United States Patent [19]

Quant et al.

[11] **3,833,790**

[45] **Sept. 3, 1974**

[54] **HEATED PRESSURE FUSING SYSTEM**

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[73] Assignee: **Xerox Corporation**, Stamford, Conn.

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[21] Appl. No.: **376,770**

[52] **U.S. Cl.** **219/216**, 219/470, 219/471

[51] **Int. Cl.** **H05b 1/00**

[58] **Field of Search** .... 219/216, 388, 469–471, 219/501, 504, 505, 243, 244; 100/93 RP; 355/9, 12

[56] **References Cited**

UNITED STATES PATENTS

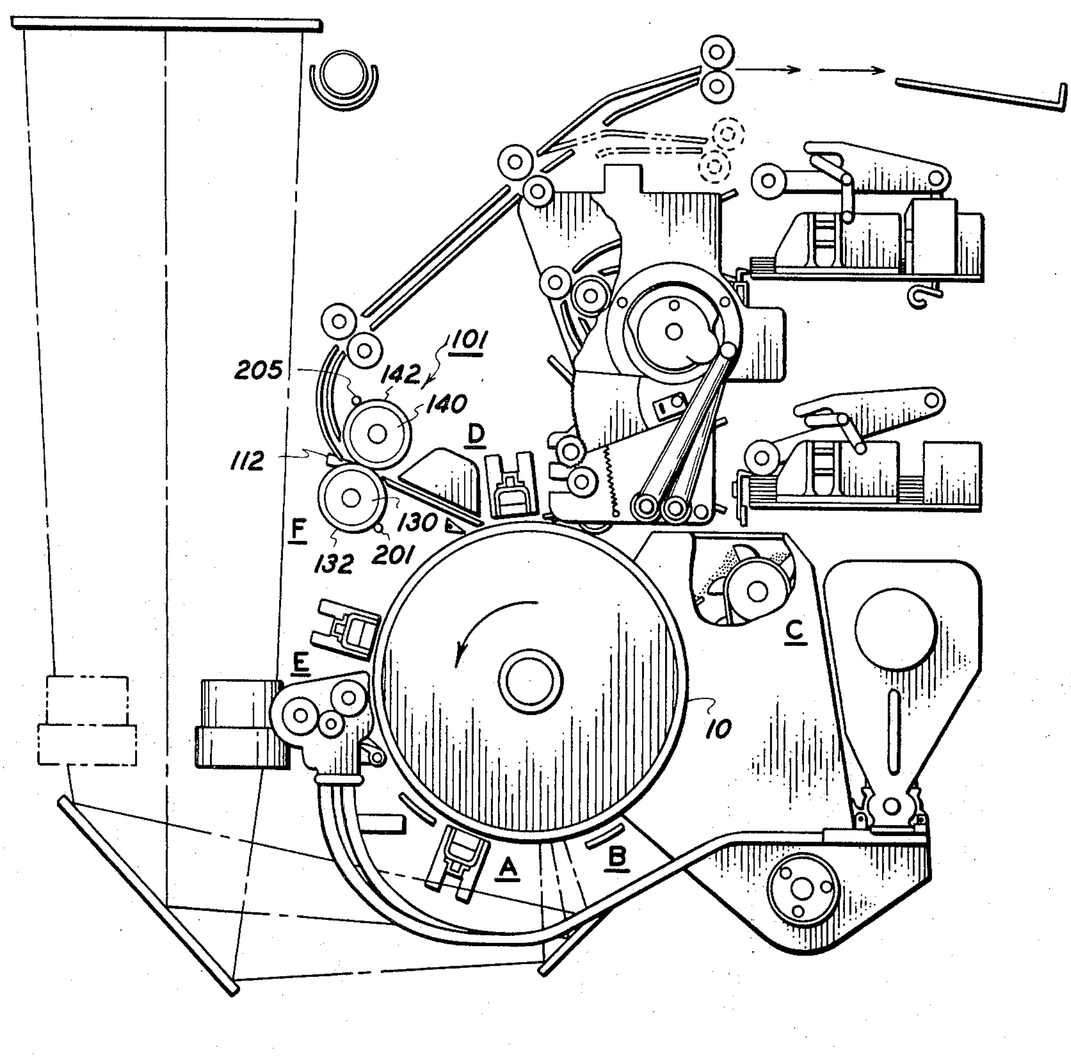
3,027,285	3/1962	Eisner et al.	219/470 X
3,074,695	1/1963	Hold et al.	219/244 X
3,584,291	6/1971	Budniak	219/501 X

Primary Examiner—C. L. Albritton

[57] **ABSTRACT**

An improved control for maintaining a substantially constant temperature at the contact arc or nip defined by pressure heated fusing rolls. A sensing device senses the surface temperature of each of the rools and supplies signals to a control circuit which combines the signals in a parallel resistance network. An output signal is supplied to electrical heating elements associated with at least one of the rolls to maintain a constant temperature at the nip.

4 Claims, 4 Drawing Figures



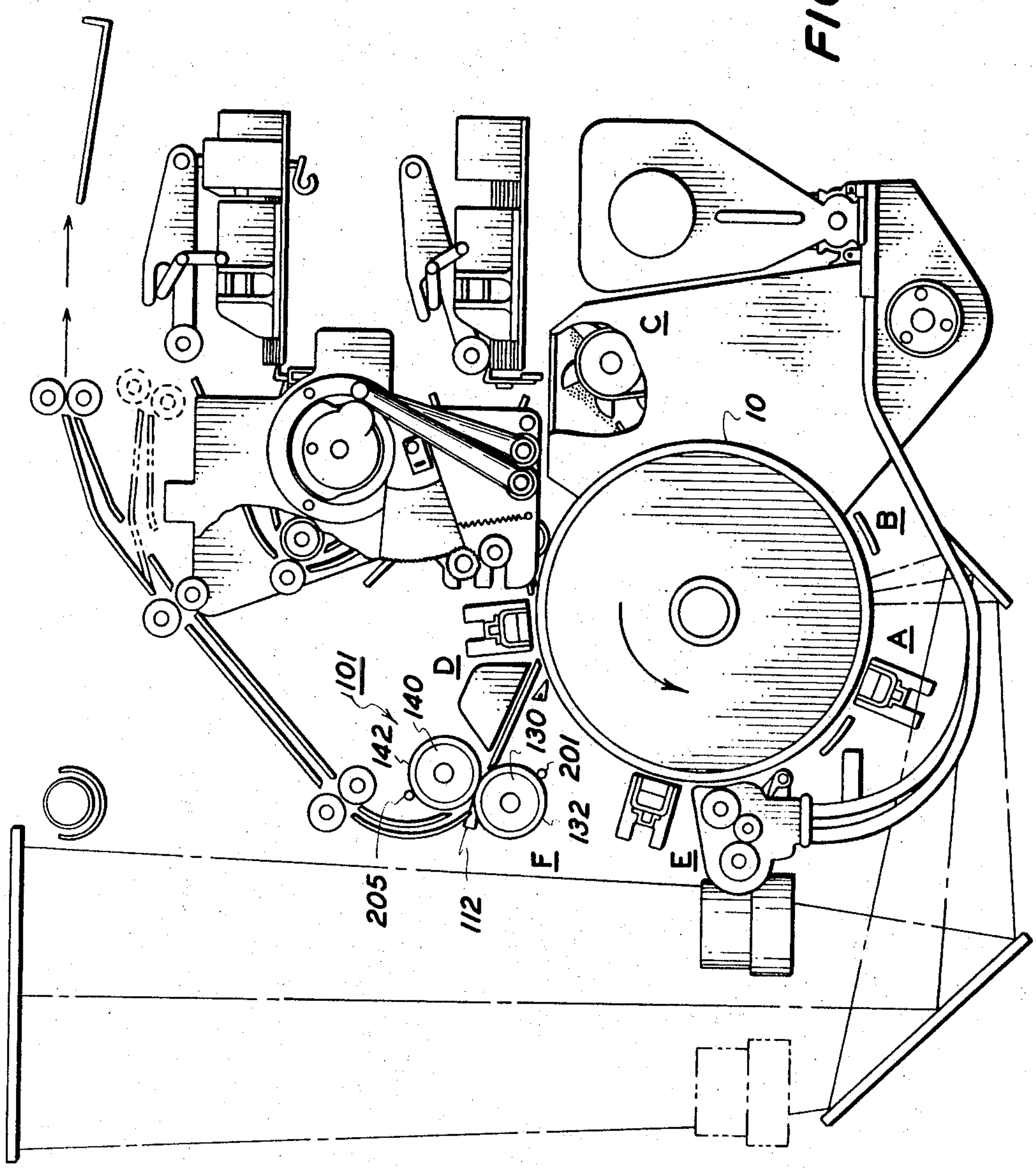
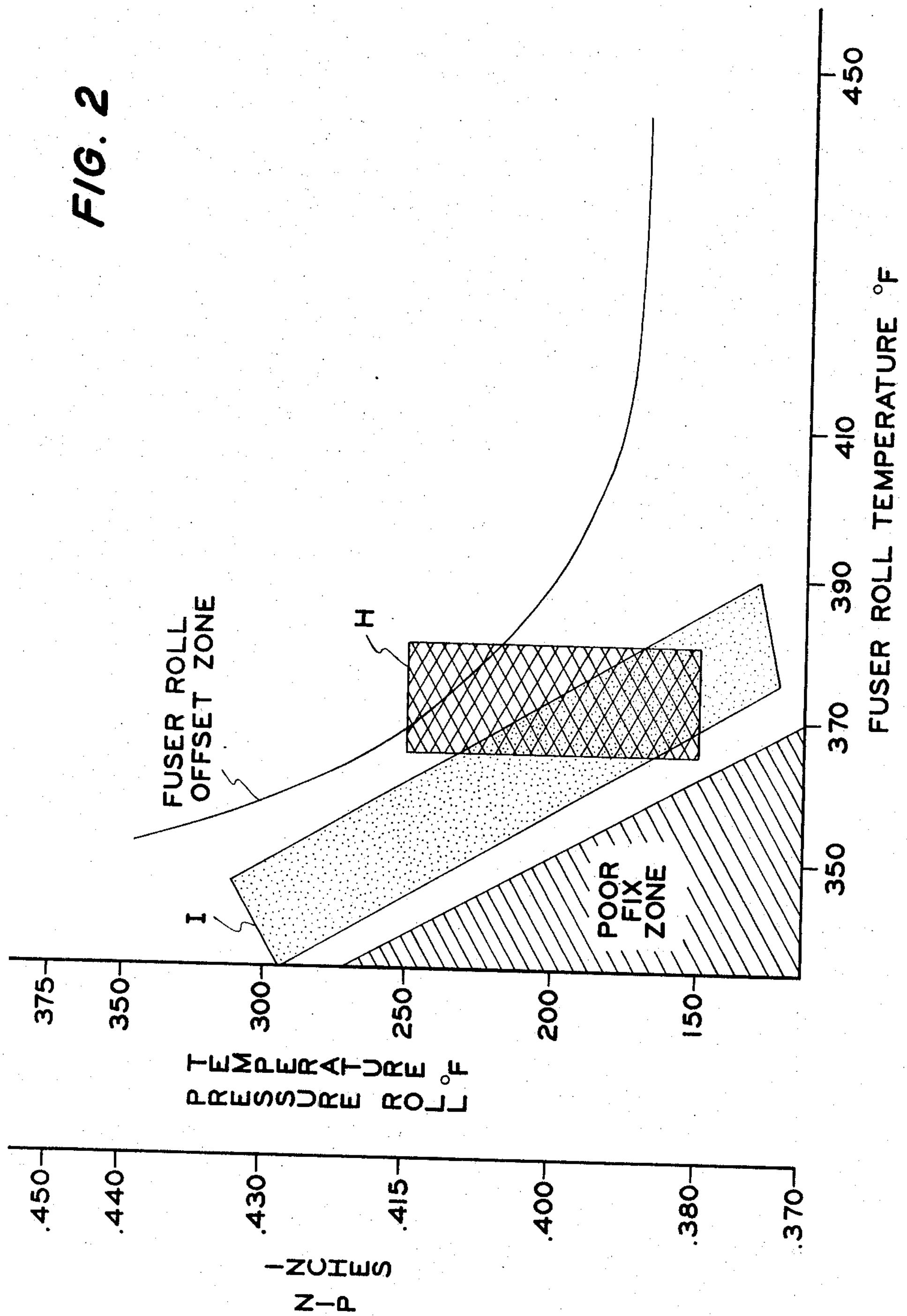


FIG. 1

FIG. 2


FUSER ROLL OFFSET ZONE
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POOR FIX ZONE
FUSER ROLL TEMPERATURE °F
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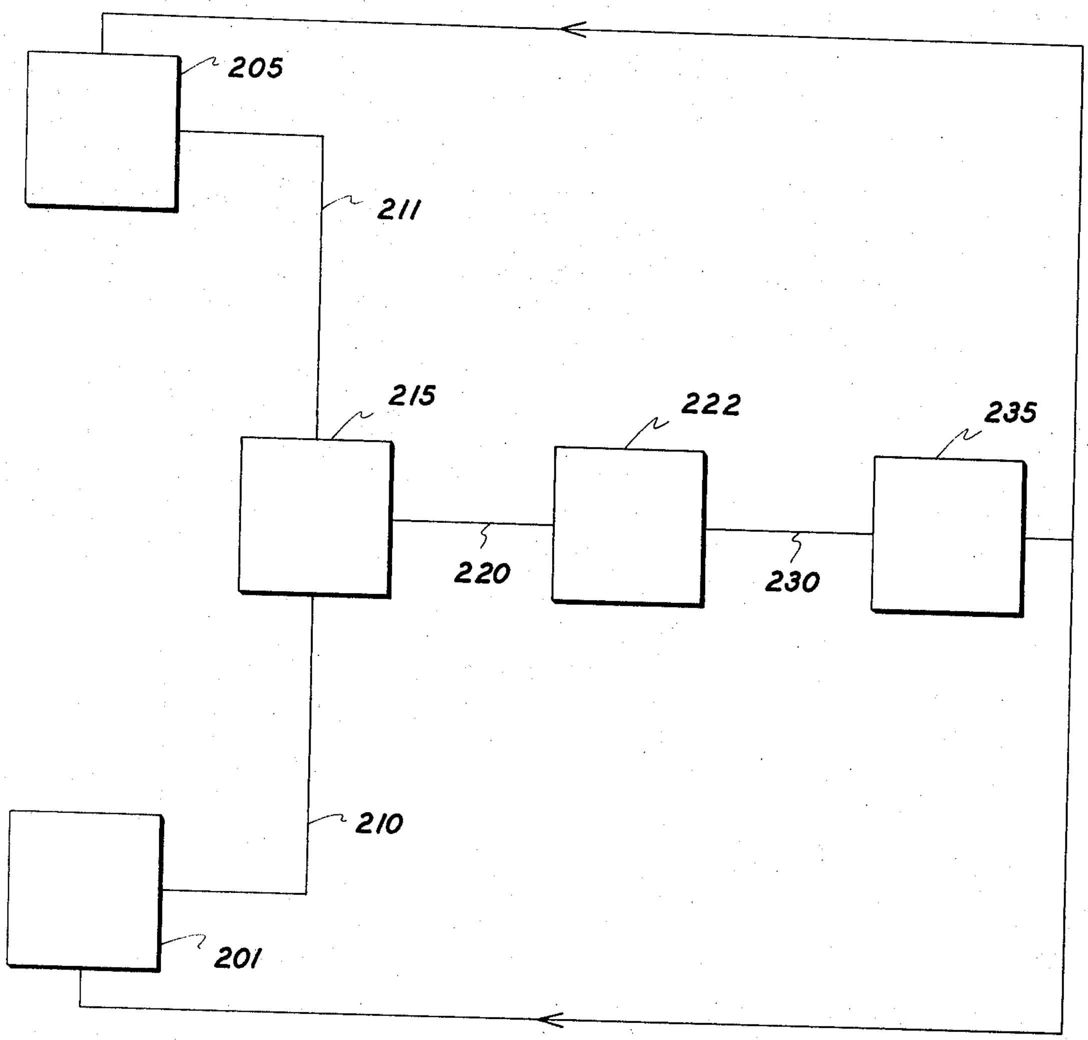

FIG. 3

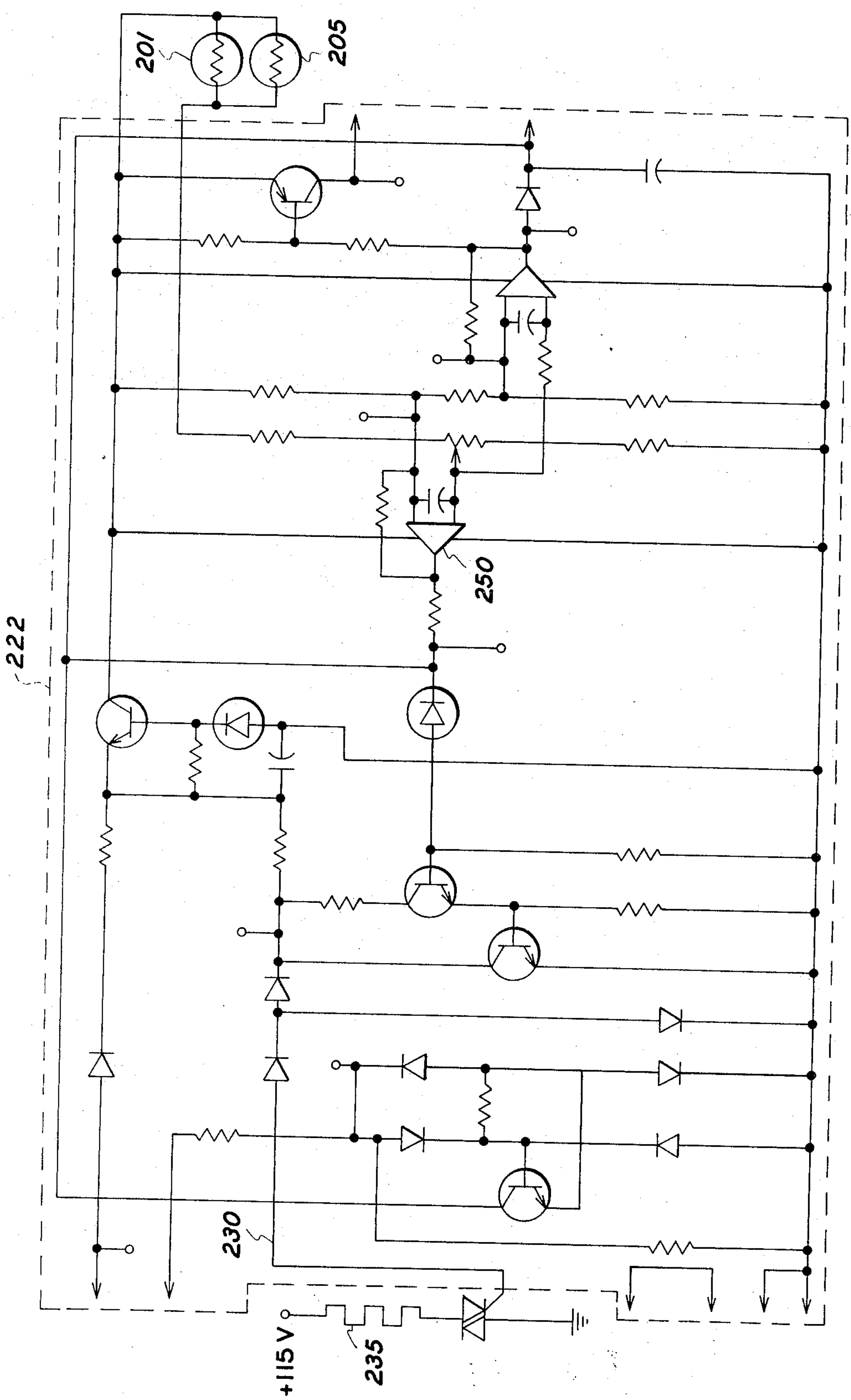

FIG. 4

HEATED PRESSURE FUSING SYSTEM

This invention relates to an improved heated pressure fusing system for use with an electrostatographic reproduction system and in particular to a closed loop control circuit for maintaining constant temperature at the fusing nip under varying operating conditions.

It has been recognized that one of the preferred ways for fusing a powder image to a substrate is to bring the powder into direct contact with a hot surface, such as a heated roller. The roller surface may be dry, i.e. no application of a liquid release agent to the surface of that roller as described for example, in U.S. Pat. Nos. 3,498,596 and 3,666,247. Alternatively, the fuser roll surface may be coated with a release agent such as silicone oil as described in U.S. Pat. Nos. 3,268,351 and 3,256,002. Heated pressure fusing systems are particularly well suited for high speed and volume copier/duplicator systems. It has been found, however, that higher temperatures and energy losses occur under varying operating conditions which include changes in ambient conditions, different copy volumes and/or speeds, varying sheet weights, etc. As a result of these higher temperatures the sheets tend to curl and stick to the roll surfaces which is undesirable from the standpoint of sheet handling and stripper finger wear on the roll surface due to excessive paper forces.

In the prior art devices only a single sensing device has been used to detect temperature at or near the nip as described for example, in U.S. Pat. Nos. 3,688,082 and 3,313,913 and British Pat. No. 1,316,616. While these devices are satisfactory in a sense, they have certain disadvantages as already mentioned above.

The present invention is an improved heated pressure fusing system which enables a constant temperature to be maintained at the fusing nip under varying load conditions.

It is therefore the principal object of the present invention to improve heated pressure fusing systems.

It is a further object of the present invention to maintain a constant temperature at the fusing nip of a heated pressure fusing system.

It is a further object of the invention to enable a closed loop control circuit to control the heat to the nip of a heated pressure fusing system.

It is a further object of the invention to regulate the temperature of a fusing nip so that it is sufficiently high to produce high quality prints and sufficiently low to minimize offset.

It is a further object of the present invention to minimize curl of copy sheets having images fixed and to the nip of heated pressure fusing rolls.

It is a further object of the present invention to conserve energy supplied to the heated element applied to heat pressure fusing systems.

It is a further object of the invention to minimize wear on stripper fingers used to strip sheets from fuser roll surfaces.

It is a further object of the present invention to maintain control temperatures at the nip of heated pressure fusing rolls regardless of varying ambient conditions, copying volume and/or speed, and sheet stock.

FIG. 1 illustrates schematically a xerographic reproducing apparatus incorporating a heated pressure fuser roll apparatus constructed in accordance with the present invention;

FIG. 2 is a graphic illustration illustrating fusing temperatures and their effect on offset and fusing quality;

FIG. 3 is a block diagram illustrating details of the present invention; and

FIG. 4 is a circuit diagram according to the present invention.

Referring now to the drawings there is shown in FIG. 1 an embodiment of the fusing system of the subject invention in a suitable environment such as an automatic xerographic reproducing machine. The automatic xerographic reproducing machine includes a xerographic plate or surface **10** formed in the shape of a drum. The plate has a photoconductive layer or light receiving surface on a conductive backing, journaled in a frame to rotate in the direction indicated by the arrow. The rotation will casue the plate surface to sequentially pass a series of xerographic processing stations. For the purpose of the present disclosure the several xerographic processing stations in the path of movement of the plate surface may be described functionally as follows:

A charging station A, at which a uniform electrostatic charge is deposited on the photoconductive plate;

An exposure station B, at which light or a radiation pattern of copies to be reproduced is projected onto the plate surface to dissipate the charge in the exposed areas thereof to thereby form a latent electrostatic image of the copy to be reproduced;

A developing station C, at which xerographic developing material, including toner particles having an electrostatic charge opposite that of the latent electrostatic image, is cascaded over the latent electrostatic image to form a toner powder image in configuration of the copy being reproduced;

A transfer station D at which the toner powder image is electrostatically transferred from the plate surface to a transfer material or a support surface;

A drum cleaning and discharge station E at which the plate surface is wiped to remove residual toner particles remaining thereon after image transfer and at which the plate is exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon; and

A fusing station F at which the powder image is permanently affixed to the support material to produce a high quality print with a minimum of offset in accordance with the invention as will be explained more fully hereinafter.

Referring now to FIG. 2 there is shown a graphic display illustrating fuser roll temperature on a horizontal axis and pressure or backup roll temperature on a vertical axis. It will be appreciated that when the temperature is in the range of over 370°F for the fuser roll and over 250°F for the backup or pressure roll there is difficulty in avoiding offset on the rolls. Also where temperatures are low, for example, the fuser temperature is below 370°F and temperature of pressure or backup roll is below 150°F that there is difficulty in obtaining high quality fixes. The rectangular block area or zone H depicts the range for maintaining the temperature of the fuser roll if offset is to be minimal and fusing quality is to be high during the operation of a present or single temperature sensing device. As copies are run on the machine the pressure roll temperature will continue to rise until offsetting occurs. Block area or zone I shows the parameters for operation with the present invention. As copies are produced on the machine the pressure roll temperature will rise. This will cause the fuser roll temperature to drop. The dropping fuser roll temperature will stabilize the pressure roll temperature. The operation will insure that the temperature in the nip is always within the fusing window, i.e., greater than minimum and less than offset temperature regardless of varying ambient conditions, copying volume and/or speed, and sheet stock.

In accordance with the present invention a constant teniepratare at the nip or contact arc is maintained to effect a minimum of offset while maintaining high quality image fusing. As best shown in FIG. **3** the fusing roll surface is thermally sensed by a sensor **201** and the pressure or backup roll is thermally sensed by a sensor **205.** An input **210** from sensor **201** and an input **211** from sensor **205** is combined in a sensing combining network **215.** Desirably the sensing combining network **215** is a parallel circuit such that an output signal **220** is a result of the combined effect of the temperatures of the fusing rolls and pressure roll surfaces. This output **220** normally is the sum of the reciprocals of the two sensors **201** and **205.** The signal **220** is then supplied to a control circuit **222** which becomes output signal **230** in the form of discrete on-off electrical signals which are supplied to one or more heating elements **235** which supplies heat to the nip of the fuser roll. These heat pulses may be supplied to any suitable electrical heating element such as a lamp or the like. It has been found that the temperature of the pressure or backup roll is sufficiently high that this will serve as feedback to the control for the fusing nip enabling a greater latitude of temperature to be used for the heating element associated with the fuser rolls as best shown by zone I in FIG. **2.** Typically, it has been found that the fuser roll may range in temperature from 380° to 310°F when the pressure roll temperature ranges from 150° to 290°F, respectively.

The operation of the invention may be best understood in connection with the circuit of FIG. **4.** This circuit is designed to give a high output of operational amplifier **250,** when the combined resistance of sensors **201** and **205** is greater than a predetermined set point. When the combined resistance drops below this set point the operational amplifier **250** gives a low output which will de-energize heating elements **235.** The system is designed to control the temperature about the set point adding heat when the resitance goes above and allowing the system to cool when the resistance goes below. In the machine standby mode when both sensors **201** and **205** are cold or the combined sensor resistance is greater than the set point, the output of amplifier **250** will go high causing the heating elements to turn on. Since the pressure roll is still cold its sensor **205** has a very high resistance and has a negligible effect on the set point. The heating elements will continue to oscillate as the fuser roll sensor **201** oscillates about the set point.

When copies are being produced the pressure roll comes into contact with the fuser roll to provide a nip for fusing. The pressure roll will start heating up causing the pressure roll sensor **205** resistance to decrease. Since the combined resistance is controlled at the same set point, when the pressure roll sensor **205** resistance decreases it forces the fuser roll sensor **201** resistance to increase in order to maintain the combined resistance constant. An increase in fuser roll sensor **201** resistance will cause the fuser roll tempeature to drop. Since the heating elements are located inside the fuser roll, equilibrium will be reached when both the fuser roll and pressure roll temperatures stabilize resulting in a constant temperature in the nip.

By this system it has been found that a constant temperature maintained at the fuser nip insures high quality fixes without undesirable offset on the surface of the fuser roll. Moreover, it will be appreciated that with a closed loop system there is a conservation of energy for producing heat at the fusing nip. It will be further appreciated that with the constant temperature at the fusing nip that the paper will not curl and that high quality fixes will be maintained at varying copying volumes and operating conditions.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a preferred embodiment, it will be understood that various omission and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. In a fusing system including first and second rolls forming a nip to exert heat and pressure to fix powder images onto copy sheets, improved apparatus for maintaining a substantially constant temperature at the nip comprising

first sensor means for detecting a temperature of a first roll surface to produce a first output resistance,

second sensor means for detecting a temperature of a first roll surface to produce a second output resistance,

first circuit means coupling said first and second output resistance to produce a combined output resistance indicative of the temperature at the nip,

second circuit means coupled with said first circuit means receiving input voltage signals representative of said combined output resistance and input voltage signals representative of a reference set point indicative of the desired nip temperature to produce electrical output signals to heating means varying with the difference of the input voltage signals in response to the combined surface temperature of the rolls to maintain a substantially constant temperature at the nip under varying operating conditions.

2. A system according to claim **1** wherein said heating means is disposed interior to at least one of said rolls.

3. A system according to claim **1** wherein said second circuit means includes an operational amplifier comparing the input voltage signals to control the constant temperatures desired at the nip.

4. A system according to claim **1** wherein said first circuit means includes a parallel resistance network.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,833,790,

DATED : September 3, 1974

INVENTOR(S) : Donald J. Quant and Edward C. Braband

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

Claim 1, line 10, "first" should read --second--.

Signed and Sealed this

Ninth **Day of** *October 1979*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

LUTRELLE F. PARKER
Acting Commissioner of Patents and Trademarks

UNITED STATES PATENT AND TRADEMARK OFFICE
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