United States Patent [19]

Hutner

[11] **3,851,144**

[45] **Nov. 26, 1974**

[54] **FEEDBACK FUSER FOR 730S**

[75] Inventor: **Mark A. Hutner**, Glenview, Ill.

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

[22] Filed: **May 24, 1973**

[21] Appl. No.: **363,440**

[52] **U.S. Cl.** **219/216**, 219/388

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

[58] **Field of Search** 219/216, 388; 355/9, 17

[56] **References Cited**

UNITED STATES PATENTS

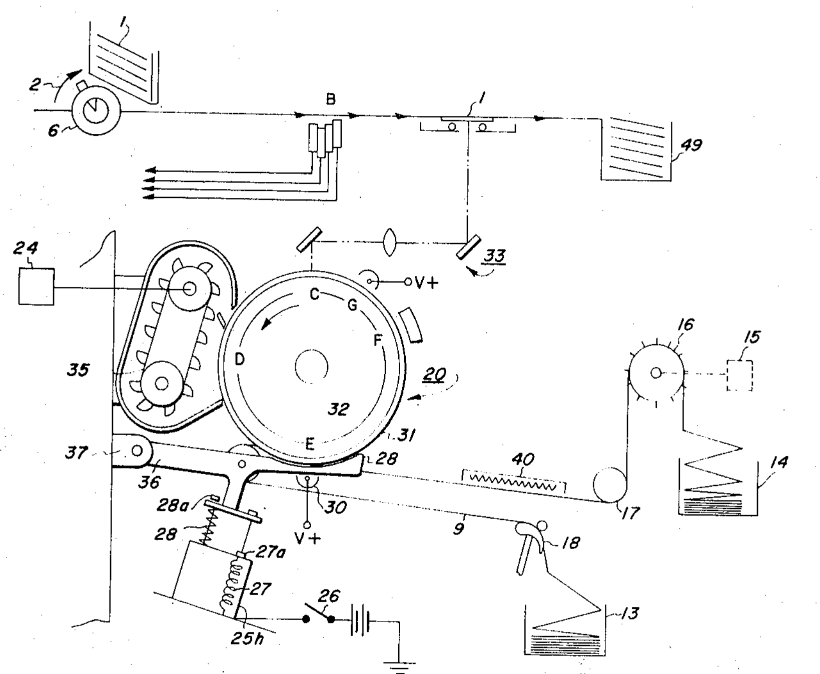
3,772,497 11/1973 Gray 219/216

Primary Examiner—C. L. Albritton

[57] **ABSTRACT**

Selective fuser apparatus and control therefor for use in xerographic reproducing apparatus. In the xerographic reproducing apparatus contemplated, documents are scanned and selectively reproduced in accordance with coded information carried thereby. The coded information is utilized for generating print or select signals when a particular document is to be reproduced and when a document is not to be reproduced a non-print or non-select signal is generated. A temperature sensor is provided for sensing the ambient temperature in the fuser assembly. Accordingly, the fuser energization is controlled in accordance with the number of non-select signals occurring between successive print signals and the ambient temperature of the fuser. Where a relatively large number of non-select signals and/or the ambient temperature in the fuser is low a greater quantity of thermal energy input to the fuser assembly is required.

25 Claims, 4 Drawing Figures



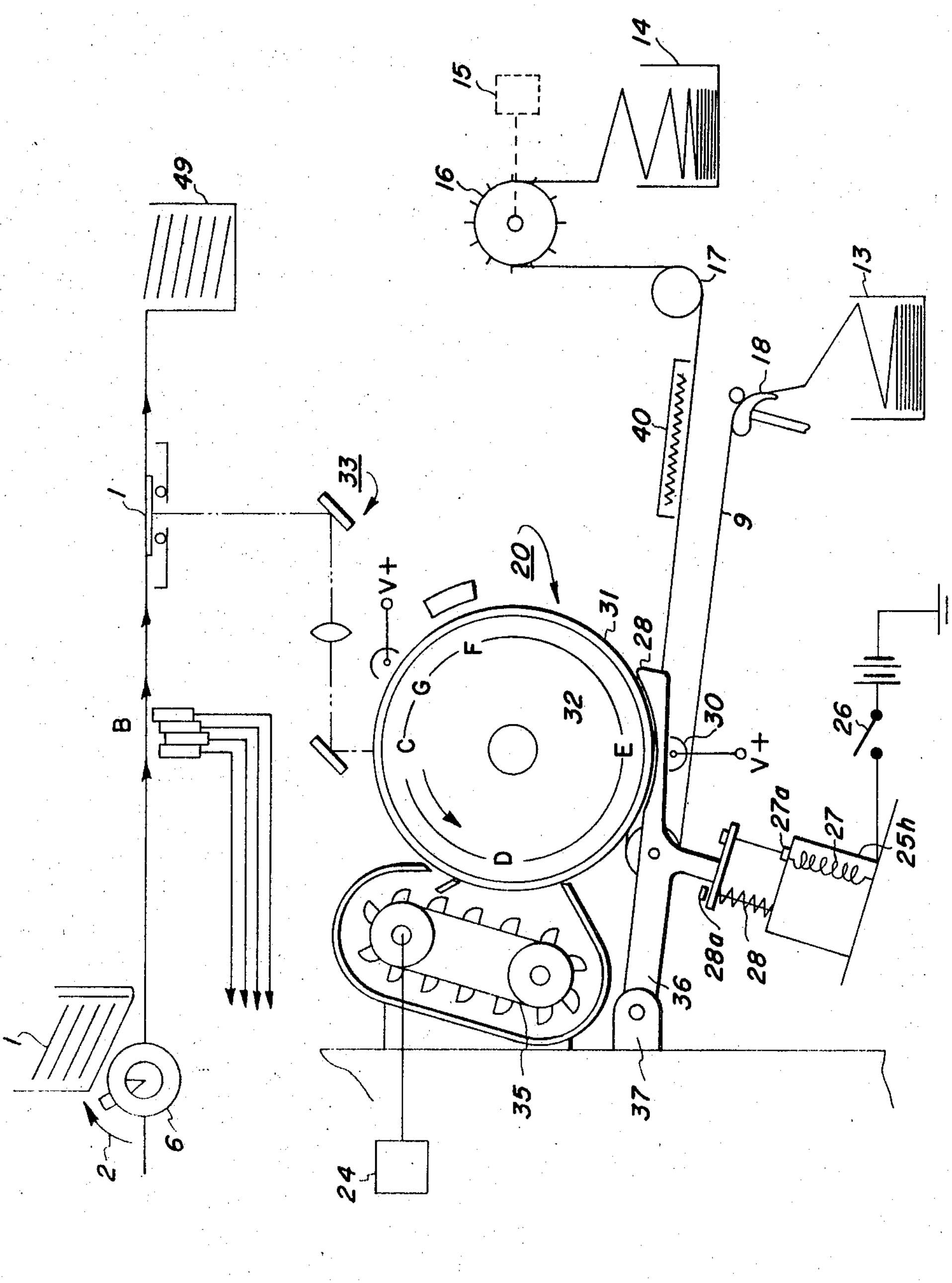

1
2
6
B
49
33
20
V+
31
28
C
G
F
32
E
D
30
9
40
17
16
15
14
13
18
26
27a
27
25h
28a
28
36
35
37
24

FIG. 1

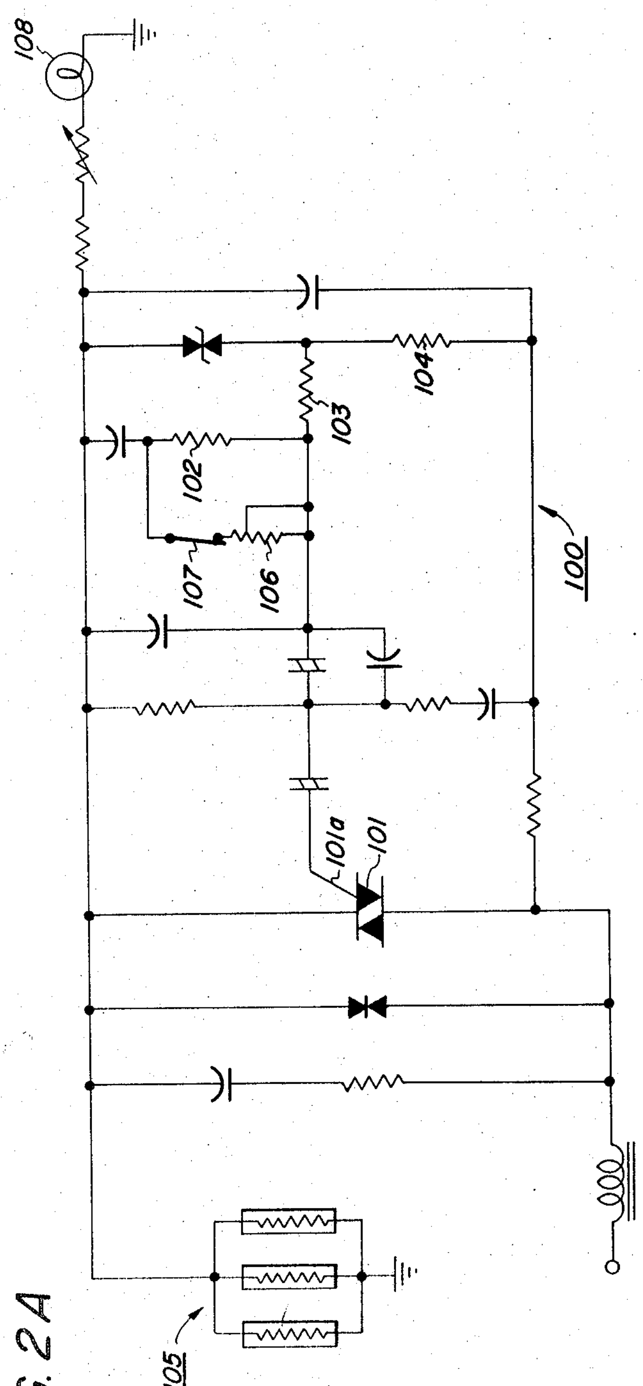

108
104
103
102
107
106
100
101a
101
105

FIG. 2A

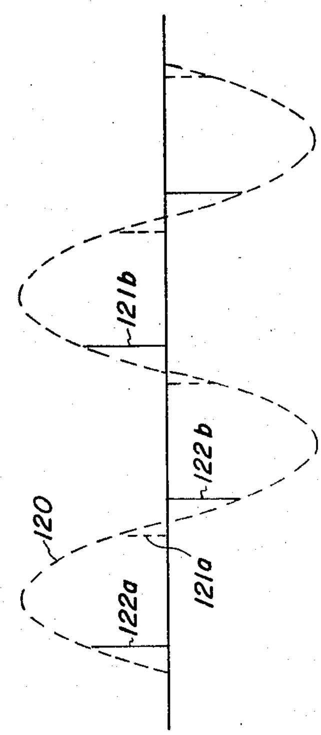

121b
122b
120
122a
121a

FIG. 2B

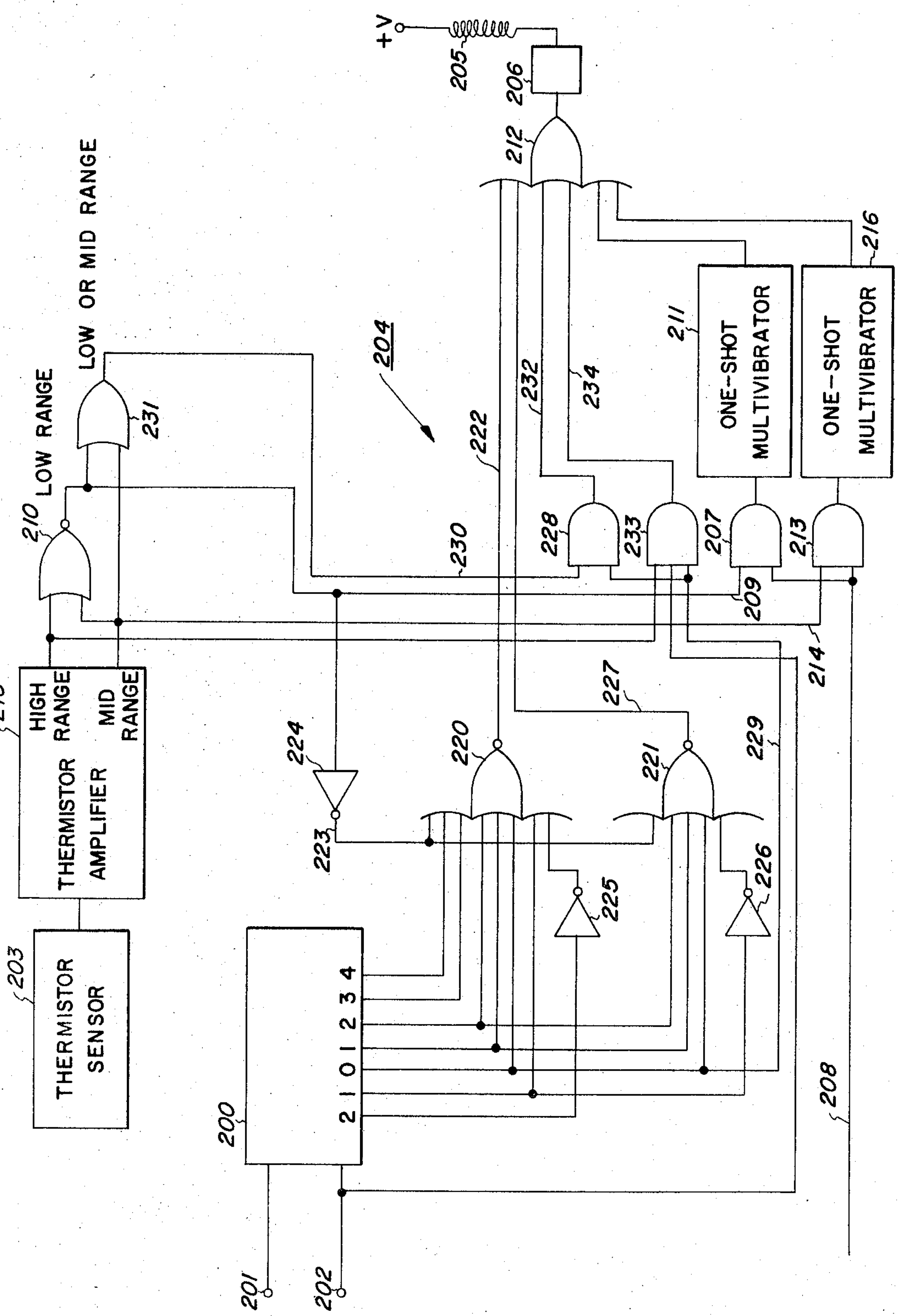

+V
205
206
212
216
211
ONE-SHOT MULTIVIBRATOR
ONE-SHOT MULTIVIBRATOR
204
222
232
234
LOW OR MID RANGE
LOW RANGE
231
210
230
228
233
207
213
209
214
215
THERMISTOR AMPLIFIER
HIGH RANGE
MID RANGE
224
220
227
221
229
223
225
226
203
THERMISTOR SENSOR
200
2 1 0 1 2 3 4
208
201
202

FIG. 3

FEEDBACK FUSER FOR 730S

BACKGROUND OF THE INVENTION

This invention relates to electroscopic fusing techniques and, more particularly, to a method of selectively regulating a fuser assembly and the apparatus therefor.

Electrophotographic reproducing techniques of the type described in detail in U.S. Pat. No. 2,297,691 issued to Chester F. Carlson, form electrostatic latent images of original documents by selectively dissipating a uniform layer of electrostatic charges deposited on the surface of a photoreceptor in accordance with modulated radiation image thereon. The electrostatic latent image thus formed is developed and transferred to a support surface to form a final copy of an original document. The development process is effected by applying electroscopic particles, conventionally known as toners, to the electrostatic latent image whereat such particles are electrostatically attracted to the latent image in proportion to the amount of charge comprising such image. Hence the areas of small charge concentration are developed to form areas of low particle density, while areas of greater charge concentration are developed to form areas where in the particle density is greater. Once transferred to the support surface, the developed image may be permanently fixed thereto by heat fusing techniques wherein the individual particles soften and coalesce when heated so as to readily adhere to the support surface.

Various modifications in fusing techniques have heretofore been developed which achieve diverse results, such techniques including selective fusing. In selective fusing, toner areas admitting of a higher density are preferentially fused leaving low density or background areas unfused. Unfused toner particles comprising background can then be removed to yield a cleaner, more readable copy. Selective fusing also contemplates the irregular, non-continuous, non-periodic operation of a fuser assembly in response to particular predetermined conditions. In this regard, selective fusing techniques are readily adapted to cooperate with selective xerographic printing techniques. Thus, if copies of only selected ones of successively scanned original documents are to be printed, a fuser assembly must be energized for each time the developed image of a selected original is transferred to the support surface. It is appreciated that if the support surface comprises a web of suitable material, such as paper, the web will be transported to the fuser assembly in an irregular manner corresponding to the scanning of the unique originals to be reproduced. Consequently, scorching or burning of the web that is stationarily disposed within the fuser assembly must be avoided, while, at the same time, sufficient heat must be accumulated in the assembly to assure an adequate fusing of the toner areas to the web.

In the implementation of either of the aforementioned fusing techniques, i.e., the fusing of toner areas of a high density to the exclusion of relatively low density areas on a continuously moving support surface or the fusing of successive toner areas disposed in image configuration upon an irregularly moving support surface, it has been found, that in addition to the problem of scorching the support surface, it is necessary to provide for a delay in raising the temperature of the fuser assembly to a proper value in response to the energization thereof, the accumulation of heat within the assembly during the duration of energization thereof and the temperature to which the assembly has cooled in the time that has expired since the immediately preceeding energization thereof.

Prior attempts at regulating a fuser assembly of the type herein contemplated in order to account for the foregoing has resulted in regulation without due consideration to the actual temperature in the fuser assembly.

Therefore, it is an object of the present invention to provide a method of and apparatus for selectively fusing electroscopic particles to a support surface.

It is another object of this invention to provide a method of an apparatus for regulating the operation of a fuser assembly in accordance with the expiration of time from an immediately preceeding energization thereof and the ambient temperature in the fuser assembly.

A further object of the present invention is to provide a method of fusing electroscopic particles to successive portions of a support base intermittently moving through a fuser assembly, and apparatus therefor.

Still another object of this invention is to provide a method of rapidly energizing a fuser assembly to permit the fixing of toner particles thereby, while precluding the possibility of scorching a support surface disposed therein and the apparatus therefor.

Yet a further object of the present invention is to provide a method of selectively energizing a fuser assembly and the apparatus therefor, in accordance with the amount of coding to which the assembly has been subjected.

Another object of this invention is to provide a method of and apparatus for fusing electroscopic particles disposed in image configuration on a support base in accordance with the intermittent movement of the surface through a fuser and the ambient temperature of the fuser.

Various other objects of the present invention will become clear from the following detailed description of an exemplary embodiment, thereof, and the novel features will be particularly pointed out in the connection with the appended claims.

In accordance with the invention, there is disclosed a fuser regulating method and apparatus therefor wherein the fuser assembly is selectively energized in accordance with prior operation of the fuser such that it rapidly attains an operating energy level sufficient to fuse to a support surface the electroscopic particles supported thereon; the fuser assembly being energized for various periods of time depending upon the period of time elapsed from the last energization thereof and the ambient temperature therein.

This invention will be more clearly understood by reference to the following detailed description of an exemplary embodiment thereof in conjunction with the accompanying drawings in which:

FIG. 1 is a schematic diagram of a selective printing apparatus with which the instrument invention may be utilized;

FIG. 2A is a schematic diagram of a conventional heating element that may be utilized in the fuser assembly of FIG. 1 and variable supply of energy therefor;

FIG. 2B depicts an AC form that is helpful in explaining the operation of the electrical circuit illustrated in FIG. 2A;

FIG. 3 is a schematic illustration of logic circuitry that may be utilized to selectively regulate the variable supply of energy depicted in FIG. 2A.

DETAILED DESCRIPTION OF THE INVENTION

For a general understanding of the selective printing apparatus in which the instant invention may be incorporated, reference is made to FIG. 1, in which some of the various system components for the apparatus are schematically illustrated. The printing apparatus illustrated herein employs electrophotographic concepts originally disclosed in U.S. Pat. No. 2,297,691, which issued in the name of Chester F. Carlson. Accordingly, the selective printing apparatus comprises an electrostatic system wherein a light image of an original to be reproduced is projected onto the sensitized surface of a phososensitive plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged developing material comprising electroscopic particles, known as toner particles, to form a powder image corresponding to the latent image on the photosensitive surface. The powder image is then electrostatically transferred to a support base to which it may be fixed by a fuser assembly whereby the powder is caused to adhere permanently to the support surface.

In the illustrated apparatus, visible document information is provided on each of the data cards **1** that are successively transported from a feeder tray **2** to a restack tray **49**. The data cards are transported in timed sequence with respect to the operation of the remaining apparatus illustrated herein, and are caused to traverse detecting station A, scanning station B and slit exposure device **34** in successive order. Each data card is additionally provided with pre-coded information thereon, which pre-coded information is determinative of the selective printing of the visible document information carried by the card. More particularly, if the pre-coded information scanned from the card by scanning station B admits of a particular pre-condition, additional logic circuitry, not shown, responds to such scanned information to derive a print signal. The thus derived print signal is operated upon in timed sequence to provide a direct correspondence between the sequential manipulation of such print signal and the particular operation performed by the apparatus illustrated in FIG. **1**.

The sequential passage of data cards from the scanning station B through the projection system **33** to the restack tray **49** will cause optical images of the visible document information on each of the data cards passing through the slit exposure device **34** to be sequentially projected upon the surface of photosensitive drum **20**. If desired, the projected images may admit of magnification. The photosensitive drum **20** is continuously driven at a constant angular velocity such that the surface thereof is moving at a velocity equal to that of data cards moving past the exposure device **34**. In moving in the direction indicated by the arrow prior to reaching the exposure station C, that portion of the photosensitive drum being exposed is uniformly charged by a corona discharge station G. The exposure of the photosensitive drum surface to the light image selectively dissipates the electrostatic charge on the surface thereof in the area struck by light, thereby forming an electrostatic latent image in image configuration corresponding to the light image projected from the visible document information on the data card transported through the slit exposure device **34**. As the photosensitive drum surface continues its movement, electrostatic image passes through a developing station D in which there is positioned a developing apparatus generally indicated by the reference numeral **13**.

In the electrostatic latent image pasisng through development station D is derived from a data card having a print signal associated therewith, such print signal is utilized to activate the developer motor **24** such that the developing apparatus may be operated to develop such electrostatic latent image. In contradistinction thereto, should the electrostatic latent image passing through the developing station D be derived from a data card not having a print signal associated therewith, the developer motor **24** is not activated and such electrostatic latent image is not developed. It is therefore, appreciated that the developing apparatus **13** is operated in an intermittent manner wherein only those electrostatic images derived from data cards having print signals associated therewith are developed at station D. As the photosensitive drum **20** continues to rotate in the direction indicated by the arrow, successive areas thereof will be provided with image information distributed thereon in the form of a distributed electrostatic charge pattern. However, only selected ones of successive areas will be developed. As illustrated herein, the developing apparatus **13** may typically be provided with electroscopic particles that are cascaded across the surface of photosensitive drum **20**, which particles are attracted electrostatically to the distributed charge pattern to form powder images.

The developed electrostatic image is transported by the photosensitive drum **20** to a transfer station E located at a point of tangency on the photosensitive drum whereat a support base **9** is intermittently moved at a speed in synchronism with the moving drum in order to accomplish transfer of the developed image. The support base **9** is here depicted as a web comprised of suitable material such as paper, plastic or the like, that it is driven from a supply **13** to selective transfer mechanism **25** through fuser assemvly **40**, about strip driving means **16** and into a strip receiving tray **14**. It will be appreciated that the support base **9** in addition to comprising paper and plastic in the form of a web, the support base **9** may also comprise a continuous strip of paper having gummed labels supported thereon which can be readily removed from the web subsequent to the reproducing operation. At the time a developed image having a print signal associated therewith arrives at the transfer station E, the associated print signal is operated upon to cause the web driving means **16** to be activated, thereby transporting the support base **9** at a velocity equal to the surface velocity of the photosensitive drum **20**. Moreover, the print signal is used to operate the selective transfer mechanism **25** whereby the support base **9** engages the photosensitive drum **20** in an arc contact. In addition, charging means **30** may be energized to provide a charge on the support base **9** prior to its engagement with the photosensitive drum so that the developed image may be electrostatically transferred from the surface of drum **20** to the adjacent side of the support base as such support base is brought into contact therewith. Thus, it is seen, that each developed electrostatic image is transferred to the support base 9; and the support base is, therefore, advanced in an intermittant manner in accordance with each print signal that is derived from the scanning information carried by the transported data cards.

After transfer, the support base 9 is transported to the fuser assembly, generally indicated by the reference number **40**, wherein the developed and transferred powder image on the support base is permanently fixed thereto. The fuser assembly **40** may comprise conventional apparatus capable of carrying out various fusing techniques such as over fusing, hot air fusing, radiant fusing, hot and cold pressure fixing and fusing and flash fusing as well as other known techniques. Merely for the purpose of explanation, it will be assumed that the fuser assembly **40** is comprised of one or more ribbon heating elements adapted to emit a suitable amount of heat when energized. The dimensions of the assembly may be such as to admit of a plurality of transferred images to be disposed therein simultaneously. Additionally, the fuser assembly is maintained at a quiescent operating temperature when not energized, the quiescent operating temperature being slightly less than the temperature normally required to fix the powder image to prevent scorching of the support base **9**. It is, therefore, readily apparent that the print signal derived from a data card is operated upon in a pre-selected sequential manner in correspondence with the transporting of a transferred image to the fuser assembly **40**. Since, however, immediately succeeding areas of the support base **9** are provided with transferred images, but succeeding ones of the data cards are not necessarily provided with the unique pre-coded scanning information, it is recognized that the support base is moved intermittently through the fuser assembly in an irregular manner. Consequently, the fuser assembly must not be continuously energized in order to avoid the scorching of the support base that is maintained in a temporary stationary relationship with respect thereto. Nevertheless, as an immediately succeeding portion of the support base is advanced to the fuser assembly, the latter must be rapidly energized to an operating level capable of fixing the electroscopic powder image upon the support base. The manner in which the fuser assembly **40** is regulated to provide the just-mentioned selective fusing is described in detail hereinbelow.

The excess electroscopic particles remaining as residue on the developed images, as well as those particles not otherwise transferred therefrom, are carried by the photosensitive drum **20** to a cleaning station F on the periphery of the drum adjacent the charging station G. The cleaning station may comprise a rotating brush and a corona discharge device for neutralizing charges remaining on the non-transferred electroscopic particles. Various other configurations and components may comprise a cleaning station F as is well known to those skilled in the art.

A more complete description of the selective printing apparatus illustrated in FIG. **1**, and the manner in which such apparatus operates, is set forth in detail in copending application Ser. No. 221,229, filed on Jan. 27, 1972 in the name of Mark A. Hutner et al. and assigned to Xerox Corporation, the assignee of the present invention. It should, however, be clearly understood that the selective fusing techniques to be described in detail hereinbelow are readily adapted for broad application and should not unnecessarily be limited to the specific system described above. It will, therefore, become readily apparent that the instant invention may be readily utilized whenever selected ones of original documents are to be reproduced. Stated otherwise, the selective fusing techniques described hereinbelow are readily adapted to fix powder images to a support base therefor on an irregular basis in accordance with the occurrence of pre-selected conditions as well as the environmental conditions of the fuser assembly itself. Thus, in addition to the selected use described with respect to FIG. **1**, the selective fusing techniques of the present invention may be employed for the preferential fusing of dense images while leaving low density or background areas unfused.

Turning now to the basic matter of the present invention, and in particular, to FIGS. **2A** and **2B**, there is schematically illustrated a conventional heating element in the form of a ribbon fuser **105** that may be typically included in the fuser assembly **40** of FIG. **1**. The heating element **105** is coupled to a variable supply of voltage generally designated by the reference numeral **100**, the latter being adapted by the heating element **105** with energy. The variable supply **100** may be a conventional voltage regulator such as Model 9T68Y7001 manufactured by General Electric and therefore, need not be described in detail herein. It should, however, be noted that variable supply **100** includes a bi-directional current conducting means **101** which may be silicon bi-directional triode device, such as a triac capable of conducting relatively high AC current in both directions and whose time of initial conduction during a half cycle is dependent upon the magnitude of the control voltage applied to the trigger input **101a** thereof. Hence, the bi-directional current conducting means **101** may function as a triggerable switch that is rendered conductive during a half cycle of an AC voltage applied thereto when the voltage exceeds a threshhold or firing level. Those of orginary skill in the art will recognize that the bi-directional current conducting means be a conventional thyristor. Once rendered conductive, the bi-directional current conducting means **101** is adapted to remain conductive until the voltage supply thereto commences a successive half-cycle.

It may be observed that the control voltage applied to the trigger input **101***a* bi-directional current conducting means **101** is derived from a voltage dividing means that comprises series connected resistance means **102, 103** and **104.** Trigger input **101***a* is coupled to the junction form by the series connection of resistance means **102** and **103.** The value of the resistance of resistance means **102** is, to some degree, determined by the intensity of radiant energy admitted by lamp **108** and, therefore, is precisely regulated. In accordance with the present invention the threshold level at which the bi-directional current conducting means **101** is rendered conductive, is decreased by selectively reducing the voltage derived by the illustrated voltage division means. Adjustable resistance means **106** is capable of being selectively connected in parallel relationship to resistance means **102** by energizable switch **107.** It should be appreciated that the effective resistance of the first stage of the illustrated voltage dividing means is decreased when the adjustable resistance means **106** is connected in parallel with resistance means **102.** Consequently, the threshold or firing level voltage applied to the trigger input **101***a* of bi-directional current conducting means 101 thus correspondingly is increased. Thus, the time of initial conduction during half-cycle is advanced and the duration of the bi-directional current conducting means 101 is increased. With adjustable resistance means 106 connected in parallel with resistance means 102, the root mean square (RMS) voltage applied to heating element 105 is decreased, resulting in a decrease in the amount of heat radiated therefrom. Adjustable resistance means 106 may comprise a conventional potentiometer, rheostat or the like whereby an adjustment of resistance value thereof enables a corresponding adjustment in the threshold or firing level of bi-directional current means. Hence, a suitably wide range in the RMS voltage applied to heat element 105 may be obtained.

The manner in which the variable supply 100 is utilized to regulate the heat radiated by heating element 105 may be readily understood by referring to FIG. 2B. Normally, the heating element 105 is maintained at a quiescent low of energization to radiate the amount of heat that is not quite sufficient to fuse electroscopic material to a support base. Nevertheless, this quiescent energization enables the radiant energy emitted by the heating element to be rapidly increased to the proper fusing level when the voltage applied to the heating element is increased. When adjustable resistance means 106 is connected in parallel with resistance means 102, a quiescent threshold level is applied to trigger input 101*a* bi-directional current conducting means 101. As illustrated in FIG. 2B, this quiescent threshold level renders the bi-directional current conducting means conducted at a point on the positive half cycle of the AC voltage supplied to the bi-directional current conducting means defined by the intersection of broken line 121*a* and AC wave form 120. The bi-directional current conducting means 101 is rendered non-conductive at the conclusion of a positive half cycle. However, at a point on the negative half cycle defined by the intersection of broken line 121*b* and AC wave form 120, the bi-directional current conducting means is again rendered conductive. It is appreciated that when the quiescent threshold level is applied to triggering point 101*a* of bi-directional current conducting means 101, the bi-directional current conducting means is rendered conductive for only a relatively small portion of an AC cycle. This duration of conductivity, however, is sufficient to apply an RMS voltage to heating element 105 whereby the heating element is maintained at a quiescent level of energization. Should the RMS voltage applied to heating element 105 be increased, the heat radiated thereby will be sufficient to fuse electroscopic material.

When energizable switch means is energized so as to assume an "open" state, adjustable resistance means 106 is thereby disconnected from resistance means 102. It may be recognized that switch means 107 may comprise a movable contact of a conventional relay, an electronic switch or the like. The disconnecting of adjustable resistance means 106 from resistance means 102 alters the ratio of division of the voltage dividing means to thereby alter the threshold level applied to triggering point 101*a*. Accordingly, the point at which the bi-directional current conducting means 101 is rendered conductive during the positive half cycle of the AC voltage applied thereto is defined by the intersection of line 122*a* and AC wave form 120 illustrated in FIG. 2B. THe conductivity of the bi-directional current conducting means is maintained until the conclusion of the positive half cycle. During the negative half cycle the AC voltage, bi-directional current conducting means 101 is rendered conductive at the point of intersection of line 122*b* and AC wave form 120. The relatively large duration of conductivity during each cycle is effective to apply an increased RMS voltage to heating element 105 whereby the heat radiated by the heating element is sufficient to fuse the electroscopic material. It should be readily understood that if energizable switch 107 is energized for a plurality of AC cycles, the amount of heat radiated by heating element 105 is proportionally increased. Therefore, the total amount of heat radiated by the heating element and consequently, the increase in temperature obtained thereby, is a function of the duration of energization of energizable switch means 107.

An exemplary embodiment of apparatus that may be utilized to energize energizable switch means 107 is schematically illustrated by the logic circuit of FIG. 3 and comprises storage means 200, temperature sensor 203, decoding means 204 and relay 205 with driver means 206 therefor.

The decoding means 204 comprises a first gating means comprising a coincidence member 207 which is adapted to produce an output signal in response to the application of predetermined signal at each of two input terminals thereof. Accordingly, coincidence means 207 may comprise a conventional AND gate whereby a binary "1" is produced at the output terminal thereof when a binary "1" is supplied to each input terminal thereof. For the purpose of the present discussion, it will be assumed that a binary "1" is represented by a positive DC potential and a binary "0" is represented by ground potential. It is, of course, understood that the foregoing binary signals may be represented by any suitable voltage potentials. Similarly, coincidence means 207 may comprise a conventional NAND gate whereby a binary "0" is produced at an output terminal thereof when a binary "1" is supplied to each input terminal thereof.

A first input terminal 208 of the gating means 207 is provided with a machine, start-up signal while a second input terminal 209 thereof coupled to the output of a second gating device 210 is provided with a signal representative of the ambient temperature of the fusing assembly. In this particular case the signal is representative of a low temperature range or an ambient temperature of less than 109°F. From the foregoing, it can be seen that when operation or start-up of the machine is initiated and the ambient temperature of the fuser assembly is in the low range, there are present high levels or positive DC potentials at the input to the gating device 207 which effects a high level output therefrom to thereby trigger a one-shot multivibrator 211 having a duty cycle of 1.3 seconds. The output from the one-shot provides a high level input to a gating means 212 the output of which provides an input to the driver means 205 for driving the relay 206 which opens the switch means 107 thereby providing a high intensity input to the heater 105 for a period of 1.3 seconds.

The gating means 212 may comprise a conventional OR gate whereby a binary "1" is produced at the output terminal thereof when a binary "1" is supplied to any one of the input terminals thereof. As in the case the gating means 207 and 213 and for the purpose of the present discussion, it will be assumed that a binary

"1" is represented by a positive DC potential and a binary "0" is represented by ground potential.

Gating means similar in function to gating means **207** comprises coincidence means **213** which is adapted to produce an output signal in response to the application of a predetermined signal at each of its two input terminals, one of which is the terminal **208** from which is derived a start-up signal and the other of which is a terminal **214** from which is derived a signal from a thermistor amplifier **215** indicative of a middle termperature range in the fuser assembly as sensed by the thermistor **203**. The output of the gating means **213** triggers a one-shot multivibrator **216** from which is derived a **1.1** second pulse for energizing the fuser **105** in the high intensity range for that period of time through the opening of the switch means **107**.

Storage means **200** is adapted to store a history of the preceeding energizations of the heating element included in the fuser assembly **40** illustrated in FIG. **1** and therefore, may comprise a plural shift register means including an input terminal for receiving an irregularly occurring selective energizing signal and a shift terminal for receiving a periodic shift signal. It is recalled that the selective printing apparatus with which the present invention may be utilized is adapted to develop and transfer an image of a given data card when the card is provided with scanning information from which a print signal is derived. As described in the aforementioned copending application Ser. No. 221,229 filed Jan. 27, 1972, a derived print signal is shifted through shift register means **200** in timed relation with the rotation of image information obtained from a corresponding data card. The image information is distributed on the surface of a rotating photosensitive drum in the form of a distributed electrostatic charge pattern. Accordingly, the relative position of the image information at any given time may be determined by the particular position occupied by the print signal as the print signal is shifted through the register means. Moreover, once the image information is developed and transferred to a portion of the support base, the movement of that portion may be represented by a corresponding shifting of the print signal through the shift register means. It should, therefore, be readily apparent that a print signal will be shifted to a predetermined position within the shift register means when a portion of the support base is advanced to the fuser assembly. Hence, electroscopic particles that are disposed in image configuration on the support base are to be fused to the support base when a print signal occupies the predetermined position. As will be soon become apparent, the print signal occupying the predetermined position need not be associated with that particular portion of the support base that is advanced to the fuser assembly. However, except for initial portions of the support base, each succeeding portion that is transported to the fuser has a powder image disposed thereon. Storage means **200**, may, therefore, comprise a portion of the aforementioned shift register means having a first stage corresponding to the predetermined position and including a plurality of succeeding stages. Alternatively, the storage means **200** may comprise an individual plural stage shift register means having a first stage corresponding to the aforementioned predetermined position and including a plurality of succeeding stages. In either case, the storage means is illustrated in FIG. **3** as comprising a plural stage shift register means wherein only seven stages have been designated as only these stages are of interest here. As is understood by those of ordinary skill in the art, a conventional shift register is adapted to shift an input signal applied thereto consecutively through the stages thereof in accordance with a transition in the shift signal applied. The shift register may, therefore, comprise a counter capable of representing timing information relating to the times of occurrences of successive input signals in accordance with the particular stages occupied thereby.

The input terminal of storage means **200** is coupled to terminal **201** to which is applied a preselected information signal such as the aforementioned print signal. The shift terminal storage means **200** is coupled to terminal **202** to which is applied a periodic shift signal. The periodic shift signal may be derived from the system clock which is explained in detail in the aforementioned copending application, Ser. No. 221,229, Filed Jan. 27, 1972. Accordingly, the periodic shift signal may take the form of a clock pulse having a period corresponding to the rate at which the data cards are scanned and imaged. The clock pulse period is thus equal to the interval of tie required to transfer successive developed images from the photosensitive drum to the support base **9**. Consequently, the clock pulse period is also equal to the interval of time required to translate successive portions of the support base **9** to the fuser assembly.

The outputs of the stages of storage means **200** are coupled to the illustrated decoding means **204**, which decoding means is adapted to analyze the sequence of print signals that have been supplied to storage means **200** as well as the ambient temperature of the fuser **40**. The decoding means **204** in addition to the already described gating means further includes gating means **220** and **221**. The gating means **220** includes a plurality of input terminals coupled to each of the seven stages of the storage means **200** and an output terminal **222** coupled to the gating means **212**. The gating means **220** has an additional input terminal **223** which is coupled to the output of the gating means **210** through an inverter member **224**.

The gating means **220** may comprise a conventional NOR gate whereby a binary "1" is produced at the output terminal thereof when a binary "0" is supplied to each input terminal thereof.

The gating means **220** is adapted to sense the expiration of a first interval of time intermediate successive occurrences of a print signal. The gating means **220** is also adapted to sense a low temperature range in the fuser assembly **40**. In accordance with the foregoing, the gating means **220** at the output thereof produces a signal admitting of a pre-established duration, for example **332** milliseconds. More particularly, gating means **220** is adapted to detect when more than six clock pulses have occurred since the occurrence of the immediately preceeding print signal. Stated differently, the gating means **220** is adapted to produce a signal of **332** milliseconds duration, two cycles before the image is transferred from the drum to the web **9** if six non-selects occur with low temperature range in the fuser chamber. Such expiration corresponds to an elapsed time since the previous energization of the heating elements **105** included in the fuser assembly **40** and that the fuser assembly has cooled to a temperature requiring an energization thereof for a duration longer than the minimum duration to attain a suitable accumulation of radiant energy in the assembly.

The first input terminal of the gating means **220** is coupled to the first stage of the storage means by means of an inverting means **225** while successive terminals to the input of the gating means **220** are coupled to successive output stages, directly, of the storage means **200.** An output signal is produced by the gating means **220** when the first stage of storage means **220** is occupied by a print signal and the other six stages of the storage means are not occupied by a print signal, combined with the fact that the fuser assembly is in the low temperature range. The inverting means **224** and **225** may comprise conventional logic negation circuits adapted to produce a binary "0" in response to a binary "1" supplied thereto, and conversely, to produce a binary "1" in response to a binary "0" supplied thereto.

The gating means **221** is provided with input terminals coupled to the second through fifth stages of the storage means **200** along with the terminal **223** which as noted is coupled to the output of the gating means **210.** The input terminal **221** coupled to the second stage of the storage means **200** is via an inverter means **226** inverter means **224** and **225.** It can be seen from a consideration of the input terminals to the gating means **221** that an output pulse is provided at output terminal **237** is three non-selects occur with the fuser chamber in the low temperature range. It can be further seen that the occurrence of such a signal takes place one cycle before transfer of the image from the photoreceptor drum to the web **9** takes place. The duration of the signal derived on output terminal **227** is 332 milliseconds. Stated differently, it can be seen that when a print cycle occupies the second stage of the storage means and no such signal occupies the third, fourth and fifth stages of the storage means along with a low temperature range sensed in the fuser chamber an output signal corresponding to such conditions is produced along output terminal **227.**

The successive stages of the storage means **200** are labeled **2, 1, 0, 1, 2, 3** and **4** and therefore correspond to, in the case of the first stage, a point in time two cycles prior to transfer of an image from the photoreceptor drum to the web **9.** Likewise the second stage of the storage means corresponds to a point in time one cycle prior to such transfer while the third stage corresponds to and coincides with transfer. The stages four through **7** correspond to points in time subsequent to transfer of an image and correspond to one, two, three or four cycles after such transfer.

Gating means **228** in the form of an AND gate similar in function to gates **207** and **213** is provided with a pair of input terminals **229** and **230** the former of which is coupled to the third stage of the storage means **200** and the latter of which is coupled to the gating means **231** in the form of an OR gate. It can be seen that an output signal on output terminal **232** is derived when the third stage of the storage means **200** is occupied by a print signal and the temperature in the fuser is in the low or mid range.

The pulse repetition rate for shifting the print signals through the storage means **200** is **332** milliseconds with the duration of such shift signals being **220** milliseconds duration. In view of the foregoing, the duration of the signals from the gating means **220, 221** and **228** is equal to the pulse repetition rate of the shift signals.

Gating means **233** is provided with a plurality of inputs one of which is coupled to the shift terminal **202** and the other two of which are coupled, respectively to the third stage of the storage means **200** and the high range take-off of the thermistor amplifier **215.** It can be seen that since one of the inputs to the gating means **233** is derived from the shift terminal the output signal from terminal **234** of the gating device **233** has a duration equal to the shift signal pulse duration of 220 milliseconds and therefore when the third stage of the storage means **200** is occupied by a print signal and the fuser assembly is in the high temperature range an output signal of 220 milliseconds duration will be provided on output terminal **234.**

The operation of the apparatus illustrated in FIG. 3 will now be described. It will be recalled that the successive portions of the support base **9** upon which the electroscopic particles are disposed in image configuration are intermittently moved through the fuser assembly **40** even though the data cards and photosensitive drum are continuously advanced and rotated respectively. Additionally, it can be seen from a consideration of FIG. **1** and the storage means **200** of FIG. **3** that there is a time delay between the incidence of transfer of the image from the photoreceptor to the support **9** and movement of a particular transferred image to the fuser assembly **40.** This delay is inherent even though all the cards being scanned would contain print signal data or coding. Accordingly, the apparatus disclosed in FIG. **3** including the storage means **200** and decoding means **204** is arranged to take into consideration that there is a delay of a plurality of cycles between the time an image is transferred and that image sees the inside of the fuser assembly **40.** For purposes of this description it will be assumed that the apparatus disclosed in FIG. **1** has not been operated for some time and therefore the ambient temperature of the fuser is in a low temperature range corresponding to a temperature of less than 109°F. When the start button of the machine is depressed by an operator, a start-up signal is generated at the input of gating device **207** via input terminal **208** and simultaneously therewith a second signal is provided via input terminal **209** to the gating device **207** which represents a low temperature condition in the fuser assembly. The coincidence of the pulses at input terminals **208** and **209** establishes an output signal from the gating device **207** which triggers a one-shot multivibrator **211** having a pulse duration of 1.3 seconds which provides an input to the gating device **212** the output of which is responded to by the driver means **206** to thereby supply the energizing coil **206** with ground potential. Accordingly, the driving means **206** may comprise a conventional transistor means having a base electrode coupled to the gating means **212,** and collector electrode coupled to the energizing coil **205** and an emitter electrode coupled to ground potential. The supplying of the energizing coil **205** with ground potential serves to open the switch **107** to establish high intensity operation of the heating element **105.** If at the time the apparatus were operated in the fuser assembly **40** contained residual thermal energy, it can be seen that the gating device **213** with coincident signals via terminal inputs **208** and **214** would produce an output signal for triggering a 1.1 second one-shot multivibrator to provide an input to the gating device **212** for supplying energy to the coil **205** from the output of the gating means **212** via the driver means **206** actuated thereby. It should be borne in mind that the foregoing has taken place prior to any card code information being sensed.

Once the code information is being sensed, the pattern of select and non-select images is transmitted to the decoding means **204** via the storage means **200.** The output of the decoding means provides signals to regulate the fuser to provide high intensity levels for fusing or the holding level to keep the fuser chamber warm and minimize the ribbon element heat up response time.

The thermistor sensor signal is divided into three temperature ranges: below 109°F; between 109° and 150°F; and over 150°F.

The shift register select pattern is divided into three groups: selects which are preceeded by other selects within the last three machine cycles (one label per cycle), selects preceeded by at least three non-selects, and selects, preceeded by at least six non-selects. The shift register signals are combined to form four basic output signals as follows: AND gating device **220** provides an output for 332 milliseconds if a select is preceeded by six non-selects and the fuser temperature is in the low range. This output occurs two cycles before the paper starts moving;

Gating means **221** provides an output for 332 milliseconds if a select is preceeded by three non-selects and the fuser temperature is in the low range. This output occurs one cycle before the paper starts moving;

Gating means **228** provides an output for 332 milliseconds if a select occurs in the cycle that the paper is moving and the temperature is in the low or mid temperature range; and

Gating means **223** provides an output for 220 milliseconds if a select occurs in the cycle that the paper is moving (i.e., print signal in third stage of means **200**) and the temperature is in the high range.

From the above, it can be seen that if the fuser chamber is in the low temperature range and a select occurs which is preceeded by six non-selects, the fuser will switch to high intensity two cycles before the paper advances from the output of gating means **220** and will continue at high intensity in the following cycle from the output of gating means **221** and also in the paper advance cycle by the output of gating device or means **228.** This will provide 996 milliseconds of high intensity fuser operation in three consecutive cycles.

For the case where the chamber is in the low range and the select is preceeded by at least three but not more than six non-selects, the fuser will remain at high intensity for 664 milliseconds from the output of gating means **221** and then gating means **228.**

While the invention has been particularly shown and described with reference to an exemplary embodiment thereof, it will be obvious to those skilled in the art that various changes and modifications in form and details may be made without departing from the spirit and scope of the invention. Thus, it is intended that the appended claims be interpreted as including obvious changes and modifications.

What is claimed is:

1. Apparatus for regulating the fusing of electroscopic particles to successive portions of a support base moved through a fuser assembly wherein said fuser assembly includes means for softening said electroscopic particles and control means therefor, said electroscopic particles corresponding to documents selectively reproduced from a series of documents scanned for such purposes, said apparatus comprising:

means for sensing at least one ambient condition of such fuser assembly;

means for generating print signals for the document to be selectively reproduced; and

means for varying the operation of said control means in accordance with the number of documents not selected for reproduction occurring intermediate successive selected documents and in accordance with at least one ambient condition.

2. Apparatus according to claim **1** wherein said means for softening said electroscopic particles comprises a source of thermal energy coupled to a power source; and

said control means comprises switch means in said power source adapted when energized to alter the operation of said thermal energy source from a first condition to a second condition.

3. Apparatus according to claim **2** wherein said source of power comprises a variable supply for applying a high voltage to said source of thermal energy during said second condition of operation.

4. Apparatus according to claim **3** wherein said sensing means comprises the temperature sensor for sensing the temperature of said fuser assembly.

5. Apparatus according to claim **4** including storage means for storing said signals in accordance with the manner in which they are generated.

6. Apparatus according to claim **5** wherein said storage means comprises a shift register means including an input terminal to which is applied said signals representing documents to be reproduced and means for continually shifting on a periodic basis each signal applied to said input terminal through said shift register means whereby the relative position occupied by signals within the shift register means is a function of the history of those documents, both selected and non-selected.

7. Apparatus according to claim **6** including decoding means coupling said shift register means and said temperature sensing means to means for actuating said switch.

8. Apparatus according to claim **7** wherein said successive portions of said support base are intermittently moved through said fuser assembly.

9. Fuser apparatus for use in a xerographic reproducing apparatus for fusing electroscopic particles to successive portions of a support base intermittently moved through said fuser apparatus, said electroscopic particles corresponding to reproduced documents selected from a series of documents scanned for such purposes, said apparatus comprising:

means in said fuser apparatus for emitting radiant energy;

temperature sensing means responsive to the ambient temperature in the fuser apparatus;

means for generating signals for the documents selected for reproduction;

power supply means operatively coupled through said means for emitting radiant energy; and

means for regulating said power supply in accordance with the number of documents not selected for reproduction intermediate successive selected documents and in accordance with the temperature sensed by said temperature sensing means.

10. Apparatus according to claim 9 wherein said power supply means comprises a variable voltage supply including switch means; and

said means for regulating said power supply means comprises means for actuating said switch means whereby to establish different voltage levels from said power supply means to said radiant energy emitting means.

11. Apparatus according to claim 10 including storage means for storing said signals in accordance with the manner in which they are generated.

12. Apparatus according to claim 11 wherein said storage means comprises shift register means including an input terminal to which is applied said signals representing documents to be reproduced and means for continually shifting on a periodic basis each signal applied to said input terminal through said shift register means whereby the relative positions occupied by signals within the shift register means as a function of the history of those documents both selected and non-selected for reproduction.

13. Apparatus according to claim 12 including decoding means coupling said shift register means and said temperature sensing means to means for actuating said switch means.

14. Apparatus according to claim 13 including start-up signal means for generating a signal when the xerographic apparatus commences operation; and

wherein said decoding means comprises gating means responsive to start-up signal means and the temperature sensed by said temperature sensing means for actuating said switch means for a first pre-determined period of time when said fuser apparatus is at a first temperature level.

15. Apparatus according to claim 14 wherein said decoding means comprises second gating means responsive to said start-up signal means and the temperature sensed by said sensing means for actuating said switch means for a longer pre-determined period of time when said fuser apparatus is at a second temperature level.

16. Apparatus according to claim 15 wherein said second temperature level is lower than said first temperature level.

17. A method of regulating the operation of a fuser assembly of a xerographic reproducing apparatus comprising the steps of:

sensing the start-up of said xerographic reproducing apparatus;

sensing the temperature of said fuser assembly; and

initiating a first pulse of a pre-determined duration for controlling the operation of said fuser when the temperature level thereof is at first level and initiating a second pulse of a different duration from that of said first pulse when the temperature of said fuser assembly is at a second level.

18. The method according to claim 17 including the step of sensing coded information on documents serially scanned by said xerographic apparatus;

generating print signals for each document having a code corresponding to selected ones of said documents to be reproduced; and

controlling the operation of said fuser assembly in accordance with the number of documents not selected for reproduction between successive print signals and in accordance with the temperature in said fuser assembly.

19. The method according to claim 18 wherein the controlling of the operation of said fuser assembly comprises energizing said fuser assembly for a period of time in accordance with the number of documents not selected between the successive selective documents and the temperature in said fuser assembly.

20. A method of regulating the operation of a fuser assembly of a xerographic apparatus wherein electroscopic particles are fused to successive portions of a support base moved through a fuser assembly, said electroscopic particles corresponding to documents selectively reproduced from a series of documents scanned for such purposes, said method comprising the steps of:

generating a print signal corresponding to each of the documents to be reproduced;

sensing the temperature of said fuser assembly;

controlling the energization of said fuser assembly in accordance with the number of documents not selected for reproduction occurring intermediate successive selected documents and in accordance with the temperature sensed.

21. The method according to claim 20 including the steps of:

generating a signal corresponding to the start-up of said xerographic apparatus prior to generating said print signals; and

controlling the energization of said fuser assembly in accordance with at least one of said signals and the temperature sensed.

22. The method according to claim 21 including the step of:

storing said print signals in accordance with the manner in which they are generated.

23. The method according to claim 22 wherein said print signals are stored in a shift register and including the step of:

continually shifting on a periodic basis each signal applied to the input terminal of said shift register whereby the relative positions occupied by said print signals within said shift register means as a function of the history of those documents both selected and non-selected.

24. The method according to claim 23 including the step of decoding the outputs from said shift register means and the sensed temperature and controlling the energization of said fuser assembly in accordance therewith.

25. The method according to claim 24 including the step of intermittently moving said support base through said fuser assembly.

* * * * *