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(54) Thermal recording method with a sinuous-belt-processor.

(57) A method for thermally processing a thermographic material *m* (1) provides good dimensional stability without undesirable density differences. The method incorporates the steps of supplying a thermographic material *m* to the thermal processor having a processing chamber (12), heating the processing chamber to a predetermined processing temperature *T_p*, and transporting the thermographic material through the processing chamber in a sinuous way (4) by transporting means comprising a first drivable belt (21) and a second drivable belt (22).

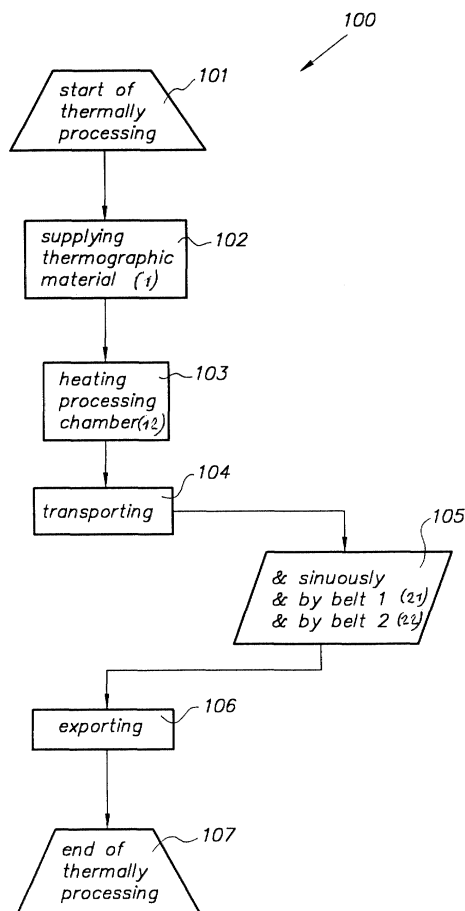


FIG. 14

Description

FIELD OF APPLICATION OF THE INVENTION

- 5 **[0001]** This invention relates to a method and an apparatus for processing a thermographic material, in particular for developing a photothermographic material.

BACKGROUND OF THE INVENTION

- 10 **[0002]** Thermally developable silver-containing materials for making images by means of exposure and then heating are referred to as photothermographic materials and are generally known. For example: "Dry Silver®" materials from Minnesota Mining and Manufacturing Company. A typical composition of such thermographically image-forming elements contains photosensitive silver halides combined with an oxidation-reduction combination of, for example, an organic silver salt and a reducing agent therefor. These combinations are described, for example, in US Patent No. 3,457,075 (Morgan) and in "Handbook of Imaging Science" by D. A. Morgan, ed. A. R. Diamond, published by Marcel Dekker, 1991, page 43.

[0003] A review of thermographic systems is given in the book entitled "Imaging systems" by Kurt I. Jacobson and Ralph E. Jacobson, The Focal Press, London and New York, 1976, in Chapter V under the title "Systems based on unconventional processing" and in Chapter VII under the title "7.2 Photothermography".

- 20 **[0004]** Photothermographic image-forming elements are typically imaged by an imagewise exposure, for example, in contact with an original or after electronic image processing with the aid of a laser, as a result of which a latent image is formed on the silver halide.

Further information about such imagewise exposures can be found in EP-A-810 467 (of Agfa-Gevaert N.V.).

- 25 **[0005]** In a heating step which then follows, the latent image formed exerts a catalytic influence on the oxidation-reduction reaction between the reducing agent and the nonphotosensitive organic silver salt, usually silver behenate, as a result of which a visible density is formed at the exposed points. For example, the development temperature is in a range between 90 to 140 °C, preferably between 100 and 130 °C, and this for about 5 to 30 seconds, preferably between 10 to 20 seconds.

- 30 **[0006]** Further information about said thermographic materials can be found, for example, in the above mentioned patent EP-A-810 467.

The development of photothermographic image-forming elements often poses practical problems. A first problem is that heat development causes a plastic film support to deform irregularly, losing flatness.

- 35 **[0007]** A second problem is that heat development often degrades dimensional stability. As the developing temperature rises, plastic film used as the support undergoes thermal shrinkage or expansion, incurring dimensional changes. Dimensional changes can result in wrinkling. Moreover, such dimensional changes are especially undesirable in preparing printing plates, because as a result, colour shift and noise associated with white or black lines appear in the printed matter.

- 40 **[0008]** In the prior art, many solutions for this dimensional problem have been disclosed, comprising the use as a support of a material which experiences a minimal dimensional change at elevated temperatures. All of these materials have their disadvantages as e.g. solvent crazing, low transparency in UV, high cost, etc.

[0009] For example, EP 0 803 765 (of Fuji Photo Film) discloses a specially prepared type of polycarbonate, having high transparency and light transmission in the UV region, recommended as a printing plate film support, and EP 0 803 766 (of Fuji Photo Film) discloses a photothermographic material comprising a support in the form of a plastic film having a glass transition temperature of at least 90 °C.

- 45 **[0010]** US-P 2,779,684 (of Du Pont de Nemours) discloses a polyester film with improved dimensional stability, which does not show any significant shrinkage when exposed to a temperature of 120°C for five minutes under conditions of no tension. Claim 1 reads: "In a process of making a dimensionally-stable polyester film which comprises forming a sheet of film from a molten highly polymeric ester substantially composed of the polyesterification product of a dicarboxylic acid and a dihydric alcohol, said ester being capable of being formed into filaments which when cold drawn show by characteristic X-ray patterns molecular orientation along the fibre axis, biaxially orienting the film by stretching it at an elevated temperature, heat-setting the film at a temperature between 150°C and 210°C under conditions such that no shrinkage occurs; the step which comprises modifying the heat-set film by heating it to a temperature of 110°C to 150°C for a period of 60 to 300 seconds while maintaining said film under a tension of about 10 to 300 psi (0.7 and 21 kg/cm²)."

- 55 **[0011]** Among the polyesters, poly-ethylene-terephthalate (PET) is a widely used and inexpensive material. However, it is not dimensionally stable at elevated temperatures. Dimensional stability of PET can be improved by a thermal stabilisation, thus rendering a thermally stabilised poly-ethylene-terephthalate film.

[0012] In "Plastics Materials", 4th edition by J.A. Brydson, Butterworth Scientific, 1982, pp. 649-650 thermal stabili-

sation of a poly-ethylene-terephthalate film PET is described as follows: "PET is produced by quenched extruded film to the amorphous state and then reheating and stretching the sheet approximately threefold in each direction at 80-100°C. In a two-stage process machine direction stretching induces 10-14% crystallinity and this is raised to 20-25% by transverse orientation. In order to stabilise the biaxially oriented film it is annealed under restraint at 180-210°C, this increasing the crystallinity to 40-42% and reducing the tendency to shrink on heating."

[0013] Also C. J. Heffelfinger and K.L. Knox, in "The Science and Technology of Polymer Films" Volume II, edited by Orville J. Sweeting, Wiley-Interscience, New York (1971), pages 616-618, describe thermal stabilisation of PET by heat setting.

[0014] In JP 08-211 547 (of applicant 3M) a special type of thermographic material is disclosed in claim 1, reading 'Heat-developing image formation element which is a heat-developing image formation element that develops at a temperature of 100°C-150°C, which consist of a heat-developing image-forming composition coated on top of a polymer support, and in which this polymer support is made dimensionally stable at development temperature by heat treatment of this polymer support at low tension and at a temperature which is higher than the glass transition temperature of the polymer, lower than the melting point of the polymer, but not lower than the development temperature plus 30°C'.

In the comparative examples of the specification, 35 mm wide strips were tested and showed a low thermal instability, i.e. a crimp which was up to 10 times lower on strips with a preconditioned support than on strips without preconditioning.

[0015] As one can see from the above, many solutions to the problem of dimensional stability have been disclosed which relate to the photothermographic material itself or to its support, or to a special method of preparation. However, in practice, such heat setting produces sheets which still deform too much during thermal processing of an imaged sheet.

[0016] From another point of view, in the specialist literature, also various apparatuses have been described for the development of thermophotographic materials.

[0017] Belt & drum-processors, as disclosed i.e. in US 6.975.772 (of Fuji Photo Film) have a disadvantage of high thermal inertia, e.g. a too slow heat supply, as a result of which the processing time becomes prohibitive.

[0018] In WO 97/28488 and in WO 97/28489 (both of applicant 3M), a thermal processor is disclosed which comprises an oven and a cooling chamber, more particularly a two-zone configured oven and a two-section configured cooling chamber.

[0019] This two-zone configuration results in uneven physical and thermal contact. Indeed, in the second zone of this oven, processing heat is transmitted to the upper side of the photothermographic material by convection, whereas processing heat is transmitted to the lower side of the photothermographic material both by conduction and by convection, which results in a degree of thermal asymmetry in the heating of the two sides of the photothermographic material. By consequence, for some highly sensitive kind of photothermographic materials the imaging quality imaging may decrease, e.g. density unevenness may appear.

[0020] Moreover, film transport by means of rollers as disclosed e.g. in said WO 97/28488 and in WO 97/28489 has further disadvantages: (i) due to a thermal discharge or unload of the roller, a repetition mark (comprising a mark per revolution of a roller) or a troublesome pattern is perceptible on the photothermographic material, (ii) in case of dust particles or flaws being present on a roller, repetitive pinholes appear on the thermographic material, (iii) automatic-cleaning of the apparatus-rollers is also rather difficult to achieve; (iv) jams of photothermographic material occur more frequently and are less easy to solve.

[0021] In summary, the prior art still needs a solution to the problem of dimensional stability of the photothermographic material while thermally processing.

[0022] The present application presents an alternate thermally processing with good dimensional stability and without undesirable density differences. In particular, the present invention does not need a complicated photothermographic material, nor a special method of preparation for the photothermographic material.

OBJECT OF THE INVENTION

[0023] The object of this invention is to provide a method for thermally processing a thermographic material with improved dimensional stability.

[0024] Other objects and advantages of the present invention will become clear from the detailed description and examples/ experiments.

SUMMARY OF THE INVENTION

[0025] We have now discovered that these objectives can be achieved by performing a method according to the independent claims.

[0026] Specific features for preferred embodiments of the invention are disclosed in the dependent claims.

[0027] Further advantages and embodiments of the present invention will become apparent from the following de-

scription and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] While the present invention will hereinafter be described in connection with preferred embodiments thereof, it will be understood that it is not intended to limit the invention to those embodiments.

Fig. 1 is a pictorial view of a thermal processor according to the present invention;

Fig. 2 is a cross- section of one embodiment of a thermal processor according to the present invention;

Figs 3 and 4 are partial sectional views of two embodiments of a thermal processor according to the present invention;

Fig. 5 is a sectional view of another embodiment of a thermal processor according to the present invention and comprising backing rollers being substantially thicker than the driving rollers;

Fig. 6 is a sectional view of another embodiment of a thermal processor according to the present invention comprising backing rollers and stationary shoes;

Fig. 7 is a perspective view showing means for driving the first and the second belt comprising a cascade free drive;

Fig. 8 is a perspective view of a heating element suitable for use in the present invention;

Fig. 9 is a cross- section of another embodiment of a thermal processor according to the present invention and comprising cleaning means and internal imaging means;

Fig. 10 is a partial view of a belt, a driving roller, and a backing roller being crowned and flanged according to the present invention;

Fig. 11 is a fragmentary side view of another embodiment of a thermal processor wherein one belt is a finite belt;

Fig. 12 is a fragmentary side view of another embodiment of a thermal processor wherein at least one belt is replaced by at least two other belts;

Fig. 13 is a fragmentary section of another embodiment of a thermal processor wherein one belt is replaced by at least one other belt and one contacting roller;

Fig. 14 is a flow chart showing a concise embodiment of a method for thermally processing a thermographic material according to the present invention;

Fig. 15 is a flow chart showing an extended embodiment of a method for thermally processing a thermographic material according to the present invention;

Fig. 16 shows the composition of a thermographic material suitable for use with the present invention;

Fig. 17 is a functional block diagram of an image recording system according to the present invention comprising an external imager;

Fig. 18 is a functional block diagram of an image recording system according to the present invention comprising an internal imager;

Figs. 19.1 - 19.3 show the evolutions over time of the temperature of a photo-thermographic material in a thermal processor with internal imaging means;

Figs. 20.1 - 20.3 show the evolutions over time of the temperature of a direct-thermographic material or a laser-thermographic material in a thermal processor with internal imaging means;

Fig. 21 shows the temperature of a resistive print head heating element during an activation pulse;

Fig. 22 illustrates an empirical registration of intermediate films;

Figs. 23.1 to 23.3 are different views of a belt comprising inherent means for guiding;

Fig. 24.1 shows a hardware compensation in transversal direction by means of different installed powers in a heating element;

Fig. 24.2 shows a hardware compensation in transversal direction and in transport direction;

Fig. 25 shows a test equipment for evaluating the flatness of a thermographic material;

Figs. 26.1 - 26.3 show evaluation templates usable for evaluating the flatness of a thermographic material.

DETAILED DESCRIPTION OF THE INVENTION

[0029] The description given hereinafter mainly comprises eight sections, namely (i) terms and definitions used in the present application, preferred embodiments of a method according to the present invention, (iii) preferred embodiments of a thermal processor according to the present invention, (iv) photothermographic applicability of the present invention, (v) direct-thermographic and laserthermographic applicability of the present invention, (vi) imager integrated applicability of the present invention, (vii) comparative experiments, (viii) further applicability of the present invention.

[0030] In some paragraphs of the instant application, reference is made to a co-pending application, entitled "Sinuous-belt-processor for thermal recording", filed on the even day and incorporated herein.

(i) Introductory explanation of terms and definitions

[0031] For the sake of greater clarity, the meaning of some specific terms applying to the specification and to the claims are explained before use.

[0032] The term "thermographic material" (being a thermographic recording material, hereinafter indicated by symbol m) comprises both a thermosensitive imaging material (being substantially lightinsensitive, and often described as a 'direct thermographic material') and a photosensitive thermally developable imaging material (often described as heat-developable light-sensitive material, or as an indirect thermographic material, or a 'photothermographic material').

[0033] For the purposes of the present specification, a thermographic imaging element le is a part of a thermographic material m (both being indicated by ref. nr. 3).

Hence, symbolically: $le \in m$

[0034] By analogy, a thermographic imaging element le , comprises both a direct thermographic imaging element and an indirect or photothermographic imaging element. In the present application the term thermographic imaging element le will mostly be shortened to the term imaging element.

[0035] By the wording "laserthermography" is meant an art of direct thermography comprising a uniform preheating step not by any laser and an imagewise exposing step by means of a laser.

[0036] A so-called "conversion temperature or threshold T_c " is defined as being the minimum temperature of the thermosensitive imaging material m necessary during a certain time range to cause reaction between the organic silver salt and reducing agent so as to form visually perceptible metallic silver.

[0037] In the present application, the term "recording on a thermographic material" comprises as well an imagewise exposing by actinic light (e.g. on a photothermographic material), as an imagewise heating by a thermal head (e.g. on a direct thermographic material) or by a laser (e.g. in laserthermography).

[0038] The wording "image", and by consequence also "imagewise", comprises as well the usual meaning of an image, as well as any other information, such as names, data, barcodes, etc.

[0039] In the present application, the term "sinuous" is understood as comprising, at least partially, a serpentine or a sinuated or a tortuous or a wavy form. The term sinuous is not meant as a synonym to sinusoidal; sinuous does not necessarily coincide mathematically exact with a goniometric sinus.

(ii) Preferred embodiments of a method according to the present invention

[0040] In order to explain the method of the present invention as clear as possible, reference is made to Fig. 14 which is a flow chart showing an embodiment of a method for thermal processing according to the present invention.

[0041] The present invention thus discloses also a method for thermally processing (started at ref. nr. 101 and ended at ref. nr. 107) a thermographic material 1, comprising the steps of supplying (ref. nr. 102) a thermographic material having an imaging element le to a thermal processor 10 having a processing chamber 12, heating (ref. nr. 103) said processing chamber to a predetermined processing temperature T_p , transporting (see ref. nr. 104) said thermographic material through said processing chamber and exporting (see ref. nr. 106) said thermographic material out of said thermal processor. Herein said 3,5 transporting said thermographic material through said processing chamber is carried out (see ref. nr. 105) in a sinuous way 4 by transporting means comprising at least a first belt 21 and a second belt 22. In some of the embodiments (see e.g. also Fig. 12; not excluding other configurations), a third belt, or a third and a fourth belt, or even more belts may be used, wherein the transporting said thermographic material through said processing chamber is carried out in a sinuous way 4.

[0042] In a preferred embodiment of the present invention, during thermally processing, said first belt 21 is, at least partially, in contact with a first side 6 of said thermographic material and said second belt 22 is, at least partially, in contact with a second side 7 of said thermographic material, opposite said first side.

[0043] It can be understood from the accompanying drawings (e.g. Fig. 2) and the corresponding description that the thermographic material l is heated as soon as it enters the thermal chamber 12, but particularly while contacting, at least partially, at least one of said first belt and said second belt. A first heating of the thermographic material thus begins as soon as the leading edge of said material leaves the first sealing means 38 in the incoming thermally isolated wall 37, even before contacting a belt on a driving roller (being, in Fig. 2, the lower belt on the first lower driving roller 25).

[0044] In another preferred embodiment, the method further comprises the steps of sensing (121) the presence of a thermographic material in the input section or in the processor, and activating the heating elements such that each belt temperature is controlled within a working range, preferably between 60 and 180 °C, more preferably between 90 and 135 °C.

[0045] By means of Fig. 15, a flow chart showing another embodiment of a method for thermal processing according to the present invention may be concisely disclosed. Herein, ref. nr. 111 indicates the start of a thermal processing, 112 the step of providing a thermographic material to a thermal processor, 113 puts the question if immediate processing of an exposed imaging element 120 is solicited by the operator, 114 indicates a driving of the transporting means in

advance to the thermal processing of a thermographic material, 115 indicates a preheating of the thermal processor in advance to the thermal processing of a thermographic material, 116 shows the effective supplying of a thermographic material to the thermal processor, 117 comprises the heating and transporting steps as described already hereabove, 118 is the exporting of the processed thermographic material, and in 119 the thermal processing is ended.

[0046] In some preferred embodiments, said transporting said thermographic material through said processing chamber is carried out during a predetermined processing time t_p , preferably ranging between 3 and 40 s, more preferably between 10 and 20 s, most preferably between 7 and 15 s.

[0047] In general, from one point of view, the present invention discloses a method for thermal processing or heat developing an imaging element, using a thermal processor according to any one of the embodiments as described in the instant specification.

[0048] From another point of view, the present invention discloses a thermal processor 10 for thermal processing a thermographic material 1, enclosing applications in a direct thermography (also including laserthermography) and in indirect thermography (or photothermography).

[0049] In particular, in any embodiment of the present said imaging element preferably is a photothermographic material.

(iii) Preferred embodiments of a thermal processor according to the present invention

[0050] For a detailed description of preferred embodiments of thermal processing according to the present invention, more information can be found in co-pending application entitled "Sinuous-belt-processor for thermal recording", filed on a same date and incorporated herein by reference.

(iv) Photothermographic applicability of the present invention

[0051] The present invention can be applied advantageously in so-called photothermography.

[0052] Thermally processable silver-containing materials for producing images by means of imagewise exposing followed by uniform heating are generally known. A typical composition of such thermographically imaging elements includes photosensitive silver halide in combination with an oxidation-reduction combination of, for example, an organic silver salt and a reducing agent therefor.

[0053] Fig. 16 (not to scale) shows a cross-section of a composition of a photothermographic material m suitable for application within the present invention. The material of the thermographic imaging element 3 comprises a polyethylene terephthalate (PET) support 65 of about 60 to 180 μm (e.g. 175 μm), optionally carrying a subbing layer 66 of about 0.1 to 1 μm (e.g. 0.2 μm) thickness, at least one emulsion layer 67 (comprising a photo-addressable thermosensitive element) of about 7 to 25 (e.g. 20 μm) thickness, and a protective layer 68 of about 2 to 6 (e.g. 4 μm) thickness (sometimes called top-layer TL). Optionally, on the other side of the PET support 65 one or more backing layers 69 is/are provided.

The photo-addressable thermosensitive element in layer 67 comprises a substantially light-insensitive organic silver salt, an organic reducing agent for the substantially light-insensitive organic silver salt in thermal working relationship therewith, photosensitive silver halide in catalytic association with the substantially light insensitive organic silver salt and a binder.

The outermost backside layer 69 may comprise a matting agent (or roughening agent, or spacing agent, terms that often are used as synonyms) to prevent sticking, e.g. polymeric beads, an antihalation dye to increase image sharpness, and / or an antistatic species to prevent the build-up of charge due to triboelectric contact.

[0054] Further details about the composition of such (indirect) thermophotographic material m may be read in EP 0 810 467 (in the name of Agfa-Gevaert).

(v) Direct-thermographic and laserthermographic applicability of the present invention

[0055] From the preceding it might be clear, that the present invention also can be applied advantageously in so-called laserthermography.

[0056] Fig. 16 (not to scale) shows a cross-section of a composition of a thermographic material m suitable for application within the present invention. The material of the thermographic imaging element 3 comprises a polyethylene terephthalate (PET) support 65 of about 60 to 180 μm (e.g. 175 μm), carrying a subbing layer or substrate 66 of about 0.1 to 1 μm (e.g. 0.2 μm) thickness, an emulsion layer 67 of about 7 to 25 μm (e.g. 20 μm) thickness, and a protective layer 68 of about 2 to 6 μm (e.g. 4 μm) thickness (sometimes called top-layer TL). Optionally, on the other side of the PET support 65 a backing layer 69 is provided containing an antistatic and/or a matting agent (or roughening agent, or spacing agent, terms that often are used as synonyms) to prevent sticking.

[0057] Further details about the composition of such thermographic material m may be read in EP 0 692 733 (in the

name of Agfa-Gevaert). The thermographic material can also contain one or more light-to-heat converting agents, preferably in layer 66, 67 or 68. This light-to-heat converting agent is often an infrared absorbing component and maybe added to the thermographic material in any form, e.g. as a solid particle dispersion or a solution of an infrared absorbing dye.

(vi) Imager integrated applicability of the present invention

[0058] Next paragraphs describe an image recording system comprising a thermal processor according to the present invention and an integrated imager. The description has three sections: (i) first, at a general systems-level, functional block diagrams, (ii) second, at an apparatus-level, a cross-section of a thermal processor comprising internal imaging means, (iii) third, at a detailed level, an evolution over time of the temperature of the thermographic material.

[0059] Fig. 17 is a functional block diagram of an image recording system 99 comprising a thermographic material 1, an external imager 95, a thermal processor 10 according to the present invention, and a control equipment 97. More specific, Fig. 18 is a functional block diagram of another image recording system 99 comprising a thermographic material 1, an internal imager 96, a thermal processor 10 according to the present invention, and a control equipment 97.

[0060] In some applications it can be wise to integrate (not shown) both an external imager 95 and an internal imager 96 within a same thermal processor 10. Herein, as a non-restrictive example, one imager can record desired image-information, while another imager can record auxiliary information (such as the name of the patient in medical radiography, or the exact type of colouring in graphical printing business, or the identification of relevant algorithms in desktop-publishing).

[0061] Fig. 9 is a schematically cross-section of a further preferred embodiment of a thermal processor 10 according to the present invention and comprising cleaning means 61, 62 (not discussed in this paragraph) and internal imaging means (indicated by ref. nrs. 93 and 94). In practice, ref. nr. 93 is e.g. a flying spot laser, a Laser Emitting Diode LED, a laser diode array, and/or a mirror or a digital micromirror device DMD, or a Charged Coupled Device CCD-array. Ref. nr. 94 preferably is a thermal head or a transparent thermal head, or a flying spot laser, a LED, a laser diode, a mirror, a digital micromirror device, etc. In order to avoid possible thermal drift in the output of said imaging means 93 and 94, optionally fibres may be introduced, or self-focusing fibres (often called 'selffocs'), or other suitable means.

[0062] More information about digital micromirror devices DMD can be found e.g. in EP-0 620 676 (in the name of Agfa-Gevaert N.V. and Texas Instruments Inc.). More information about different embodiments of a transparent thermal head and methods of using a transparent thermal head can be found in pending applications EP-A 99.204.069.1 and EP-A 99.204.070.9 (of Agfa-Gevaert N.V.) More information about the use of a laser diode array can be found in WO 99/21719 array (of Agfa-Gevaert AG), the shortened abstract reading: 'The invention relates to a device for inscribing thermographic material. The inventive device comprises a heating means with which the thermographic material is preheated to a temperature being lower than a writing temperature ... The thermographic material can be inscribed with a writing means which is distanced from the thermographic material ... having a plurality of individually controllable point sources. The thermographic material can be inscribed in a point-by-point manner with said point sources.'

[0063] Now, reference is made to Figs. 19.1-19.3 which show (but not to scale) evolutions over time of the temperature of the thermographic material m , relating to photothermography.

An embodiment of a thermal processor with an integrated imaging means 93 which is positioned rather in the begin of the chamber 12, can be applied e.g. advantageously in photothermographic applications. In reference to Figs. 19.1 to 19.3, Fig. 19.2 illustrates an embodiment wherein the temperature T_m of the photothermographic material first raises from an ambient temperature T_a to a temperature T_1 somewhat below (say 5°C or 5 K , more preferably 2°C or 2 K or less) the threshold temperature T_c of the thermographic material, then, at moment t_w , an imagewise exposure takes place (indicated by arrow E_x); thereafter, thermal processing is carried out at a temperature T_2 being above the threshold temperature T_c . Fig. 19.3 illustrates a second embodiment wherein the temperature T_m of the photothermographic material raises to a constant temperature T_3 somewhat above the threshold temperature T_c and then an imagewise exposure takes place (again indicated by arrow E_x). Fig. 19.1 is given only for illustrating a usual evolution of temperature T_m as known from prior art, without making use of a thermal processor with integrated imager as now disclosed by the present invention. A remarkable advantage of a method as illustrated in Figs. 19.2 and 19.3 comprises an increased sensitivity of the photothermographic materials so that the necessitated energy of exposure may be decreased.

[0064] An embodiment of a thermal processor with an integrated imaging means 94 which is positioned further to the mid or even to the end of the chamber 12, can be applied advantageously e.g. in direct thermography.

[0065] In direct-thermography, also comprising laser-thermography, imagewise recording by heat is carried out on a pixel-by-pixel base. Moreover, an optical density only can be perceived if the local temperature of an imaging element is equal to or greater than the processing temperature of the thermographic material.

[0066] The effect of feeding one activation pulse 46 to e.g. a resistive print head heating element (not shown) of a thermal print head 94 is illustrated in Fig. 21, showing the temperature on the vertical axis and the time on the horizontal axis. During said activation pulse 46 the temperature of the resistive print head heating element, indicated as T_{Ie} rises

from e.g. 20 °C to 300 °C, rising steeply at first and then more gradually. After the activation has been switched off, the resistive print head heating element cools down.

[0067] More information about such activation can be read e.g. in EP-0 627 319 (of Agfa-Gevaert N.V.). It has to be remarked that a resistive print head heating element as mentioned in this paragraph is quite different from an electrically resistant heating element 31 as shown in Fig. 8.

[0068] Now, reference is made to Figs. 20.1-20.3 which show (but not to scale, in particular not on a linear scale) evolutions over time of the temperature T_I of an imaging element I_e being part of the thermographic material m , relating to direct thermography or to laserthermography.

[0069] In reference to Figs. 20.1 to 20.3, Fig. 20.2 illustrates an embodiment wherein the temperature T_{I_e} of the imaging element first raises to a temperature T_5 somewhat below (say 5 °C, more preferably 2 °C or less) the processing temperature T_p , then an imagewise recording (by heat) takes place (indicated by arrow Ex) at moment tw . After recording W , the imaging element is kept at a temperature T_7 above the processing temperature T_p , and finally the imaged thermographic material is exported to an exit tray (ref. nr. 9 in Fig. 9). Fig. 20.3 illustrates a second embodiment wherein the temperature T_{I_e} of the thermographic material first raises to temperature T_8 somewhat below (say 5 °C, more preferably 2 °C or less) the processing temperature T_p , then an imagewise recording takes place (indicated by arrow Ex); thereafter, the imaging element is kept at a temperature T_9 below T_c , and finally the imaged thermographic material is exported to an exit tray.

Fig. 20.1 is given only for illustrating a usual evolution of the temperature of a direct-thermographic material as known from prior art, without making use of a thermal processor with integrated imager as now disclosed by the present invention. A remarkable advantage of a method as illustrated in Figs. 20.2 & 20.3 comprises a stable and uniform temperature over the whole thermographic material, an increased sensitivity of the thermographic materials so that the necessitated energy for writing may be decreased (so that e.g. a more economic writing head or laser can be installed), that a neutral (black) tone image can be achieved and that also more grey levels can be achieved. More in particular, a method as illustrated in Figs. 20.3 has the additional advantage of less danger of fogging as the temperature T_9 after recording is below the processing temperature of the thermographic material, rendering a better ratio for maximum to minimum density, or a better signal-noise-ratio, symbolically represented as D_{max} / D_{min} or S / N .

[0070] It has been remarked before that Figs. 19 and 20 are not drawn to scale. Yet, some practical values can be indicated. First, the threshold temperature T_c and the processing temperature T_p , which are dependent on the specific kind of thermographic material, generally are in a range between 90 and 140 °C, preferably between 100 and 130 °C, more preferably about 115 °C. Second, the processing time t_3 - t_4 of a photothermographic material generally is in a range between 3 and 30 s, preferably between 5 and 20 s. Third, recording energy for a direct-thermographic material is also dependent on the specific kind of thermographic material and restricted by the specific kind of recording. Generally, the time-constants during recording are rather small, and a recording time t_6 - t_7 often is less than 0.1 s.

[0071] To illustrate a possibility of compensation in the transversal direction X , Fig. 24.1 shows a hardware possibility comprising three different installed powers P_1 - P_3 in a heating element 31. of course, more or less than three heating zones can be used, with or without symmetrical heating.

Fig. 24.2 shows an embodiment of a heating element 31 in which various powers (see $P_{1,1}$ - $P_{1,2}$ - $P_{1,3}$ up to and including $P_{m,n}$) can be switched on by hardware both in the transversal direction X as in the transport direction Y of the thermographic material (see terminals Mij - Nij).

[0072] Referring to the paragraphs describing Figs. 9 and 15, the present application thus discloses also a method for thermally processing a thermographic material $1'$ which method further comprises a step of imagewise exposing 123 said thermographic material while transporting said thermographic material through said processing chamber.

[0073] It may be clear that in a method according to the application, said thermographic material is a photothermographic material. But it may be also clear that in a method according to the application, said thermographic material may be a direct-thermographic material.

[0074] Another embodiment of a method according to the present application further comprises the steps of uniformly preheating (125), within said thermal processor, said direct-thermographic material to a temperature within 3 K below the processing temperature, and imagewise exposing 123, within said thermal processor, said direct-thermographic material by means of a laser (93, 94) or by means of a print head resistive heating element.

A still further preferred embodiment of a method according to the present application further comprises a step of measuring 127 an optical density of the thermographic material after processing.

[0075] In general, the present application comprises a method for heat developing an imaging element of a photothermographic material, using a thermal processor according to any one of the embodiments as disclosed in the present or in the co-pending specification.

[0076] As mentioned in the background section of the present invention, thermal development of photothermographic image-forming materials often causes a plastic film support to deform irregularly, thus losing flatness. According to the instant object, the present invention discloses thermally processing a thermographic material with improved dimensional stability.

[0077] Comparative experiments, conducted by the inventors, sustain this object. In order to be as clear as possible, these experiments are disclosed hereafter, in four consecutive paragraphs, relating to (1) an empirical evaluation of flatness of a thermographic material, (2) an empirical evaluation of optical homogeneity of a processed thermographic material, (3) an empirical evaluation of geometrical spread in optical homogeneity of a processed thermographic material, and (4) an empirical evaluation of registration monitoring of a processed thermographic material.

(viii.1) Empirical evaluation of flatness of a thermographic material.

[0078] First, tests for evaluating the flatness or planeness of a thermographic material, before processing and after processing, are described in full detail. Hereto, reference is made to Fig. 25 showing a test equipment 140 for evaluating the flatness of a thermographic material 1, and to Fig 26.1 - 26.3 which are plane views of evaluation templates or gauges used in test equipment 140 for evaluating the flatness of a thermographic material.

[0079] Test equipment 140 comprises a plane table 141 (having e.g. a surface plate in cast iron according to DIN 876), an illumination source 142 (preferably tubular fluorescent lights, partially covered by a black aperture 147 having a long but small opening), an apertured sight 143 (preferably made of a black material, such as a blacked metal), and an arbitrary angle of sight 144.

[0080] According to the optical law of Snellius, in air, an incoming beam 145 under an angle of incidence α reflects to an outgoing beam 146 under an angle of refraction β being equal to angle of incidence α . However, with regard to Fig. 25, it has to be noted, first that illumination source 142 emits light in a plurality of directions (because of the illumination source being not specular, but rather diffuse), although being restricted to a certain angle by means of aperture 143. Second, thermographic material 1 reflects incident light in a rather diffuse manner, dependent on the specific kind of thermographic material and on its geometrical position (preferably being parallel to the illumination source, and more preferably, both having a horizontal level) and its degree of flatness.

[0081] An inspector perceives through apertured sight 143 a reflection of the illumination source 142 caused by thermographic material 1, which is e.g. a thermographic film, being thermally processed or not processed.

[0082] If material 1 has a high flatness, the observed reflection nr 155 is quite straight or rectilinear. If material 1 has a low flatness, the observed reflection 154 is quite curved; mainly because of local deformations, irregularities, or wrinkles. A curved reflection may touch or even pass some of the reference lines 153, the number of crossed reference lines indicating a numerical evaluation of the perceived flatness of the material 1.

[0083] Further, following reference nrs are used: 150 indicating a plane table of high quality (with a width W_t and a length L_t), 151 indicating a template for flatness, 152 indicating holes for air evacuation, 153 indicating reference lines on the template, 154 indicating prohibitive nonflatness of thermographic material 1, and ref. nr. 155 indicating thermographic material with acceptable flatness.

Thermographic film 1 has a width W_f and a length L_f , and is preferably positioned either with the length L_f of the thermographic material 1 parallel to the reference lines 153 (see Fig 26.2 and Fig. 26.3) or with the width W_f of the thermographic material 1 parallel to the reference lines 153.

After bringing a thermographic material 1 on a template 151, one has to wait some time (e.g. 2 min) so that air is free to evacuate between thermographic material and template or table.

[0084] Experiments were carried out on unimaged thermographic film coded 'PET 100CI, comprising clear-base PET-films of 100 μ m thickness, with the dimensions W_f and L_f being 200 mm x 300 mm. The heating conditions of a thermal processor according to the present invention were controlled such that the first zone 41 (being "central" to the direction of transportation Y) of each heating element 31 (see Figs. 2 and 8) reached a temperature of 132.5 °C; and such that each auxiliary heating element 32 (see Fig. 2) reached a temperature of 131.5 °C.

[0085] Remark that in the present experiments, relating to films I with a width W_f substantially smaller than the width of the thermal processor, the second zone 42 and the third zone 43 (both being "acentral" to the direction of transportation Y) of each heating element 31 (see Figs. 2 and 8) were not electrically activated.

[0086] The processing speed was regulated at 600 mm/min (equivalent to 10 mm/s). Processing time for the thermographic material I was e.g. 38 s. >>

Table 1

	Film 1i ↓	Film 2i ↓	Film 3i ↓	Average
Film Fbl	0	0	0	0
Film Fov	6	7	>> 7	> 6.7
Film Finv	1	2	1	1.3
Film Fov+inv	2-3	3-4	3-4	3.3

[0087] With regard to the above table, the following symbols are explained:

- film Fbl comprises blank films 11, 21 and 31, each without any thermal processing;
- film Fov comprises films 12, 22 and 32, each heated in a conventional oven at 145 OC during 15 min;
- film Finv comprises films 13, 23 and 33/ each thermally processed according to the present invention;
- film Fov+inv comprises films 14, 24 and 34, each being first heated in a conventional oven at 145 OC during 15 min, and thereafter being processed according to the invention.

[0088] Some conclusions resulting from the above experiment:

- an unimaged thermographic film (of the kind as PET 100C) submitted to said heating in a conventional oven with hot air definitely shows a prohibitive nonflatness (see row Fov);
- a thermographic film thermally processed according to the present invention retains a good flatness (see row@ Finv);
- a thermographic film first submitted to said heating in a conventional oven and thereafter being processed according to the present invention returns to an intermediate flatness (see rows Fov and Fov+inv).

(viii.2) Empirical evaluation of optical homogeneity of a processed thermographic material.

[0089] Second, tests for evaluating the homogeneity in density of a thermographic material, before processing and after processing, are described in full detail.

[0090] Experiments were carried out on uniformly exposed direct-thermographic film Dry View SP829 (commercially available from Eastman Kodak) comprising clear-base PET-films of 100 μ m thickness, with dimensions being 200 mm x 300 mm.

The uniformly exposing took place in a DryView 8700 Laser Imager (of 3M) and was set to result in an optical density of about 1.05 (+/- 0.05), which is a density with high perceptibility by the human eye of any density variations.

[0091] As described in relation to the foregoing experiment (cf. planeness), the heating conditions in a processor according to the present invention were controlled such that the first zone 41 (being acentral" to the direction of transportation Y) of each heating element 31 (see Figs. 2, 8) reached a temperature of 132.5 QC; and such that each auxiliary heating element 32 (see Fig. 2) reached a temperature of 131.5 QC.

[0092] After thermally processing, the density of the developed film was measured at several places by means of a densitometer Macbeth TM type TR927. A first evaluation focuses on an 'overall homogeneity', whereas a second evaluation focuses on 'local homogeneity'.

[0093] After having imaged and having processed quite a lot of thermographic films according to the above mentioned method, on each film the optical density in nine typical spots (as e.g. a spot at the leading edge or 'begin' and at the left side of a film, say in the upper left corner) was measured. Thereafter, in each of these nine spots, the mathematical averaged value of the measured density was noticed in a table.

Table 2.

	Left of Wf	Centre of Wf	Right of Wf
Begin of Lf	1.07	1.05	1.06
Mid of Lf	1.08	1.07	1.07
End of Lf	1.08	1.06	1.07

[0094] From this experiment, it can be seen clearly that the overall homogeneity in optical density of a processed thermographic film is within 0.03 D (see optical densities 1.05 versus 1.08).

[0095] In another experiment, the optical density was measured in and around some arbitrary spots. More precisely, first the optical density in an arbitrary spot of the processed thermographic material was measured (say point C), and thereafter optical densities were measured within a circle of radius 20 mm around said point C.

Exemplary results are summarised e.g. in the next table:

[0096]

Table 3

1.09 D		1.09 D
--------	--	--------

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Table 3 (continued)

1.10 D	1.10 D	1.09 D
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[0097] From this experiment, it can be seen clearly that the local homogeneity in optical density of a processed thermographic film is within 0.01 D (see optical densities 1.09 versus 1.10).

(vii.3) Empirical evaluation of geometrical spread in optical homogeneity of a processed thermographic material.

[0098] In the next experiment, a transparent calibration wedge (showing 23 consecutive density steps) was first exposed on a film Dry View Blue laser imaging film DVB 98-0439-9816-4 (with dimensions of 430 mm x 550 mm) in a same apparatus (DryView 8700 Laser imager). Thereafter, said exposed films were thermally processed in a thermal processor according to the present invention (and regulated at the same conditions, e.g. 131.52°C and 132.52, as described w.r.t. the foregoing experiments). Finally, film densities were measured by means of a densitometer Macbeth TR927.

Table 4.

Wedge step	Left	Mid	Right	Delta
1	0.19	0.20	0.20	0.01
2	0.20	0.2	0.21	0.01
3	0.21	0.21	0.22	0.01
4	0.22	0.22	0.24	0.02
5	0.26	0.25	0.27	0.02
6	0.32	0.32	0.34	0.02
7	0.41	0.41	0.43	0.02
8	0.57	0.57	0.59	0.02
9	0.80	0.81	0.80	0.01
10	1.16	1.18	1.17	0.02
11	1.60	1.61	1.60	0.01
12	2.01	2.04	2.02	0.03
13	2.37	2.40	2.39	0.03
14	2.65	2.67	2.65	0.02
15	2.83	2.85	2.83	0.02
16	2.96	2.98	2.98	0.02
17	3.00	3.01	2.98	0.03
18	3.09	3.11	3.09	0.02
19	3.12	3.14	3.12	0.02
20	3.10	3.12	3.12	0.02
21	3.12	3.12	3.14	0.02
22	3.20	3.21	3.19	0.02
23	3.22	3.24	3.23	0.02

[0099] From the above experiments, summarised in Table 4, one may conclude that the spread in optical density in a processing according to the present invention may attain 0.01 to 0.03 D, which is very acceptable.

(vii.4) Empirical evaluation of registration monitoring of a processed thermographic material.

[0100] In graphics applications, a colour-image generally is reproduced using different (say 3, 4 or more) 'colour-selection films' or shortly 'selections' (say yellow Y, magenta M, and cyan C, optionally also black K; see Figs. 22.1 to 22.3).

High precision registration of the intermediate colour-films is an important precondition sine qua non in obtaining a good quality (comprising spatial resolution) colour-image printed on a press. The registration of the intermediate colour-films themselves is dependent upon the addressability of the imager and upon the dimensional stability of the film.

[0101] In a pre-press environment several different methods of registration are used and they vary from application to application. In the present specification, such registration monitoring is used as a quantitative measure of the dimensional stability of the thermographic film after thermal processing.

[0102] If the imagesetter has no facilities for punching the film, to achieve registration of the film on the printing press, a film has to be checked before mounting on the press.

[0103] This can be carried out using e.g. a so-called best fit method', which is explained by way of examples illustrated in figures 22.1 to 22.3.

Common to Figs. 22.1 to 22.3, a rectangular diagram first represents the geometrical dimensions (i.e. width W_f being e.g. 550 mm and length L_f being e.g. 650 mm) of a film 1. Secondly, in each of the four corners of the film, a circular tolerable variation area 79 is indicated (e.g. with a radius of 50 μ m). Thirdly, each film has a 'registration cross' 75, as imaged in each of the four corners of each film (thus, in this example, there are in total $3 \times 4 = 12$ registration crosses).

[0104] In a best fit registration evaluation, the following steps are carried out:

- (i) all selections are brought together, by laying them one above the other (see Fig. 22.2);
- (ii) all corresponding registration crosses (e.g. the 'left bottom corner registration cross') of all 3 films are averaged (see reference nr 77);
- (iii) if at least one of these 'averaged registration crosses' falls outside its corresponding circular tolerable variation area, the selections are called 'out of tolerance' and unacceptable for use;
- (iv) if each of these averaged registration crosses" falls inside its corresponding circular tolerable variation area, the selections are called 'within tolerance' and acceptable for use (see Fig. 22.4).

[0105] After having executed a plurality of experiments, the registration monitoring of a thermographic material processed according to the present invention confirmed to be very acceptable.

(viii) Further applicability of the present invention

[0106] The present invention can be used to produce both images in reflection (based, for example, on paper, inter alia, used in the copying sector) and images in transparency (based, for example, on black-and-white or coloured film, inter alia, used in medical diagnoses).

[0107] It may be clear that an apparatus or a method according to the present invention can be used in photothermography, in direct thermography, and in laserthermography, especially comprising so-called monosheet thermographic materials.

[0108] Applications are encountered both in graphical applications (generally with high contrast) and in medical applications (generally with reproduction of a large number of continuous tones).

[0109] Having described in detail preferred embodiments of the current invention, it will now be apparent to those skilled in the art that numerous modifications can be made therein without departing from the scope of the invention as defined in the appending claims.

Parts list

[0110]

- 1 thermographic material m
- 2 imaging element le
- 3 material path
- 4 sinuous way
- 5 an image
- 6 a first side of a thermographic material
- 7 a second side of a thermographic material
- 8 input tray
- 9 exit tray
- 10 thermal processor
- 12 processing chamber
- 13 exit section
- 14 first part of the processing chamber
- 15 second part of the processing chamber
- 16 means for supplying
- 17 means for heating

	18	means for transporting
	19	means for exporting
	21	first belt
	211, 212, 213	other lower belts
5	22	second belt
	221, 222, 223	other upper belts
	23	ridge of a belt
	24	contacting roller
	25	lower driving roller
10	26	upper driving roller
	27	backing roller
	28	edge rollers
	29	crowned roller
	30	heating
15	31	heating element
	32	auxiliary heating element
	33	heat isolation means
	34	first heat transmission means
	35	second heat transmission means
20	36	third heat transmission means
	37	thermally insulated walls
	38	first sealing means
	39	second sealing means
	41	first temperature zone
25	42	second temperature zone
	43	third temperature zone
	46	activation pulse
	47	temperature evolution T_{le} of a print head heating element
	49	connections to the heating element
30	50	means for driving
	51	cascade-free drive
	52	electromotor
	53	transmission
	54	pulley
35	55	worm
	56	wormwheel
	57	flange
	58	shoes
	59	upper exporting means
40	60	finite belt
	61	first cleaning unit
	62	second cleaning unit
	63	unroll drum
	64	round-up drum
45	65	support
	66	subbing layer
	67	emulsion layer
	68	protective layer
	69	backing layer
50	84	cover
	85	handle
	86	hinge
	87	piston mechanism
	88	lower frame
55	89	upper frame
	91	processing temperature T_p
	92	processing speed v_p
	93	first integrated imaging means

94	second integrated imaging means
95	external imager
96	internal imager
97	controlling equipment
5 99	image recording system
100-130	several steps of a method according to the invention
140	test equipment for flatness
141	plane table
142	illumination sources
10 143	apertured sight
144	angle of sight
145	incoming beam
146	outgoing beam
147	aperture
15 150	plane table
151	template for flatness
152	holes for air evacuation
153	reference line
154	thermographic material with unacceptable nonflatness
20 155	thermographic material with acceptable nonflatness

Symbols:

[0111]

25	D	optical density
	ϕ	diameter of a roller
	dH	horizontal distance
	dV	vertical distance
30	E	modulus of elasticity
	Ex	exposure
	f	thickness of a film
	F, Fbl, Fov, Finv	comparative films
35	G	gap between two belts
	le	imaging element
	m	thermographic material
	Lr	length of a roller
	Lf	length of a film
	Lt	length of a table
40	Mij,	Nij electric terminals
	P	power (e.g. P _{1,1} - P _{m,n} ...)
	rB, rB1, rB2	radius of backing rollers
	rD, rD1, rD2	radius of driving rollers
	tB, tB1, tB2	thickness of a belt
45	Ta	ambient temperature
	Tc	threshold temperature
	T _{le}	temperature of an imaging element
	Tp	processing temperature
	Tm	temperature of a thermographic material
50	TM	trade mark
	tw	time of exposure
	vP	processing speed
	W	width
	Wf	width of a film
55	wt	width of a table
	X	transversal direction
	y	transport direction of a thermographic material
	Z	vertical direction

Y1	transport direction of the lower belt
Y2	transport direction of the upper belt
Y11 Y12 Y13	transport direction of lower belts
Y21 Y22 Y23	transport direction of upper belts
Y, M, C, K	yellow, magenta, cyan and black colour selection
α	angle of incidence
β	angle of refraction
σ_y	yield strength

Claims

1. A method for thermally processing a thermographic material (1), comprising the steps of

- supplying (102) a thermographic material having an imaging element 1e to a thermal processor (10) having a processing chamber (12),
- heating (103) said processing chamber to a predetermined processing temperature T_p ,
- transporting (104) said thermographic material through said processing chamber,
- exporting (106) said thermographic material out of said thermal processor,

characterised in that said transporting said thermographic material through said processing chamber is carried out (105) in a sinuous way (4) by transporting means comprising a first belt (21) and a second belt (22).

2. The method according to claim 1, wherein during said transporting said thermographic material through said processing chamber, said first belt (21) is in contact with a first side (6) of said thermographic material and said second belt (22) is in contact with a second side (7) of said thermographic material, opposite said first side.

3. The method according to claim 1 or claim 2, wherein said thermographic material is heated while contacting at least one of said first belt and said second belt.

4. The method according to any one of the claims 1-3, further comprising the steps of

- sensing (121) the presence of said thermographic material in said thermal processor, and
- activating a heating element (31) such that the temperature of each of said first belt and said second belt is controlled within a working range.

5. A method according to any one of the preceding claims, further comprising a step of imagewise exposing (123) said thermographic material while transporting said thermographic material through said processing chamber.

6. A method according to any one of the preceding claims, wherein said thermographic material is a photothermographic material.

7. A method according to claim 5, wherein said thermographic material is a direct-thermographic material.

8. A method according to claim 7, further comprising the steps of - uniformly preheating (125), within said thermal processor, said direct-thermographic material to a temperature within 3 K below the processing temperature T_p , and

- imagewise exposing (123), within said thermal processor, said direct-thermographic material by means of a laser (93, 94) or by means of a print head resistive heating element.

9. A method according to any one of the preceding claims, further comprising a step of measuring (127) an optical density of the thermographic material after processing.

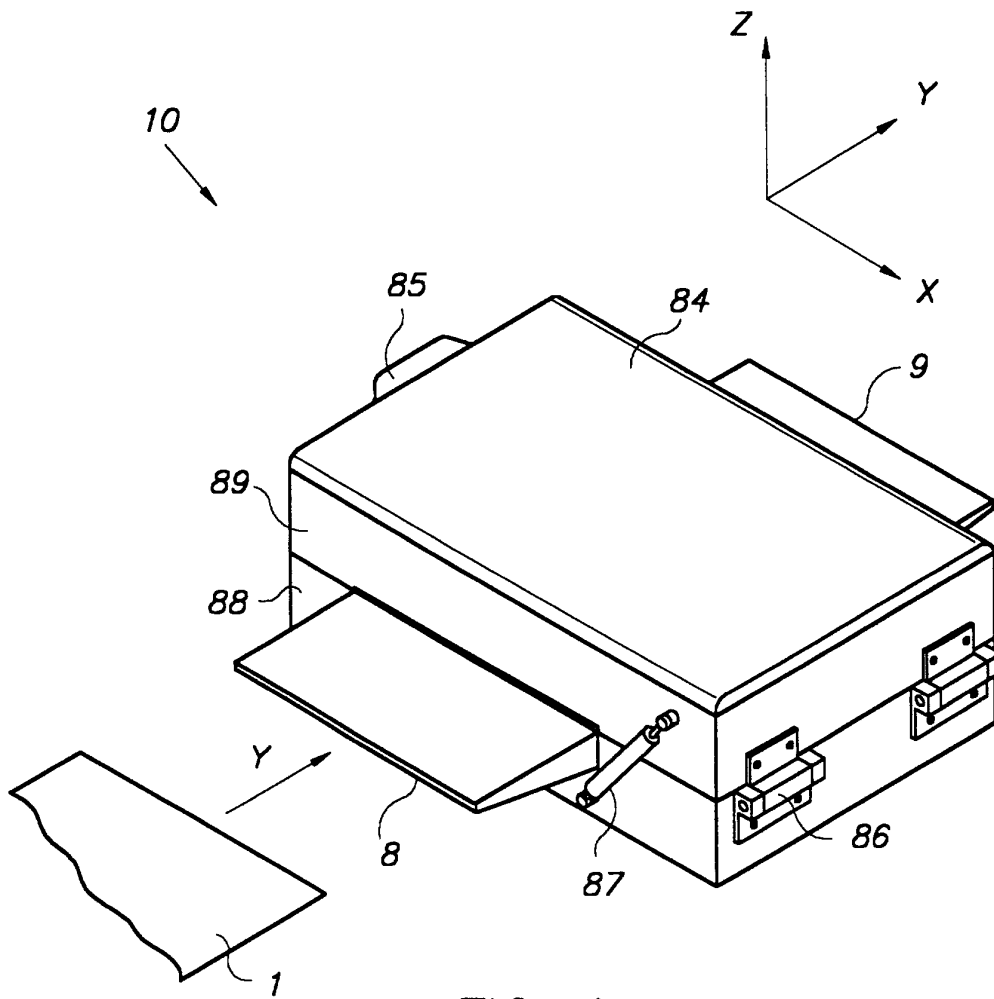


FIG. 1

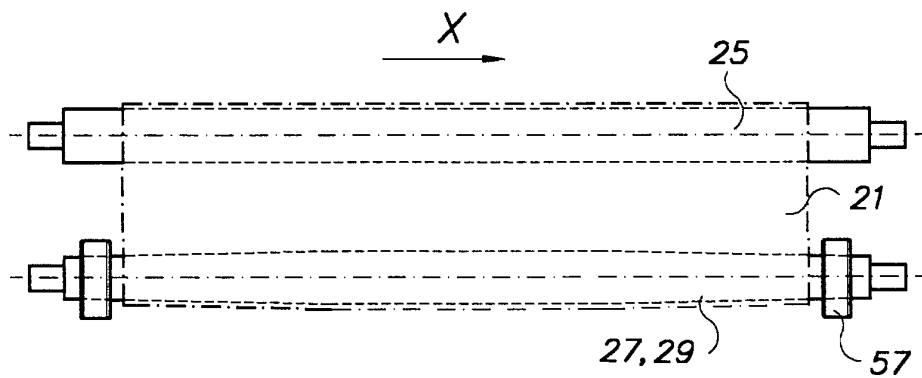


FIG. 10

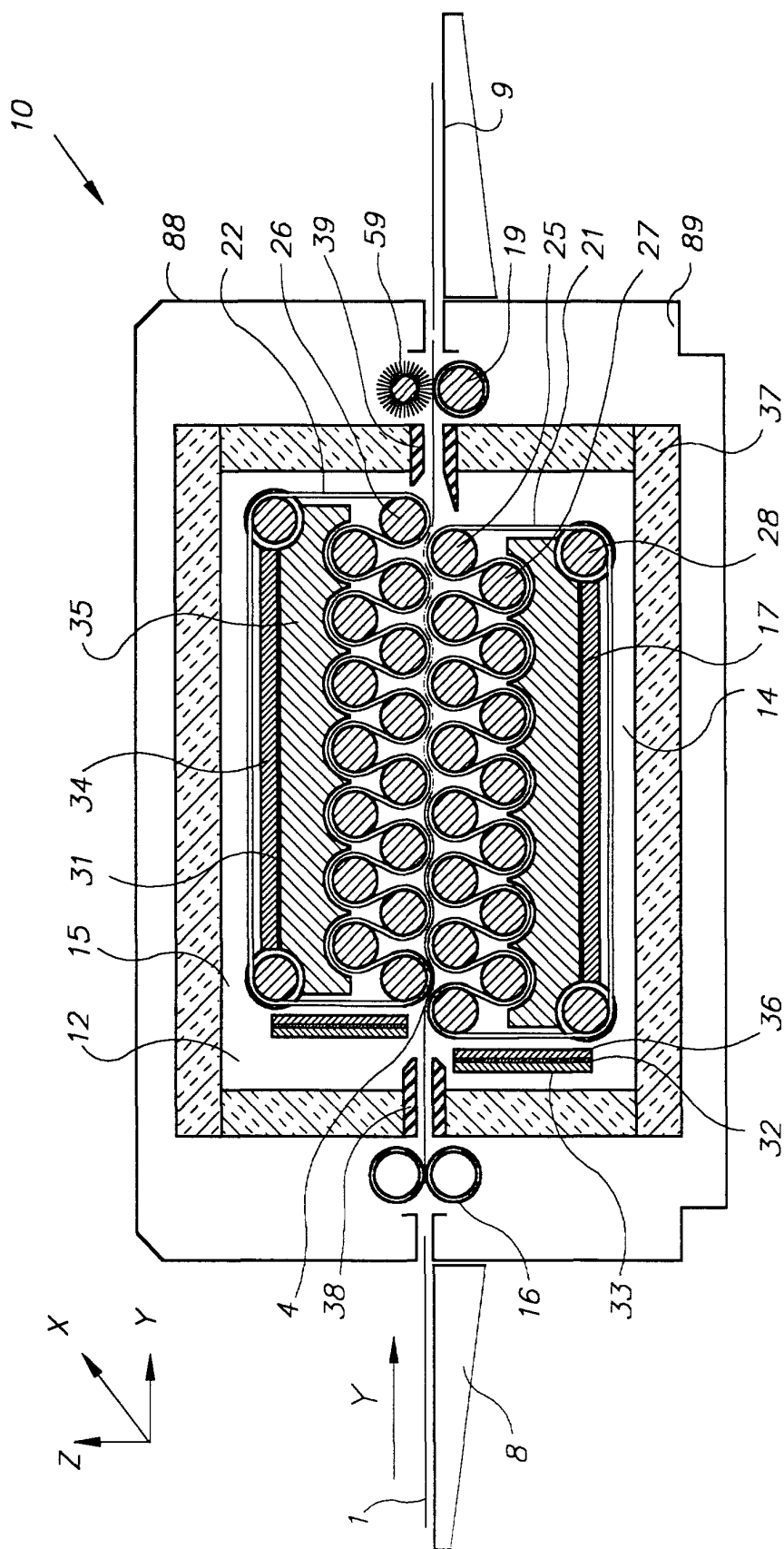


FIG. 2

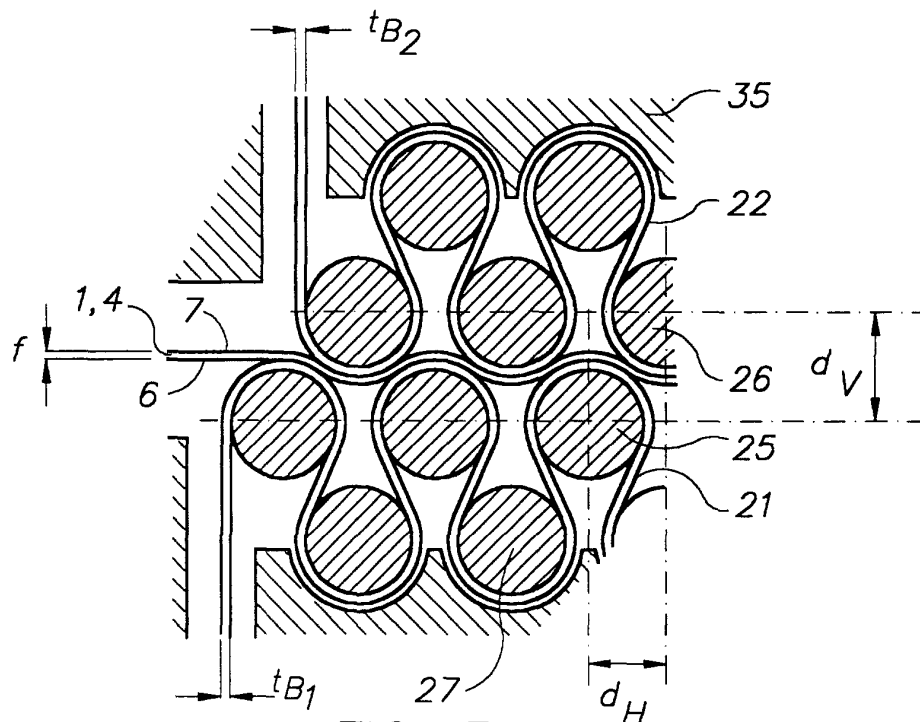


FIG. 3

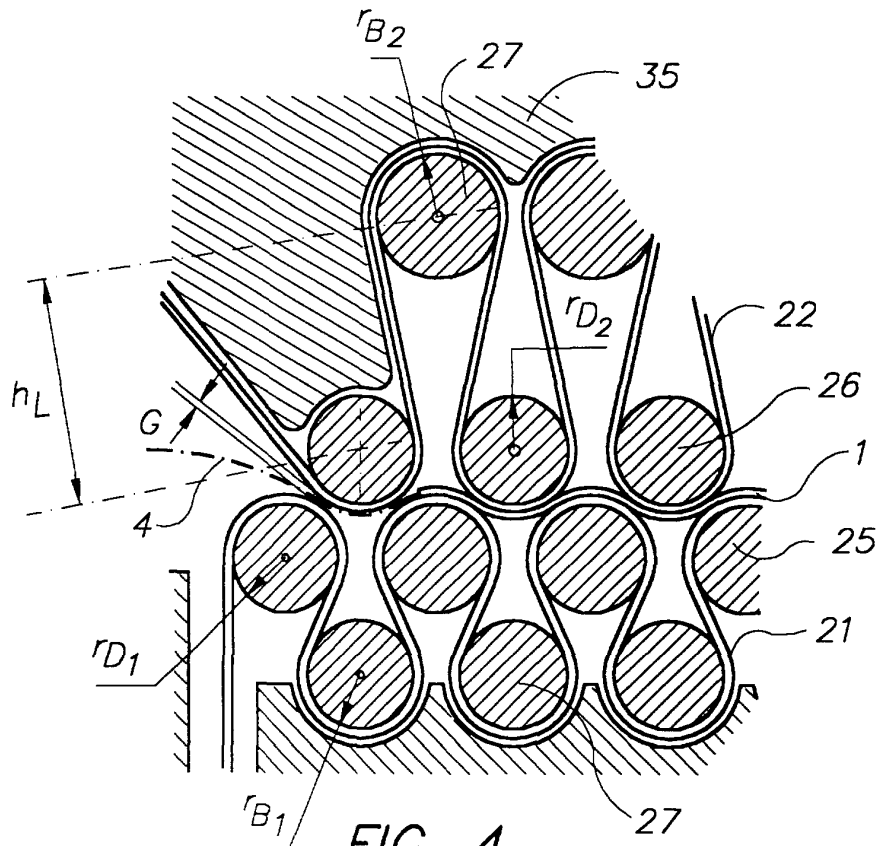


FIG. 4

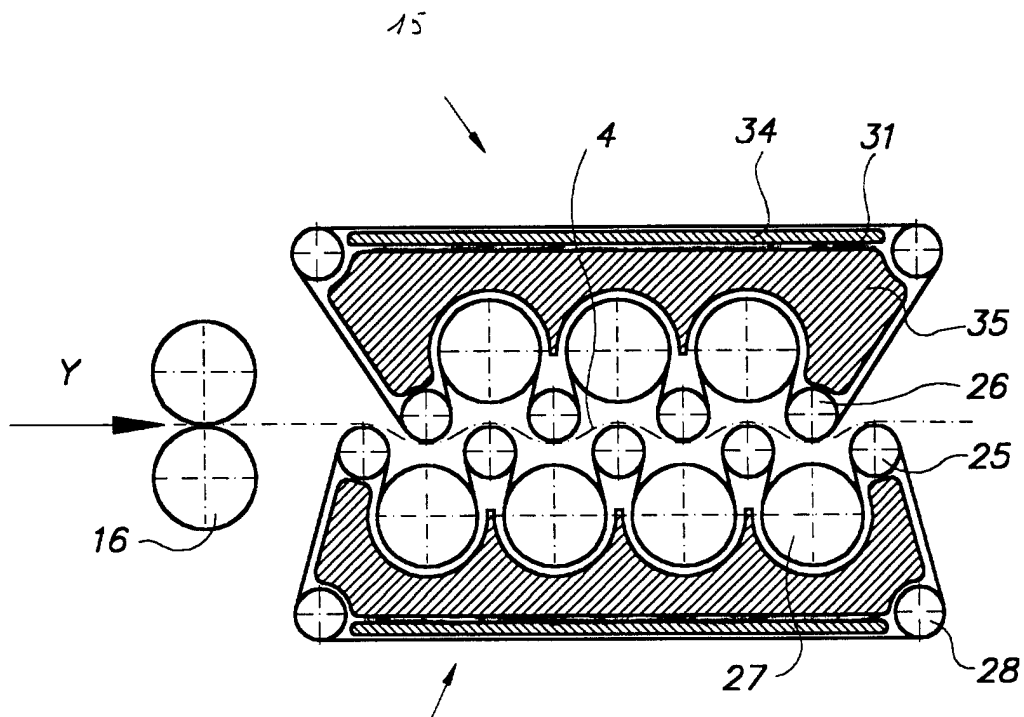


FIG. 5

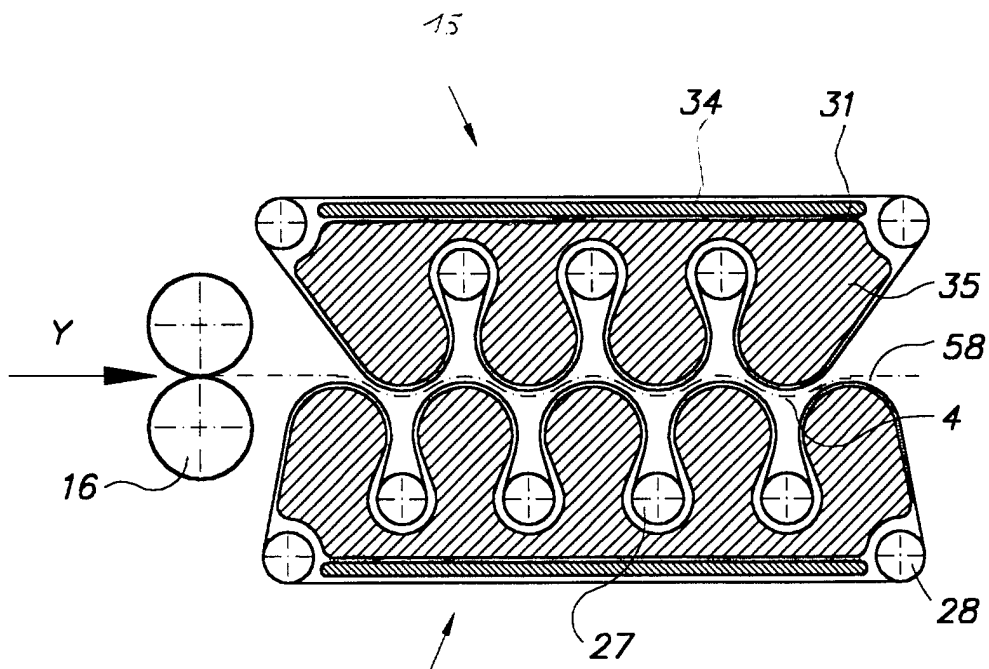


FIG. 6

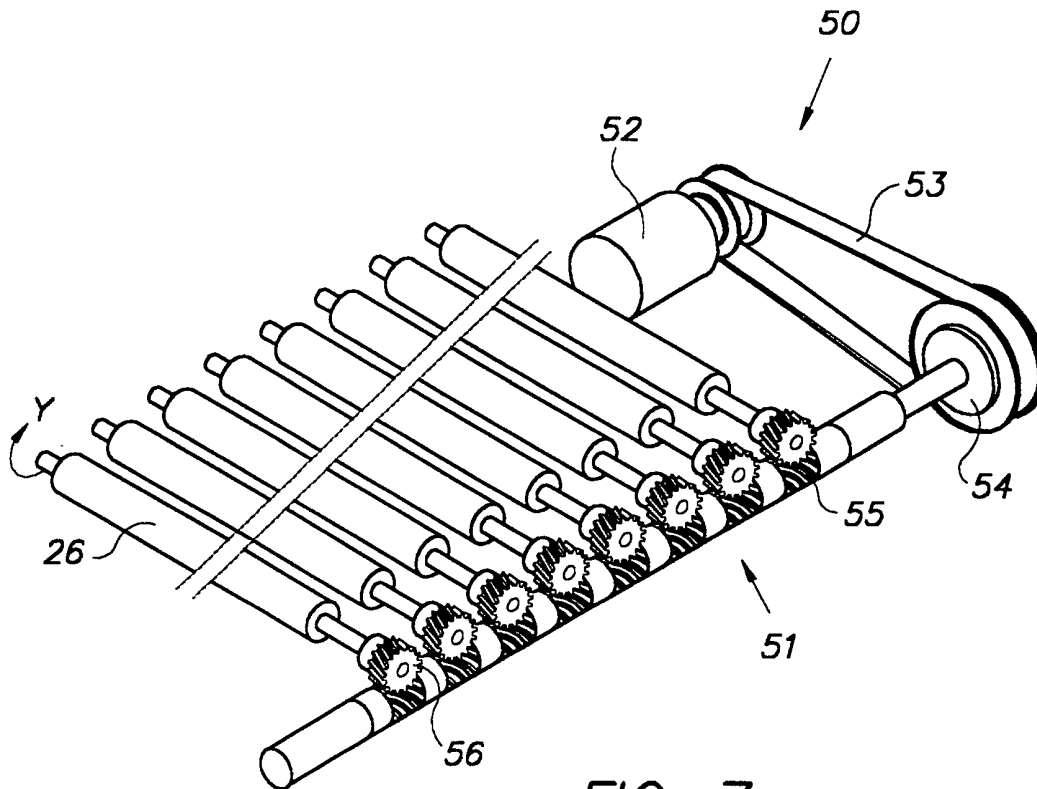


FIG. 7

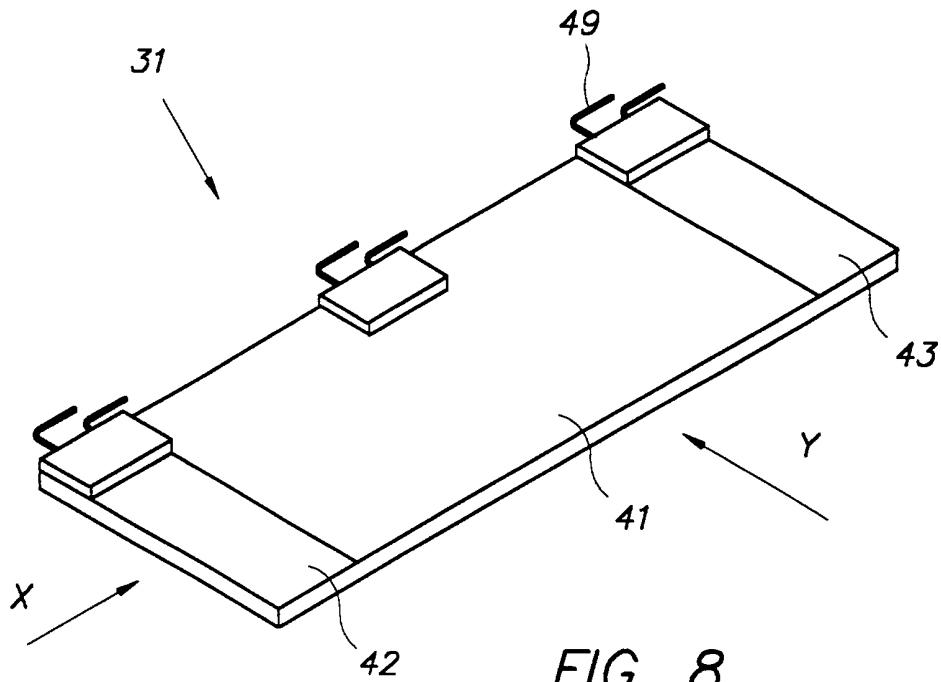


FIG. 8

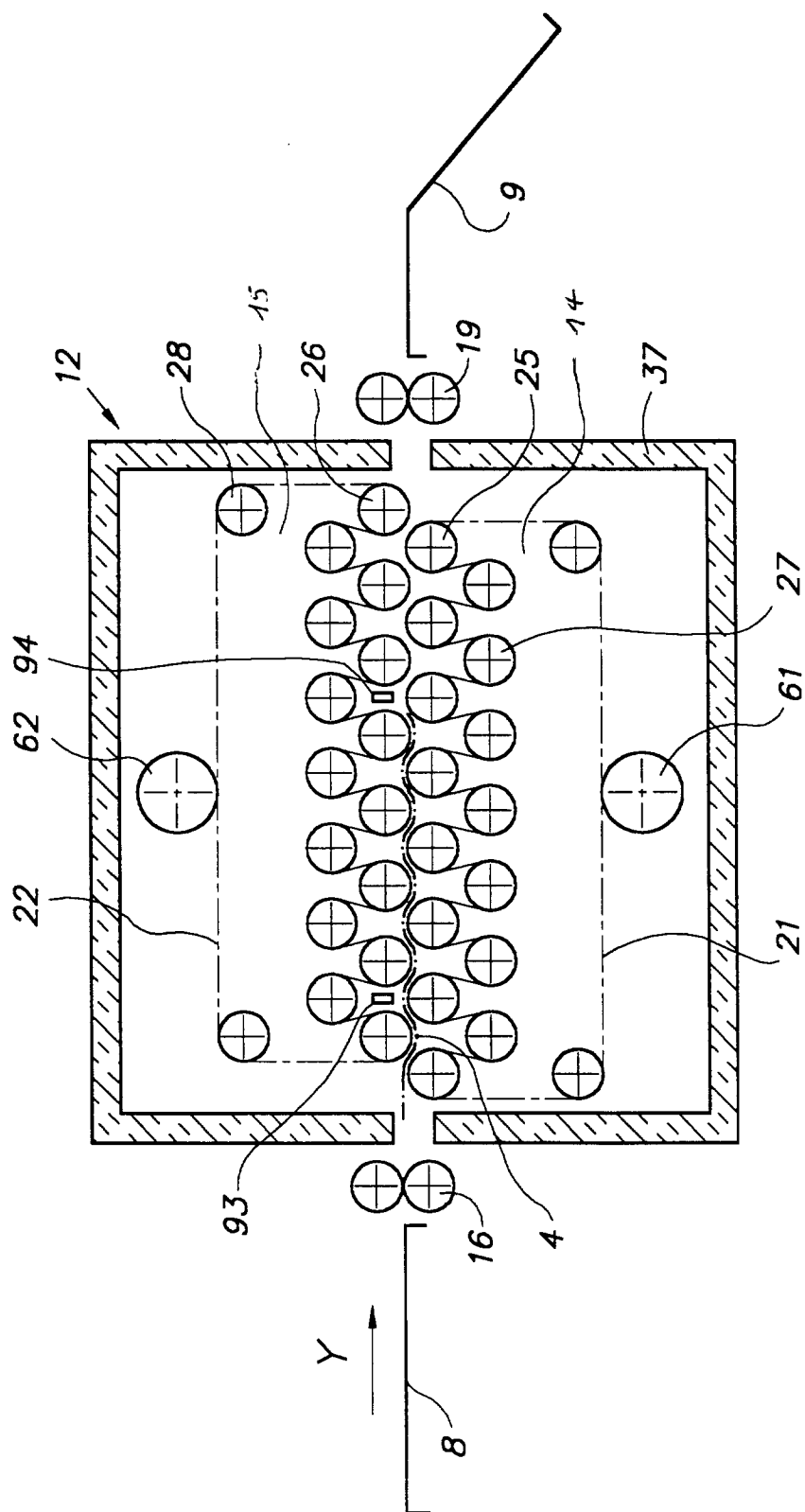


FIG. 9

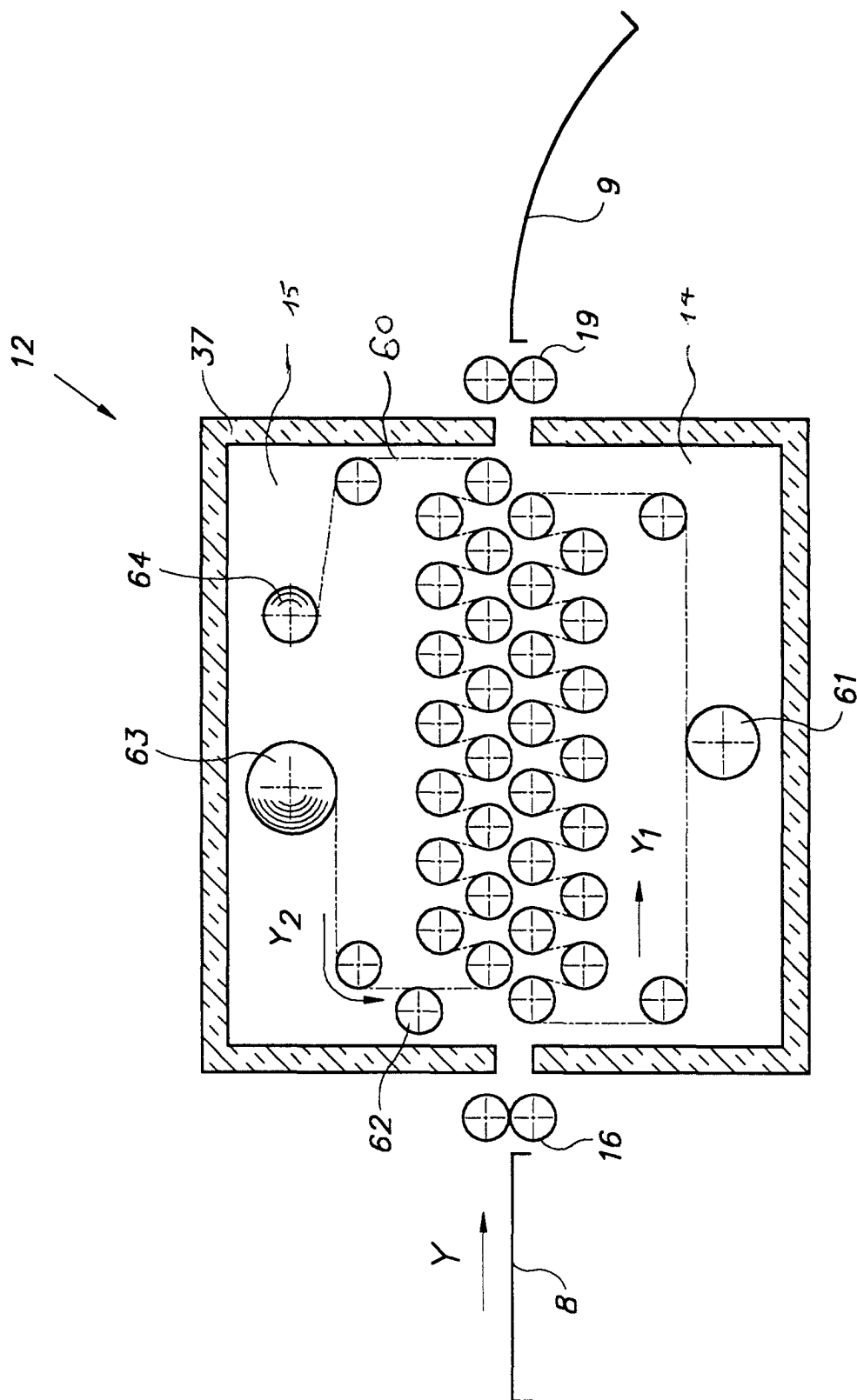
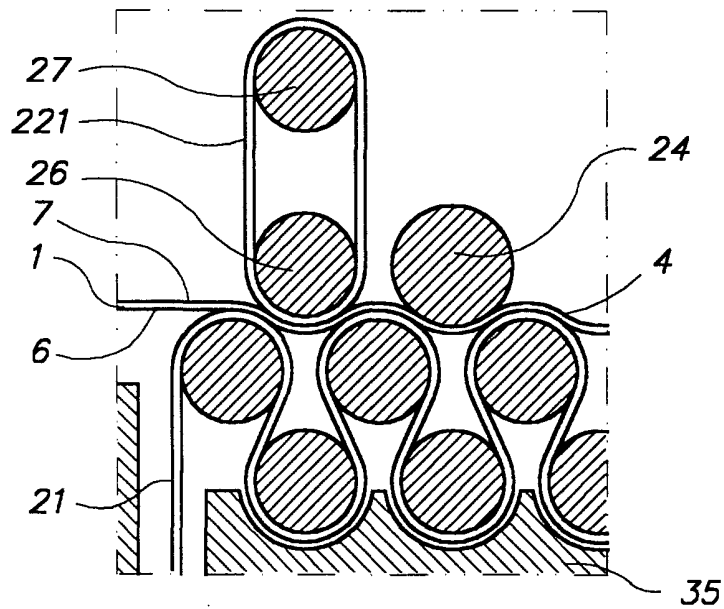
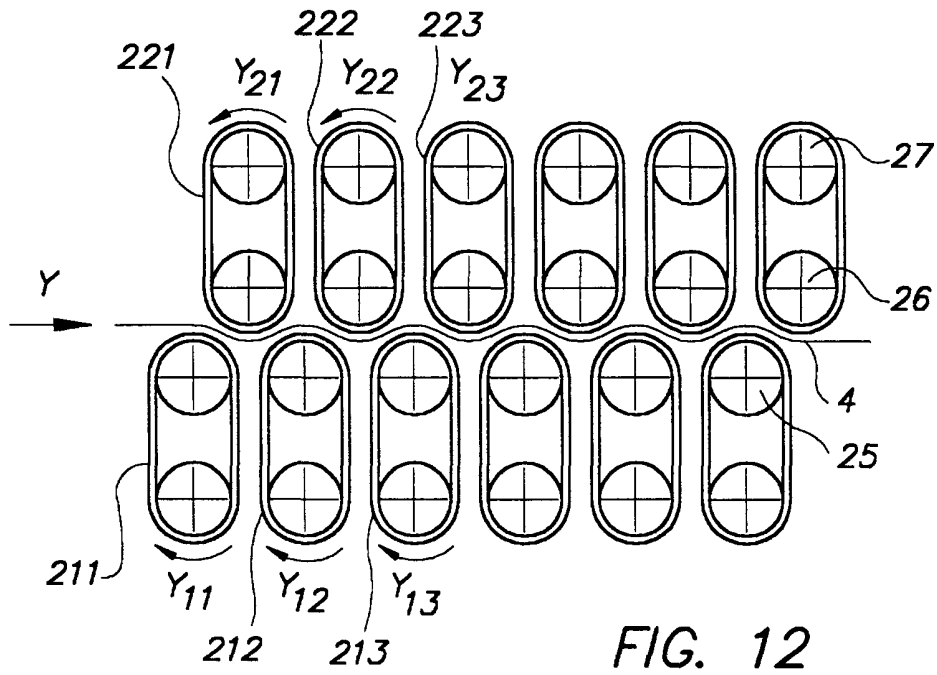


FIG. 11



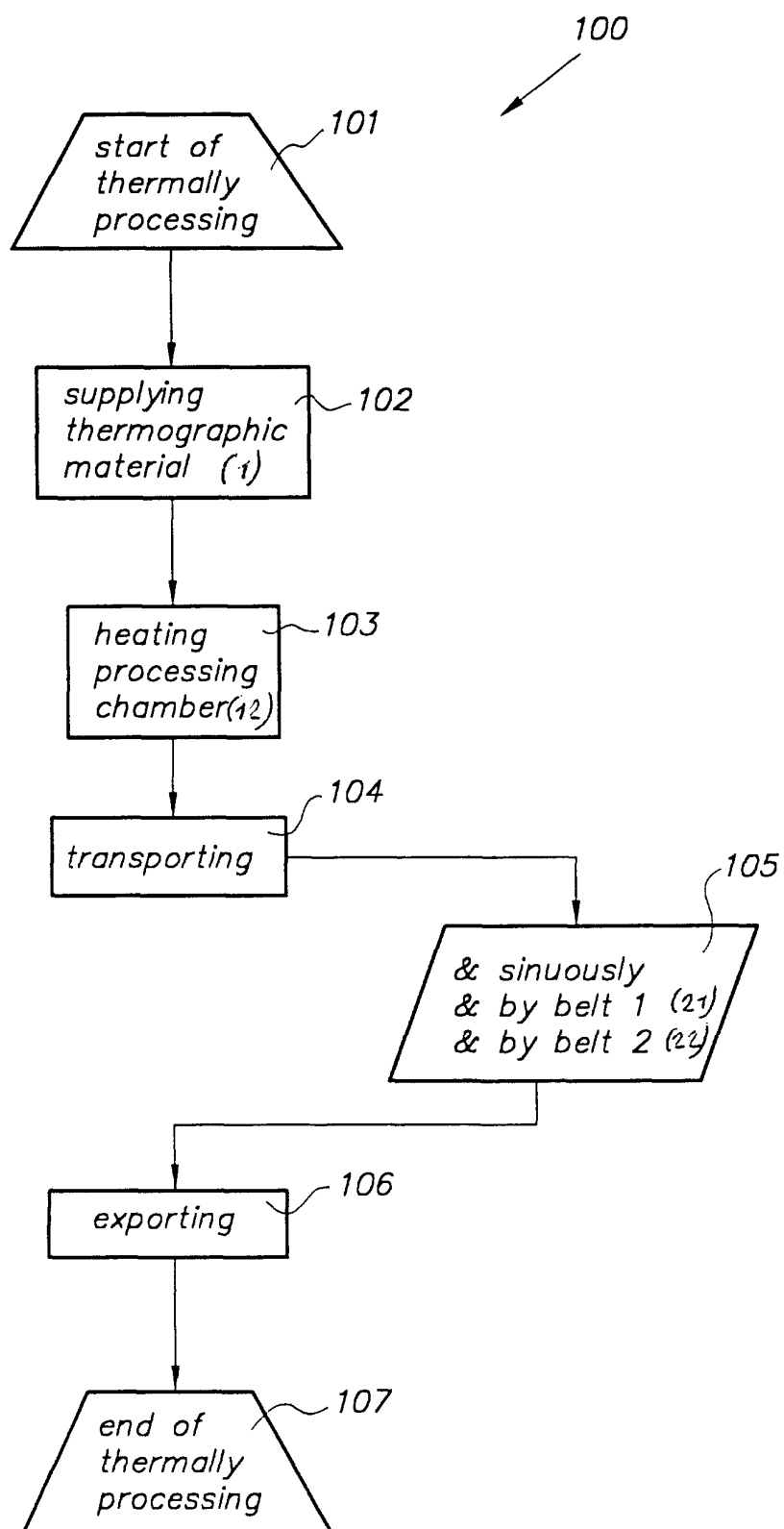


FIG. 14

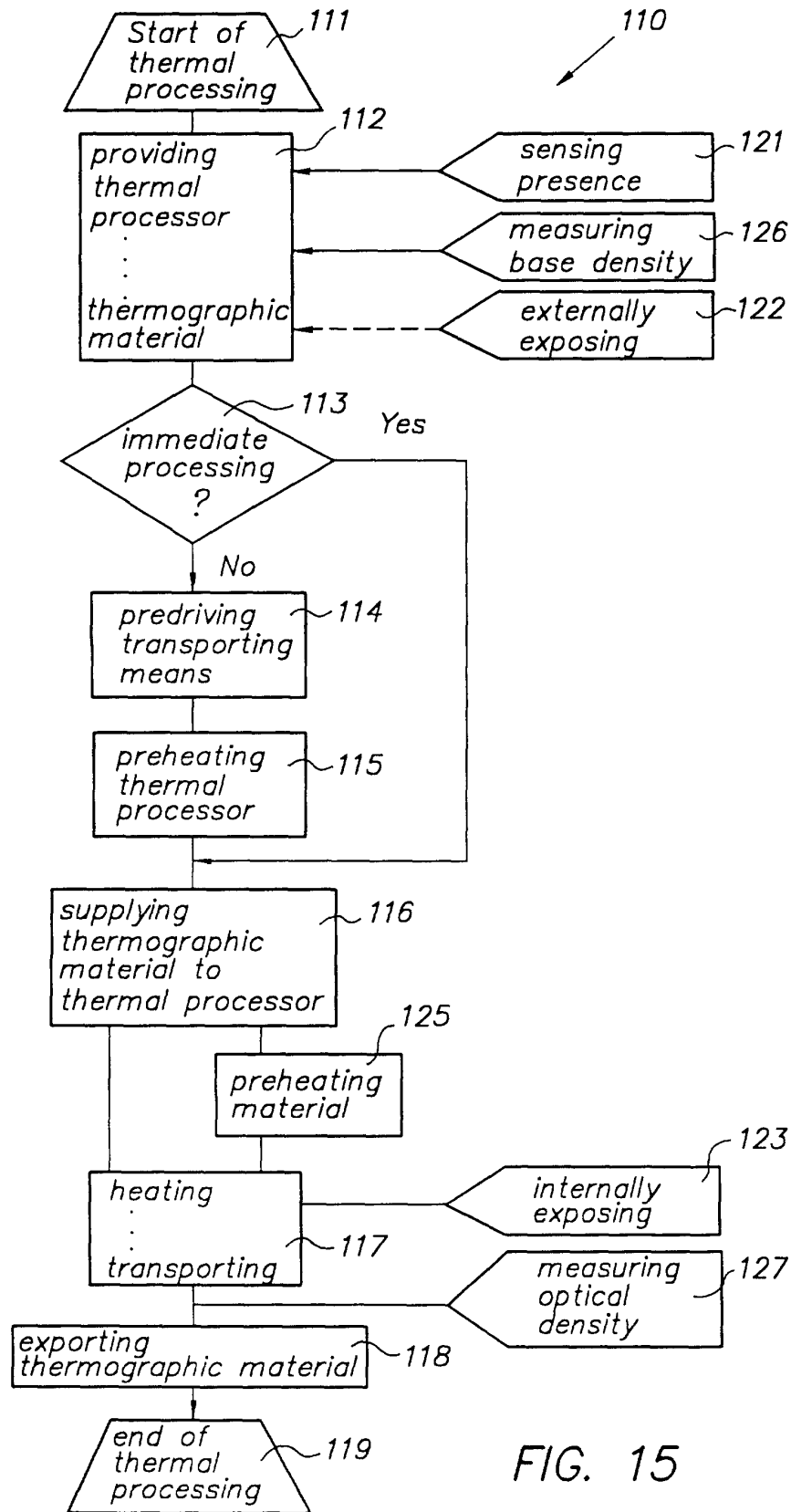
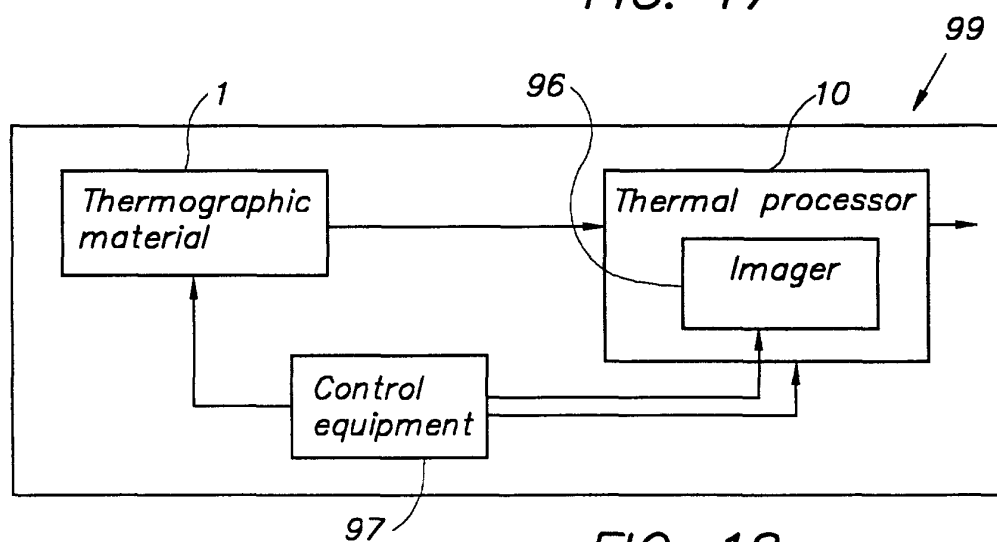
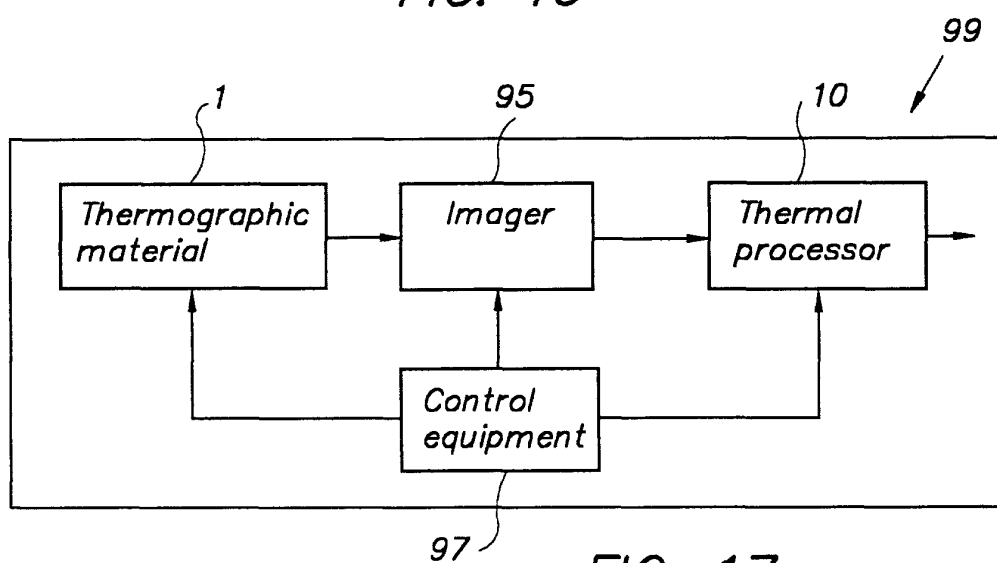
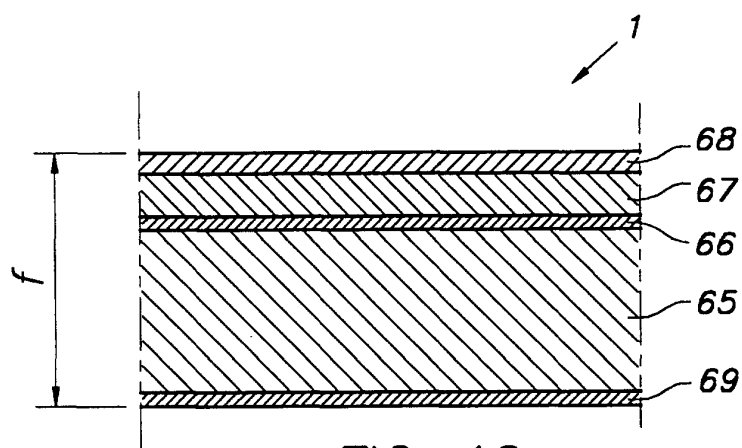


FIG. 15



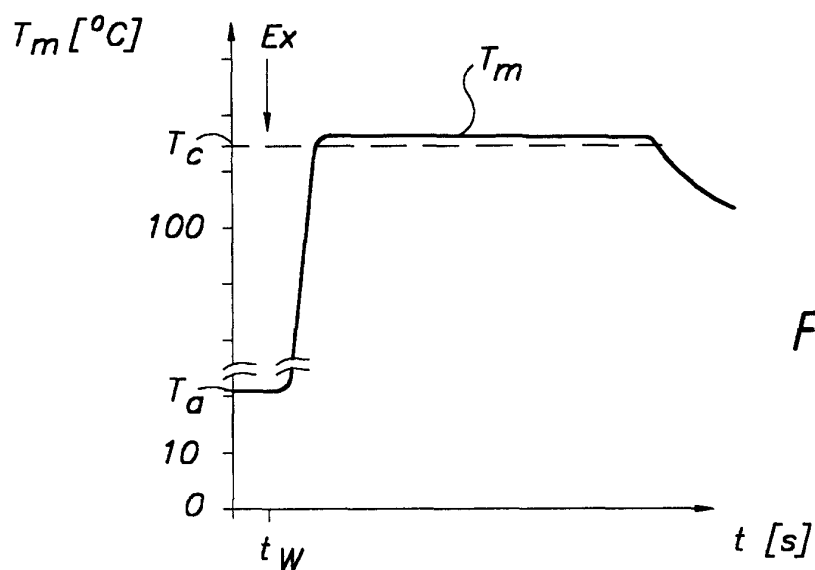


FIG. 19.1

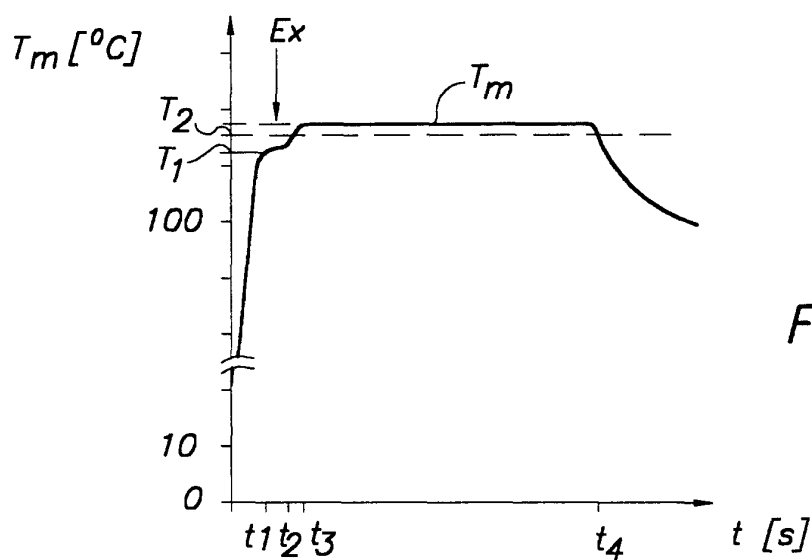


FIG. 19.2

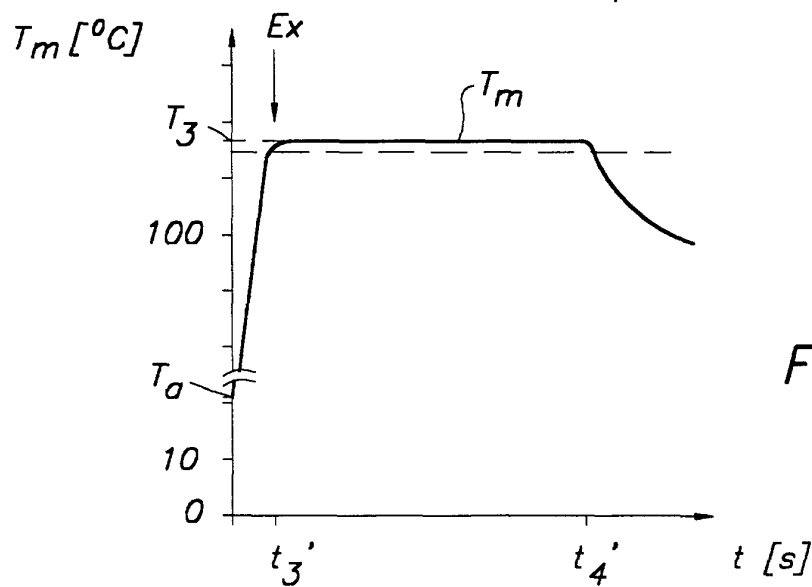


FIG. 19.3

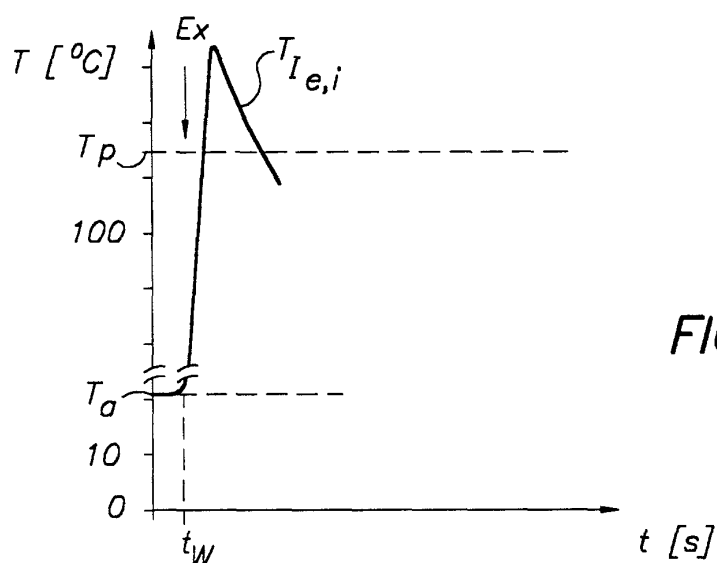


FIG. 20.1

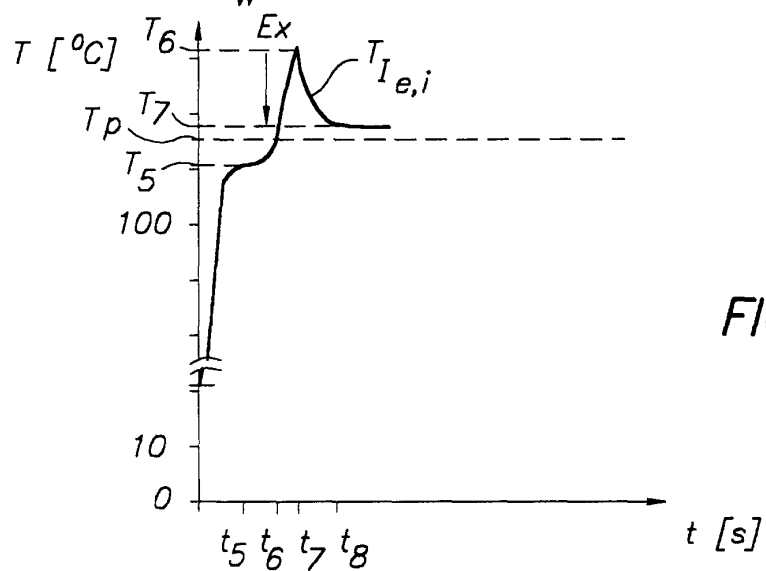


FIG. 20.2

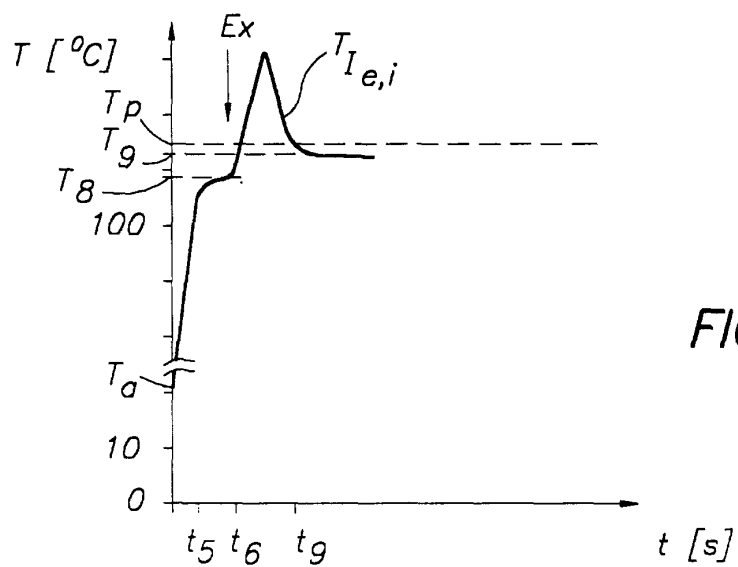


FIG. 20.3

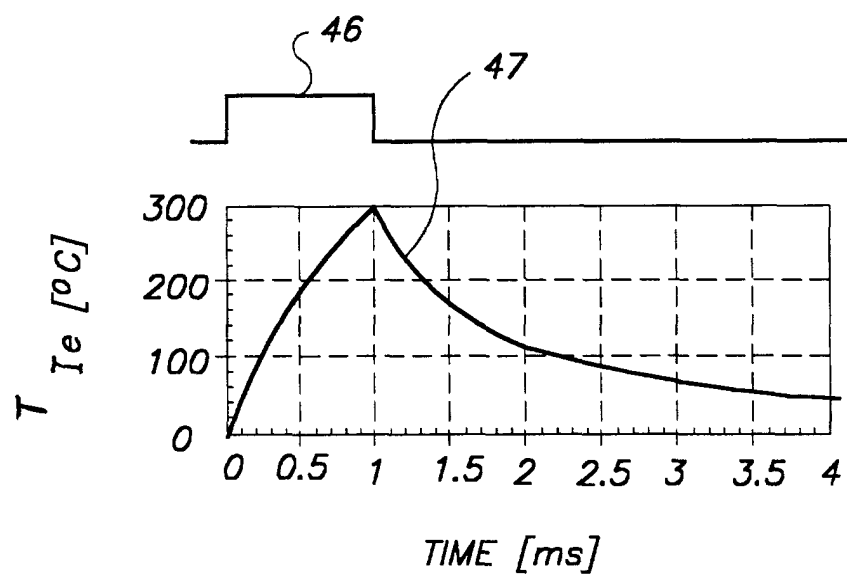


FIG. 21

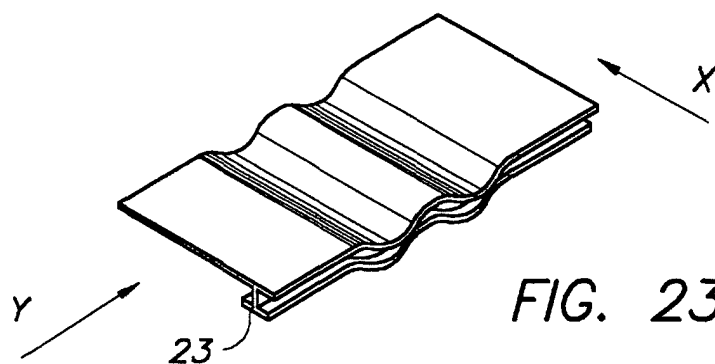


FIG. 23.1

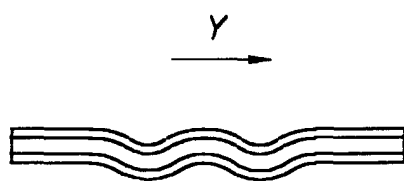


FIG. 23.2

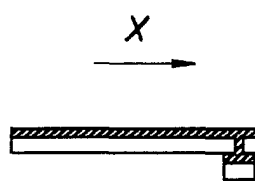


FIG. 23.3

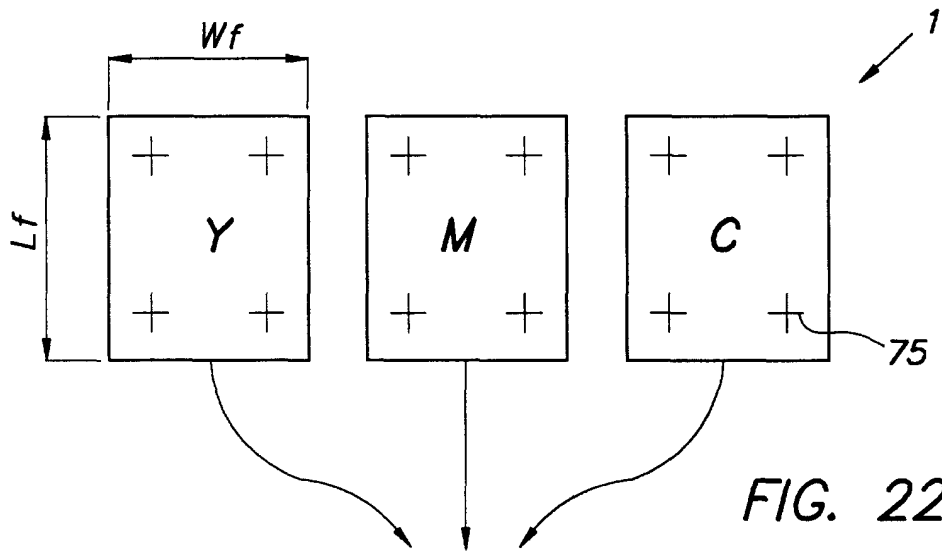


FIG. 22.1

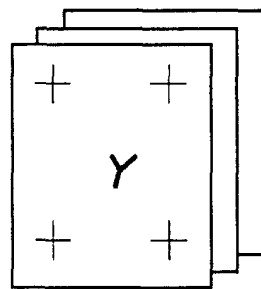


FIG. 22.2

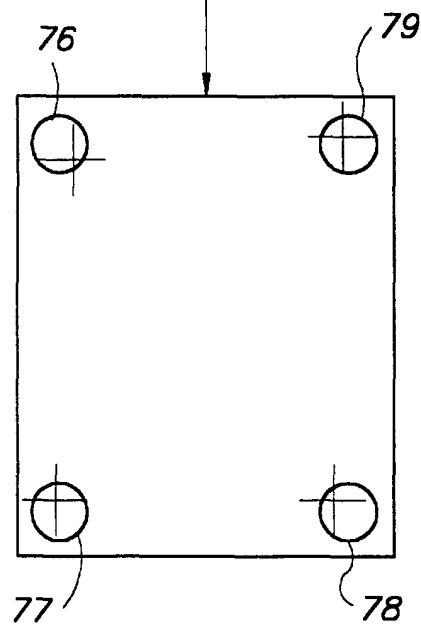


FIG. 22.3

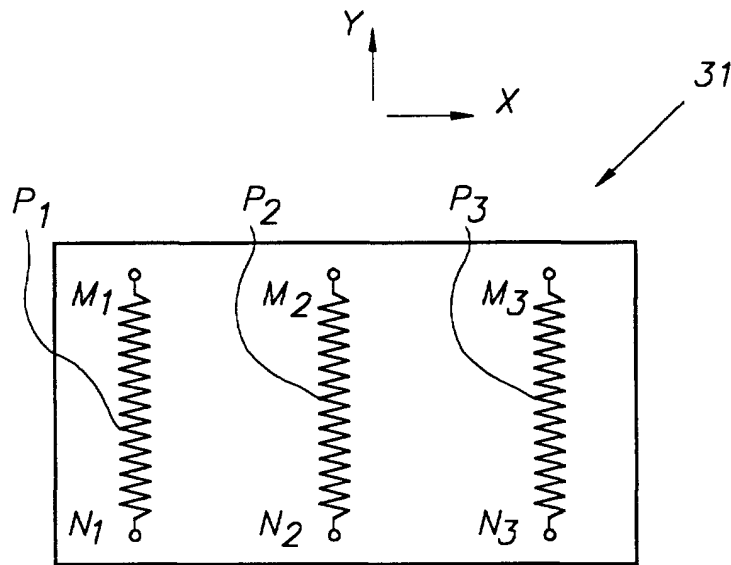


FIG. 24.1

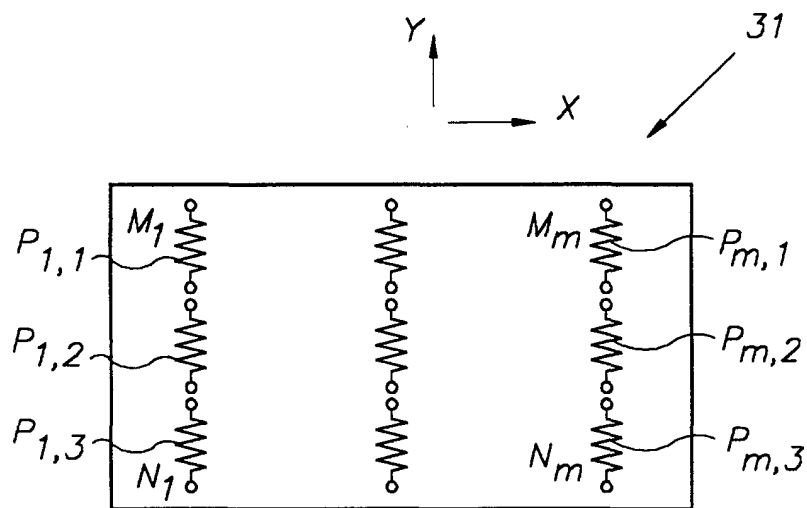


FIG. 24.2

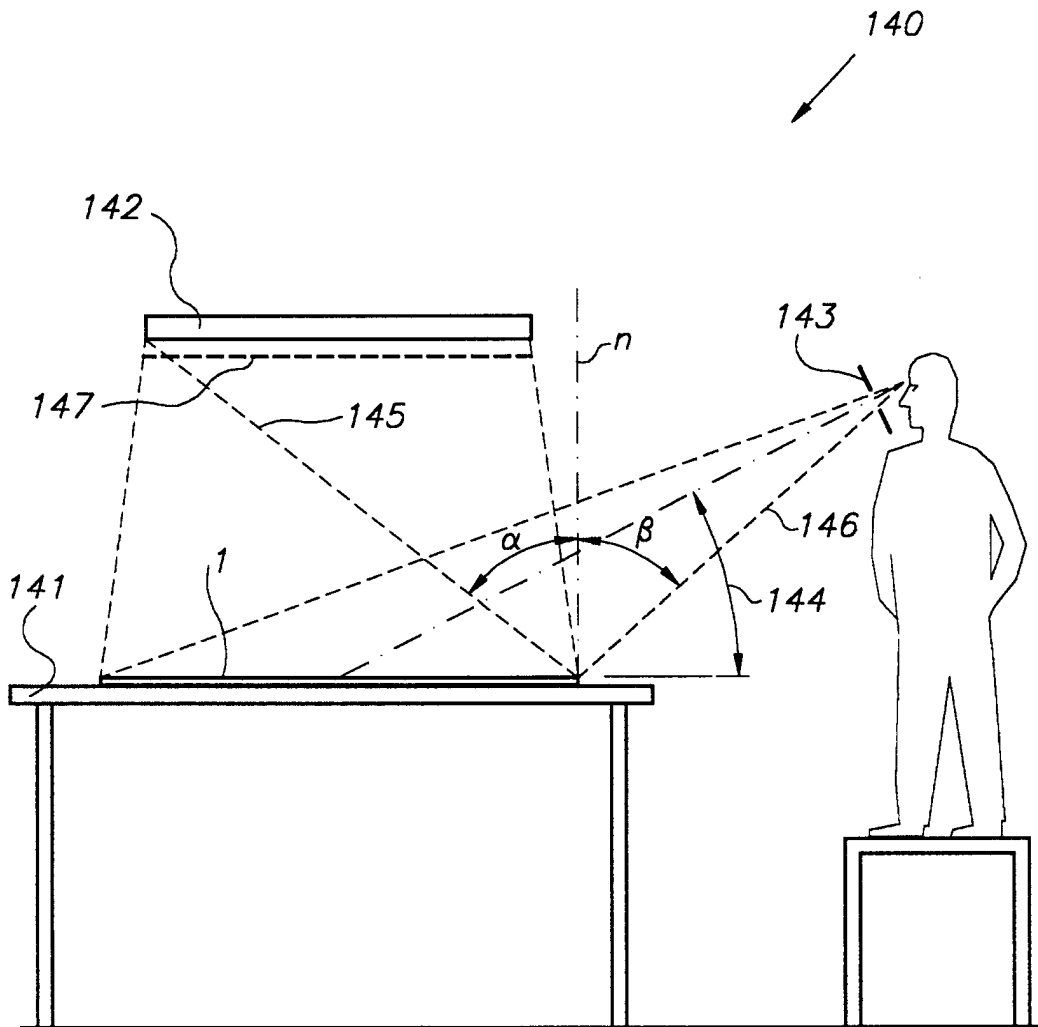
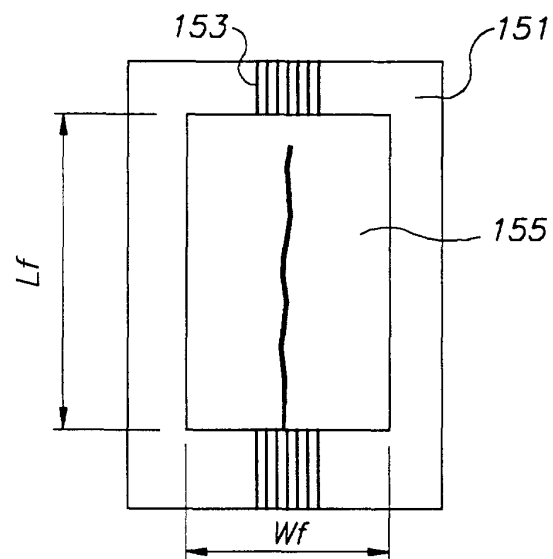
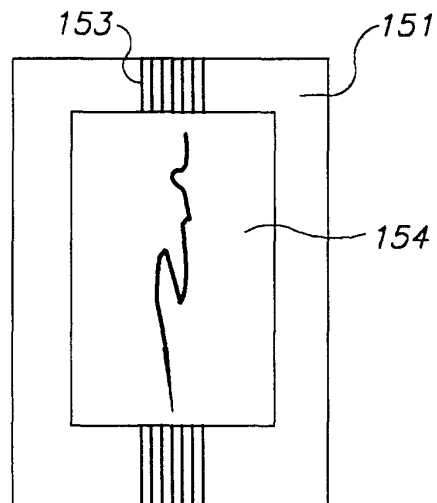
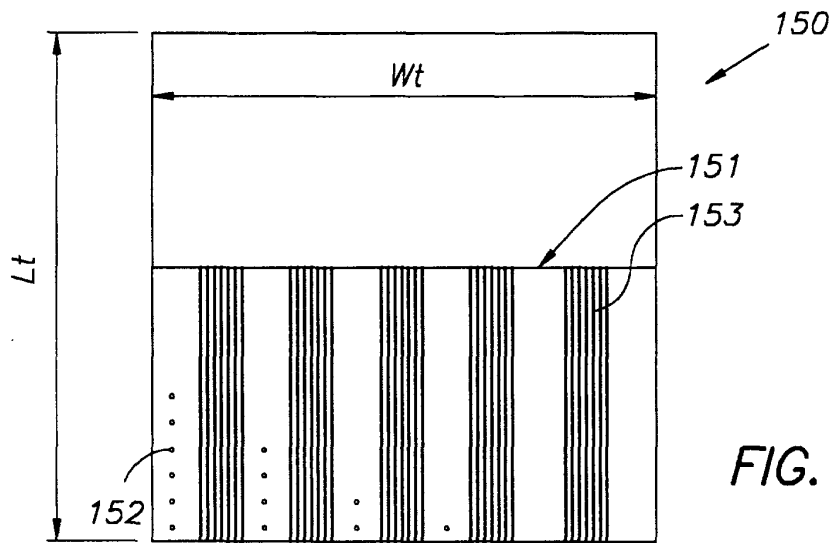


FIG. 25





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 20 2681

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			G03D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		5 January 2001	Boeykens, J
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