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[54] **PROCESS FOR SELECTIVELY DEFORMING A THERMOPLASTIC LAYER**

[75] Inventors: **Günther Schädlich**, Wiesbaden; **Roland Moraw**, Naurod ub. Wiesbaden, both of Germany

[73] Assignee: **Hoechst Aktiengesellschaft**, Germany

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[63] Continuation of Ser. No. 206,604, Dec. 10, 1971, abandoned.

[30] **Foreign Application Priority Data**

Dec. 14, 1970 Germany 2061417

[52] **U.S. Cl.** .... **96/1.1**; 346/74 ES; 346/74 TP
[51] **Int. Cl.** **G03g 13/00**
[58] **Field of Search** 96/1.1

[56] **References Cited**

UNITED STATES PATENTS

3,196,008	7/1965	Mihajlov et al.	96/1.1
3,196,012	7/1965	Clark	96/1.1 X
3,245,053	4/1966	Brown et al.	96/1.1 X
3,262,122	7/1966	Fleisher et al.	96/1.1
3,284,196	11/1966	Mazza	96/1.1
3,328,776	6/1967	Hughes et al.	96/1.1 X
3,413,146	11/1968	Anderson et al.	96/1.1 X
3,526,879	9/1970	Gundlach et al.	96/1.1 X
3,801,314	4/1974	Goffe	96/1.1 X

FOREIGN PATENTS OR APPLICATIONS

581,917	0000	Belgium	96/1.1

OTHER PUBLICATIONS

Glenn, "Thermoplastic Recording," *Journal of Applied Physics*, Vol. 30, No. 12, Dec. 1959, pp. 1870–1873.

Primary Examiner—Norman G. Torchin
Assistant Examiner—John R. Miller
Attorney, Agent, or Firm—James E. Bryan

[57] **ABSTRACT**

This invention relates to the process for deforming a thermoplastic layer by forming an electrostatic image thereon and heating it, the improvement which comprises effecting deformation in a part of the layer only, and effecting the heating by a dry thermal treatment.

8 Claims, 11 Drawing Figures

FIG. 1

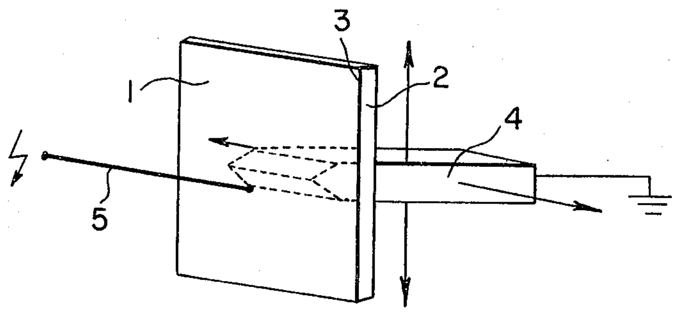


FIG. 2a

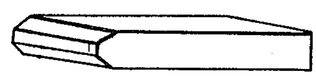


FIG. 2b

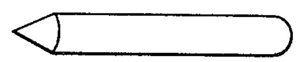


FIG. 2c

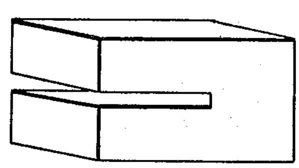


FIG. 2d

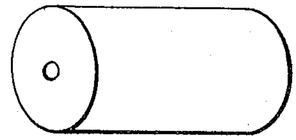


FIG. 3

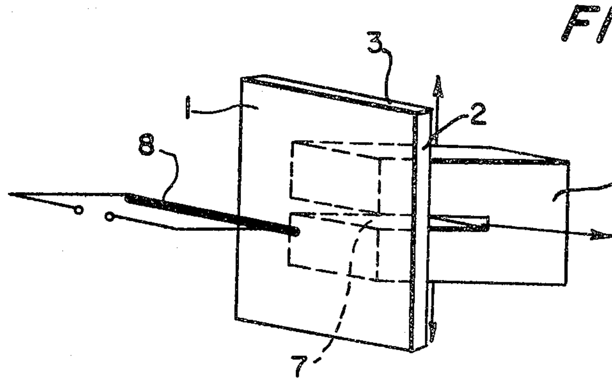
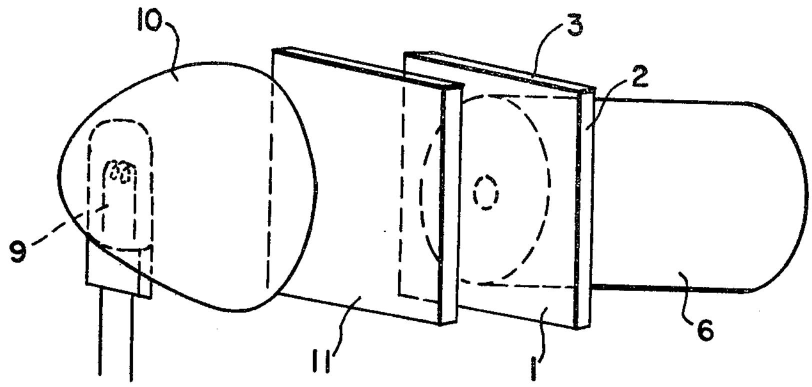


FIG. 4



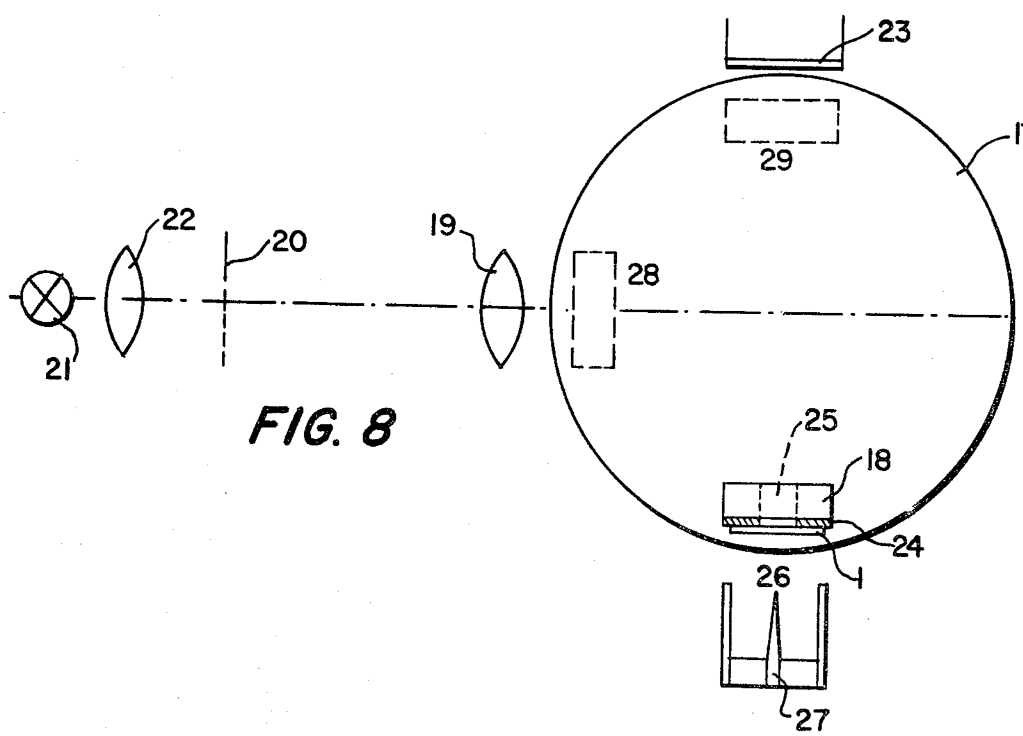


FIG. 8

FIG. 5

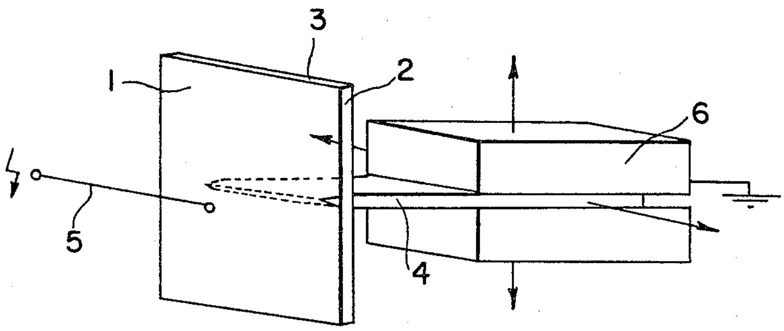


FIG. 6

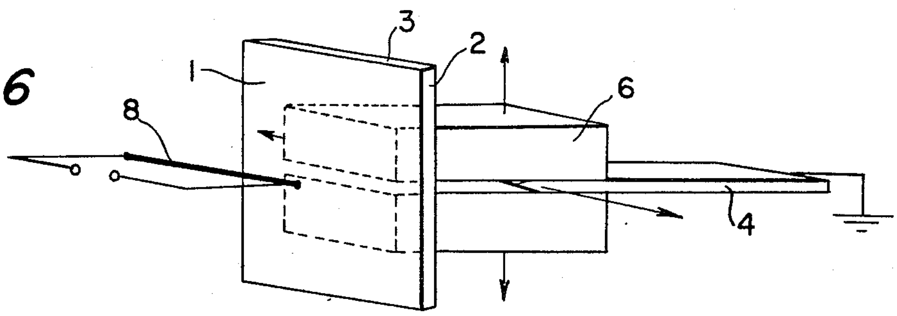
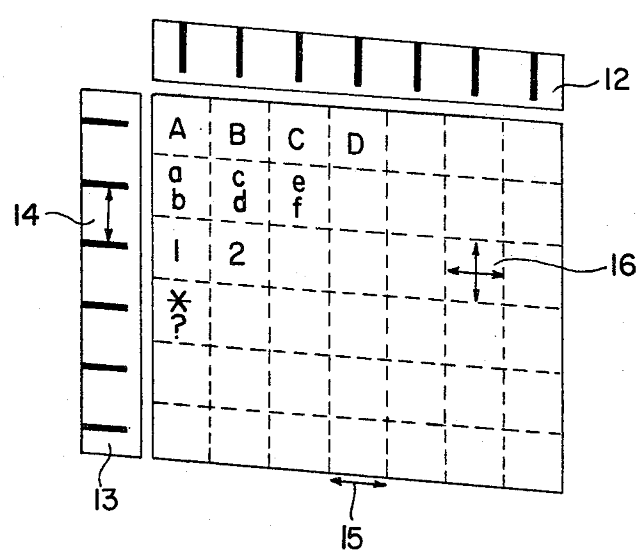


FIG. 7



PROCESS FOR SELECTIVELY DEFORMING A THERMOPLASTIC LAYER

This is a continuation of application Ser. No. 206,604, filed Dec. 10, 1971, now abandoned.

PROCESS AND APPARATUS FOR DEFORMING A THERMOPLASTIC LAYER

This invention relates to a process for deforming a thermoplastic, preferably photoconductive layer suitable for recording a deformation image or containing such an image, by electrostatic, if desired image-wise charging, followed either by image-wise exposure and heating, or by heating alone, and to an apparatus suitable for performing the process.

Processes for the preparation of deformation images by electrophotographic means are known. The recording material comprises support of dielectric, possibly transparent material, e.g. plastic film or glass, which may be provided with an electrically conductive layer of tin oxide, aluminum or the like, or of an electroconductive supporting material, e.g. an aluminum foil. On this support, there is a layer of a thermoplastic resin, preferably mixed with photoconductive substances, or these substances may be in a separate layer. The surface of the material may be provided with an electrically non-conductive layer which alters the reflection of light. The electrophotographic recording material is electrostatically charged under a corona device, image-wise exposed, and then softened. During softening, the surface of the plasticized resin becomes deformed under the influence of the latent charge image and forms a deformation image. Different kinds of deformation images are obtained, depending on the electrostatic charge. In the case of a relatively high charge, the surface of the charged areas assumes an irregular structure, so that an image produced by light scattering is formed which can be viewed or projected (frost image). If the material is charged to a lower potential, a continuous relief line is produced on the otherwise smooth background, which line marks the boundary where there is a discontinuity in the magnitude of the charge, caused by image-wise exposure (photoplastic recording). The relief images produced are viewed through a phase contrast microscope or made visible by means of a Schlieren optical system.

Softening of the layer provided with a charge image may be effected by treatment with solvent vapors or by immersion in a solvent. Alternatively, it may be effected by the application of heat, e.g. by immersion in a warm dielectric liquid. Frequently, the heat energy required for development is supplied by irradiation. By the same technique, the deformation image produced may be erased by softening.

In the known processes, the recorded original is reproduced as a whole. This has the disadvantage that in the case of a faulty composition of originals, the whole image has to be deleted by the softening procedure described. So far, it has not been possible to effect a partial deformation, i.e. to correct signal lines or points, or to complete the desired information or delete undesired information. Further, it has not been possible hitherto to gradually change the recorded information at different points of time. However, such techniques are of great importance for modern systems of information.

The present invention provides a process for producing or erasing a deformation image within a very narrow zone and at different points of time.

This is achieved by a process for deforming a thermoplastic, preferably photo-conductive layer suitable for recording a deformation image or containing such image, by electrostatic, if desired image-wise charging, followed either by image-wise exposure and heating, or by heating alone, in which process deformation is effected only in a portion of the layer, by using templates during charging and/or heating, and heating is performed by a dry thermal treatment.

The term "deforming a thermoplastic, preferably photoconductive layer" comprises the formation as well as the erasure or correction of a deformation image.

The deformation image is produced in the usual manner, by spraying electric charges, if desired in the form of an image, upon the thermoplastic layer, or, in the case of a thermoplastic photoconductive layer, by charging, image-wise exposure, and thermal development. The erasure of a deformation image is performed by heat treatment. Correction of a deformation image is effected by erasure of one image and formation of another.

For deforming a portion only of the layer, appropriate templates are used, e.g. high voltage electrodes or counter-electrodes of suitable shape for electrostatic charging, and appropriately shaped cooled or heated templates which are in contact with the recording material, for erasure. In a preferred embodiment of the invention, deformation of the layer is performed by lines or points.

In this manner, a desired alteration of the existing information is achieved without influencing the information stored in neighboring areas.

The process of the invention for line-wise or point-wise deformation may be applied to all types of originals and writing. It is of particular advantage, however, for use in the micro recording field. In this field, reduction scales of 6:1 to about 30:1, and in special cases even larger, are usual. The deformation process according to the present invention is particularly suitable for holographic recordings.

The size of a hologram may be reduced down to areas within the range of square millimeters, without substantially impairing the visibility of the image by the signal-noise ratio. Therefore, it is possible to store on a recording material so-called sub-holograms in the form of small holograms which are spaced from each other and preferably are arranged in lines. According to the present process, it is possible to selectively insert or erase individual sub-holograms whose size corresponds to side lengths of a few millimeters or even fractions of a millimeter. Since a combination of methods is possible, i.e. to produce sub-holograms by means of laser beams in one area and insert alphanumerical characters by image-wise exposure in other areas, an effective method is obtained for coding the holograms in such a manner that a certain hologram may be selected by techniques usual in the micro-recording field.

It has been found that charge images present on a thermoplastic, preferably photoconductive layer, can be converted into deformation images by heat irradiation, e.g. by infra-red rays, without substantially influencing neighboring deformation images during thermal development. Obviously, the formation of deformation images under the influence of electrostatic repulsion within the charge image proceeds much faster than the levelling of deformation images.

According to the present invention, charges which are confined to a very narrow zone may be applied to the thermoplastic layer by means of electron beams. Charging by means of a corona device is technically less expensive, however. For this purpose, a potential of some thousand volts is applied to a thin wire or a comb of metal needles, so that charges are sprayed upon the recording material lying beneath the corona, while it is grounded from the back, either directly or via a counter-electrode.

When using this charging method, it must be taken into account whether the thermoplastic, preferably photoconductive layer is applied to a non-conductive supporting film, or is on an electrically conductive intermediate layer.

The invention will be further illustrated by reference to the accompanying drawings in which

FIG. 1 illustrates the fundamental processes for charging a recording material which contains no electrically conductive intermediate layer,

FIG. 2a–2d indicate various shapes and types of templates,

FIG. 3 illustrates a process for developing or erasing deformation images along a narrow region,

FIG. 4 illustrates an infra-red radiator for heating an area of recording material to be developed or erased,

FIG. 5 illustrates the fundamental process used to produce special deformation images on thermoplastic photoconductive surfaces on which deformation images are already present. In FIG. 5 the recording material contains no conductive intermediate layer,

FIG. 6 illustrates thermal development of the material shown in FIG. 5,

FIG. 7 illustrates contact bars for adjusting an image, and

FIG. 8 illustrates an apparatus according to the invention including a closed, circular movement of the recording material.

FIG. 1 illustrates the fundamental process for charging a recording material which contains no electrically conductive intermediate layer. A grounded counter-electrode template in the form of a wedge-shaped cutting edge 4 of electroconductive material is pressed, from the back, i.e. from the support, upon the mounted recording material 1 comprising the support 2 and the thermoplastic photoconductive layer 3. The mounting for the recording material, e.g. a vacuum frame provided with an opening in the center thereof for the counter-electrode, is not shown in the drawing.

The recording material 1 faces a corona wire 5 which is connected to a high voltage source (not shown). The corona wire 5 is arranged such that it may be displaced relative to the recording material 1. Preferably, it is located opposite to the cutting edge 4. In any case, with this arrangement, the recording material is charged only in a narrow zone which is determined by the contact with the cutting edge 4. The width of the charging area may be reduced to a few tenths of a millimeter. By image-wise exposure, a charge image may be produced within the charging area on the recording material 1, and this becomes visible in the form of a deformation image during the following thermal developing process.

In order to be able to charge different areas of the recording material 1, it is necessary for the wedge-shaped cutting edge 4 to be arranged such that it can be moved relative to the recording material in the direction of the arrows shown in the drawing. When performing the process, either the recording material 1 or the cutting edge 4 may be stationary. The various positions may be adjusted by means of micrometer screws, for example.

The shape of the counter-electrode templates is not restricted to that of the wedge-shaped cutting edge 4 in FIG. 1, but the template may also have a blunt edge, as shown in FIG. 2a, when a wider area is to be charged. For point-wise charging, the counter-electrode template may have a cone-shaped end, as shown in FIG. 2b. When charging individual lines, a counter-electrode of such shape also may be moved during the charging operation. Further, it is possible for the counter-electrode template to be provided with a slot (FIG. 2c) or a hole (FIG. 2d), so that lines or points remain free from charges and no deformation image is formed in these areas. From the types of templates shown, more complicated shapes may be composed, if such shapes should become necessary. However, the preferred shapes for the counter-electrode templates are those having a pointed, cone-shaped, or wedge-shaped end.

For the local charging of recording materials consisting of thermoplastic, preferably photoconductive layers on conductive supporting materials, or of supporting materials with a conductive intermediate layer, on the other hand, specially shaped, possibly movable high-voltage electrode templates must be used, which correspond in their shapes to the counter-electrodes described above.

The specially shaped high-voltage electrodes also may be used for recording materials without electroconductive intermediate layers when correspondingly shaped counter-electrodes are used, or when the recording materials are simply backed by an electroconductive material. In the interest of sharper focusing, however, the system comprising a shaped high-voltage electrodes and shaped counter-electrode is preferred.

The process steps used in the deformation process according to the invention for the purpose of developing or erasing relief images, by a dry thermal process, are the same for all recording materials described, regardless of whether they contain a photoconductor or not and are with or without an electroconductive intermediate layer. Obviously, with the recording materials of the invention, the equalization of temperature throughout the recording material is effected within fractions of a second. By placing the recording material upon a template of readily heat-conducting material, a temperature profile may be produced in the recording material even by uniform irradiation with infra-red rays, in that the areas in contact with the template are heated to noticeably lower temperatures than the freely stretched areas. This effect may be utilized for a locally defined thermal development of charge images into deformation images, or for the local erasure of deformation images by smoothing them out at elevated temperature. Therefore, irradiation with heat rays is performed while the back of the recording material is in contact with shaped templates of readily heat-conducting material.

The principle of the process for developing or erasing deformation images along a narrow region is illustrated in FIG. 3. A metal template 6 provided with a slot 7 is pressed from the back upon the support of a mounted recording material **1** comprising the support **2** and the thermoplastic layer **3** which carries the charge or relief image (the mounting for the recording material being not shown). The metal template **6** may be maintained at room temperature or it may be adjusted to another temperature, especially cooled. The recording material **1** faces a heating wire **8** which emits infra-red radiation. Alternatively, a laminar heating element or other infra-red radiator may be used. Further, the infra-red radiator and recording material may be either arranged such that they are movable with respect to each other, or they may be stationary. In any case, a deformation image is developed or erased on the recording material opposite slot **7** only.

Preferably, an infra-red radiator is employed the radiation area of which is geometrically adapted to the area on the recording material which is to be developed or erased. Such adaptation may be achieved by a suitably coiled heating wire or by interpolating appropriate screens. Closely coiled infra-red radiators **9** (see FIG. **4**) with an elliptical reflector **10** are particularly suitable, because in this case the emitted radiation may be focused in a particularly favorable manner.

It is also possible for the template **6** to be movable in the direction of the arrows (FIG. **3**). The template may not only be of the slotted shape shown in FIG. **3**, but the most varied geometrical shapes and sizes are possible. The preferred basic shapes, from which more complicated patterns may be formed, are templates having circular or slot-like openings, corresponding to the shapes indicated in FIGS. **2*c*** and **2*d*** for the high voltage templates or counter-electrode templates.

It has been found that the area which is developed or erased, does not correspond to the area determined by the slot or the opening in the template. In most cases, a smaller area is developed or erased, and the size is also dependent upon the thickness of the recording material used.

For instance, in the case of a slot of a width of 0.5 mm, the area which is developed or erased is not 0.5 mm wide, but about 0.3 mm, when a recording material of a thickness of 40 μm is used. When the recording material is 120 μm thick, an area of about 0.45 mm is developed or erased.

In a further embodiment of the process according to the invention, the described templates used for the pointed deformation by dry thermal treatment of a recording material may be replaced by heated stamps having the shape of the described high voltage electrodes or counter-electrodes, the stamps being pressed from the back upon the support of the recording material. In this manner, it even may be possible to eliminate the infra-red radiation. In this case, deformation takes place only in those areas where the heated stamp is in contact with the recording material.

Point-shaped, circular, wedge-shaped and square stamps have proved to be particularly suitable. Stamps in the form of a planar surface have proved to be particularly advantageous.

When it is desired to produce special deformation images on thermoplastic photoconductive surfaces on which deformation images are already present which must be impaired, charging and developing may be combined, by charging only small areas and developing only the charged areas by heating, after image-wise exposure. For this purpose, the recording material may be first suitably charged and then conveyed, after image-wise exposure, to a corresponding developing station. Care must be taken that the charging area and the developing area correspond exactly. This difficulty may be avoided when the position of the recording material relative to the templates is not changed during charging and development. In FIG. **5**, the fundamental process to be used for recording materials containing no conductive intermediate layers is shown. The counter-electrode **4** in the form of a wedge-shaped cutting edge is moved in the opening of the developing template **6**, which is provided with a slot. During charging, the counter-electrode is advanced until it touches the back of the recording material and may be moved along the recording material **1** in the direction of the arrows.

At this stage, the template **6** which will be later used for development, is retracted. During thermal development after image-wise exposure, the counter-electrode **4** is retracted, and template **6** is advanced and touches the back of the recording material **1**, as shown in FIG. **6**.

For the combined charging and development of recording materials having an electrically conductive intermediate layer, the recording material may be in contact from the back with a template of suitable shape, and a correspondingly shaped high voltage electrode template is then arranged exactly opposite it. After charging, the high voltage electrode is removed from the recording material.

For performing the process of the invention, an apparatus is required by which the individual areas of the layer which are to be deformed can be exactly located. The apparatus contains the structural elements normally required for the relief process, viz. mounting for the recording material, charging station, exposure station, and a station for dry thermal treatment. The recording material executes a relative movement with respect to the individual stations, i.e. it may travel along a closed, e.g. circular path, or on an elongated path.

Thus, the present invention is also concerned with an apparatus for performing the process for deforming a thermoplastic, preferably photoconductive layer. For electrostatic charging and/or heating, high-voltage electrode templates and counter-electrode templates, and/or deformation templates (see numeral **4** and FIGS. **2*a***, **2*b***, **2*c***, and **2*d***) of materials of good electroconductivity or heat-conductivity are provided. Cone-shaped or wedge-shaped high-voltage electrode templates or counter-electrode templates (numeral **4** and FIG. **2*b***) and/or deformation templates provided with a hole or a slot (see FIGS. **2*c*** and **2*d***) are preferred.

Heating is effected by supplying thermal energy, preferably only to the areas to be defomed. Infra-red radiators, e.g. halogen-tungsten lamps, whose effectiveness can be increased by focusing the rays, have proved to be of advantage. A closely coiled infra-red radiator **9** in combination with an elliptic reflector **10** (see FIG. **4**) has proved to be particularly favorable. In addition, it is possible to remove the actinic components of the light by interposing a colored glass filter **11**.

The devices for electrostatic charging and dry thermal treatment are arranged such that they are movable in relation to the deformable portion of the thermoplastic layer. The desired positions can be reproduceably adjusted by means of measuring instruments, such as micrometer screws.

Two contact bars **12** and **13**, which are at right angles to each other and whose contact separations **14** correspond to the screen width of the image field, are advantageously used for adjustment, as shown in FIG. **7**, so that the transistion from one image field **16** to the next may correspond, e.g., to one image unit. By merans of the contact bars, an electrical control is possible, so that the desired adjustment can be made automatically.

In FIG. **8**, the apparatus according to the invention is illustrated by reference to a closed, circular movement of the recording material. The apparatus contains a turntable **17** provided with the mounting **18** for the recording material **1**, an optical system **19** for reproduction, and original **20**, a lamp **21** with a condensor **22**, and the heating station **23**.

The recording material **1** is fastened to the mounting by means of a metallic suction plate **24**. The mounting **18**, which may be, e.g., of cast aluminum, may be connected to a thermostat (not shown). For deformation of the recording material, the mounting **18** with the suction plate **24** has in its center, preferably only in one spot, a bore **25** with a fixed diameter of, e.g., 7 mm, into which the differently shaped templates for electrostatic charging and/or heating are fitted.

For deforming different areas of the recording material — which can also be achieved by a relative movement between the recording material and the templates, as described above — a mounting is advantageously used which is provided with a rectangular opening of larger size, e.g. of about 15 × 15 mm. For electrostatic charging of a surface, a metal plug may be inserted into this opening, which completely fills it. When only a portion of the area is to be charged, the metal plug is replaced by a plug of dielectric material, e.g. plexiglass, provided with a screen-like arrangement of bores of approximately 2 mm diameter, into which a counter-electrode may be inserted for selective charging.

For selective heating, a metal plug is inserted which opposite to the area to be deformed on the recording material, is provided with a bore of corresponding diameter (2 mm) into which the specially shaped template is inserted. Where the metal plug is in contact with the recording material, the thermal energy supplied is carried off so quickly that the recording material is not deformed in this area.

By turning the turntable, the mounting **18** carrying the recording material **11** is conveyed to the different stations required for image formation. The turntable **17** is turned by a synchronous motor with a variable gear. The peripheral speed may be adjusted as desired. A speed of 2 cm per second, which may be increased or reduced by several steps, has proved to be advantageous.

In position **26**, opposite to the corona device **27**, the material is charged, and at **28** it is image-wise exposed. In order to avoid blurring during exposure, the drive of the turntable may be interrupted by an adjustable contact switch and the turntable stopped by an electromagnet. After a predetermined dwell at station **28**, the electro-magnet releases the turntable and the mounting with the recording material thereon is conveyed to the thermal developing station **23** (position **29** of the turntable).

The invention will be further illustrated by the following examples:

EXAMPLE 1

20 g of polystyrene having an average molecular weight of about 30,000, 10 g of low molecular weight poly-α-methylstyrene, and 3 g of 2,5-bis-(p-diethylaminophenyl)-1,3,4-oxadiazole are dissolved in 70 ml of chloroform. The resulting solution is cast upon a 50 μ thick polyethylene terephthalate film placed on a whirler. After 10 seconds, the coated film, which is still wet, is taken from the whirler and stored for 15 minutes at room temperature unti it is dry to the touch. Finally, it is heated for 20 minutes at a temperature of 50°C in a circulating air drier to remove the solvent.

A sample of the coated film is pressed upon a metallic suction plate which is provided with a bore of 7 mm diameter in its center. Into this bore, metal templates of different shapes may be inserted which contact the back of the coated film only during charging. The coated film is charged by passing it at a distance of 1.5 cm and a speed of 2 cm per second past a needle corona to which a potential of −8 kV has been applied.

Subsequently, the material is exposed to the light of a 200 watt projector lamp, using an optical system of *f* = 35 mm. A transparent original showing **8** printed lines of 2 mm height each is reproduced at a scale of reduction of 15:1.

The image is adjusted such that it is projected centrally upon the bore in the suction plate. Exposure time is 10 seconds. For development, the coated film on the suction plate is positioned at a distance of 0.5 cm from a 2 cm wide, 8 cm long, and 0.01 cm thick steel sheet to which a voltage of 2.8 volts is applied for 1.5 seconds. The heating power is about 0.5 kW.

Depending on the shape of the metal template inserted into the bore during charging, some parts of the coated film are not charged, so that relief images are produced in which some lines are missing. The results are compiled in the following Table 1:

TABLE 1

Shape of the Template (in contact during charging only)	Numbers of the Reproduced Lines (the lines are consecutively numbered from 1 to 8)
level circular area of a diameter of 7 mm	1, 2, 3, 4, 5, 6, 7, 8, i.e. all the lines of the original are reproduced as relief images
level circular area with a slot of 1 mm width	1, 2, 3, —, —, 6, 7, 8,
level circular area with a bridge of 2 mm height and 1 mm width	—, —, —, 4, 5, —, —, —,

EXAMPLE 2

1 g of copper phthalocyanine, 5 g of low molecular weight polymethyl styrene, and 10 g of polystyrene having an average molecular weight of about 30,000 are dissolved in 50 ml of chloroform which contains 1 drop of silicone oil per liter of chloroform. A 50 μ thick polyester film carrying a 22 μ thick top layer of polyvinylidene chloride is coated with this solution as described in Example 1 and then dried. Charging, exposure, and development are as described in Example 1, with the exception that the metal template with the level circular area closes the bore during charging; the exposure time is 1/**200** seconds; and metal templates of different shapes are in contact with the back of the coated material during development. Depending on the shape of the metal templates used, a corresponding

area of the coated material remains undeveloped during thermal development. The results are compiled in the following Table 2:

Table 2

Shape of the Template (in contact during development only)	Numbers of the Reproduced Lines (the lines are consecutively numbered from 1 to 8)
level circular area of a diameter of 7 mm	(none of the lines of the charge image are developed into a relief image)
level circular area with a slit of 1 mm width	—, —, —, 4, 5, —, —, —,
level circular area with a machined bridge of 2 mm height and 1 mm width	1, 2, 3, —, —, 6, 7, 8,

The same results are obtained when an electrically non-conductive layer of indium, which increases reflection, is applied to the thermoplastic photoconductor layer at a reduced pressure of at least 10^{-6} Torr. before the image is produced.

EXAMPLE 3

A thermoplastic photoconductive film is produced as described in Example 1, except that the support is replaced by a polyester film carrying a vacuum-deposited aluminum layer. The aluminum foil is to be regarded as the support. Further treatment is as described in Example 2. The results obtained are analogous to those of Example 2.

EXAMPLE 4

A polyester film is provided with a photoconductive layer as described in Example 1, using 2-vinyl-4-(4'-diethylaminophenyl)-5-(2'-chlorophenyl)-1,3-oxazole as the photoconductor. Charging is as described in Example 1; exposure and development are carried through as described in Example 2. For the charging procedure, the corona device is adjusted to a positive potential of 8 kV. The results are compiled in Table 3.

Table 3

Shape of the Template used during Charging	Shape of the Template used during Thermal Development	Number of the Reproduced Lines (the lines are consecutively numbered 1 - 8)
level circular surface with a slot of 1 mm width	level circular area with a machined bridge of 2 mm height and 1 mm width	1,2,3,—, —, 6, 7,8,
level circular area w. machined bridge 2 mm high and 1 mm wide	level circular area with a slot of 1 mm width	—, —, —, 4,5,—, —, —,

EXAMPLE 5

A film consisting of a 19 μ thick polyester film to which a thermoplastic photoconductor layer of 20 μ thickness was applied as described in Example 2 is charged as described in Example 1. During charging, the film rests on a suction plate provided with an opening through which a brass bar of 7 mm diameter is partially inserted. The brass bar has a central bore of 0.5 mm diameter, through which a metal pin with a cone-shaped point is pushed until it touches the back of the film.

The original used for exposure is a transparent film showing a line pattern which is reproduced at a reduction scale of 15:1. Thermal development is effected as described in Example 2, after the metal pin has been retracted through the metal template and the metal template with the 0.5 mm diameter bore has been advanced until it touches the back of the film. The scaled-down image of the line pattern is visible on the film in a circular relief image of 0.28 mm diameter. When a polyester film of 100 μ thickness is used for coating, the relief image produced has a diameter of 0.48 mm.

EXAMPLE 6

1 g of poly-N-vinyl carbazole, 1 g of trinitrofluorenone, 10 g of chlorinated diphenyl, and 10 g of low molecular weight poly-α-methylstyrene are dissolved in 50 ml of tetrahydrofuran. Coating and drying are as described in Example 1, using a polyester film as the support. During the charging process, the metal template with the level circular surface is inserted into the suction plate. During thermal development, the metal template with the slot is inserted into the suction plate until it touches the film. During exposure, the original is masked in such a manner that only one line is reproduced on the film.

Each time after the formation of one image, the original is displaced by one line, and the film lying on the suction plate is shifted by the same distance. Thus, the individual lines of the original are reproduced one after the other on the film carrying the thermoplastic photoconductor layer. The results are shown in Table 4 below.

Table 4

Reproduced Line (the number of the line is stated)	Lines which can be Read as Deformation Images (the number of each line is given)
1	1,
2	1, 2,
3	1, 2, 3,
4	1, 2, 3, 4,
5	1, 2, 3, 4, 5,
6	1, 2, 3, 4, 5, 6,

EXAMPLE 7

A polyester film is coated as described in Example 6 and then dried, and a relief image is produced thereon by the method stated in Example 1. The film carrying the relief image is placed upon the suction mounting in such a manner that the relief image is in the center of the bore. Then a metal template is inserted into the bore, which has a level circular surface with a 0.5 mm wide slot. The layer side of the material is irradiated with infra-red radiation as described in Example 1. The relief image is levelled out in the areas not in contact with the template, viz. opposite the slot, whereas it is retained in all other areas

EXAMPLE 8

A polyester film is coated and dried as described in Example 2. For charging, exposure, and development, the method of Example 1 is repeated, with a metal template being in full contact with the back of the material during charging. A complete relief image is therefore obtained which shows 8 lines, according to the original used. In order to exchange an item of the invention recorded, e.g. a certain number in the present case, a metal template with a 0.5 mm bore is inserted into the suction mounting and the recording material showing the relief image is positioned in such a manner that the number to be replaced is opposite the bore. Adjustment is facilitated by using either a mounting which is movable in a vertical plane to the bore, or a movable metal template having a bore.

When the material is irradiated with infra-red radiation as described in Example 1, only the relief image opposite the bore is levelled. After the erasing process, the recording material is charged again, with a plug being inserted into the bore in the metal template. After the new number has been beamed upon the material, the plug in the bore of the metal template is retracted and the material is again irradiated with infrared light. In the area of the erasure, a new relief image is formed which shows the desired number. All other areas of the image remain unchanged.

When the new number is reproduced by this method without prior erasure of the original number, a relief image of the new number on top of a weak relief image of the original number is obtained.

EXAMPLE 9

A thermoplastic layer containing no photoconductor is produced on a polyester film according to the method stated in Example 1. This layer is uniformly charged as described in Example 1 and then touched for 5 seconds with a metal template comprising a glass plate as the support and a thin metal layer thereon showing a line pattern. The charge image produced on the thermoplastic layer is developed into a relief image by irradiation with infra-red rays.

The film carrying the relief image is placed upon a suction mounting provided with a bore in such a manner that the relief image faces outwardly and is opposite the center of the bore. A metal pin of 1 mm diameter is inserted into the bore until it touches the back of the film. The other end of the metal pin is insulated and a resistance wire is coiled around it to which such a voltage is applied, via an adjustable transformer, that the metal pin is heated to a temperature of about 75°C. After about 5 minutes, the relief image has become noticeably flatter in the vicinity of the heated metal pin. When using infra-red radiation, as is normal for development, the relief image opposite the heated metal pin

may be levelled within fractions of a second, without visibly damaging the relief images in the other areas of the material.

EXAMPLE 10

A polyester film is coated as described in Example 2, dried, and then charged in a predetermined area by means of an electrode having a cross-section of 1.5 to 2 mm, similarly as in Example 1. Exposure is performed with the aid of laser light which is separated into two component rays by means of a beam splitter, to produce a hologram.

One of the component rays is directly beamed upon the charged recording material, and the other component ray passes a diffusing lens and the original and strikes the recording material in such a manner that the two component rays are superimposed. The recording material is behind a shutter with an opening of 1.2 × 2 mm. After an exposure time of 1 second (He/Ne-Laser of 2 mW, T_{00} mode, diverging light) and thermal development, a relief image is obtained on which the object is visible under illumination with the direct component ray. With a hologram of a size of 1.2 × 2 mm, the noise does not prevent the reproduction of the image. Further holograms are produced by the same method, except that other areas of the recording material are charged, exposed, and developed.

It will be obvious to those skilled in the art that many modifications may be made within the scope of the present invention without departing from the spirit thereof, and the invention includes all such modifications.

What is claimed is:

1. In the process for deforming only a selected area of an image on a thermoplastic layer applied to a supporting film by heating said thermoplastic,

the improvement which comprises non-selectively heating the thermoplastic layer from the front by dry thermal treatment and simultaneously contacting the supporting film in the back of the non-selected area with a material having an even surface and good heat conductivity.

2. A process according to claim **1** in which heating is effected in a selected area bearing an electrostatic image.

3. A process according to claim **1** in which heating is effected in a selected area bearing a deformation image.

4. A process according to claim **1** in which the thremoplastic layer is photoconductive.

5. A process according to claim **1** in which the supporting film is non-electroconductive.

6. A process according to claim **1** in which deformation is effected in point- or line-wise areas.

7. A process according to claim **1** in which deformation is effected on micro cards.

8. A process according to claim **1** in which deformation is effected on holograms.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,897,247

DATED : July 29, 1975

INVENTOR(S) : Gunther Schadlich et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 64, after "must" insert --- not ---.

Column 7, line 6, "merans" should read --- means ---.

Column 8, line 64, "seconds" should read --- second ---.

Column 12, line 36, after "thermoplastic" insert --- layer ---.

Signed and Sealed this

twenty-fifth **Day of** *November 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

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