

[54] **THERMAL PROCESSOR**

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219/469, 250/65 T

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[58] Field of Search219/216, 388, 469-471;
100/93 P; 250/65 J, 65 ZE; 263/6 E; 118/620

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[57] **ABSTRACT**

A thermal processing device comprises a roller having a metallic core and an outer layer of elastomeric plastic material which permits a sheet or strip of photosensitive material that is to be developed to be held and maintained in intimate contact with a heating element. The heating element comprises a ceramic resistance member which forms a semi-cylindrical shoe about the roller, the latter being maintained in intimate contact with the heating element. With such a structure, it is not necessary to maintain the heating element in a standby condition, because the heating element will be brought to the proper operating temperature so quickly that the sheet or strip of material that is to be processed can be fed into the nip of the heating element and the roller a few seconds after turning on of the electrical energy that is applied to the heating element.

8 Claims, 2 Drawing Figures

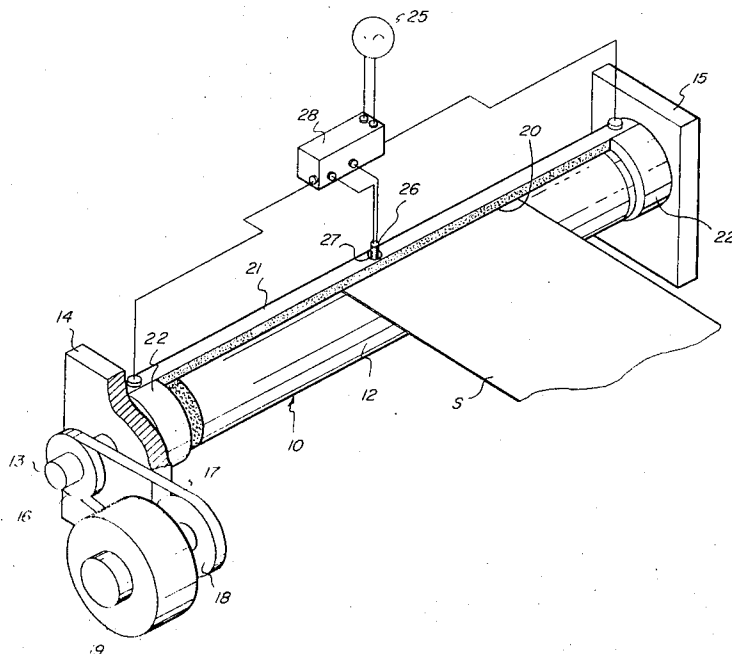


FIG. 1

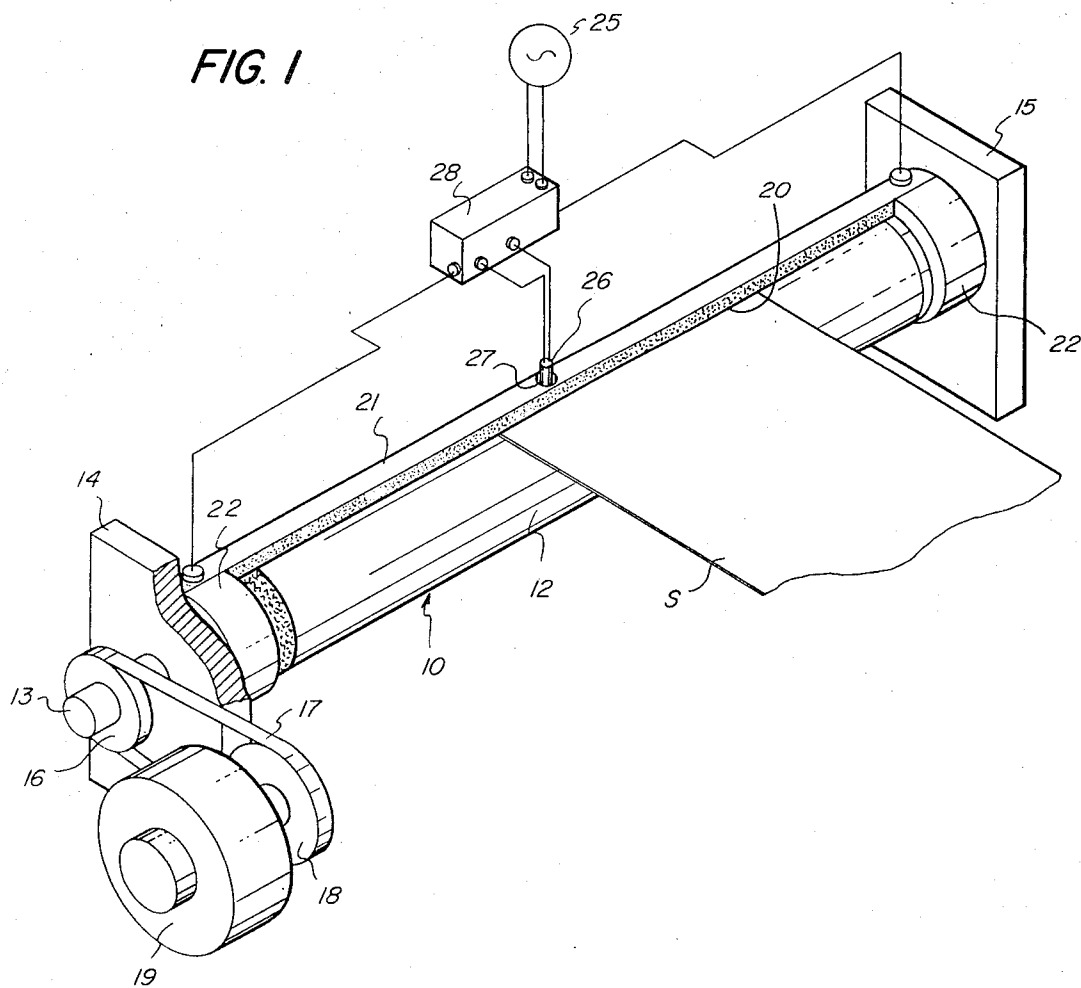
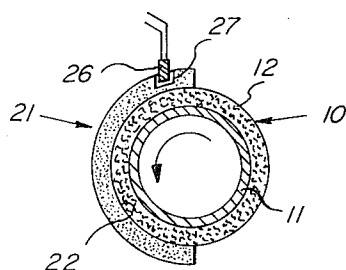


FIG. 2



THERMAL PROCESSOR

FIELD OF THE INVENTION

This invention relates to a device for thermal processing of a photographic image and, more particularly, to a thermal processor in which a latent image on a sheet or strip of photosensitive material can be developed by the application of heat when the sheet or strip is moved between and relative to a heating element and a resilient roller.

DESCRIPTION OF THE PRIOR ART

It is well-known in the photographic industry to develop or process an exposed sheet or strip of photosensitive material with liquid developers to generate a visual image from the latent image carried by such photosensitive material. With the advent of dry, thermal photographic processes, the processing of the photosensitive material requires only heat to convert the latent image on the carrier sheet or strip into a visual image. Normally, such devices for processing the latent image by thermal energy are of necessity rather large and bulky in structure in order to generate the heat required for development. In addition, such devices usually require considerable time to warm up in order to produce heat of a temperature sufficient to develop the latent image. As a result, a considerable amount of energy is dissipated by these devices whether on a standby or actual use condition. It is, therefore, desirable that for a dry, thermal processing system, a device be devised that has a high efficiency of heat transfer and is economical and simple to construct.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a thermal processing device which includes a heating element of low mass in the form of a heating shoe that has very little, if any, thermal lag.

It is another object of the invention to provide a thermal processing device in which substantially no lag is encountered in bringing a heating element to a desired operating temperature at the first point or line of actual application of the heat.

It is still a further object of the invention to provide a thermal processing device in which a heating element operable under a wide selection of voltage-current combinations can be used, thereby eliminating the need for costly controls to generate and maintain such voltage-current combinations.

More particularly, the thermal processing device of this invention comprises a roller having a metallic core and an outer layer of elastomeric plastic material which permits the sheet or strip of photosensitive material that is to be developed to be held and maintained in intimate contact with the heating element. The heating element comprises a ceramic resistance member which forms a semi-cylindrical shoe about the roller, the latter being maintained in intimate contact with the heating element. With such a structure, it is not necessary to maintain the heating element in a standby condition, because the heating element will be brought to the proper operating temperature so quickly that the sheet or strip of material that is to be processed can be fed into the nip of the heating element and the roller a few

seconds after turning on of the electrical energy that is applied to the heating element. It will be appreciated from the description which follows hereafter that the disclosed thermal processing device is one in which the sheet or strip of material is not only processed but is also advanced through the device by the driving relationship which exists between the roller and the heating element.

DESCRIPTION OF THE DRAWING

Reference is now made to the accompanying drawing wherein like reference numerals and characters designate like parts and wherein:

FIG. 1 is a perspective view of a thermal processing device in accordance with the invention; and

FIG. 2 is a vertical section through the device shown in FIG. 1 and showing the relationship of the heating element to the elastomeric plastic layer forming the outer layer of the rotatable drive roller.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawing, a cylindrical roller 10 comprises a metallic core 11, which can be in the form of a tubular member or a solid member, and a layer 12 of an elastomeric plastic material which is carried by the outer peripheral surface of the core. The roller 10 is provided with a bearing extension 13 on each end thereof and is suitably journaled in spaced, side walls 14 and 15 which can be part of the processor structure or housing. One bearing extension 13 extends through its respective side wall, such as wall 14 in FIG. 1, and carries a pulley 16 that is driven by a belt 17 through the medium of a pulley 18 mounted on the shaft of a motor 19. The peripheral surface of the layer 12 is in generally intimate contact with the inner peripheral surface 20 of a heating element generally designated by the numeral 21. The heating element 21 is semi-cylindrical in shape and is formed of a commercially available ceramic resistance material. As shown in FIG. 1, the heating element 21 can be maintained in position relative to the roller 10 by semi-cylindrical sleeves 22, which are of an electrically and heat insulating material.

The layer 12 carried by roller 10 can be of a material, such as soft polyurethane, foam rubber, or a similar material that is generally pliant or resilient and capable of withstanding the necessary operating temperatures. In other words, any pliant or resilient material can be used so long as the material does not lose its elastic properties when subjected to heat. The peripheral surface of this layer of material is arranged relative to the surface 20 of the heating element 21 so as to be in generally intimate contact therewith. A source potential 25, preferably an AC source, is connected across the ends of heating element 21. The temperature of heating element 21 can be monitored by a thermistor 26 that is mounted in a well or recess 27 in the heating element. An AC control unit 28 is interposed between the source of potential 25 and the heating element 21 to control the voltage-current input to heating element 21 as monitored by the thermistor 26. The heating element 21 forms, in effect, a shoe which engages about one-half of the peripheral surface of the layer 12, see FIG. 2.

The speed at which the roller 10 is rotated is dependent on the rate required for processing the photosensitive material. Processing of the sheet or strip of photosensitive material takes place by merely inserting the leading edge of such sheet or strip, designated by the letter S, into the nip between the driven roller 10 and the heating element or shoe 21. The sheet S is thereby moved through the device at the desired rate and in such a manner as to effect thermal processing of the latent image carried thereby. It will be obvious from the description which follows that the processing can be continuous or intermittent. Hence, the reference to a sheet of photosensitive material is meant to include a discrete sheet having one or more latent images, as well as a strip or web of material having a plurality of latent images arranged in any format thereon.

The following example together with the drawing illustrates the actual construction and operation of an embodiment of the device. This example presents and describes an operable arrangement but is not meant to restrict or limit the invention in any way to this particular example.

A hollow, cylindrical, ceramic resistance element 12 inches long and of 1 inch outside diameter, having a resistance of 7.5 ohms, was cut in half lengthwise to form a generally semi-cylindrical heating element or shoe. The ends of this shoe were mounted by means of electrically and thermally insulating sleeves relative to a pair of spaced plates. A roller carrying an outer layer of soft polyurethane was mounted relative to the shoe with the inner surface of the shoe in intimate contact with the polyurethane layer of the roller. The roller was coupled to a small motor and the ends of the heating element or shoe were connected to a 117 volt source of AC potential. An infrared thermometer was used to monitor the shoe temperature and when the source of potential was applied to the shoe, the temperature reached the desired operating level of about 140°C in approximately 5 to 10 seconds. This represents substantially no lag in that a time of 1 to 3 minutes has been previously required. The voltage was then reduced to 12 volts to maintain the desired temperature. The roller was rotated at a linear surface speed of ½ inch per second. An exposed sheet of photosensitive material, that is developable by heat, was inserted into the nip formed by the shoe and the polyurethane roller. The sheet was drawn into the device and moved relative to the shoe in thermally conductive contact therewith. The sheet was fully processed and showed a measured density (D-max) of 1.2.

The performance of the device was improved significantly by the use of a thermistor secured to the back surface of the heating element and connected to an AC power control. With this arrangement, it was possible to automatically control the amount of power delivered to the heating element which responded immediately to changes in heat demand as a result of insertion of a relatively cool sheet of material into the nip of the heating element and roller. Very little variation in temperature was noted ($\pm 1^\circ\text{C}$) as the control unit cycled, and no appreciable change in temperature could be detected as a result of insertion of the relatively cold sheet. It was determined that a quicker response could be obtained without a temperature "overshoot" by mounting the thermistor in a recess or hole in the heat-

ing element and suitably electrically insulated therefrom. From a cold start only 10 seconds were required for placing the device in an operating condition.

The temperature coefficient of the ceramic-resistive material was intentionally kept low ($\pm 0.05\%/^\circ\text{C}$) for effective use in this application. However, positive temperature coefficient resistors with temperature coefficients as high as $7\%/^\circ\text{C}$ at 135°C are commercially available. With such a resistance, no thermistor or AC control device would be necessary because at a transition temperature of $135^\circ\text{--}145^\circ\text{C}$, the resistance would suddenly increase ideally to the value needed to maintain the desired current through the resistor to maintain a processing temperature of 140°C .

This invention has been described in detail with particular reference to a preferred embodiment thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

We claim:

1. An electrical, thermal device for processing a sheet of material bearing one or more latent images, comprising:

a roller having a cylindrical core and an outer layer of elastomeric plastic material carried by said core;

a ceramic, resistive heating element extending axially of said roller and having a surface thereof contiguous to at least a portion of the peripheral surface of said outer layer;

a source of potential connected to said element for generating heat; and

drive means coupled to said roller for moving said sheet of material at a predetermined continuous rate in thermally conductive contact with said element so that the latter effectively heats said sheet of material.

2. An electrical, thermal device in accordance with claim 1 wherein said outer layer comprises polyurethane.

3. An electrical, thermal device in accordance with claim 1 wherein said outer layer is an electrically resistive foam rubber.

4. An electrical, thermal device in accordance with claim 1 wherein said outer layer is a soft electrically resistive rubber.

5. An electrical, thermal device in accordance with claim 1 wherein the surface of said heating element is contiguous to at least 180° of the peripheral surface of said outer layer.

6. An electrical, thermal device in accordance with claim 1 wherein the cross section of said heating element is generally an annulus sector.

7. An electrical, thermal device in accordance with claim 1 wherein said heating element is semi-tubular and the inner surface thereof is contiguous to said outer layer.

8. An electrical, thermal device for processing a sheet of material bearing at least one latent image, comprising:

a roller having a cylindrical core and an outer layer of polyurethane carried thereby;

a generally semi-tubular ceramic electrically resistive heating element, the inner surface of which is

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generally contiguous to the peripheral surface of
said outer layer;
a source of potential connected to said heating ele-
ment for generating heat; and
drive means coupled to said roller for moving said 5

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sheet of material at a predetermined rate in ther-
mally conductive contact with said heating ele-
ment so that the latter effectively heats said sheet
of material thereby developing said latent image.

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