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SINGAPORE (7)

PATENT SPECIFICATION

(11) **1 580 398**

1 580 398

(21) Application No. 19538/77 (22) Filed 10 May 1977

(31) Convention Application No. 687084

(32) Filed 13 May 1976 in

(33) United States of America (US)

(44) Complete Specification published 3 Dec. 1980

(51) INT CL³ G11B 7/24

(52) Index at acceptance

G2X 2

G5R B20 B21 B265 B352 B361 B36Y B571 B57X B701 B711 B71X B783

(19)



(54) RADIATION-SENSITIVE RECORD

(71) We, NORTH AMERICAN PHILIPS CORPORATION, residing at 100 East 42nd Street, New York 10017, New York, United States of America, a Corporation organised and existing under the laws of the State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

Radiation beam recording mediums may be generally divided into two types. First recordings may be made by projecting a radiation beam into a record coated with a photographic layer or a photoresist layer. The image immediately produced in this type of layer is latent, that is, further processing is necessary prior to the time the record may be "played back".

A second type of radiation-sensitive medium provides an immediate change in the optical properties of the recording medium. This latter type of medium is generally referred to as a direct read after write or DRAW material. Examples of such DRAW materials are thin layers of metals such as rhodium or beryllium, metal compounds such as arsenic selenide, bismuth compounds, amorphous semiconductors, and photochromic materials such as KCl with N_aF_a centers.

These materials experience a physical change such as melting or evaporation, or a chemical reaction such as decomposition or combination in response to a radiation beam.

The recording process for any of the above types of record medium involves manufacturing the blank record, recording the information thereon, developing if necessary and encasing the record to protect the same from damage. Between the stages of manufacturing the blank record and encasing the record the radiation-sensitive surface is subject to damage by scratching or nicking due to mishandling. Furthermore, some recording media are subject to chemical contamination prior to recording from handling or from atmospheric pollution.

It is therefore desirable to protect the material in some manner after the blank record is manufactured. An apparently obvious solution would be to coat one side of the transparent disc with radiation-sensitive materials and to coat the sensitive materials with a protective layer. Unfortunately, while the protective layer would prevent scratches and nicks prior to recording, in the case of non-DRAW recording materials the protective layer must be removed prior to development of the sensitive material, while in the case of most DRAW materials, where the recording process generally involves melting and evaporation or chemical reactions producing gaseous by-products, the protective layer would interfere with the physical and chemical processes.

The invention provides a radiation-sensitive record comprising a first disc-shaped member, a second disc-shaped member in coaxial confronted relationship with a first surface of said first disc-shaped member and spaced therefrom, a pair of coaxial spacer rings of different diameters sealed between the confronting surfaces of said first and second disc-shaped members coaxially therewith and forming an annular space therebetween, at least one of said disc-shaped members being transparent, and a radiation-sensitive recording layer on one of said confronting disc surfaces enclosed within said annular space.

Thus, in order to protect the radiation-sensitive surface of blank DRAW and non-DRAW records in accordance with the invention, the recording medium is enclosed between two members in the form of opposed coaxial discs with two spacer rings between the discs to maintain a separation between the facing disc surfaces and to seal the enclosure. The radiation-sensitive material is applied to one or both of the disc surfaces prior to assembly. In view of the fact that the records are to be used with a radiation beam focussing objective it is

preferable to project the beam through a relatively thin 50 μ—200 μ member. On the other hand, it is preferable to provide the radiation-sensitive medium on a stable surface. Thus, it is desirable to place the radiation-sensitive layer on a relatively thick surface. In one embodiment of the invention therefor, a reflective DRAW material is applied to a relatively thick 500μ—2000μ surface or substrate while the beam is focussed through both a transparent relatively thin 175μ cover disc and through the gas enclosed between the discs.

In the event a two-sided recording disc is desired, two transparent relatively thick discs separated by the spacer rings may be provided. In this case, of course, the radiation-sensitive material is applied to both inside surfaces of the two discs enclosed within said annular space and the radiation may be focussed separately through each disc on to the radiation-sensitive material coated thereon. In the two sided configuration, that is, in the last described embodiment wherein the information may be recorded separately on both sides of the record, it may be necessary to place an extremely thin 150μ—175μ disc-shaped separator between the two rigid transparent discs to prevent solid particles or liquid droplets formed as a by-product of recording on one radiation-sensitive surface from affecting a recording previously recorded on the opposite radiation-sensitive surface. This last configuration may be achieved in several different manners. First, the separator may have the same diameter as the transparent relatively thick discs. In this case an additional set of spacer rings will be necessary, one set of spacer rings being placed on each side of the thin separator disc. One set of spacer rings may, however, be eliminated by attaching the separator disc to the rims of the two spacer rings of a single set of such rings.

One of the problems associated with the above types of two sided blank records is that the recording beam must be focussed through a relatively heavy objective to compensate for the thickness of the discs through which the light passes. In order to avoid this difficulty a further embodiment utilizes a single relatively thick disc having both major surfaces covered with radiation-sensitive material. The radiation-sensitive material is enclosed on each side by a relatively thin transparent disc and a separate pair of spacer rings.

The spacer rings need not form a perfect pneumatic seal, and in some cases is may be advantageous to form one or more apertures in the rings to adjust the internal pressures caused by centrifugal forces acting on the gas between the layers when the disc is rotated at high velocities.

The radiation-sensitive layer may be a reflecting material having a thickness equal to $n(2N-1)\lambda/4$, where N is a positive integer, λ is equal to the wavelength of the radiation to be used for reading the record, and n is the refractive index of the material.

Also, when the first disc-shaped member is relatively thick compared to the thickness of the second disc-shaped member, the radiation-sensitive recording layer may be on the inside surface of said second member enclosed within said annular space.

The invention also provides a radiation-sensitive record comprising a first substantially rigid cylindrically-shaped member, a second transparent cylindrically-shaped member, relatively thin compared to the thickness of said first cylindrically-shaped member, and having an inside diameter larger than the outer diameter of said first cylindrically-shaped member and in coaxial confronting relationship therewith, a pair of coaxial substantially identical spacer rings sealed between the confronting surfaces of said first and second cylindrically-shaped members and forming a cylindrically-shaped space therebetween, and a radiation-sensitive recording layer on the surface of said first cylindrically-shaped member that is in confronting relationship with said second cylindrically-shaped member and enclosed within said cylindrically-shaped space.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is a partial section of a first embodiment of a record in accordance with the invention,

Figure 2 is a partial section of a second embodiment of a record in accordance with the invention,

Figure 3 is a partial section of a third embodiment of a record in accordance with the invention,

Figure 4 is a partial section of a modification of the embodiment shown in Figure 2,

Figure 5 is a partial section of a fourth embodiment of a record in accordance with the invention,

Figures 6 and 7 are portions of sectional views of parts of the embodiments of Figures 2 and 1 showing how a recording is to be made on such records,

Figure 8 is a partial section of a fifth embodiment of a record in accordance with the invention,

Figure 9 is a planar view of a modification of the spacer rings shown in Figures 1 to 5 inclusive, and

Figure 10 is a partial sectional view of a modification of the spacer rings shown in the embodiment of Fig. 8.

Fig. 1 shows a relatively thin 175μ transparent disc 1. A second substantially rigid relatively thick disc 4 is arranged coaxially with the transparent disc 1. Separating the discs 1 and 4 and forming an annular sealed spaced therebetween is a pair of resilient annular coaxial members or spacer rings, 2, 3. It is noted that in Fig. 1 as well as in all of the other Figures the relative dimensions of the various members have been intentionally distorted to simplify the drawing. In reality, the diameter to thickness ratios of all of the discs are much larger than that represented in the drawings.

In Fig. 1, a radiation-sensitive layer 5 is provided on the surface of disc 4 that is enclosed within the annular space between the discs 1, 4. The radiation-sensitive layer in this embodiment may be radiation reflecting such as a thin layer of bismuth, arsenic selenide, rhodium, etc., or may be radiation absorbing.

The recording and playback of a disc shown in Fig. 1 will generally be performed as shown in Fig. 7. That is, during recording, a beam of radiation 11 is projected through the disc 1 and the space between the discs onto the radiation-sensitive layer 5. The by-products of the recording process will remain in the space between the discs thereby protecting the objective (not shown) that focusses the radiation beam 11 on the layer 5 and, in the case of recording materials such as arsenic selenide, the utilization of the annular sealed space between the records according to the invention prevents the poisonous by-products of recording from escaping into the atmosphere. The relatively thin disc 1 through which the light is projected furthermore enables the use of a relatively light weight objective, thus facilitating the focussing of the beam 11 onto the layer 5. If the radiation-sensitive material produces a vapor that tends to deposit on the inside surface of the disc 1 restricting the radiation transmission properties thereof, or if the passage of the radiation beam through the two refracting interfaces formed by the inner and outer disc surfaces and the surrounding air makes the location of the focal point of the radiation beam difficult to control, the disc 4 may be made of a transparent material and the recording may be made by focussing the beam through the disc 4 onto the layer 5. A spindle hole 6 through both discs facilitates the placement of the assembly on a turn-table.

Fig. 2 shows a two sided disc configuration, that is, a disc on which recordings may be independently made on both sides thereof. The resilient sealing members 2, 3 are identical to those of Fig. 1 and will therefore not be described. In Fig. 2 two identical relatively thick transparent discs 7A, 7B are assembled in the same manner as the discs of Fig. 1. A separate layer 5A, 5B of radiation-sensitive material is provided on the inside surfaces of both discs. During recording and play-back the radiation beam 11 will be focussed through either disc 7A, 7B on the corresponding radiation-sensitive layer 5A, 5B provided thereon (see Fig. 6). In this case the radiation-sensitive layers must be made of a reflecting material.

Following the recording of a first side of the record of Fig. 2 the nature of the radiation-sensitive layer may be such that the by-products of recording the other side may deposit on and degrade the recording on the first side. This is especially true in the case of a metallic radiation-sensitive layer. To remedy this situation a relatively thin separator disc 8 as shown in Fig. 3 is provided. If the major diameter of the separator disc 8 is the same as the transparent discs 7A, 7B an additional set of spacer rings must be used. Thus, a first set of spacer rings 2A, 3A is provided between the separator disc 8 and transparent disc 7A, forming a first annular space therebetween, while a second set of spacer rings 2B, 3B provides a second annular space between disc 7B and the separator disc 8. As in Fig. 2 the reflective radiation-sensitive material is provided on the inside surfaces of the discs 7A, 7B. Obviously the spindle hole may be continued through the separator disc 8.

One of the two sets of spacer rings of the record shown in Fig. 3 may be eliminated by using a separator disc 8 that has a smaller diameter than the discs 7A, 7B and by attaching the separator disc 8 to the inner rim of spacer ring 2 and to the outer rim of spacer ring 3 as shown in Fig. 4.

While the two sided record shown in Figs. 2 to 4 inclusive operates satisfactorily it is advantageous, as explained above, to focus the radiation beam 11 through a relatively thin transparent member. Fig. 5 shows a disc configuration wherein a relatively thick disc 10 is coated on both major surfaces with the radiation-sensitive layer 5A, 5B. As in Fig. 3, two sets of spacer rings 2A, 2B, 3A, 3B are utilized in order to form two annular spaces adjacent each radiation-sensitive layer. As with the configuration of Fig. 1 the relatively thick member may be reflective, thus permitting the use of a non-reflective radiation-sensitive layer. In this respect it is noted that where the radiation-sensitive material is non-reflecting and a reflective disc is used to support the material the inter-action between the recording beam and the radiation-sensitive material must be such as to either physically remove the material locally as in the case with carbon black or arsenic selenide, or to change an opaque material into a clear

material, or a clear material to an opaque material, as with amorphous semiconductor glasses or photochromics.

As shown in Figs. 6 and 7 the recording and reproducing beam may be focussed through a transparent disc onto a radiation-sensitive layer provided on the disc or may be focussed through both a transparent disc and a gas layer sealed between the disc and a second disc, onto a radiation-sensitive layer on the second disc.

The same techniques used with manufacturing discs may be applied to cylinders. This is shown in Fig. 8 where a relatively thick cylinder 16 is coated on the outside with a radiation-sensitive material 15. A thinner and larger transparent cylinder 12 surrounds the cylinder 16 coaxially. Between two cylinders at the end thereof are two resilient sealing rings, or spacer rings, 13, 14 forming a cylindrical sealed space adjacent the radiation-sensitive layer. During recording and reading the cylindrical assembly is rotated on its axis while a beam such as 11 in Fig. 7 is focussed through the transparent material and the gas layer onto the radiation-sensitive material.

In the event that more support is necessary between the various discs of any of the records shown in Figs. 1 to 5 inclusive the spacer shown in Fig. 9 could be substituted for the different pairs of spacer rings. The spacing member of Fig. 9 consists of two coaxial spacing rings 2C, 3C with four radial spokes 17 connecting the rings. While increasing the strength of the assembly the recording surface is reduced by the area of the spokes.

Fig. 10 shows a spacing assembly which may be substituted for the spacing rings of Fig. 8. In a manner analogous with the structure of Fig. 9, four spokes 18 parallel to the axis of the cylinder connect the two outer rings 13A, 14A providing additional structural rigidity.

In the case of a DRAW material the spacer rings are permanently connected to the discs or drums by cement or glue at the mating surfaces. A non-DRAW record, however, requires access to the radiation-sensitive material following the recording thereon for the purpose of development and therefor must employ a temporary bond between the discs and the spacer rings using a material such as an adhesive. A recording apparatus utilizing radiation-sensitive discs is known from U.S. Patent 3,908,080.

WHAT WE CLAIM IS:—

1. A radiation-sensitive record comprising a first disc-shaped member, a second disc-shaped member in coaxial confronted relationship with a first surface of said first disc-shaped member and spaced therefrom, a pair of coaxial spacer rings of different diameters sealed between the confronting surfaces of said first and second disc-shaped members coaxially therewith and forming an annular space therebetween, at least one of said disc-shaped members being transparent, and a radiation-sensitive recording layer on one of said confronting disc surfaces enclosed within said annular space.

2. A radiation-sensitive record as claimed in claim 1, wherein said first disc-shaped member is relatively thick compared to the thickness of said second disc-shaped member and wherein said radiation-sensitive recording layer is on the inside of said first member.

3. A radiation sensitive record as claimed in claim 2, wherein said first member is transparent, and wherein said radiation-sensitive layer is a reflective material.

4. A radiation-sensitive record as claimed in claim 2, wherein said first member is made of a reflective material.

5. A radiation-sensitive record as claimed in claim 4, wherein said radiation-sensitive recording layer is a reflective material.

6. A radiation-sensitive record as claimed in claim 4, wherein said radiation-sensitive recording layer is opaque prior to recording.

7. A radiation-sensitive record as claimed in claim 1, wherein both said first and said second disc-shaped members are transparent, and wherein a radiation-sensitive layer is provided on each confronting disc surface enclosed within said annular space.

8. A radiation-sensitive record as claimed in claim 7, further comprising a disc-shaped separator means intermediate said two radiation-sensitive layers and coaxial with said disc-shaped members for dividing said annular space into two annular spaces.

9. A radiation-sensitive record as claimed in claim 8, wherein said pair of spacer rings is affixed between one major surface of said separator means and said first disc-shaped member, and further comprising an additional pair of spacer rings coaxial with said disc-shaped members and affixed between the other major surface of said separator means and said second disc-shaped member.

10. A radiation-sensitive record as claimed in Claim 8, wherein said separator means is affixed to the surface of one of said spacer rings closest to the axis thereof and to a surface of the other of said spacer rings furthest from the axis thereof.

11. A radiation-sensitive record as claimed in Claim 2, further comprising an additional disc-shaped member, relatively thin compared to said first disc-shaped member, in coaxial confronted relationship with the second surface of said first member, an additional pair of spacer rings

material, or a clear material to an opaque material, as with amorphous semiconductor glasses or photochromics.

As shown in Figs. 6 and 7 the recording and reproducing beam may be focussed through a transparent disc onto a radiation-sensitive layer provided on the disc or may be focussed through both a transparent disc and a gas layer sealed between the disc and a second disc, onto a radiation-sensitive layer on the second disc.

The same techniques used with manufacturing discs may be applied to cylinders. This is shown in Fig. 8 where a relatively thick cylinder 16 is coated on the outside with a radiation-sensitive material 15. A thinner and larger transparent cylinder 12 surrounds the cylinder 16 coaxially. Between two cylinders at the end thereof are two resilient sealing rings, or spacer rings, 13, 14 forming a cylindrical sealed space adjacent the radiation-sensitive layer. During recording and reading the cylindrical assembly is rotated on its axis while a beam such as 11 in Fig. 7 is focussed through the transparent material and the gas layer onto the radiation-sensitive material.

In the event that more support is necessary between the various discs of any of the records shown in Figs. 1 to 5 inclusive the spacer shown in Fig. 9 could be substituted for the different pairs of spacer rings. The spacing member of Fig. 9 consists of two coaxial spacing rings 2C, 3C with four radial spokes 17 connecting the rings. While increasing the strength of the assembly the recording surface is reduced by the area of the spokes.

Fig. 10 shows a spacing assembly which may be substituted for the spacing rings of Fig. 8. In a manner analogous with the structure of Fig. 9, four spokes 18 parallel to the axis of the cylinder connect the two outer rings 13A, 14A providing additional structural rigidity.

In the case of a DRAW material the spacer rings are permanently connected to the discs or drums by cement or glue at the mating surfaces. A non-DRAW record, however, requires access to the radiation-sensitive material following the recording thereon for the purpose of development and therefor must employ a temporary bond between the discs and the spacer rings using a material such as an adhesive. A recording apparatus utilizing radiation-sensitive discs is known from U.S. Patent 3,908,080.

WHAT WE CLAIM IS:—

1. A radiation-sensitive record comprising a first disc-shaped member, a second disc-shaped member in coaxial confronted relationship with a first surface of said first disc-shaped member and spaced therefrom, a pair of coaxial spacer rings of different diameters sealed between the confronting surfaces of said first and second disc-shaped members coaxially therewith and forming an annular space therebetween, at least one of said disc-shaped members being transparent, and a radiation-sensitive recording layer on one of said confronting disc surfaces enclosed within said annular space.

2. A radiation-sensitive record as claimed in claim 1, wherein said first disc-shaped member is relatively thick compared to the thickness of said second disc-shaped member and wherein said radiation-sensitive recording layer is on the inside of said first member.

3. A radiation sensitive record as claimed in claim 2, wherein said first member is transparent, and wherein said radiation-sensitive layer is a reflective material.

4. A radiation-sensitive record as claimed in claim 2, wherein said first member is made of a reflective material.

5. A radiation-sensitive record as claimed in claim 4, wherein said radiation-sensitive recording layer is a reflective material.

6. A radiation-sensitive record as claimed in claim 4, wherein said radiation-sensitive recording layer is opaque prior to recording.

7. A radiation-sensitive record as claimed in claim 1, wherein both said first and said second disc-shaped members are transparent, and wherein a radiation-sensitive layer is provided on each confronting disc surface enclosed within said annular space.

8. A radiation-sensitive record as claimed in claim 7, further comprising a disc-shaped separator means intermediate said two radiation-sensitive layers and coaxial with said disc-shaped members for dividing said annular space into two annular spaces.

9. A radiation-sensitive record as claimed in claim 8, wherein said pair of spacer rings is affixed between one major surface of said separator means and said first disc-shaped member, and further comprising an additional pair of spacer rings coaxial with said disc-shaped members and affixed between the other major surface of said separator means and said second disc-shaped member.

10. A radiation-sensitive record as claimed in Claim 8, wherein said separator means is affixed to the surface of one of said spacer rings closest to the axis thereof and to a surface of the other of said spacer rings furthest from the axis thereof.

11. A radiation-sensitive record as claimed in Claim 2, further comprising an additional disc-shaped member, relatively thin compared to said first disc-shaped member, in coaxial confronted relationship with the second surface of said first member, an additional pair of spacer rings

of different sizes affixed between said first disc-shaped member and said additional disc-shaped member and coaxial therewith forming an additional annular space therebetween, and an additional radiation-sensitive layer on the second surface of said first disc-shaped member opposite said additional disc-shaped member and enclosed within said additional annular space.

12. A radiation sensitive record as claimed in claim 11, wherein said first disc-shaped member is a reflecting disc.

13. A radiation-sensitive record as claimed in claim 12, wherein said radiation-sensitive layers are radiation-absorbing layers prior to recording.

14. A radiation-sensitive record as claimed in claim 11, wherein said radiation-sensitive layer is made of a reflecting material.

15. A radiation-sensitive record as claimed in claim 12, wherein said radiation-sensitive layer is a reflecting material having a thickness equal to $n(2N-1)\lambda/4$, where N is a positive integer, λ is equal to the wavelength of the radiation to be used for reading the record, and n is the refractive index of the material.

16. A radiation-sensitive record as claimed in claim 1, wherein said spacer rings further comprise additional spoke-shaped members having a thickness substantially equal to the thickness of said spacer rings and extending radially between said pair of spacer rings.

17. A radiation-sensitive record comprising a first substantially rigid cylindrically-shaped member, a second transparent cylindrically-shaped member, relatively thin compared to the thickness of said first cylindrically-shaped member, and having an inside diameter larger than the outer diameter of said first cylindrically-shaped member and in coaxial confronting relationship therewith, a pair of coaxial substantially identical spacer rings sealed between the confronting surfaces of said first and second cylindrically-shaped members and forming a cylindrically-shaped space therebetween, and a radiation-sensitive recording layer on the surface of said first cylindrically-shaped member that is in confronting relationship with said second cylindrically-shaped member and enclosed within said cylindrically-shaped space.

18. A radiation-sensitive record as claimed in claim 17, wherein said spacer rings further comprise a plurality of spoke-shaped members having a thickness substantially equal to the thickness of said spacer rings and extending therebetween substantially parallel to the axis of said cylindrically-shaped members.

19. A radiation-sensitive record as claimed in claim 1, wherein said first disc-shaped member is relatively thick compared to the thickness of the second disc-shaped member and wherein said radiation-sensitive recording layer is on the inside surface of said second member enclosed within said annular space.

20. A radiation-sensitive record substantially as described with reference to any one of Figures 1 to 5 inclusive or to Figure 8 of the accompanying drawings.

21. A radiation-sensitive record substantially as described with reference to any one of Figures 1 to 5 inclusive comprising the spacing member described with reference to Figure 9 of the accompanying drawings.

22. A radiation-sensitive record substantially as described with reference to Figures 8 and 10 of the accompanying drawings.

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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1980
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.