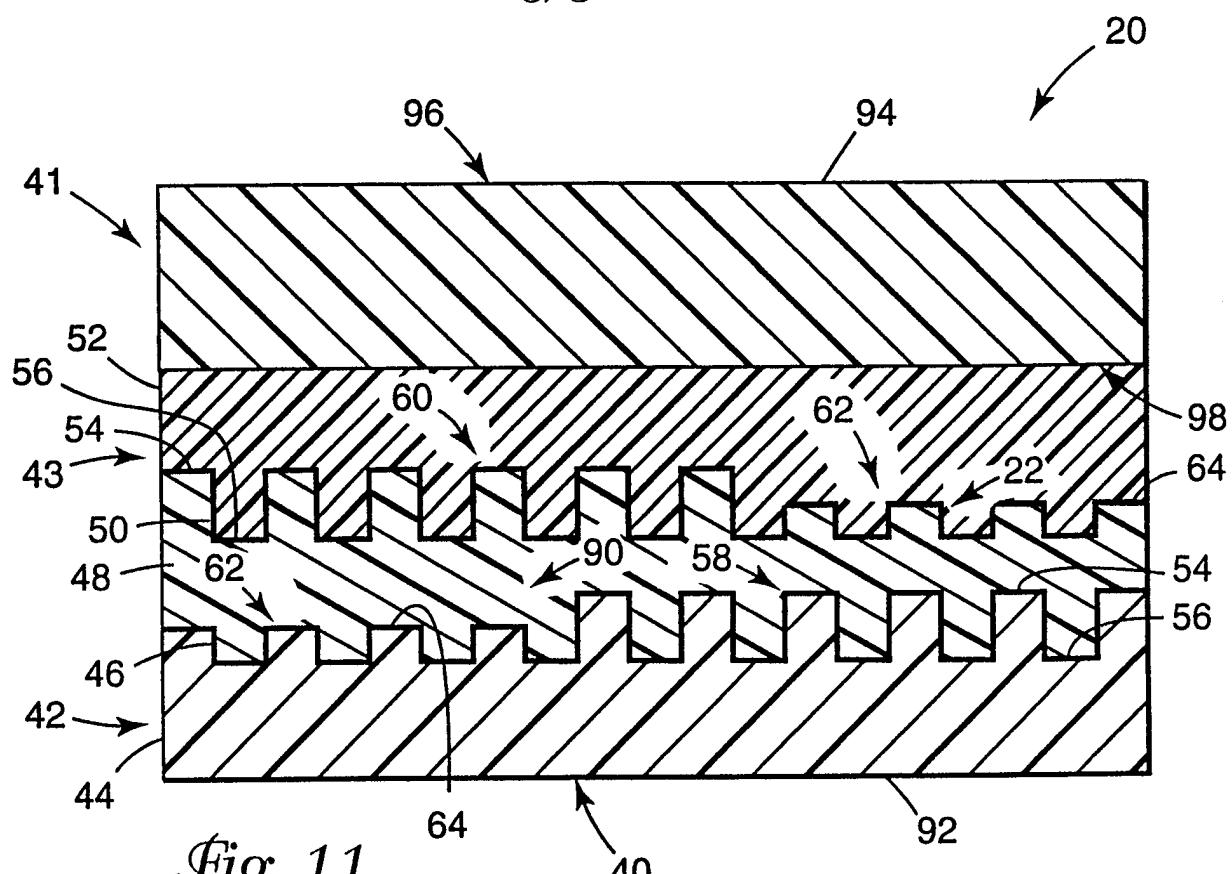


Fig. 11

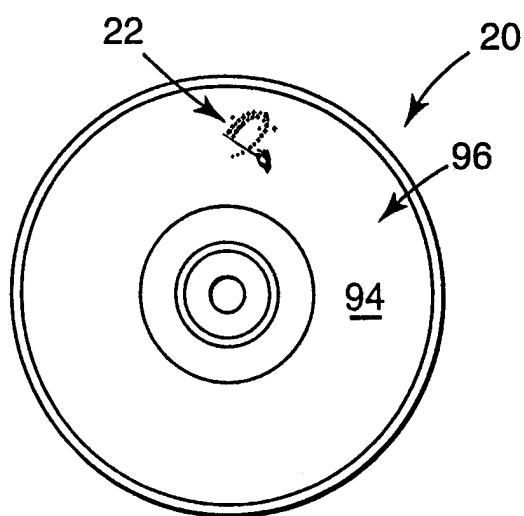


Fig. 12

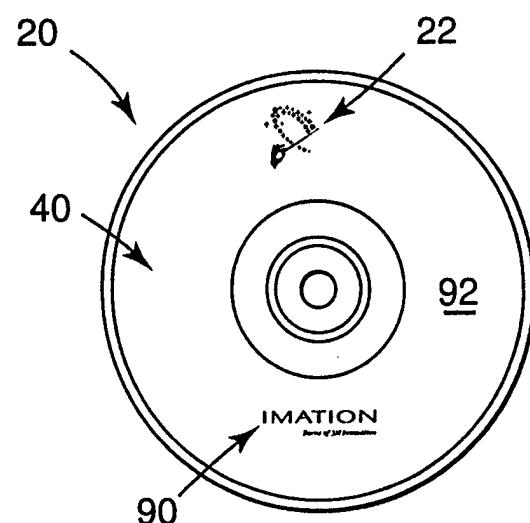


Fig. 13

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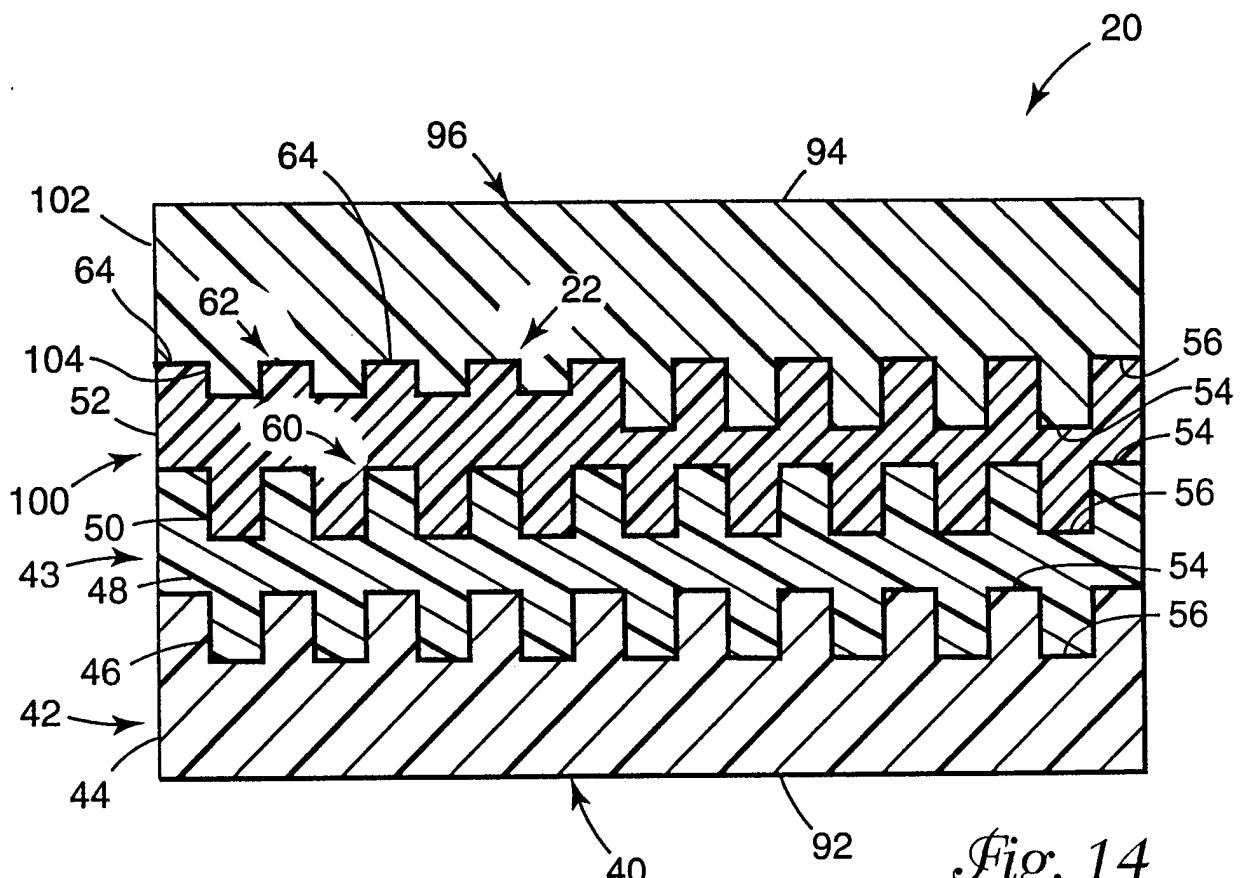


Fig. 14

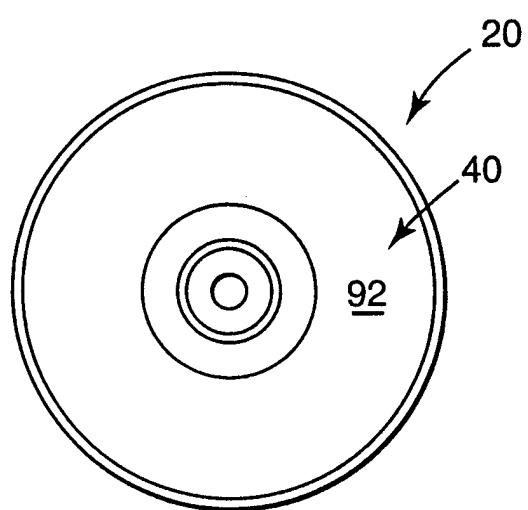


Fig. 15

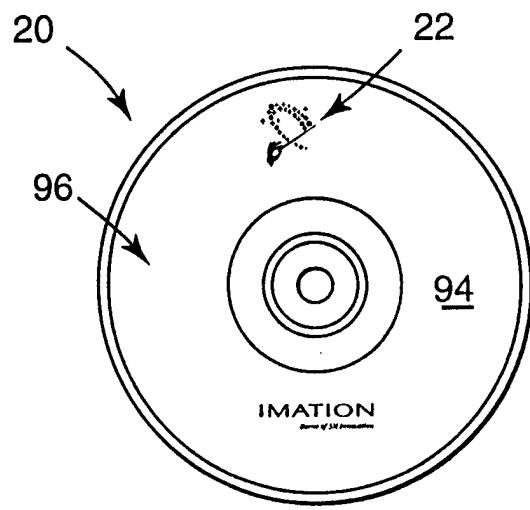
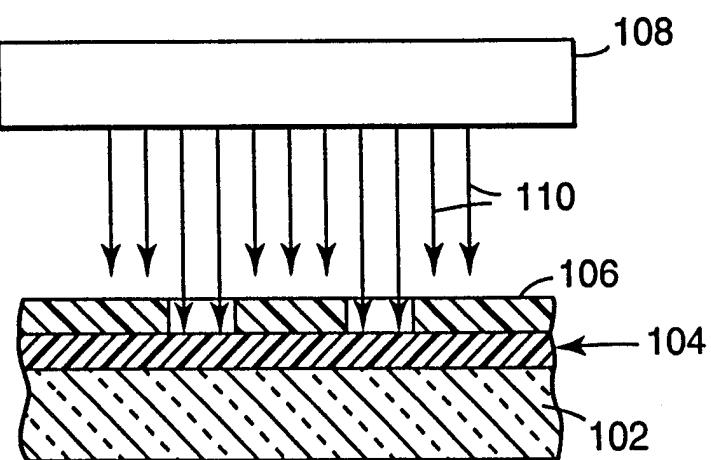
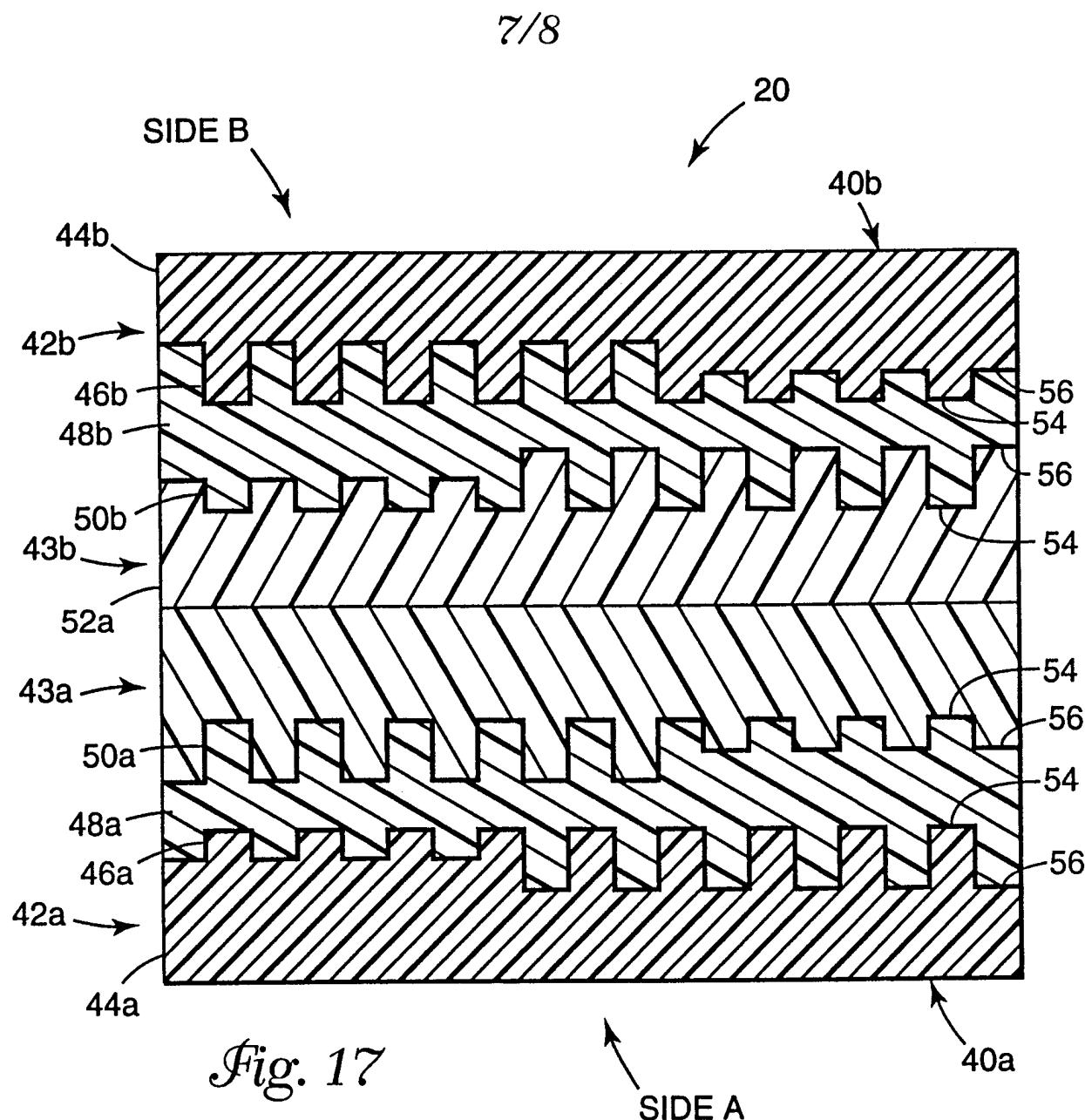


Fig. 16



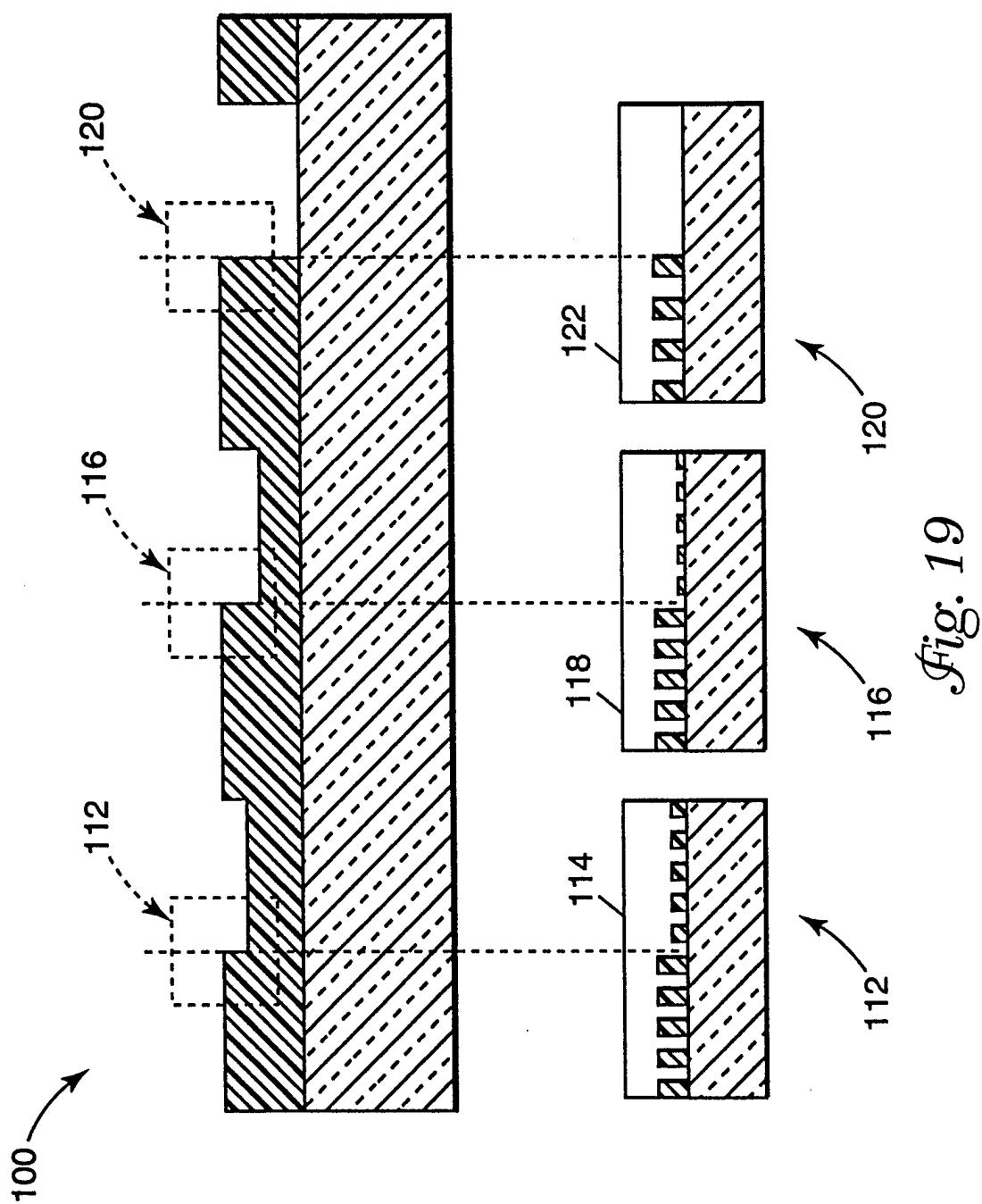


Fig. 19

# INTERNATIONAL SEARCH REPORT

In International Application No

PCT/US 98/05355

**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC 6 G11B7/24 G11B23/40

According to International Patent Classification(IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>PATENT ABSTRACTS OF JAPAN          vol. 096, no. 010, 31 October 1996          -&amp; JP 08 167170 A (PIONEER VIDEO          CORP;PIONEER ELECTRON CORP), 25 June 1996,          see abstract          -&amp; US 5 751 690 A (OHIRA ET AL.) 12 May          1998          see abstract; figures 2A-4          see column 2, line 31 - column 3, line 19          ---          -/--       </p>	1-3,5,7

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

<sup>o</sup> Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

9 June 1998

17/06/1998

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**INTERNATIONAL SEARCH REPORT**

Int'l Application No

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## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US 98/05355

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	PATENT ABSTRACTS OF JAPAN vol. 096, no. 011, 29 November 1996 -& JP 08 180463 A (PIONEER VIDEO CORP; PIONEER ELECTRON CORP), 12 July 1996, see abstract -& US 5 675 570 A (OHIRA ET AL.) 7 October 1997 see abstract; figures 1,2,4-7 see column 5, line 20 - column 7, line 18 ---	1-3,5,7
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Y	PATENT ABSTRACTS OF JAPAN vol. 097, no. 002, 28 February 1997 -& JP 08 273331 A (TOSHIBA CORP), 18 October 1996, see abstract; figures 1,3 ---	1-3,6,7
A	WO 94 10684 A (PMDC INC ; WISE JAMES SCOTT (US); MCBRIDE RANDALL RAY (US); HARDEN) 11 May 1994 see abstract; figures 1A-1B see page 8, line 22 - page 11, line 16 ---	1-9
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