82841/87

COMMONWEALTH OF AUSTRALIA

The Patents Act 1952

601533

CONVENTION APPLICATION FOR A PATENT

We, THORN EMI plc, a British Company, of 4 Tenterden Street, London W1R 9AH, England, hereby apply for the grant of a Patent for an invention entitled "REPLICATION OF CARRIERS BEARING DIGITALLY RECORDED INFORMATION" which is described in the accompanying complete specification.

This application is a Convention application and is based on the application numbered 86 29223 for a patent or similar protection made in the United Kingdom on 6th December, 1986.

Our address for service is care of CALLINANS, Patent Attorneys, of 48 Bridge Road, Richmond, 3121, Victoria, Australia.

D A T E D this 8th day of December, 1987.

THORN EMI plc

By its Patent Attorneys:

CALLINANS

Colin Maurice

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 2-7-90

To: The Commissioner of Patents.

Form 6
Form 7

Regulation 11 (1)
Regulation 11 (2)

COMMONWEALTH OF AUSTRALIA

Patents Act 1952-60

Declaration in Support of (a) A Convention Application (b) ~~An Application~~ for a Patent ~~or Patent of Addition~~

(a) Delete for Non-Convention Application.

(b) Delete for Convention Application.

In support of the ~~Application~~/Convention Application made by

(c) Insert Full Name of Application.

(c) THORN EMI plc

for a patent/~~patent of addition~~ for an invention entitled:

(d) Insert Title of Invention.

(d) "REPLICATION OF CARRIERS BEARING DIGITALLY RECORDED INFORMATION"

(e) Insert Full Names of Declarant(s).

I/~~We~~ (e) RICHARD ARTHUR ALEXANDER HURST

(f) Insert Address(es) of Declarant(s).

of (f) THORN EMI Patents Limited, The Quadrangle, Westmount Centre, Uxbridge Road, Hayes, Middlesex, UB4 OHB, England.

do solemnly and sincerely declare as follows:—

(g) Delete when Applicant is a Company.

~~1. I am/We are the applicant(s) for the patent/patent of addition~~
~~or~~

(h) Delete when Applicant is an Individual. Fill in Name of Applicant if a Company.

(h) I am/~~we are~~ authorised by THORN EMI plc

the applicant for the patent/~~patent of addition~~ to make this declaration on its behalf.

(i) For Non-Convention Application, delete. For Convention Application, fill in details of basic application.

2. (i) The basic application[redacted] as defined by Section 141 of the Act was/~~were~~ made in Great Britain on the 6th day of December, 1986 19 by THORN EMI plc

(j) Delete for Non-Convention Application by Assignee of Inventor and for Convention Application.

3. ~~I am/We are the actual inventor(s) of the invention~~
~~or~~

(k) Delete for Non-Convention Application by Inventor and for Convention Application by Assignee.

(k) ~~I am/We are the actual inventor(s) of the invention referred to in the basic application~~
~~or~~

(l) Delete for Application by Inventor. For Application by Assignee, insert name, address and occupation of Inventor.

(l) ANTHONY LANG, 82, Woodstone Avenue, Epsom, Surrey, England; and PAUL BLOCH, Wayside, 33, Manor Road, South Hinksey, Oxfordshire, England.

~~is~~/are the actual inventor(s) of the invention and the facts upon which the applicant ~~I am/we are~~/~~the said Company~~ is entitled to make the application are as follows:

(m) Insert details of Assignment, etc. Date of Assignment only is insufficient.

(m) The applicant is a person who would, if a patent were granted upon an application made by the said actual inventors be entitled to have the patent assigned to it.

(4) Delete for Non-Convention Application.

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

(12) PATENT ABRIDGMENT (11) Document No. AU-B-82841/87
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 601533

(54) Title
REPLICATION OF CARRIERS BEARING DIGITALLY RECORDED INFORMATION

International Patent Classification(s)
(51)[4] G11B 007/28

(21) Application No. : 82841/87 (22) Application Date : 08.12.87

(30) Priority Data

(31) Number (32) Date (33) Country
8629223 06.12.86 GB UNITED KINGDOM

(43) Publication Date : 16.06.88

(44) Publication Date of Accepted Application : 13.09.90

(71) Applicant(s)
THORN EMI PLC

(72) Inventor(s)
ANTONY LANG; PAUL BLOCH

(74) Attorney or Agent
CALLINAN LAWRIE

(56) Prior Art Documents
AU 61326/86 G11B 7/28

(57) Claim

1. Equipment for the replication of carriers bearing digitally recorded information comprising means to locate a transparency of a carrier at a replication station, the carrier bearing digitally recorded information, means to position a photosensitive plate at the replication station, means to illuminate the carrier and the plate to effect holographic patterning on the photosensitive plate, means to produce one or more replication carriers each having representations of the digitally recorded information derived from the holographic patterning on said photosensitive plate.

3. A method for the replication of carriers bearing digitally recorded information comprising locating a transparency of a carrier at a replication station, the carrier bearing digitally recorded information, positioning a photosensitive plate at the replication station, illuminating the carrier and the plate at the replication station to effect holographic patterning on the photosensitive plate,

.../2

producing one or more replication carriers each having representations of the digitally recorded information derived from the holographic patterning on said photosensitive plate.

Australia

Form 10

PATENTS ACT 1952

COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE

Short Title:

Int. Cl:

601533

Application Number:
Lodged:

Complete Specification—Lodged:
Accepted:
Lapsed:
Published:

Th... the amendments ... under Section 49 and is correct for printing

Priority:

Related Art:

TO BE COMPLETED BY APPLICANT

Name of Applicant: THORN EMI plc

Address of Applicant: 4 Tenterden Street, London Wlr 9AH, England

Actual Inventor: ANTONY LANG and PAUL BLOCH

Address for Service: CALLINANS [redacted], Patent Attorneys, of 48-50 Bridge Road, Richmond, State of Victoria, Australia.

Complete Specification for the invention entitled: "REPLICATION OF CARRIERS BEARING DIGITALLY RECORDED INFORMATION"

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

*Note: The description is to be typed in double spacing, pica type face, in an area not exceeding 250 mm in depth and 160 mm in width, on tough white paper of good quality and it is to be inserted inside this form.

REPLICATION OF CARRIERS BEARING DIGITALLY RECORDED INFORMATION

This invention relates to the replication of carriers bearing digitally recorded information, for example Compact Discs, using optical phase conjugation.

PCT Patent Specification No. WO 87/00334 discloses the creation of a hologram which represents a Compact Disc and thereafter effecting replying from the recreated real image. Thus the hologram represents a 3-D image of an actual Compact Disc and the reading laser interrogates the real image, i.e. looks for $\lambda/4$ deep pits in the image.

An object of this invention is to provide for potentially cheaper replication than is achievable by conventional pressing and may even be used for in-store replication. Another object of this invention is to provide replication which is compatible with existing Compact Disc players.

The present invention provides equipment for the replication of carriers bearing digitally recorded information comprising means to locate a transparency of a carrier at a replication station, the carrier bearing digitally recorded information, means to position a photosensitive plate at the replication station, means to illuminate the ~~carrier~~ transparency and the plate to effect holographic patterning on the photosensitive plates, means to produce one or more replication carriers each having representations of the digitally recorded information derived from the holographic patterning on said photosensitive carrier.

Preferably, a carrier comprises a disc. Alternatively, it may comprise a card.

The present invention also provides a method for the replication of carriers bearing digitally recorded information comprising locating a transparency of a carrier at a replication station, the carrier bearing digitally recorded information, positioning a photosensitive plate at the replication station, illuminating the ~~carrier~~ transparency and the plate at the replication station to effect holographic patterning on the photosensitive plate, producing one or more replication carriers each having representations of the digitally recorded information derived from the holographic patterning on said photosensitive plate.

The present invention also embodies a replicated carrier produced by the equipment and/or the method hereinabove defined.

In order that the invention may more readily be understood, a description is now given, by way of example only, reference being made to the accompanying drawings in which:-

Figures 1 to 4 relate to a system of replication embodying the present invention;

Figure 5 relates to a modification to the system of Figures 1 to 4;

Figures 6 to 8 relate to another modification to the system of Figures 1 to 4;

Figures 9 to 11 relate to material for use in the system of Figures 1 to 4;

The manufacture of Compact Discs by the holographic method of the present invention has three stages, namely mastering, product of the sub-master holograms and replication.

In the mastering stage, the master disc for holographic replication is produced by a modification of the standard Compact Disc mastering technique. Before the master disc can be recorded, the substrate and the information to be recorded are prepared. The master disc substrate is a polished glass disc approximately twice the diameter of a Compact Disc. This is cleaned, inspected and coated with a thin layer of reflective metal such as chromium. The disc is then coated with an organic adhesive layer, followed by a thin layer of positive photoresist approximately 0.1 micrometers thick. The disk is then baked to increase the stability of the photoresist.

The data to be recorded (for example music, computer data bases, computer programmes etc is digitized (if necessary) and encoded into the standard format (see, for example, "Principles of Optical Disc Systems" by G. Bouwhuis et al, ISBN 0-85274-785-3) including the addition of subcode information and error correction information. The disc is then ready to be recorded.

To record the master disc, the blank substrate is placed on a standard mastering machine. The blank disc is spun at the same speed at the final Compact Disc (read/write velocity = 1.25 metres per second). Light from a deep blue laser (usually of wavelength 457.9 nanometres from an argon ion laser or 442 nanometres from a helium cadmium laser) is passed through a high speed optical modulator (usually an electro-optical or acousto-optical modulator) which modulates the intensity of the light beam in accordance with the data to be recorded. The light beam is then expanded using either a negative lens or a telescope, so that it fills the aperture of a high numerical aperture objective lens. This lens focuses the light onto the photoresist layer. Some of the light is reflected by the disc and passes back through the objective lens, and is passed via a beamsplitter to a video camera which monitors the focus condition of the system.

The depth of focus of the lens is approximately +/- 0.5 micrometres, and therefore a dynamic focusing system is required. Light from a red or infra-red laser (for example a helium neon or diode laser) is coupled into the optical system using a dichroic mirror. The photoresist is of low sensitivity to red and infra-red light.

This light is reflected by the disc and is used to provide a focus error signal using, for example, the double-wedge Foucault method. The error signal is used to control the current flowing through a coil wound around the objective lens, which is mounted inside a magnet. This moves the objective lens up and down to keep the light focused on the disc. The linear translation of the objective and the rotation of the master disc must also be controlled. The linear translation is measured with an inductive speed transducer and the rotational velocity is measured with a tachometer, both being controlled by closed loop servo systems.

The effect of the light on the exposed regions of the photoresist is to locally change its solubility.

To develop the disc, it is removed from the mastering machine and placed on a developing machine. The disc is spun and an alkaline solution is made to flow over the surface of the photoresist. This dissolves the photoresist in the exposed regions which exposes the metal layer in these regions. Development times are typically 20 to 30 seconds. Slight variations in the photoresist properties and recording conditions may be compensated for by adjustments in the development time. The pit structure is monitored during development by illuminating a specially recorded test band on the disc with light from a helium neon laser. The intensities of the first diffracted order are a measure of the amount of material dissolved away, and can therefore be used to stop the development process at the optimum time.

After the disc has been developed the exposed metal regions are removed with an acid or plasma etch. The remaining photoresist is then chemically removed and the disc is washed and dried. The resulting master disc is a transparency with transmitting regions in an opaque metal layer. These apertures correspond to the pits on a conventional master disc. After the disc has been developed, the intensities of the first and second diffracted transmission orders may be measured over the recorded area to provide information about the uniformity and quality of the pits.

The next stage of the manufacturing process concerns the production of the holographic sub-masters. A holographic plate 1 is optically contacted to the hypotenuse face of a 45 degree prism 2, with refractive index matching fluid between them to ensure good contact. The two short faces of the prism need to be anti-reflection coated to avoid stray reflected light. A thin spacer 3 is placed against the holographic plate 1 and the master transparency 4 (with glass substrate 5 and information-carrying layer 6) is placed against the other side of the spacer 3. The combination of prism, holographic plate, spacer and transparency are clamped around the edge of the sandwich to hold them in the same relative positions (see Figure 1). These are then placed in the optical system shown schematically in Figure 2.

Linearly polarized light from a deep blue laser 7 (for example an argon ion or helium cadmium laser) is passed through a half-wave plate 8 in a rotating mount to rotate the orientation of the polarization direction to any desired direction. A shutter 9 controls the exposure time (for example a leaf shutter of the type used in photographic cameras). The light then passes through a polarizing beamsplitter 10 (for example a thin film polarizing beamsplitter cube), which outputs two beams of light with orthogonal polarizations. By rotating the half-wave plate 8, the relative amplitudes of the two orthogonal polarization states in the light beam incident on the polarizing beamsplitter may be varied and thus the relative intensities of the two beams leaving the polarizing beamsplitter 10 may be varied.

In order for these two light beams to interfere with each other to record a hologram, they must have the same polarization state. As output from the polarizing beamsplitter 10 the two beams have orthogonal polarization states, so one of the beams must have the direction of its polarization axis rotated by 90 degrees. This may be achieved by placing suitably oriented half-wave plate 11 in one of the beams.

Each of the light beams is then expanded using beam expanders 12 and 13 so that they are of large enough diameters to fill the apertures of prism 2.

Suitable beam expanders may be produced using a telescope with two positive lenses, the first of these lenses being a microscope objective and the second a doublet lens. A pinhole aperture is placed at the focus of the first lens to remove the outer regions of the diffraction pattern produced by the first lens and thus improve the uniformity of the intensity distribution across the beam. The second lens is placed so that its focal point coincides with the pinhole, thus producing a collimated output beam.

The beams are deflected by plane mirrors 15 and 16 and directed into two of the faces of the prism 2. The light is diffracted by the apertures on the master transparency and spreads out in the air gap produced by the spacer 3 between the transparency 4 and the holographic plate 1.

The other beam is passed perpendicularly through one of the short faces of the prism 2. It passes into the holographic plate 1, is totally-internally-reflected at the air-holographic emulsion interface and leaves the prism 2 through the other short face.

Thus there are three light beams in the holographic emulsion:- the beam transmitted by the master transparency 4, the beam incident on the hypotenuse face of the prism 2 before reflection and the totally-internally-reflected beam. Each of these interferes with the other two to form a complex hologram of mixed Lippmann and transmission types. The holographic plate 1 is then separated from the prism 2, processed in the normal way and placed back in optical contact with the prism 2.

The optical path lengths in the two beams must be approximately equal so that the beams are coherent with one another when they are recombined so as to produce high contrast fringes.

The holographic mastering equipment must be mounted on an optical table fitted with a vibration damping system of the type commercially available. Also the system must be enclosed in a box to exclude air currents.

The next stage is to place the hologram 1 in a replication unit (see Figure 3).

Linearly polarized light from a deep blue laser 20 (for example an argon ion or helium cadmium laser) is passed through a half-wave plate 21 to rotate its plane of polarization as before, because the hologram reconstructs two images of the master transparency with a phase difference due to total internal reflection which is polarization dependant. A shutter 22 is also required as before.

A spacer 23 is then placed up against the hologram 1 and a photosensitive target disc 24 is placed against the spacer. Disc 24 has several layers, the substrate being cut from sheet polycarbonate or injection moulded in a plain mould (i.e. flat on both sides), and coated with a photosensitive layer, a metal reflecting layer and a protective lacquer layer.

Hologram 1, spacer 23 and disc 24 are then clamped together around the edge in similar fashion to before. With the laser beam expanded using a beam expander 25 of the type described previously, it is passed into a short face of a prism 26, which face corresponds to that from which the light emerged during the hologram recording state. This light is diffracted by the hologram into several beams. Two of these are replicas of the light transmitted by the original master transparency, but travelling in the opposite direction to converge at point on the target disc corresponding to the pits on the final Compact Disc. The rest of the light is totally internally reflected at the emulsion-air interface and exits from the third face of the prism 26.

There will be a phase difference between the two reconstructed images of the disc due to the polarization sensitive phase change which occurs when the light is reflected at the hypotenuse face of the prism. As the polarization of the incident light is varied, the relative phase of the images changes. If the phase difference is zero, the amplitudes add and the intensity of the image is maximised. If the phase difference is 180 degrees, the amplitudes subtract, and the intensity of the image is minimised. The reconstructed image of the disc consists of a large number of intense spots, corresponding to the pits on the Compact Disc. The target disc is photo-sensitive, and undergoes some physical or chemical change when illuminated by light of the appropriate wavelength.

After exposure, the target disc is removed, and replaced with an unexposed disc. This cycle is repeated for each replica disc.

In use, the laser power is high enough to be a potential hazard to the sight of the operator. Therefore the replication unit is enclosed in a box, with safety devices fitted to shut off the laser beam if the box was opened whilst the laser was running.

The holographic manufacturing process is summarized in the flow diagram of Figure 4.

The target discs may be made by injection moulding. An alternative, cheaper method which utilises cheaper equipment is to produce sheets of the appropriate material by extrusion and then cut them into appropriate disc shapes.

One problem with the method described is that the resulting image on the target disc will be reversed relative to the original master disc. One solution is to reverse the direction of rotation of the original glass master disc during recording. Alternatively, a sub-master disc is contact-printed as shown in Figure 5. Thus, a thin, flexible transparent disc 30 (for example a polymer disc) is coated with a thin layer of metal 3 (for example chromium) followed by a layer of positive photoresist 32. The original glass master disc 33 is placed face down on top of the resultant pile so that the photoresist layer 32 on the flexible disc is in contact with the metal layer 34 on the glass disc. The two discs 30, 33 are held in close contact with (for example) a slight difference in air pressure.

The flexible disc 30 is then flood exposed to ultra-violet light through the original glass master disc 33 and processed as before. This results in a flexible "mirror image" copy of the master disc.

The next stage is to record the holographic sub-master. The method described previously assumes that the master disc and target disc are perfectly flat. In practice they are not exactly flat, causing focussing problems.

To solve these problems the holographic recording equipment must have a reference surface against which the flexible master disc can be pushed, so that the information carrying layer lies in a well defined plane. This may be a flat glass plate 35, the optical quality of this plate not being critical (see Figure 6).

The hologram plate 36 is exposed as before, processed and replaced in the same position relative to the spacer 37 and glass reference plate 35. From now on the hologram 36, spacer 37 and reference plate 35 are treated as one object. If the reference plate introduces any aberrations to the beam, these are cancelled out when the hologram is reconstructed. The hologram/spacer/reference plate sandwich is now placed in the replication unit.

The target discs have the form shown in Figure 7, namely a thin flexible polymer disc 38 is coated with a layer of aluminium 39 followed by a layer of photosensitive (e.g. photoresist) material 40. A target disc is then pushed up against the reference surface in the replicating unit using, for example, a slight difference in air pressure, so that the photosensitive layer is in contact with the reference surface. The hologram is now reconstructed to expose the target disc. After exposure, the target disc is laminated onto a transparent polymer substrate (for example polycarbonate) 1.2mm thick to form the final disc. The replication process is summarized in Figure 8.

In a variant to the above-described methods, photochromic discs are used in place of target discs with photoresist layers. Thus for example, a polymer disc substrate is coated with a layer of reflective metal, for example aluminium, followed by a layer of fixable photochromic material, in a transparent binder. When the photochromic layer is exposed to ultra-violet or blue light it switches to a form which absorbs light of a longer wavelength. Thus a disc compatible with standard Compact Disc players can be obtained by exposing the photochromic layer to ultra-violet or blue light to darken small areas corresponding to the "pits" on a conventional disc.

Spiropyrans are a well known class of photochromic organic compounds. They are initially transparent to visible light, but become absorbent to red light if exposed to ultra-violet light.

Figure 9 shows the spectral absorption of a typical spiropyran. If it is exposed to ultra-violet light of wavelength λ_1, an absorption band around λ_3 is generated and the initially transparent spiropyran becomes coloured. Unfortunately this colouration is not stable and has a lifetime of usually less than a few weeks.

A stable colouration is achieved if the spiropyran reacts when an acid HX forming a coloured salt (see Figure 10). This acid HX may be generated within a layer containing a spiropyran by adding an acid donor compound. Maslowski (Applied Optics, Vol.13, p.857, 1974) found that some organic compounds containing a CBr_3CH_2 group are very suitable. If such a molecule absorbs ultra-violet light, hydrogen bromide (HBr) is generated and this immediately reacts with the spiropyran to form a stable salt. By a suitable choice of acid donor compound it is possible to select the wavelength required to generate the HBr. The material is totally insensitive to visible light and stable over many years provided it is protected from ultra-violet light.

A specific example of such a disc can be produced as follows (see Figure 11a which relates to exposure of the disc, and Figure 11b which relates to reading it once laminated onto the substrate): the disc 50 is made as two discs laminated together, the bottom half of the disc being a thin and flexible polymer disc 51 (for example polycarbonate). This is coated with an aluminium reflective layer 52 followed by a layer of fixable photochromic material 53 (for example a spiropyran with an acid donor compound). For this application the spiropyran and acid donor compound need to be dissolved in a suitable transparent polymer. The disc 50 is exposed from the photochromic side to ultra-violet or blue light, either one spot at a time as in conventional write-once optical disc systems, or all in one exposure using, for example, holographic project.

The disc is then laminated onto an ultra-violet blocking substrate 54 of, for example, polycarbonate with adhesive 55. The polycarbonate may be tinted with an ultra-violet blocking dye, in order to prevent the disc being darkened by environmental ultra-violet light from, for example, the sun.

As Compact Disc players use a diode laser operating at a wavelength of 780 nonometres, the photochromic material is optimised to be transparent at this wavelength before writing, but to absorb strongly at this wavelength after writing.

The claims defining the invention are as follows:-

1. Equipment for the replication of carriers bearing digitally recorded information comprising means to locate a transparency of a carrier at a replication station, the carrier bearing digitally recorded information, means to position a photosensitive plate at the replication station, means to illuminate the ~~carrier~~ transparency and the plate to effect holographic patterning on the photosensitive plate, means to produce one or more replication carriers each having representations of the digitally recorded information derived from the holographic patterning on said photosensitive plate.

2. Equipment according to Claim 1, wherein the carriers comprise discs.

3. A method for the replication of carriers bearing digitally recorded information comprising locating a transparency of a carrier at a replication station, the carrier bearing digitally recorded information, positioning a photosensitive plate at the replication station, illuminating the ~~carrier~~ transparency and the plate at the replication station to effect holographic patterning on the photosensitive plate, producing one or more replication carriers each having representations of the digitally recorded information derived from the holographic patterning on said photosensitive plate.

4. A method according to Claim 3, wherein the carriers comprise discs.

5. Equipment for the replication of carriers bearing digitally recorded information substantially as hereinbefore described with reference to the accompanying drawings.

6. A method for the replication of carriers bearing digitally recorded information substantially as hereinbefore described with reference to the accompanying drawings.

D A T E D this 13th day of June, 1990.

THORN EMI plc

By their Patent Attorneys:

CALLINAN LAWRIE

5 200 026

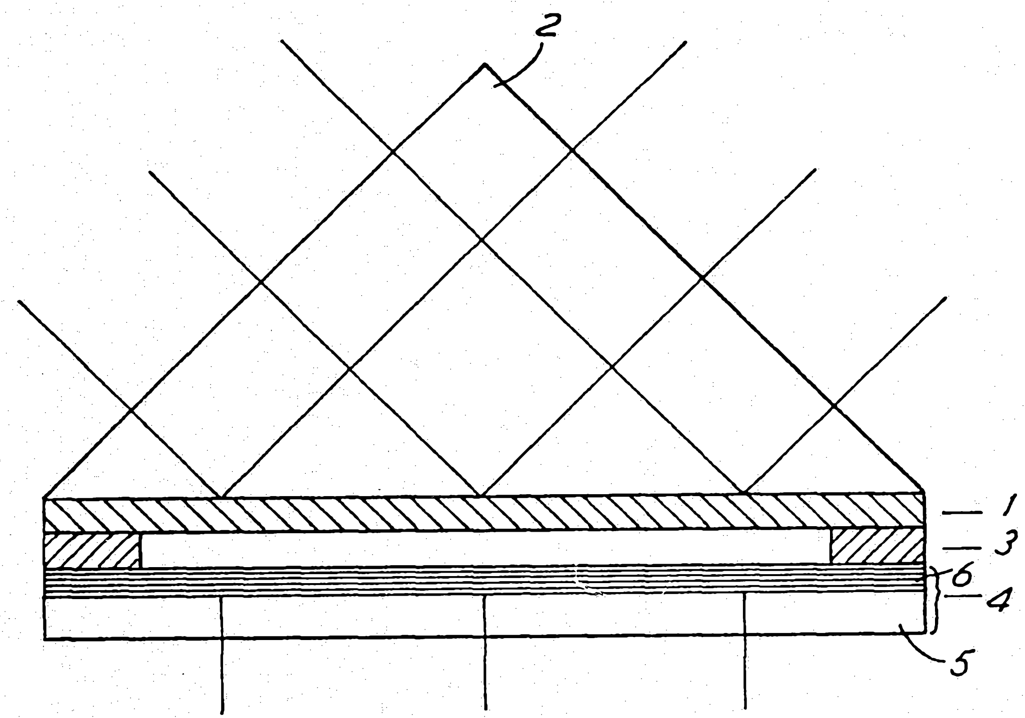


FIG.1

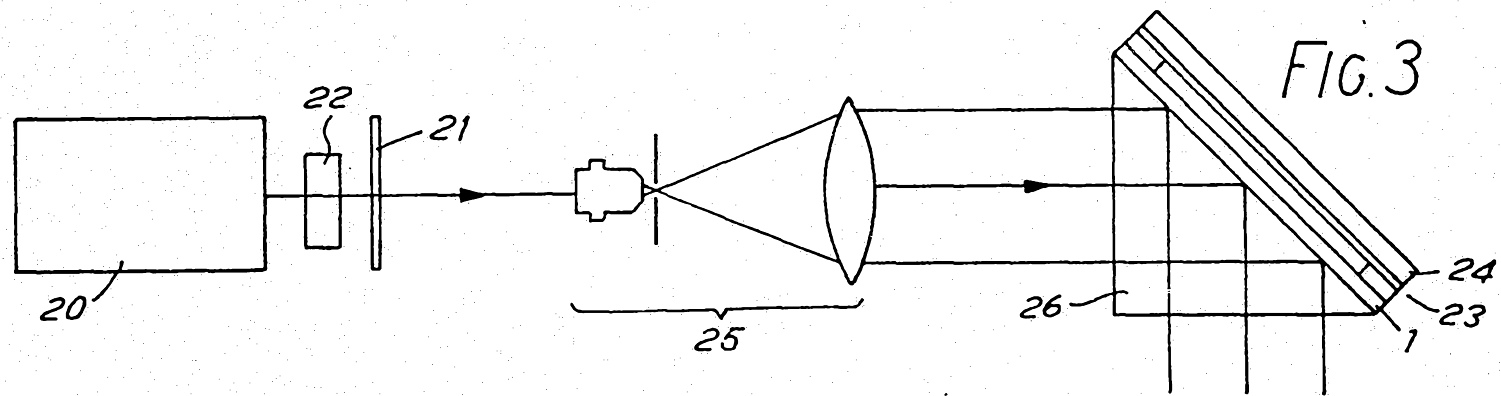
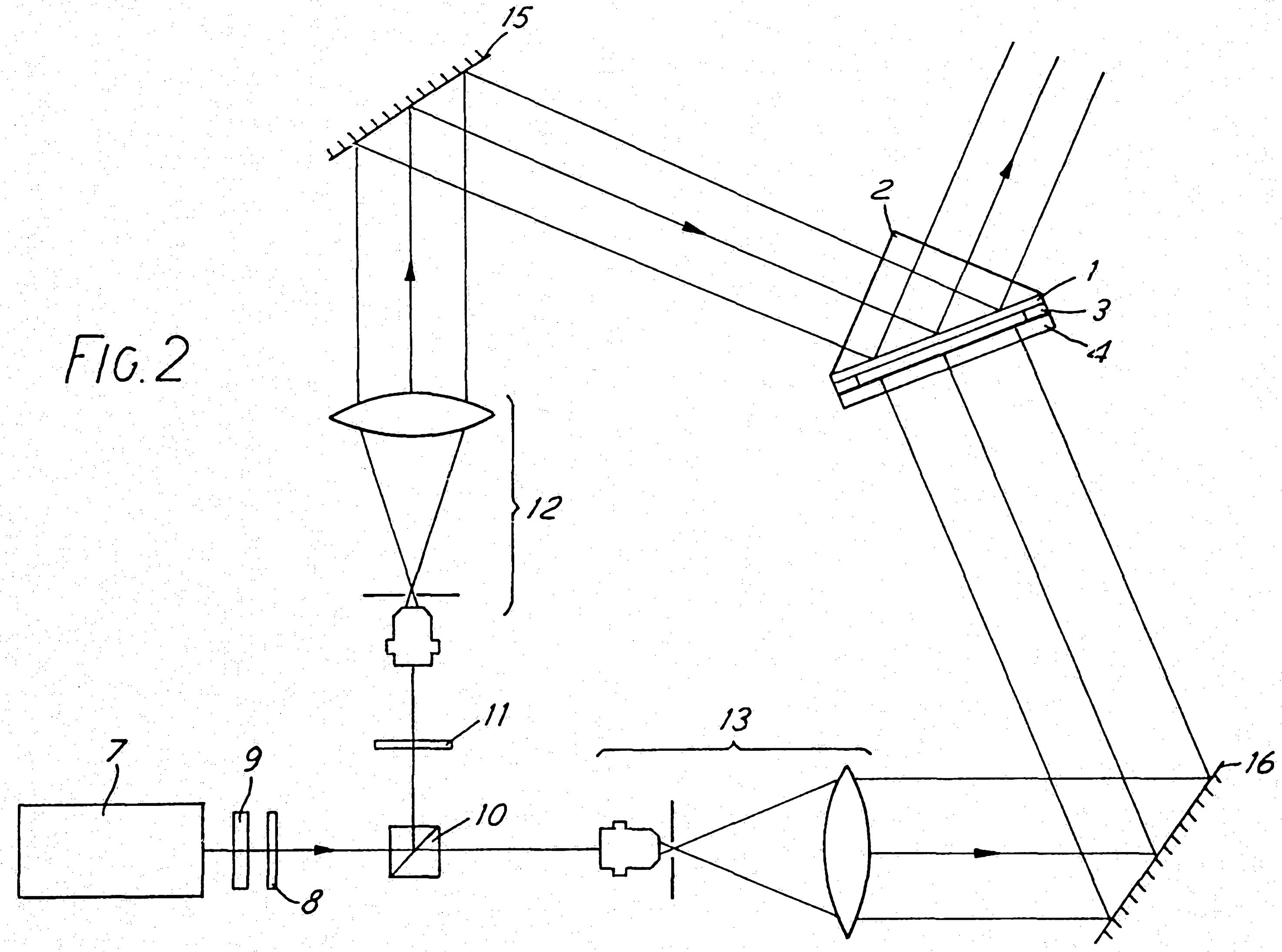


FIG.3

FIG. 2



82 841/87

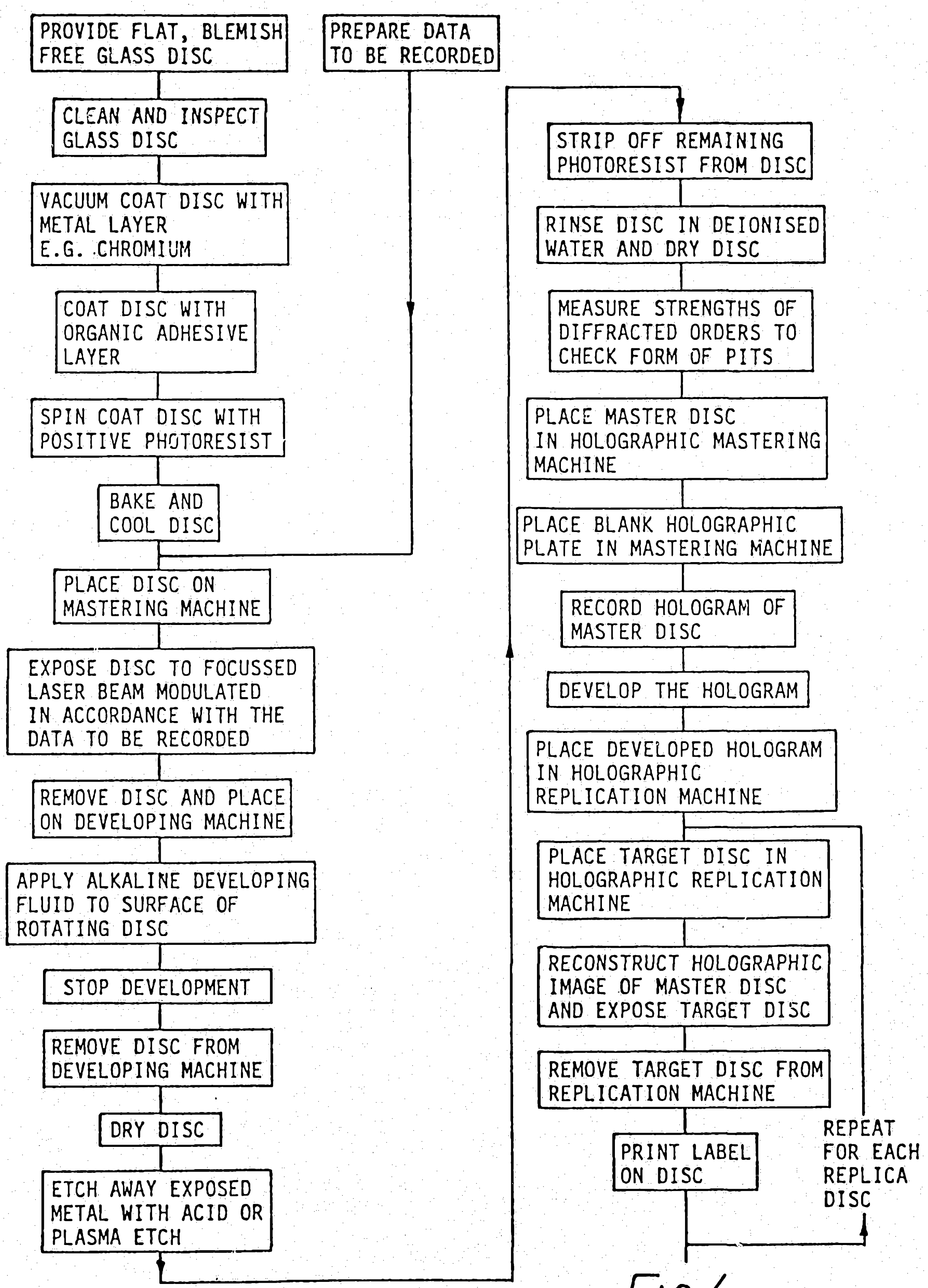

PROVIDE FLAT, BLEMISH FREE GLASS DISC
CLEAN AND INSPECT GLASS DISC
VACUUM COAT DISC WITH METAL LAYER E.G. CHROMIUM
COAT DISC WITH ORGANIC ADHESIVE LAYER
SPIN COAT DISC WITH POSITIVE PHOTORESIST
BAKE AND COOL DISC
PREPARE DATA TO BE RECORDED
PLACE DISC ON MASTERING MACHINE
EXPOSE DISC TO FOCUSSED LASER BEAM MODULATED IN ACCORDANCE WITH THE DATA TO BE RECORDED
REMOVE DISC AND PLACE ON DEVELOPING MACHINE
APPLY ALKALINE DEVELOPING FLUID TO SURFACE OF ROTATING DISC
STOP DEVELOPMENT
REMOVE DISC FROM DEVELOPING MACHINE
DRY DISC
ETCH AWAY EXPOSED METAL WITH ACID OR PLASMA ETCH
STRIP OFF REMAINING PHOTORESIST FROM DISC
RINSE DISC IN DEIONISED WATER AND DRY DISC
MEASURE STRENGTHS OF DIFFRACTED ORDERS TO CHECK FORM OF PITS
PLACE MASTER DISC IN HOLOGRAPHIC MASTERING MACHINE
PLACE BLANK HOLOGRAPHIC PLATE IN MASTERING MACHINE
RECORD HOLOGRAM OF MASTER DISC
DEVELOP THE HOLOGRAM
PLACE DEVELOPED HOLOGRAM IN HOLOGRAPHIC REPLICATION MACHINE
PLACE TARGET DISC IN HOLOGRAPHIC REPLICATION MACHINE
RECONSTRUCT HOLOGRAPHIC IMAGE OF MASTER DISC AND EXPOSE TARGET DISC
REMOVE TARGET DISC FROM REPLICATION MACHINE
PRINT LABEL ON DISC
REPEAT FOR EACH REPLICA DISC

FIG.4

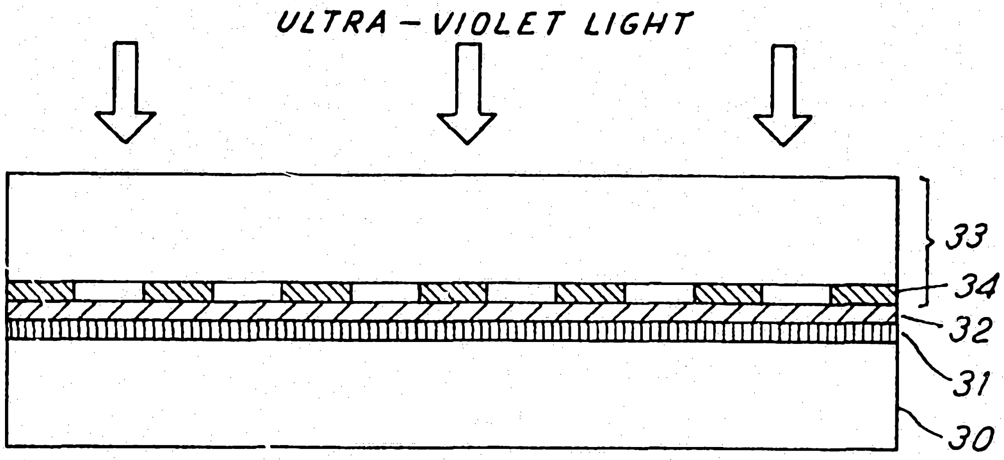


FIG. 5

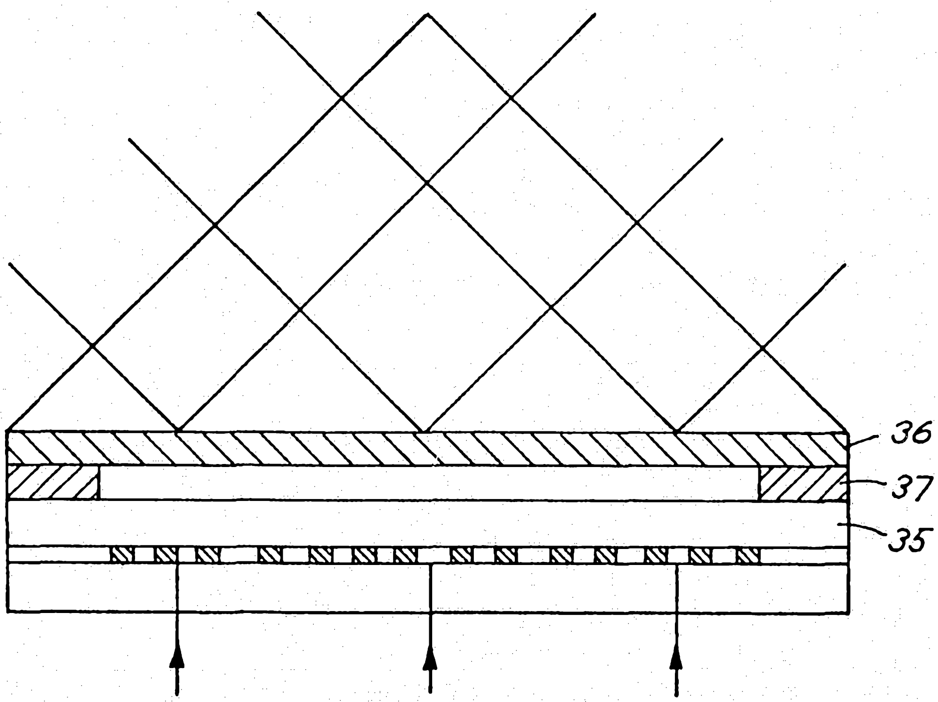


FIG. 6

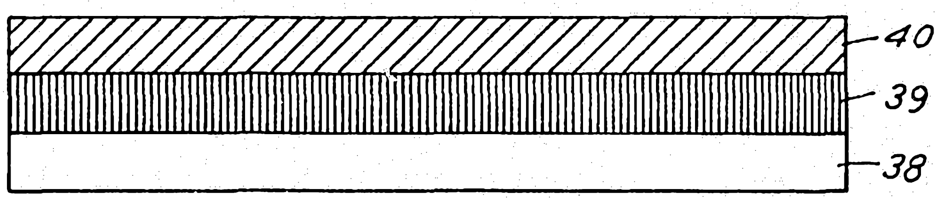


FIG. 7

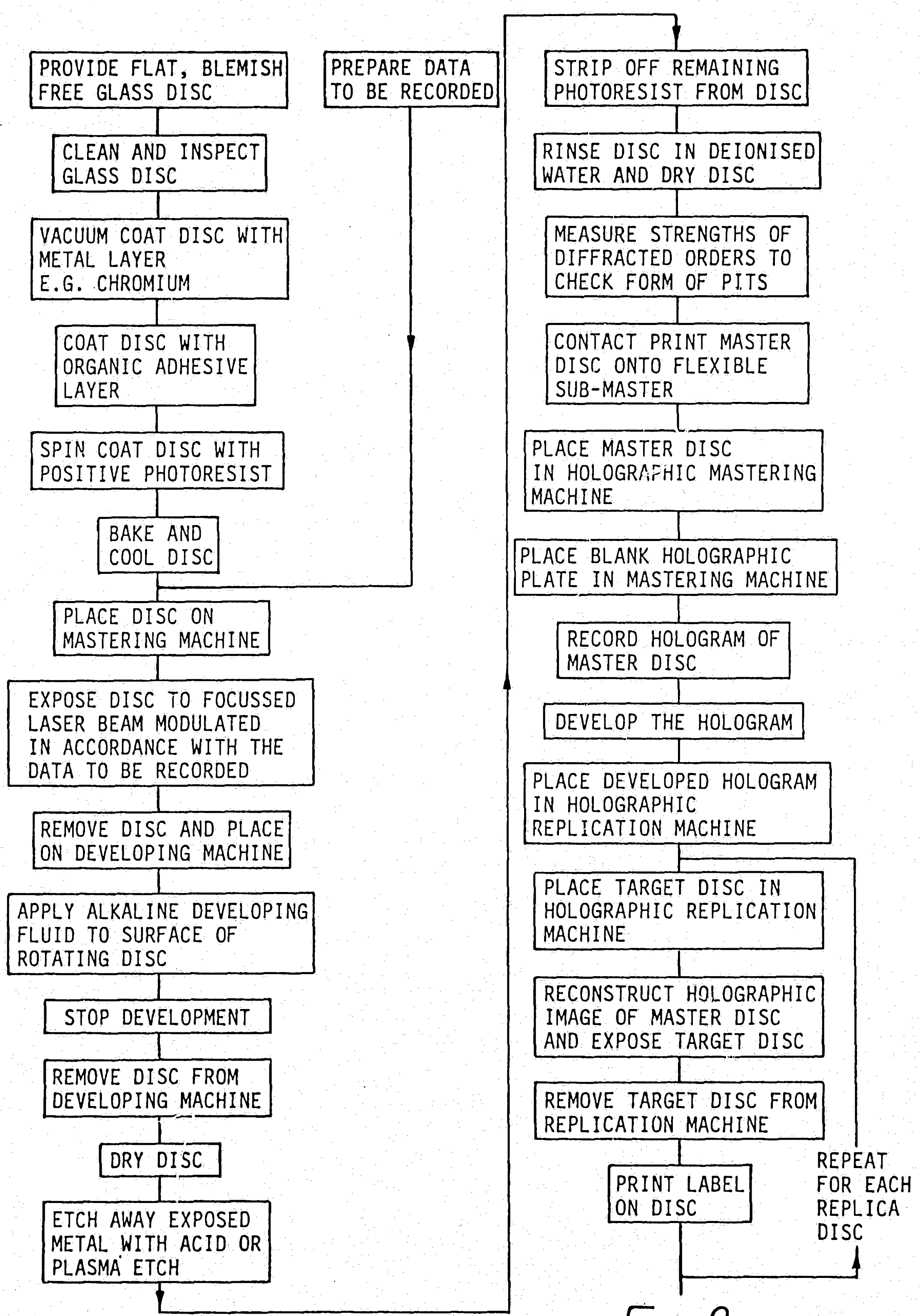

PROVIDE FLAT, BLEMISH FREE GLASS DISC
PREPARE DATA TO BE RECORDED
CLEAN AND INSPECT GLASS DISC
VACUUM COAT DISC WITH METAL LAYER E.G. CHROMIUM
COAT DISC WITH ORGANIC ADHESIVE LAYER
SPIN COAT DISC WITH POSITIVE PHOTORESIST
BAKE AND COOL DISC
PLACE DISC ON MASTERING MACHINE
EXPOSE DISC TO FOCUSSED LASER BEAM MODULATED IN ACCORDANCE WITH THE DATA TO BE RECORDED
REMOVE DISC AND PLACE ON DEVELOPING MACHINE
APPLY ALKALINE DEVELOPING FLUID TO SURFACE OF ROTATING DISC
STOP DEVELOPMENT
REMOVE DISC FROM DEVELOPING MACHINE
DRY DISC
ETCH AWAY EXPOSED METAL WITH ACID OR PLASMA ETCH
STRIP OFF REMAINING PHOTORESIST FROM DISC
RINSE DISC IN DEIONISED WATER AND DRY DISC
MEASURE STRENGTHS OF DIFFRACTED ORDERS TO CHECK FORM OF PITS
CONTACT PRINT MASTER DISC ONTO FLEXIBLE SUB-MASTER
PLACE MASTER DISC IN HOLOGRAPHIC MASTERING MACHINE
PLACE BLANK HOLOGRAPHIC PLATE IN MASTERING MACHINE
RECORD HOLOGRAM OF MASTER DISC
DEVELOP THE HOLOGRAM
PLACE DEVELOPED HOLOGRAM IN HOLOGRAPHIC REPLICATION MACHINE
PLACE TARGET DISC IN HOLOGRAPHIC REPLICATION MACHINE
RECONSTRUCT HOLOGRAPHIC IMAGE OF MASTER DISC AND EXPOSE TARGET DISC
REMOVE TARGET DISC FROM REPLICATION MACHINE
PRINT LABEL ON DISC
REPEAT FOR EACH REPLICA DISC

FIG. 8

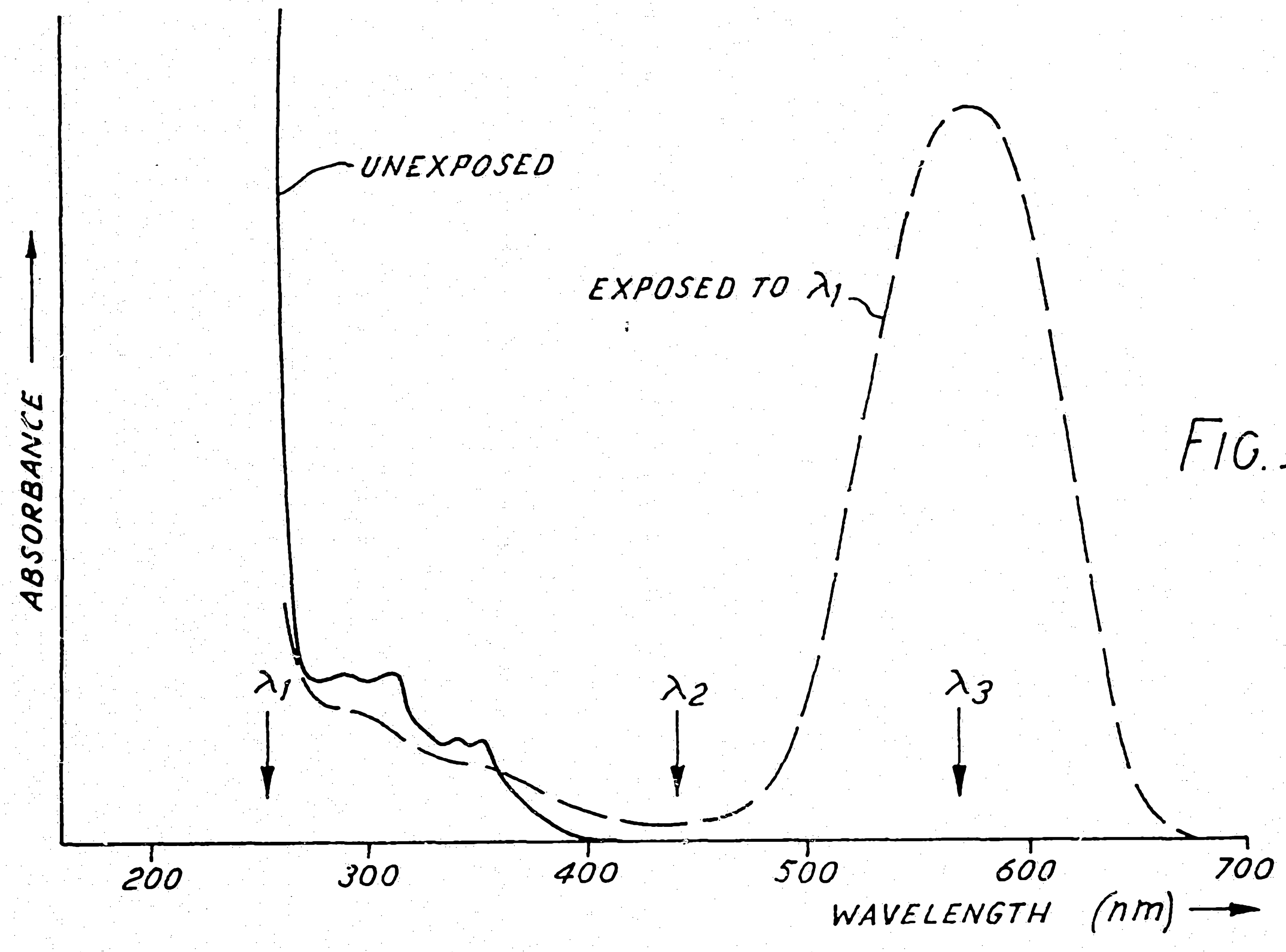

UNEXPOSED
EXPOSED TO λ_1
ABSORBANCE
λ_1
λ_2
λ_3
200
300
400
500
600
700
WAVELENGTH (nm)

FIG. 9

5 200 02041

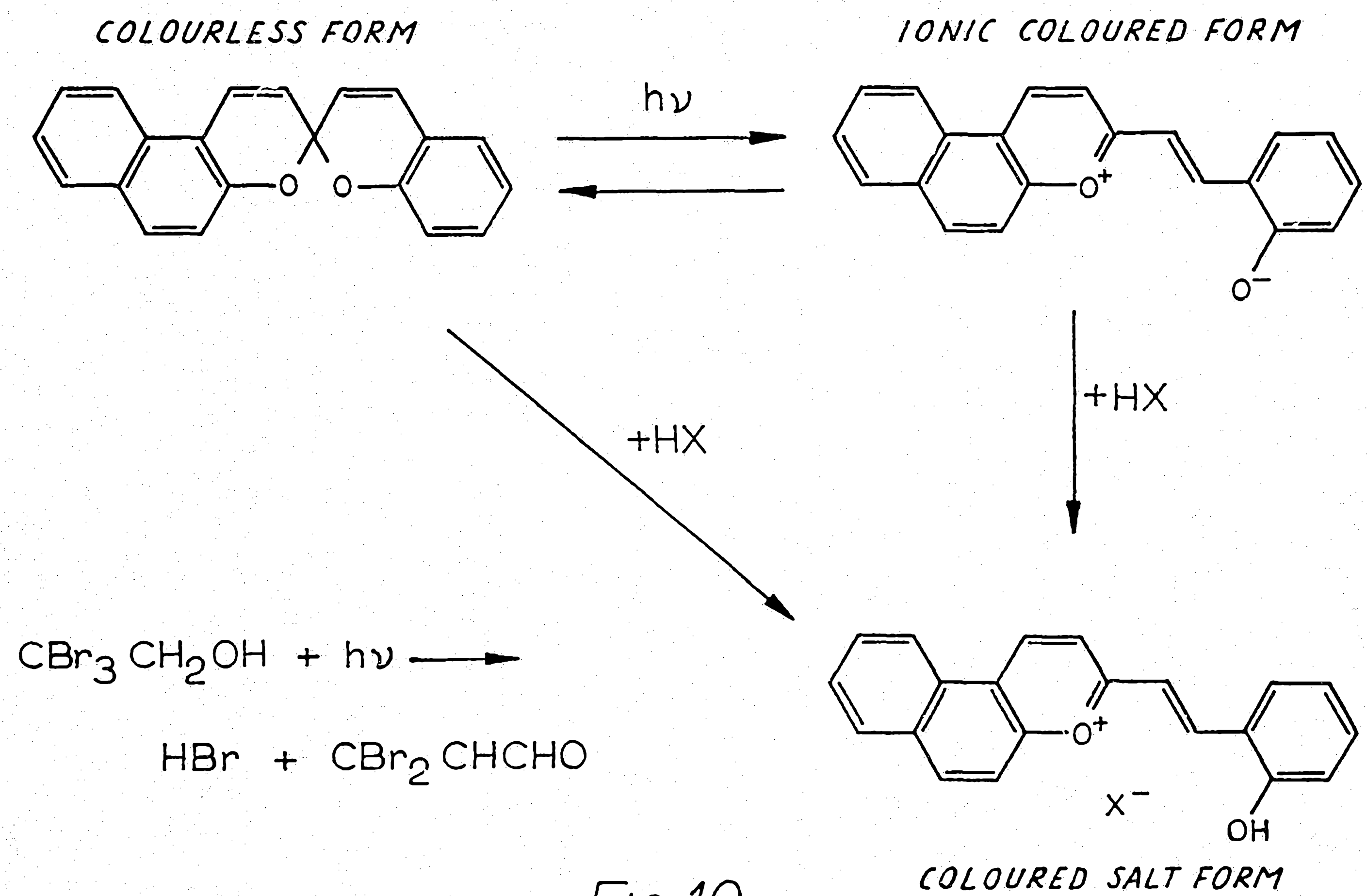


FIG.10

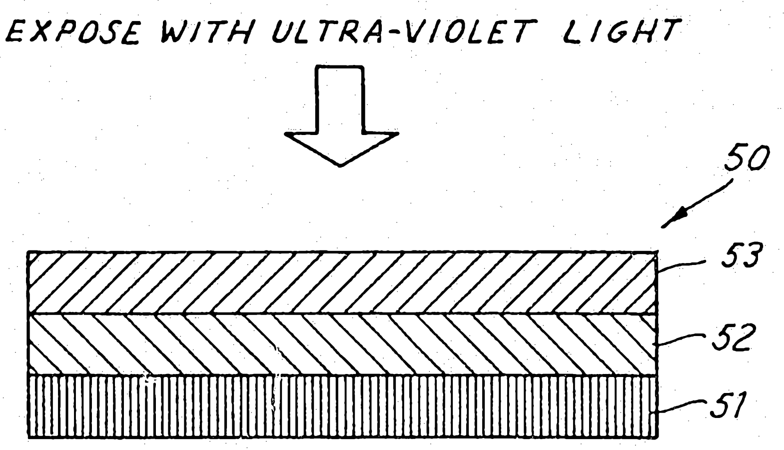


FIG.11A

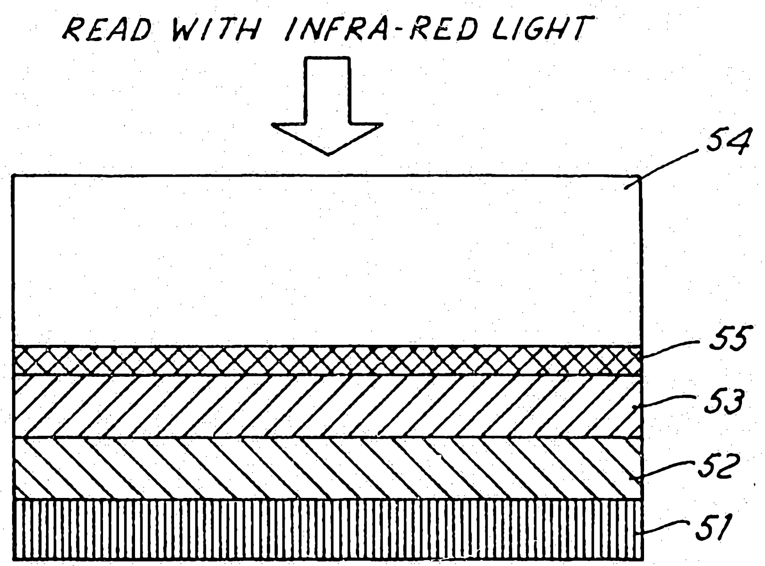


FIG.11B