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(12) (19) (CA) **Brevet-Patent**

(11) (21) (C) **2,139,139**
(22) 1994/12/28
(43) 1995/06/29
(45) 2000/06/20

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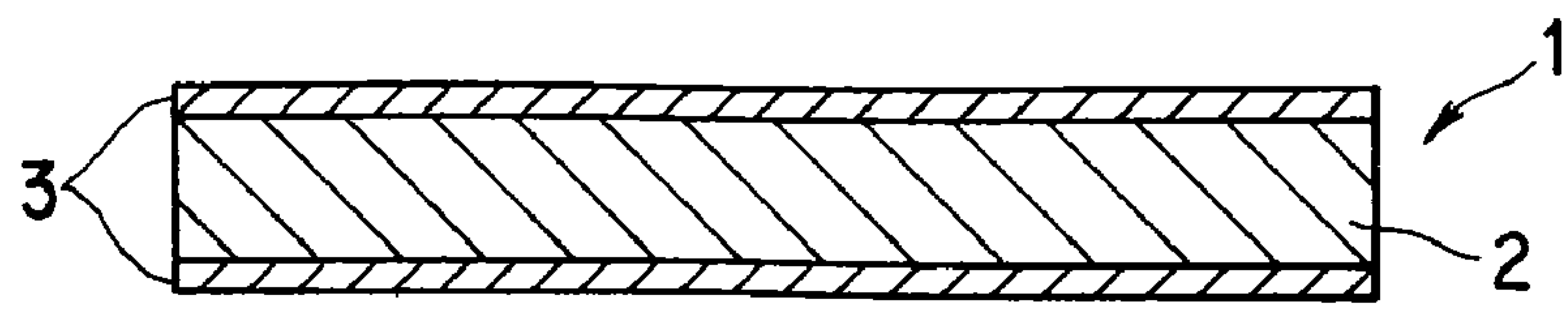
(51) Int.Cl.^{5} B05D 3/06, G03G 7/00
(30) 1993/12/28 (5-337183) JP
(30) 1993/12/28 (5-337182) JP

(54) **FILMS DE PLASTIQUE MODIFIES ET MATERIAUX D'ENREGISTREMENT UTILISANT CES FILMS**

(54) **MODIFIED PLASTIC FILMS AND RECORDING MATERIALS UTILIZING THEM**



(57) A modified plastic film comprising a plastic film provided on its both surfaces with ionizing radiation cured resin layers having a hardness equal to or harder than a pencil hardness of H and recording material comprising the modified plastic film, wherein their waving formed during storage in high humidity or caused by heat are markedly reduced.

ABSTRACT

A modified plastic film comprising a plastic film provided on its both surfaces with ionizing radiation cured resin layers having a hardness equal to or harder than a pencil hardness of H and recording material comprising the modified plastic film, wherein their waving formed during storage in high humidity or caused by heat are markedly reduced.

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MODIFIED PLASTIC FILMS AND RECORDING MATERIALS UTILIZING THEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a modified plastic film and, particularly, it relates to a modified plastic film wherein waving of whole film caused by heat and waving of film edges caused by moisture are reduced. The present invention further relates to recording materials utilizing such a modified plastic film and, particularly, it relates to recording materials wherein waving of whole recording sheet caused by heat and waving of edges of recording sheet caused by moisture are reduced when it is used for copying in plain paper copier (PPC), laser beam printers and the like.

2. Prior Art

Since plastic films are transparent, excellent in chemical resistance, easy to form and inexpensive and they have enough strength, they have been used as various supports of industrial materials, building materials, materials for decoration, materials for home use and the like such as second original films, graphic arts films, films for overhead projector, video tapes, audio tapes, floppy discs and photographic films. Those plastic films include polyester films, polycarbonate films, acetylcellulose films, polyvinyl chloride films and the like.

For the use of plastic films as supports of various recording sheets, there have been used plastic films of which both surfaces are laminated with thermosetting recording layers formed from acrylic polyols, isocyanates and, optionally, matting agents in order to improve solvent resistance of the paper sheets which is required for retouch or correction with various writing materials on the sheets.

However, plastic materials generally have a relatively low softening temperature. For example, polyester, which is the most commercially popular plastic material, has a glass transitiontemperature of about 70℃ and if a plastic film composed of it is employed for a use where it is heated to a temperature above its glass transition temperature, the film would be softened and hence deformed. Examples of such a use include recording sheets such as those for second original films for PPC and films for overhead projectors and, when plastic films are used as printing sheets for PPC and the like, the films are deformed due to the temperature for fixing toner and they are ejected in a very wavy form as a whole. Such phenomena are particularly remarkable in machines using a high temperature for fixing such as laser beam printers and machines using a long fixing time and, in such machines, the sheets would cause jamming on their transfer route.

Therefore, plastic films can be used for this purpose only in machines using a low fixing temperature and a short fixing time. And laser beam printers and the like, which use a high fixing temperature, cannot use plastic films but only paper sheets.

Various films using plastic films are usually cut into sheets and stacked or rolled for their storage. The films stored in the form of stacked sheets or rolled film absorb moisture from four edge sides in the case of stacked sheets and from both ends of roll in the case of rolled sheets and they exhibit wavy edges (referred as "petal phenomenon" hereinafter) when they are spreaded or unrolled. The petal phenomenon causes various problems. For example, in the field of photograving, it causes bad contact of photosensitive films upon contact exposure, bad cutting line of masking films in automatic drawing machines, distortion of cut lines, bad position of sheets and the like. Also in the field of design drafting, it causes various problems such as walk-off, distortion of lines and bad position of sheets when drawing with pen plotters on tracing films, sheet jamming when copying second originals by PPC, and bad contact of ejected second originals with photosensitive materials upon contact exposure.

As a method for preventing the petal phenomenon, humidity controling paper sheets, of which humidity is also controled, have been interleaved between each of piled films to reduce the influence of outside air humidity. Therefore, the additional process step for interleaving the humidity controling paper sheets is inevitable and the paper sheets should be pealed and discarded upon use of the films. These steps make the process troublesome and may cause problems from the viewpoint of resource-saving.

The present invention has been completed to solve the above problems and the object of the present invention is to provide a modified plastic film of which waving in the whole film caused by heat and edge waving caused by moisture are markedly reduced. A further object of the present invention is to provide recording material which retain flat form and does not cause jamming even though it is used in printers utilizing high toner fixing temperature such as laser beam printers and of which petal phenomenon caused by moisture absorption upon its storage is prevented.

SUMMARY OF THE INVENTION

To achieve the above objects, the modified plastic film of the present invention is provided on its both surfaces with layers of ionizing radiation cured resin having a hardness equal to or harder than a pencil hardness of H. The layers of ionizing radiation cured resin preferably contain photopolymerizable prepolymers, photopolymerizable monomers and photopolymerization initiators.

The recording material of the present invention comprises a plastic film both of which surfaces are provided with layers of ionizing radiation cured resin having a hardness equal to or harder than a pencil hardness of H and a layer for easy adhesion of toner is provided on at least one of the layers of ionizing radiation cured resin.

The layers of ionizing radiation cured resin preferably contain photopolymerizable prepolymers, photopolymerizable monomers and photopolymerization initiators and they may contain matting agents. The layer for easy adhesion of toner preferably comprises a resin having a glass transition temperature of from 45 to 100 °C and it may contain an antistatic agent.

In accordance with one aspect of the present invention there is provided a modified plastic film comprising a plastic film provided on both of its surfaces with cured resin layers having a hardness equal to or harder than a pencil hardness of H, the cured resin layers being formed by coating an ionizing radiation curable mixture of a photopolymerizable prepolymer, a photopolymerizable monomer and a photopolymerization initiator on the plastic film and irradiating the mixture.

In accordance with another aspect of the present invention there is provided a recording material comprising: a plastic film provided on both of its surfaces with cured resin layers having a hardness equal to or harder than a pencil hardness of H, the cured resin layers being formed by coating an ionizing radiation curable mixture of a photopolymerizable prepolymer, a photopolymerizable monomer and a photopolymerization initiator on the plastic film and irradiating the mixture; and a toner receptive layer comprising a resin having a glass transition temperature of from 45 to 100 °C provided on at least one of the cured resin layers.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross-sectional view of an exemplary modified plastic film according to the present invention wherein the modified plastic film 1 comprises a plastic film 2 and ionizing radiation cured resin layers 3.

Figs. 2(a) and 2(b) are drawings representing moisture characteristics of an exemplary modified plastic film of the present invention wherein the numbers adjacent to petals 4 indicate heights of the petals.

Figs. 3(a) and 3(b) are drawings representing moisture characteristics of a conventional plastic film 2 wherein the numbers adjacent to petals 4 indicate heights of the petals.

Fig. 4 is a photograph of an exemplary modified plastic film of the present invention after ejection from a copier.

Fig. 5 is a photograph of a conventional plastic film after ejection from a copier wherein petals 4 are observed.

Fig. 6 is a cross-sectional view of an exemplary recording material sheet according to the present invention wherein the recording material sheet 1 comprises a plastic film 2, ionizing radiation cured resin layers 3 and a layer for easy adhesion of toner 5.

Figs. 7 (a) and (b) are drawings representing moisture characteristics of an exemplary recording material sheet of the present invention wherein the numbers adjacent to petals 4 indicate heights of the petals.

Figs. 8 (a) and (b) are drawings representing moisture characteristics of a conventional recording material sheet wherein the numbers adjacent to petals 4 indicate heights of the petals.

Fig. 9 is a photograph of an exemplary recording material sheet of the present invention after ejection from a copier.

Fig. 10 is a photograph of a conventional recording material sheet after copying.

DETAILED DESCRIPTION OF THE INVENTION

The modified plastic film of the present invention will be explained below.

As shown in Fig. 1, the modified plastic film 1 has a structure wherein a plastic film 2 is laminated on its both surfaces with ionizing radiation cured resin layers 3.

For the plastic film 2, polyethylene terephthalates, polybutylene terephthalates, polycarbonates, polypropylenes, polyethylenes, acetylcelluloses, vinyl chloride resins, fluorocarbon resins and the like may be used and those subjected to a stretching process, in particular, biaxial stretching are preferred since they have improved mechanical strength and dimentional stability.

The thickness of the plastic film may be suitably selected depending on the material used and it generally ranges from 4 to 250 μ m.

The ionizing radiation cured resin layers 3 provided on the both surfaces of the support hold the plastic film therebetween and fix it to prevent deformation of the plastic film caused by heat and moisture. The resin layers are formed from a paint containing resins curable by irradiation of electron rays or ultraviolet (UV) rays.

The ionizing radiation curable paint contains photopolymerizable prepolymers, photopolymerizable monomers and photopolymerization initiators and, optionally, additives such as sensitizers, pigments, fillers, non-reactive resins and leveling agents and solvents.

Structure, functionality and molecular weight of the photopolymerizable prepolymers influence on the curing of the ionizing radiation curable paint, and they decide properties of the ionizing radiation cured layer such as adhesive property, hardness and anti-crack property. Photopolymerizable polymers have functional groups introduced into their skeletons, which may cause radical polymerization and/or cation polymerization when radiated by ionizing radiation. Those causing radical polymerization are particularly preferred since they show higher curing rate and hence provide high degree of freedom with respect to the resin design.

As the radically polymerizable prepolymers, acrylic prepolymers having acryloyl groups are particularly preferred and they may have two or more acryloyl groups per molecule and can form three dimentional reticular structure. As the acrylic prepolymers, urethane acrylates, epoxyacrylates, melamine acrylates, polyester acrylates and the like may be used.

The photopolymerizable monomers are used to improve workability of the photopolymerizable prepolymer of high viscosity by diluting it to lower the viscosity and to impart coating strength as crosslinking agents. As the photopolymerizable monomers, one or more of monofunctional acrylic monomers such as 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate, 2-hydroxypropyl acrylate and butoxyethyl acrylate, bifunctional acrylic monomers such as 1,6-hexanediol acrylate, neopentyl glycol diacrylate, diethylene glycol diacrylate, polyethylene glycol diacrylate and hydroxypivalate neopentyl glycol acrylate, polyfunctional acrylic monomers such as dipentaerythritol hexaacrylate, trimethylpropanetriacrylate and pentaerythritol triacrylate and the like may be used.

As the amount of the photopolymerizable monomers added to the paint is increased, the coating becomes harder. Therefore, its mixing ratio should be suitably selected so that desired hardness or desired flexibility can be obtained. When the films are used as supports for various materials, their hardness may be adjusted depending on the properties desired for the specific purposes of the films. For example, for a use where the films are bended or folded, their hardness may be adjusted by mixing non-reactive resins excellent in flexibility to obtain desired flexibility. As such non-reactive resins, thermosetting or thermoplastic acrylic resins, epoxy resins and the like may be used.

The photopolymerization initiators have a catalytic function and added to initiate the polymerization reactions of acryloyl groups upon radiation of ionizing radiation within a short period and accelerate the reaction. The photopolymerization initiators are particularly required when the curing is performed by UV radiation, while sometimes they are not needed when an electron radiation with high energy is used. The photopolymerization initiators include those causing radical polymerization by cleavage, those causing radical polymerization by abstracting hydrogen atoms and those causing cation polymerization by generating ions. Any of those photopolymerization initiators can be used for the present invention and they include photopolymerization initiators for radical polymerization such as benzoin ethers, ketals, acetophenones, thioxanthones and the like and photopolymerization initiators for cation polymerization such as diazonium salts, diaryliodonium salts, triarylsulfonium salts, triarylpyrylium salts, benzylpyridinium thiocyanate, dialkylphenacylsulfonium salts, dialkylhydroxyphenylsulfonium salts, dialkylhydroxyphenylphosphonium salts and the like and those of complex type and one or more of them can be used. The photopolymerization initiators are mixed in an amount of 2 to 10% by weight, preferably 3 to 6% by weight based on the solid matter of the resin.

Further, the ionizing radiation curable paint may contain additives such as sensitizers, pigments, fillers, non-reactive resins and leveling agents. The compositions may be diluted with solvents compatible with them to form paints.

In order to cure the ionizing radiation curable paint, it is radiated with electron rays or UV rays. When the radiation is carried out with electron rays, electron rays with an energy of accelerating voltage of not more than 1000 keV, preferably 100 to 300 keV, and a wavelength of not more than 100 nm may be radiated by using an electron radiation accelerator of scanning type or curtain type. When the radiation is carried out with UV rays, UV rays with a wavelength of from 100 to 400 nm, preferably 200 to 400 nm and an energy of 71 to 285 kcal/mol may be radiated by ultra high pressure mercury lamps, high pressure mercury lamps, low pressure mercury lamps, carbon arc, xenone arc, metal halide lamps and the like.

The ionizing radiation cured resin layer having such a composition as described above may be formed by coating the ionizing radiation curable paint onto a plastic film and irradiating it with an electron ray or UV ray. The ionizing radiation curable paint may be coated on the plastic film by a usual coating method such as Mayer bar coating, blade coating, gravure coating, spin coating and spray coating.

When the ionizing radiation curable paint coated on a plastic film is cured by radiating it with an electron ray or UV ray, the curing may be greatly influenced by the presence of oxygen and the thickness of the coating. Radicals generated by the radiation of ionizing radiation capture oxygen and hence the presence of oxygen inhibits the curing. Therefore, when the thickness of the coating is thin, the ratio of the surface area relative to the volume of the coating becomes thicker and the curing is likely to be inhibited by oxygen in air. On the other hand, when the thickness of the coating is thick, it becomes difficult for the ionizing radiation to permeate into the inside of the coating. As a result, curing of the deeper portion becomes insufficient, while the surface portion may be cured, and bad adhesion between the layer of ionizing radiation cured resin and the polyester film is caused due to the presence of the interfacial portion not cured. In order to avoid such inhibition of curing or a portion not cured, the radiation of electron ray, in particular, can be performed in the presence of an inert gas such as N_2 gas. Further, by adjusting the thickness of the coating, employing photopolymerizable prepolymers and photopolymerizable monomers of high curing rate and increasing the amount of the photopolymerization initiator to be added, the inhibition of curing may be prevented.

The hardness of the ionizing radiation cured resin layer should be equal to or harder than a pencil hardness of H, preferably 2H, determined according to JIS-K5400. When it is softer than H, deformation of the plastic films caused by humidity or heat cannot be effectively prevented.

The thickness of the ionizing radiation cured resin layer may vary depending on material and thickness of the plastic film used. That is, if the plastic film having a lower glass transition temperature or a higher thickness is used, the ionizing radiation cured resin layer should have a relatively higher thickness. However, even though the thick plastic film is used, if it is used for a purpose where a relatively short heating time is used, heat is not easily transmitted to the inside of the film and hence it is not likely to be deformed. Accordingly, in such a case, a relatively lower thickness of the layer may be used. As described above, the thickness of the ionizing radiation cured layer cannot be definitely defined, but it may have a thickness of 1 to 30μm, preferably 3 to 10 μm, when it is a polyester film and used as printing sheets for a laser beam printer utilizing a temperature of 200℃ for thermal fixing.

Such a modified plastic film held between the ionizing radiation cured layers shows substantially no waving phenomenon even if it is used for a copying machine utilizing a temperature of more than 200℃ for thermal fixing. Further, the petal phenomena are markedly reduced when it is left in high humidity in a stacked or rolled form.

It is considered that the waving phenomenon caused by heat is prevented by a high glass transition temperature and a high hardness of the ionizing radiation cured resin layer. That is, since the ionizing radiation cured resin layers are provided on the both surfaces of the plastic film and thereby a structure where the plastic film is held between the ionizing radiation cured resin layers is formed, the plastic film cannot be deformed even though it is softened by heat. Further, it is considered that the fact that the structure makes heat transmission to the plastic film difficult also contributes to prevent the waving phenomena.

In addition, the petal phenomena caused by humidity are also reduced and this is considered to be due to the fact that since the plastic film is held between the ionizing radiation cured resin layers the plastic film cannot be deformed even though the edges of the film absorb moisture.

By using the modified plastic films as base materials and providing various layers on the ionizing radiation cured resin layers, materials having various characteristics, of which waving caused by heat and waving of their edges caused by moisture are prevented, can be prepared.

For example, second original films for PPC, films for overhead projectors and the like may be prepared by providing layers for easy adhesion of toner on the ionizing radiation cured resin layer, and they may be used as printing sheets for PPC, laser beam printers and the like, of which waving is clearly reduced.

Further, tracing films or films for electrographic recording may be prepared by providing writing layers or electrographic recording layers. When they are used in pen plotters or electrographic plotters, distortion of lines, bad position of paper sheets, jamming of paper sheets and the like can be avoided since their petal phenomena are reduced. In addition, when drawings prepared as described above are used as second originals and printed onto photosensitive materials, they do not cause bad contact.

Further, masking films can be prepared by providing peelable masking layers on the modified plastic film and they may be used in automatic drawing machines without bad cutting, distortion of cut lines, bad position of films and the like. Bad contact also is not caused when they are printed to photosensitive materials.

Furthermore, by providing photosensitive layers, the modified plastic films can be used as photosensitive films not showing bad contact upon printing and not losing flatness of supports by developing solution upon developing.

By providing magnetic layers, they may be used as video tapes, audio tapes, floppy discs, pre-paid cards and the like and they may be used for any purposes requiring flatness of plastic films.

The recording material of the present invention will be explained hereinafter.

The recording material of the present invention comprises the modified plastic film of the present invention described above at least one of which surfaces is provided with a layer for easy adhesion of toner. Specifically, as shown in Fig. 6, the recording material 10 comprises a plastic film 2, ionizing radiation cured resin layers 3 provided on the both surfaces of the plastic film and a layer for easy adhesion of toner 5 provided on the ionizing radiation cured resin layer 3.

Though the plastic film 2 and the ionizing radiation cured resin layer may be the same as those used for the modified plastic films 1 described above, when the modified plastic films are used for recording material, the ionizing radiation curable paint may contain a matting agent in order to improve writing property. As the matting agent, silica, titanium oxide, zinc oxide, calcium carbonate, barium sulfate, magnesium oxide and the like may be used. The matting agent can be used in an amount of 10 to 200% by weight, preferably, 20 to 100% by weight based on the solid matter of the resin.

The layer for easy adhesion of toner 5, which is provided on the ionizing radiation cured resin layers 3, is provided in order to improve fixing of toner used in PPC, laser beam printers and the like and may provided on the surface(s) of both or one of the ionizing radiation cured resin layers 3.

Preferably, the layers for easy adhesion of toner comprises resins having a glass transition temperature of 45 to 100 ℃. A glass transition temperature not less than 45℃ is preferred to prevent blocking when a large number of recording sheets are stacked, and a glass transition temperature not more than 100 ℃ is preferred to improve adhesion of toner. However, if it is used in a machine using a high fixing temperature, a resin having a glass transition temperature of more than 100℃ may be also used. As the resins, there can be mentioned homopolymers and copolymers of acrylic resins, polyethylene, polystyrene, poly(vinyl chloride), polyacrylonitrile, poly(vinyl butyral), poly(vinyl acetate), polyamide, polyester and the like, and they can be used alone or in any combination thereof.

The layer for easy adhesion of toner may be added with various additives, if necessary. Particularly preferred additive is an antistatic agent. By adding antistatic agents, transfer, adhesion of toner and handling properties of the recording material can be improved.

The layer for easy adhesion of toner should have a thickness of not less than 0.1 μm.

Further, if good adhesion between the layer for easy adhesion of toner and the ionizing radiation cured resin layer cannot be obtained, the adhesion may be improved by subjecting the ionizing radiation cured resin layer to a surface treatment or providing an anchor coating layer.

Further, any desirable properties of the layer for easy adhesion of toner can be obtained by adding additives to it and, in addition, any layers having desired properties may be provided on the layer for easy adhesion of toner depending on the specific purposes of the recording material.

The recording material having the structure described above shows substantially no waving of films even though it is used for copying machines utilizing a fixing temperature of not less than 200 ℃. Further, when stacked sheets or rolls of the recording material are left in high humidity, the petal phenomena are markedly reduced.

The explanations hereinabove are exemplary ones and the present invention is not limited thereto. That is, for instance, an adhesion layer may be interposed between the plastic film and the ionizing radiation cured resin layer and the plastic film may be subjected to a treatment for easy adhesion.

EXAMPLES

The present invention will be further explained by referring to the following working examples.

Example 1

An ionizing radiation curable paint having the following composition was prepared and coated on both surfaces of a polyester film having a thickness of 50μm by a Mayer bar. The coated resin layers were irradiated by a UV ray for 1 to 2 seconds by means of a high pressure mercury lamp to provide ionizing radiation cured resin layers having a thickness of 3.5 μm and thereby a modified plastic film was provided.

Composition of Ionizing Radiation Curable Resin

(solid matter: 25% by weight)

UV curable acrylic resin	13.0 parts by weight
(UniDic 17-806: Dainippon Ink & Chemicals Inc.)	
Methyl ethyl ketone	12.0 parts by weight
Toluene	12.0 parts by weight
Ethylcellosolve	4.7 parts by weight
Photopolymerization initiator	0.3 parts by weight
(IrgCure 651: Ciba Geigy Inc.)	

The obtained modified plastic film was tested to evaluate its petal phenomena and waving caused by temperature.

(1) Test for evaluating petal phenomena

The obtained modified plastic film was cut into sheets having a size of 594 × 841 mm. The sheets (100 sheets) were stacked and left at a temperature of 36.5℃ and a relative humidity of not less than 90% for 24 hours. Then, third sheet and 50th sheet from the top were examined with respect to occurrences of petal phenomena. The petals 4 of the third film sheet 1 and the 50th film sheet 1 were shown in Figs. 2 (a) and (b), respectively. The numbers in the figures indicate the heights of the petals.

As a comparison (Comparative Example 1), a polyester film having a thickness of 50μm was cut and stacked as described above and left under the same conditions as described above. Then, occurrences of the petal phenomena in the films were evaluated in the same manner as described above. The petals 4 of the third film sheet 2 and the 50th film sheet 2 were shown in Figs. 3 (a) and (b). The numbers in the figures indicate the heights of the petals.

As clearly seen from the above results, few petal phenomena were observed in the modified plastic film of the present invention, it was observed that it maintained flatness under the high humidity condition.

(2) Test for evaluating waving caused by high temperature

By using the obtained modified plastic film, a printing process was carried out in a copier for large size drawings (Xerox 5080: Fuji Xerox Co.,Ltd) at a fixing temperature of film mode 4 (about 250 ℃). As shown in Fig. 4, the modified plastic film after the printing showed no waving like the film before the printing.

As a comparison, a printing process was carried out in the same manner in a copier for large size drawings as described above excepting that a polyester film of a thickness of 50 μm was used. During the printing process, the polyester film was jammed on its transfer route of the copier for large size drawings after the fixing area. When a carrier paper sheet (5 cm) was attached to the front end of the polyester film, the printing process could be carried out without causing jamming. However, as shown in Fig. 5, large number of waving having heights of more than 10 mm and it was not practically acceptable.

As clearly seen from the above results, no heat-dependent waving was observed and the flatness was remarkably improved in the modified plastic film of the present invention.

Example 2

An ionizing radiation curable paint having the following composition was prepared and coated on both surfaces of a polyester film having a thickness of 50μm by a Mayer bar. The coated resin layers were irradiated by a UV ray for 1 to 2 seconds by means of a high pressure mercury lamp to provide ionizing radiation cured resin layers having a thickness of 7.0 μm.

Composition of Ionizing Radiation Curable Resin

(solid matter: 23% by weight)

UV curable acrylic resin	13.0 parts by weight
(UniDic 17-806: Dainippon Ink & Chemicals Inc.)	
Photopolymerization initiator	0.3 parts by weight
(IrgCure 651: Ciba Geigy AG)	
Matting agent (silica)	4.5 parts by weight
(Sylysia 740: Fuji Silysia Chemical Co.,Ltd.)	
Matting agent (silica)	0.8 parts by weight
(Aerosil R-974: Nippon Aerosil Co.,Ltd.)	
Methyl ethyl ketone	18.0 parts by weight
Toluene	23.0 parts by weight
Butyl acetate	10.0 parts by weight

A paint for easy adhesion of toner having the following composition was applied to the surfaces of both of the obtained ionizing radiation cured resin layer by a Mayer bar and dried to form layers for easy adhesion of toner having a thickness of 1μm and thereby recording material was obtained.

Composition of Paint for Easy Adhesion of Toner

Acrylic resin emulsion	2.0 parts by weight
(Johncryl 780: Johnson Polymer Co.,Ltd)	
Acrylic resin emulsion	8.0 parts by weight
(Nicasol RX301: Nippon Carbide Co.,Ltd)	
Antistatic styrene resin	1.0 parts by weight
(VERSA TL-125: Kanebo NSC Co.,Ltd.)	
Water	34.0 parts by weight
Meta-modified alcohol	15.0 parts by weight

Comparative Example 2

An thermosetting resin paint having the same composition as the ionizing radiation curable resin used in the example excepting that it contained the following components instead of the UV curable acrylic resin and the photopolymerization initiator was prepared and coated on a polyester film having a thickness of 50μm by a Mayer bar. The coated resin layer was subjected to a heat treatment at 150℃ for 1 minute and 30 seconds to provide thermosetting resin layers having a thickness of 7.0μm.

Acrylic Polyol	17.5 parts by weight

(AcryDic A-814: Dainippon Ink & Chemicals Inc.)

Isocyanate curing agent 2.6 parts by weight

(Takenate D-110N: Takeda Chemical Industries, Ltd.)

The same layers for easy adhesion of toner were formed on the obtained thermosetting resin layers to obtain recording material utilizing thermosetting resin.

Those two kinds of recording material obtained in Example 2 and Comparative Example 2 were tested to evaluate occurrence of the petal phenomena and occurrence of waving caused by high temperature.

(1) Test for evaluating petal phenomena

The recording material obtained in Example 2 was cut into sheets having a size of 594× 841 mm. The sheets (100 sheets) were stacked and left at a temperature of 36.5℃ and a relative humidity of not less than 90% for 24 hours. Then, third sheet and 50th sheet from the top were examined with respect to occurrences of petal phenomena. The petals 4 of the third recording sheet 10 and the 50th recording sheet 10 were shown in Figs. 7 (a) and (b), respectively. The numbers in the figures indicate the heights of the petals.

Then, the recording material utilizing thermosetting resin which is obtained in Comparative Example 2 was cut and stacked as described above and left under the same conditions as described above. Then, occurrences of the petal phenomena in the sheet were evaluated in the same manner as described above. The petals

4 of the third film sheet 2 and the 50th film sheet 2 were shown in Figs. 8 (a) and (b), respectively. The numbers in the figures indicate the heights of the petals.

As clearly seen from the above results, few petal phenomena were observed in the recording material of the present invention, and it was observed that it maintained flatness under the high humidity condition.

(2) Test for evaluating waving caused by high temperature

By using the recording material obtained in Example 2, a printing process was carried out in a copier for large size drawings (Xerox 5080: Fuji Xerox Co.,Ltd) at a fixing temperature of film mode 4 (about 250℃). As shown in Fig. 9, the recording material of Example 2 after the printing showed no waving like the film before the printing. Further, the fixed toner was not removed when the printed surface was rubbed.

By using the recording material utilizing thermosetting resin of Comparative Example 2, a printing process was carried out under the same conditions as described above in the copier for large size drawings. During the printing process, the recording material utilizing thermosetting resin was jammed on the transfer route of the copier after the fixing area. When a carrier paper sheet (5 cm) was attached to the front end of the recording sheet, the printing process could be carried out without causing jamming. However, as shown in Fig. 9, large number of waving having heights of more than 10 mm were occurred and it was not practically acceptable.

As clearly seen from the above results, no temperature dependent waving was observed and the flatness was remarkably improved in the recording sheet of the present invention.

ADVANTAGES OF THE INVENTION

As seen from the above explanations, because of the ionizing radiation cured layers provided on the both surfaces of the plastic film, which contain photopolymerizable prepolymers, photopolymerizable monomers and photopolymerization initiators and have a hardness equal to or harder than a pencil hardness of H, waving of the whole film is not seen in the modified plastic films of the present invention even though they are heated to a temperature more than 200℃ and occurrence of the petal phenomenon is prevented and their flatness can be maintained when the films in the form of stacked sheets or rolls are left under circumstances of high temperature and high humidity. Therefore, by providing various layers on the ionizing radiation cured layers, it is possible to impart the above-described properties to various materials utilizing the plastic films as their supports.

Further, in the recording material of the present *invention*, because the layer for easy adhesion of toner is provided on the ionizing radiation cured resin layer of the modified plastic film, good toner fixing property can be obtained.

Claims:

1. A modified plastic film comprising a plastic film provided on both of its surfaces with cured resin layers having a hardness equal to or harder than a pencil hardness of H, the cured resin layers being formed by coating an ionizing radiation curable mixture of a photopolymerizable prepolymer, a photopolymerizable monomer and a photopolymerization initiator on the plastic film and irradiating the mixture.

2. The modified plastic film of claim 1 wherein said cured resin layers are formed by free radical polymerization.

3. The modified plastic film of claim 1 wherein said photopolymerization initiator is 2-10% by weight of solid matter in said curable mixture.

4. A recording material comprising:

a plastic film provided on both of its surfaces with cured resin layers having a hardness equal to or harder than a pencil hardness of H, the cured resin layers being formed by coating an ionizing radiation curable mixture of a photopolymerizable prepolymer, a photopolymerizable monomer and a photopolymerization initiator on the plastic film and irradiating the mixture; and a toner receptive layer comprising a resin having a glass transition temperature of from 45 to 100 °C provided on at least one of the cured resin layers.

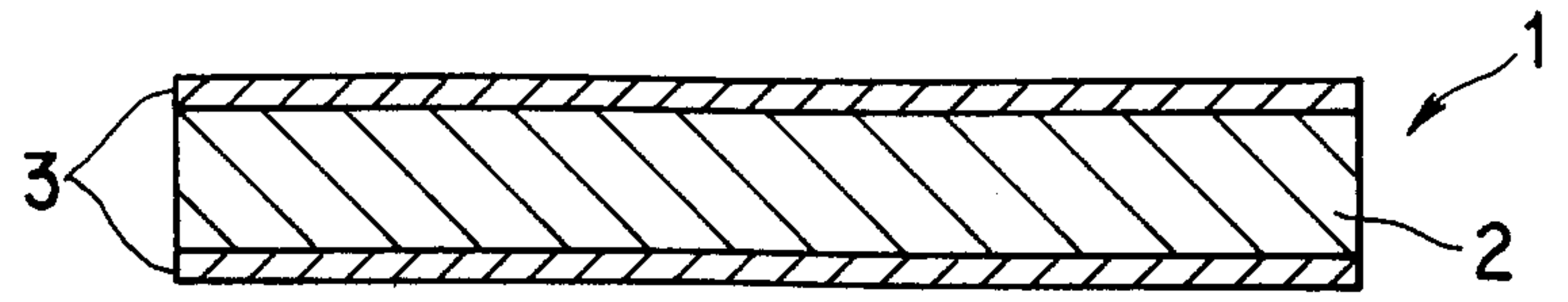
5. The recording material of claim 4 wherein at least one of the cured resin layers contains a matting agent.

6. The recording material of claim 4 wherein said toner receptive layer contains an antistatic agent.

7. The recording material of claim 4 wherein said cured resin layers are formed by free radical polymerization.

8. The recording material of claim 4 wherein said photopolymerization initiator is 2-10% by weight of solid matter in said curable mixture.

FIG. 1



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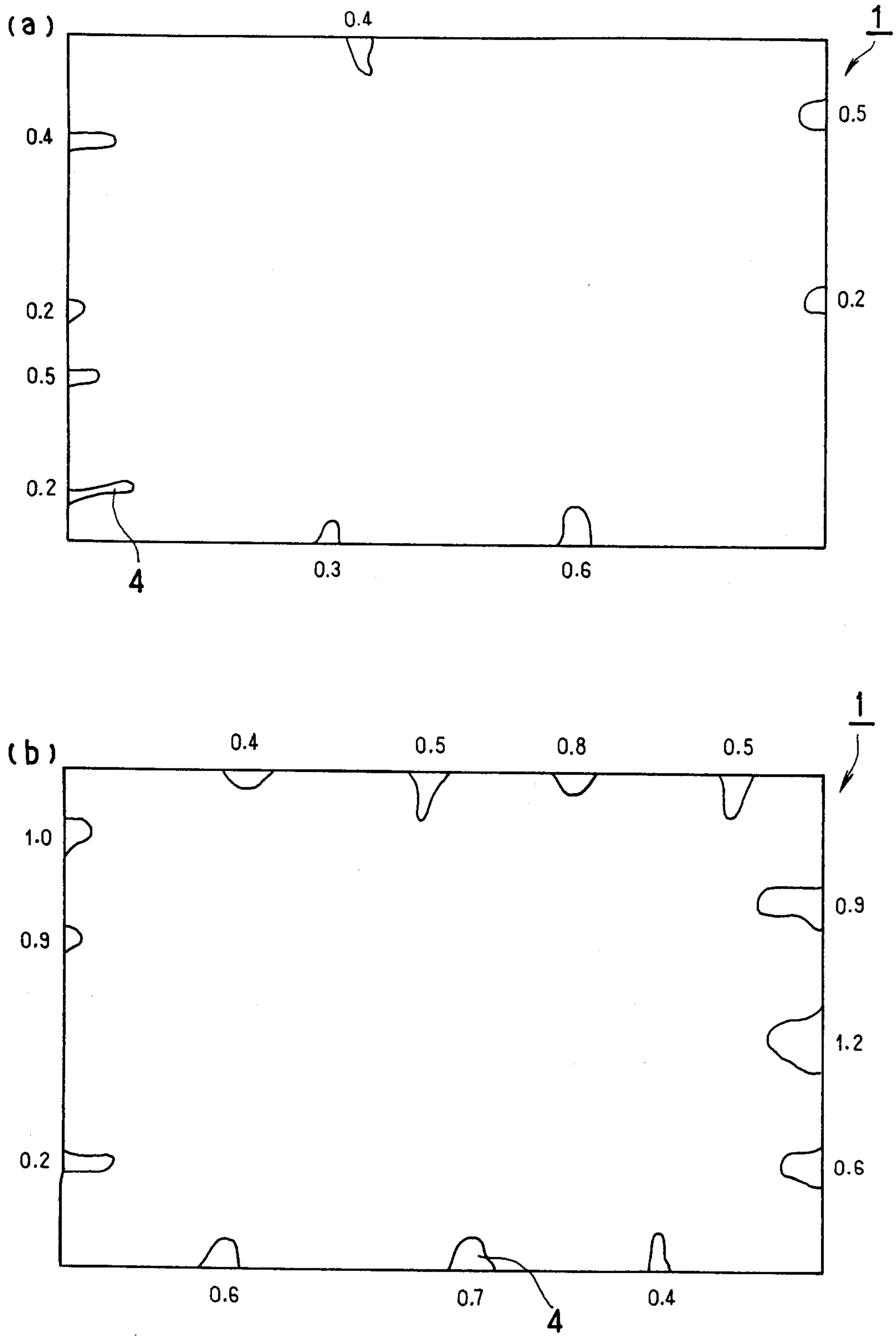
2139139

FIG. 2



Kirby, Eades, Gale, Baker

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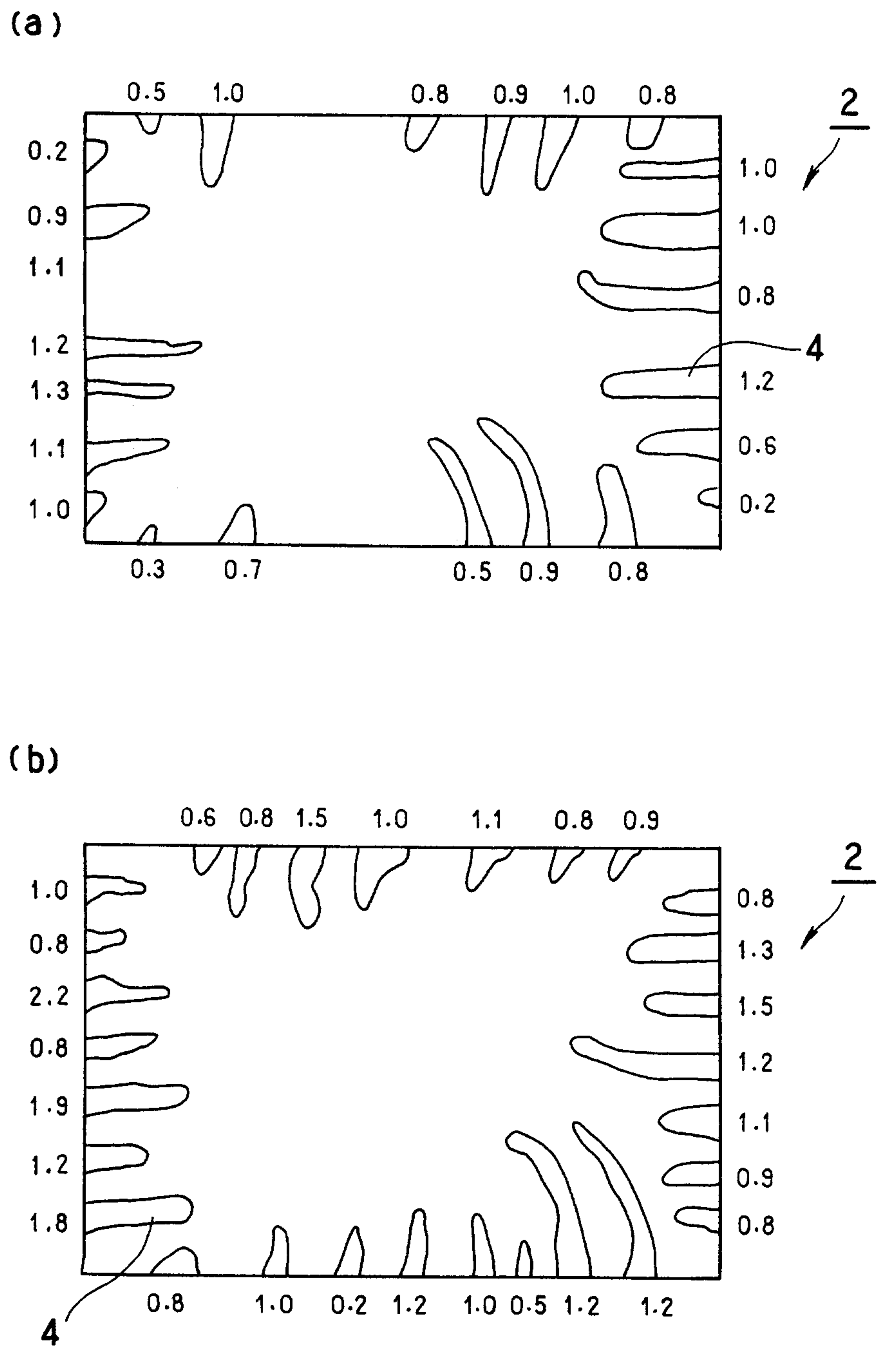
FIG. 3



Kirby, Eades, Gale, Baker

FIG. 4

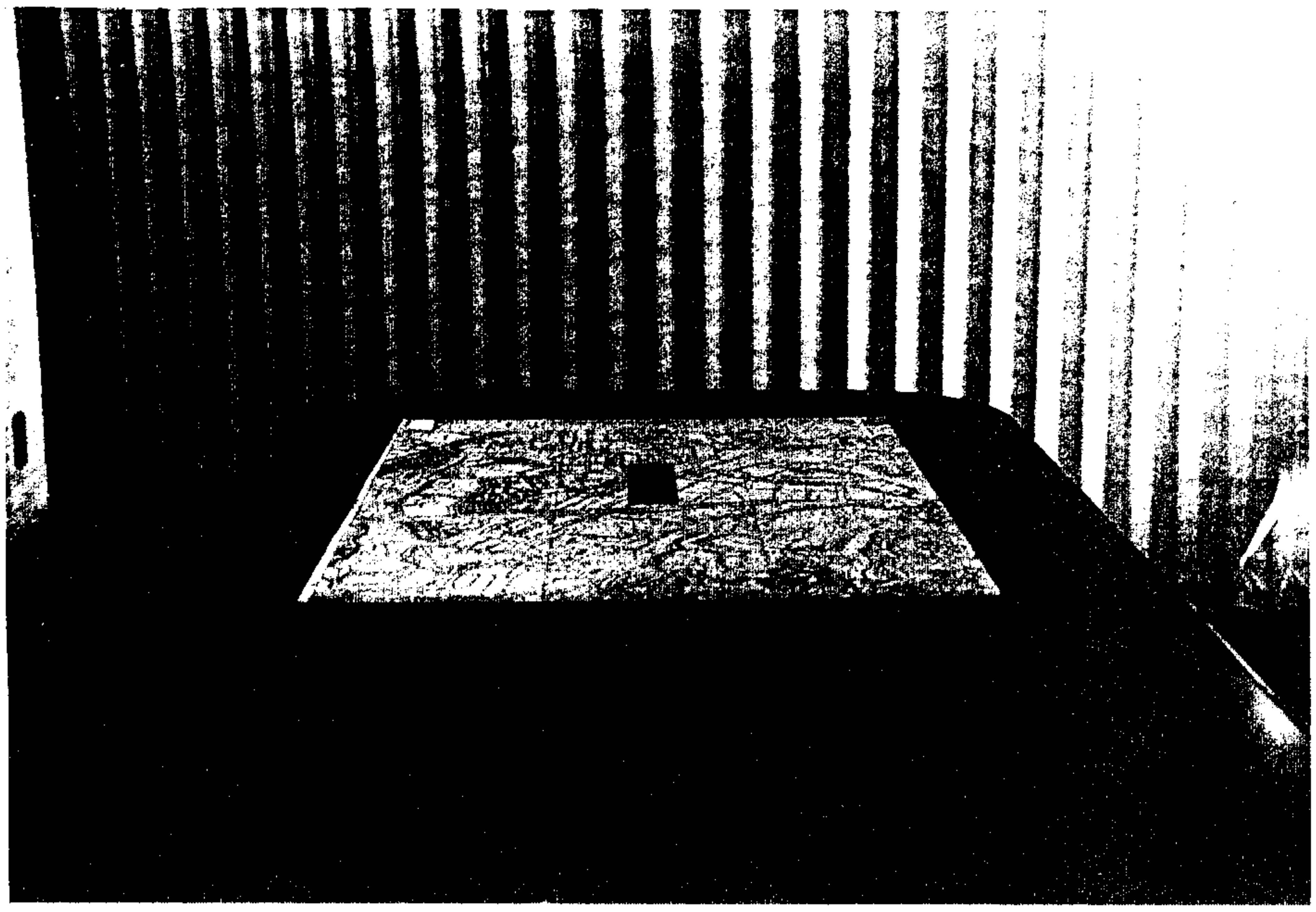
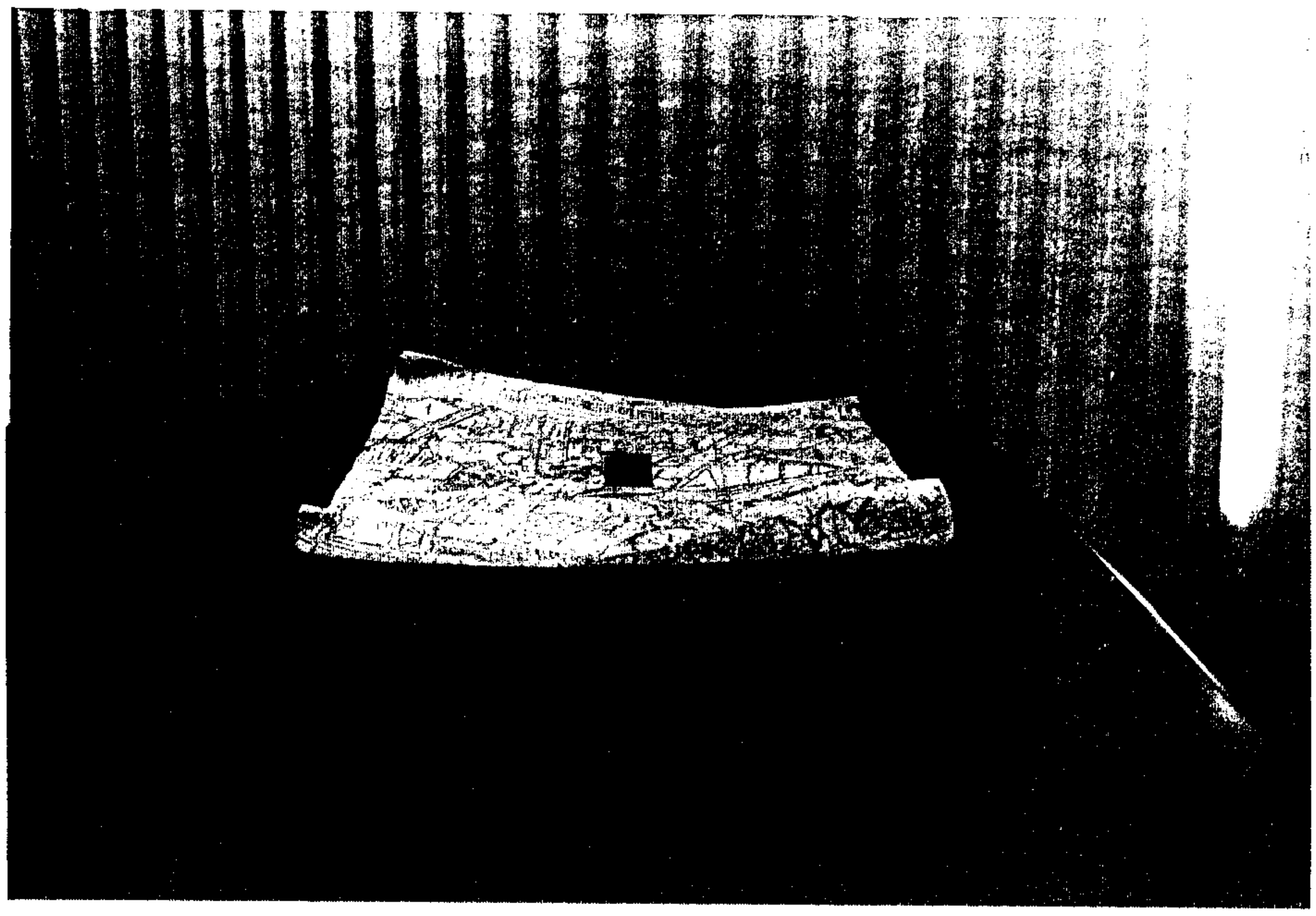
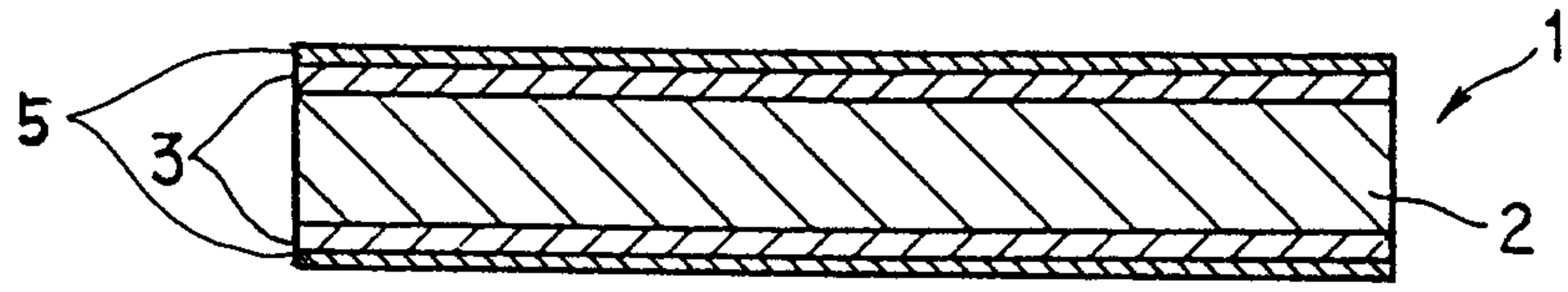


FIG. 5



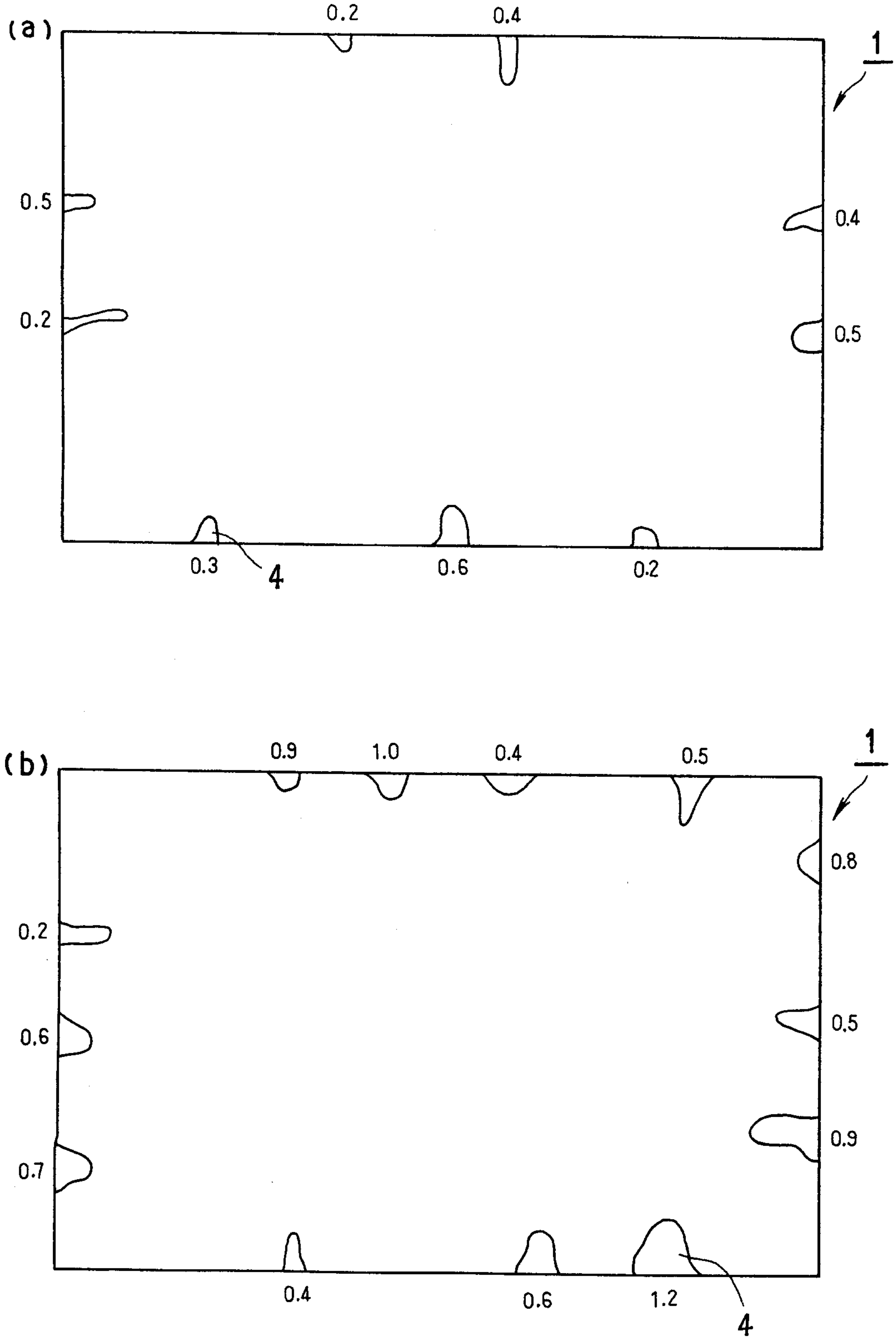
Kirby, Eades, Gale, Baker

FIG. 6



Kirby, Eades, Gale, Baker

FIG. 7



Kirby, Eades, Gale, Baker

2139139

FIG. 8

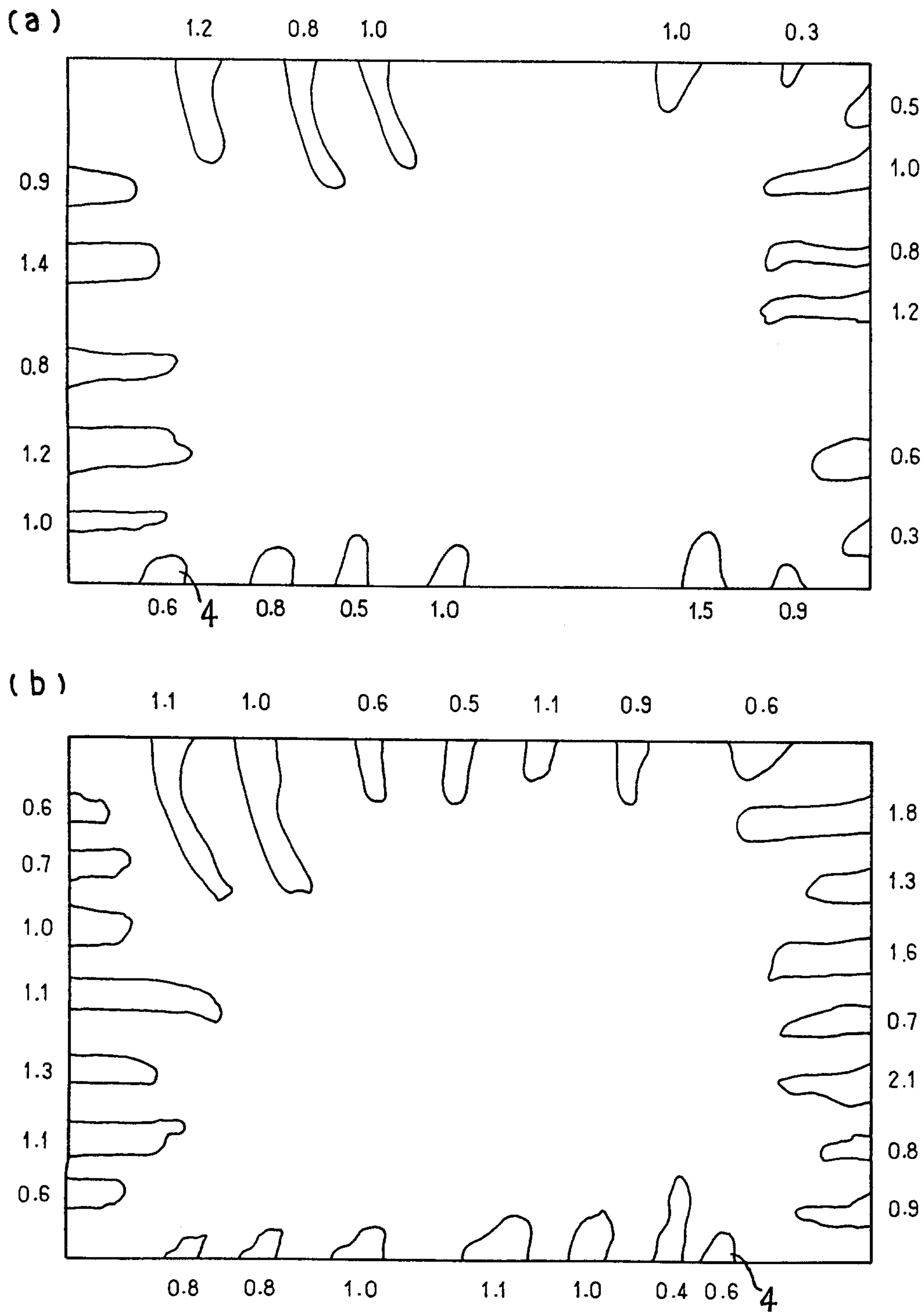


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FIG. 9

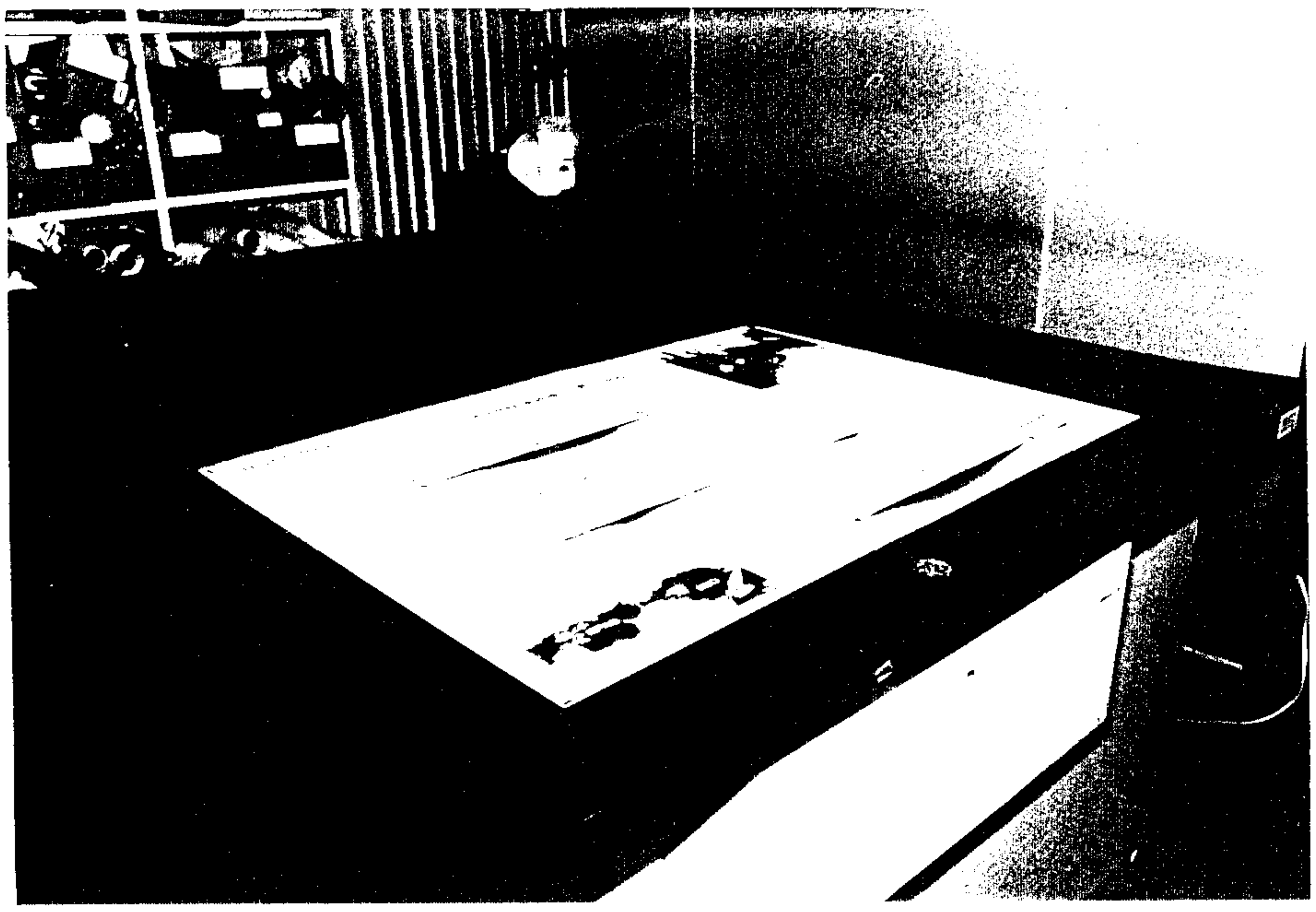

FIG. 10