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Hutner

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[54] **SELECTIVE FUSING**

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

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

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[21] Appl. No.: **221,193**

[52] **U.S. Cl.** ..... **219/216**, 219/388, 250/65 ZE

[51] **Int. Cl.** **B60i 1/02**

[58] **Field of Search** ..... 219/216, 388; 250/65 ZE, 65 T

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Primary Examiner—William M. Shoop, Jr.
Attorney—James J. Ralabate et al.

[57] **ABSTRACT**

Fuser regulating methods and the apparatus therefor are provided in accordance with the teachings of the present invention wherein a fuser assembly is selectively energized in accordance with the intermittent movement of successive portions of a support base through the fuser assembly such that said fuser assembly rapidly attains an operating temperature sufficient to fuse to said support base the electroscopic particles supported thereon. The fuser assembly is energized for a pre-established minimum period of time when successive portions of the support base are moved therethrough within a first time duration. The fuser assembly is energized for a second pre-established period of time greater than the minimum period of time when a first interval of time has expired since the immediately preceding energization thereof. If a second interval of time has expired since the immediately preceding energization of the fuser assembly, the assembly is energized for a third pre-established period of time when the next successive portion of the support base is advanced thereto. The second interval of time is greater than the first interval of time and the third pre-established period of time is greater than the second pre-established period of time. Further periods of energization may be established in accordance with the amount of time that has expired since an immediately preceding energization.

15 Claims, 5 Drawing Figures

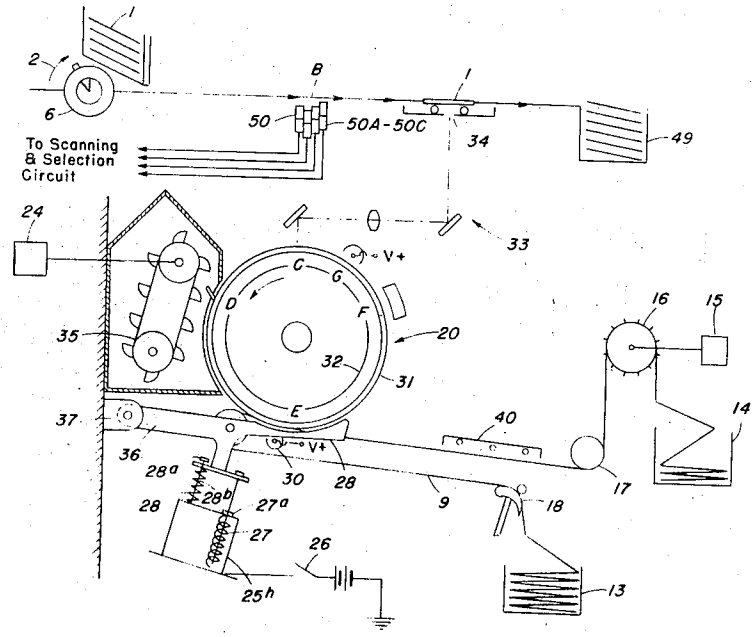


Fig. 1.

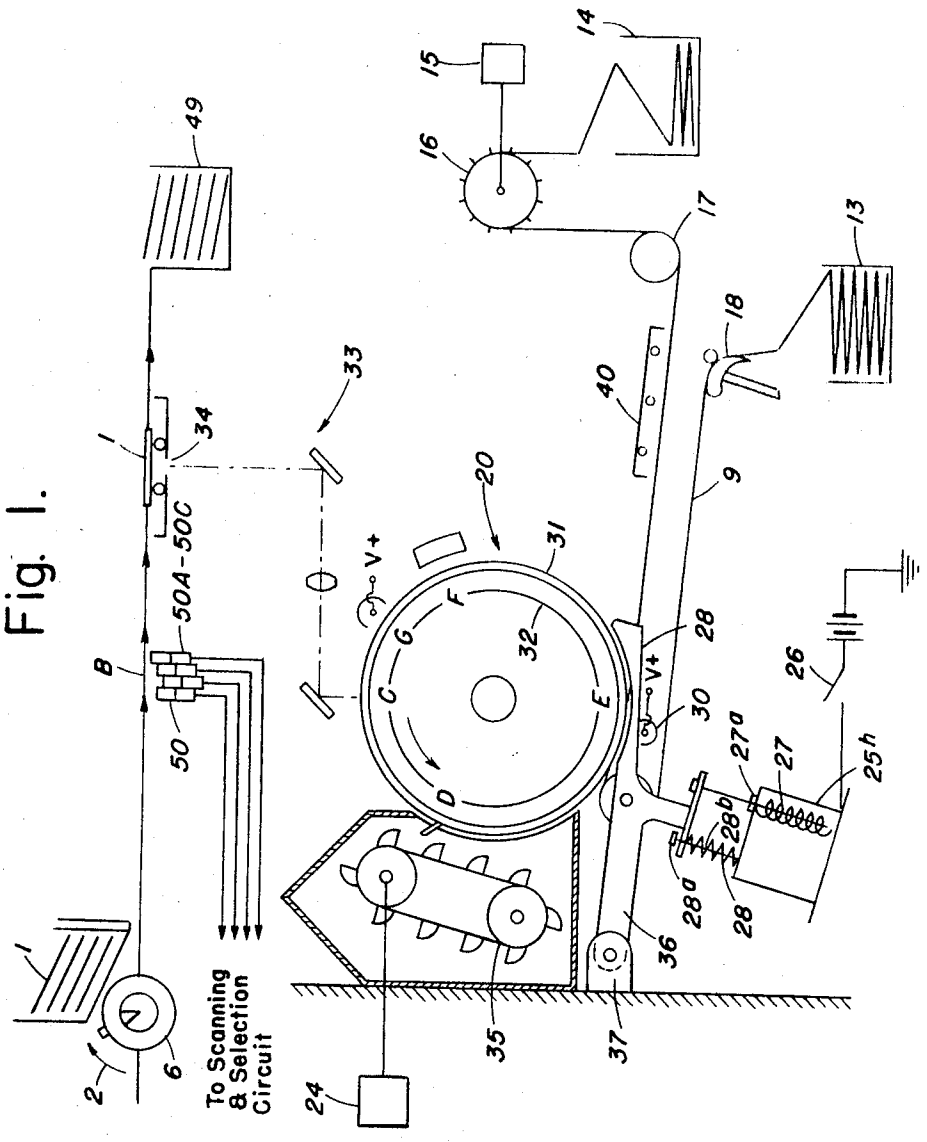


Fig. 2A.

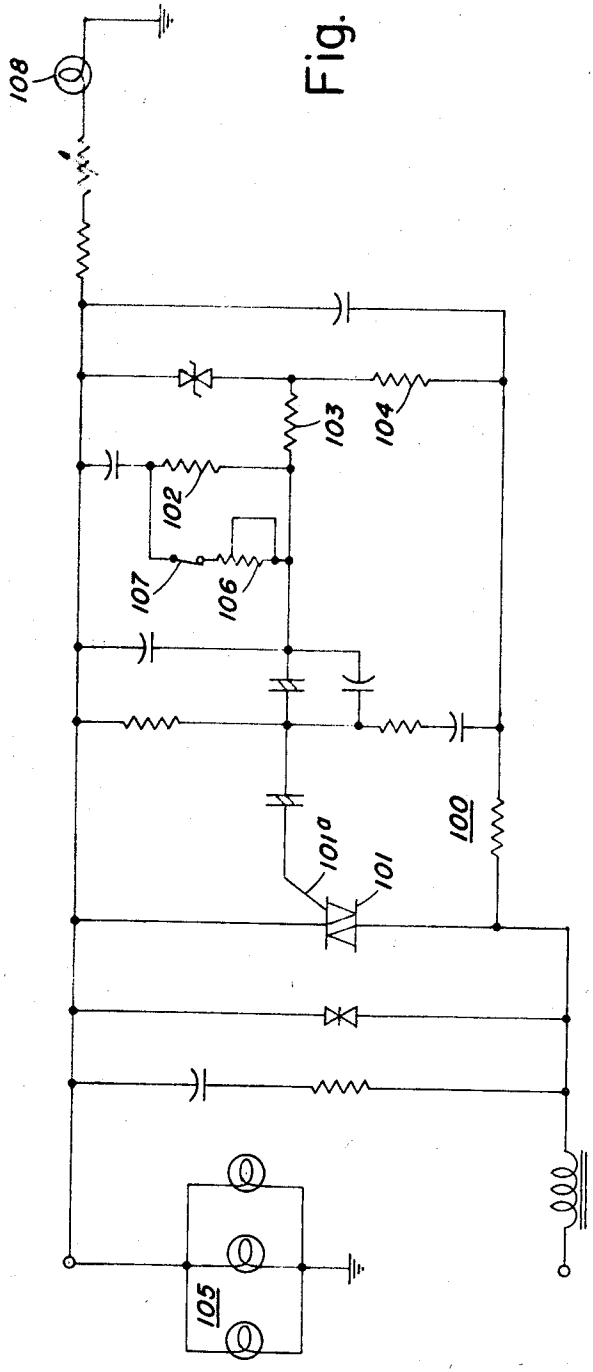

108
103
104
102
107
106
100
101a
101
105

Fig. 2B.

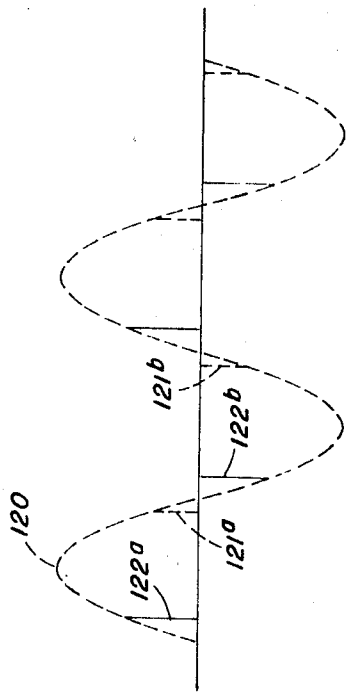

120
121b
122b
122a
121a

Fig. 4.

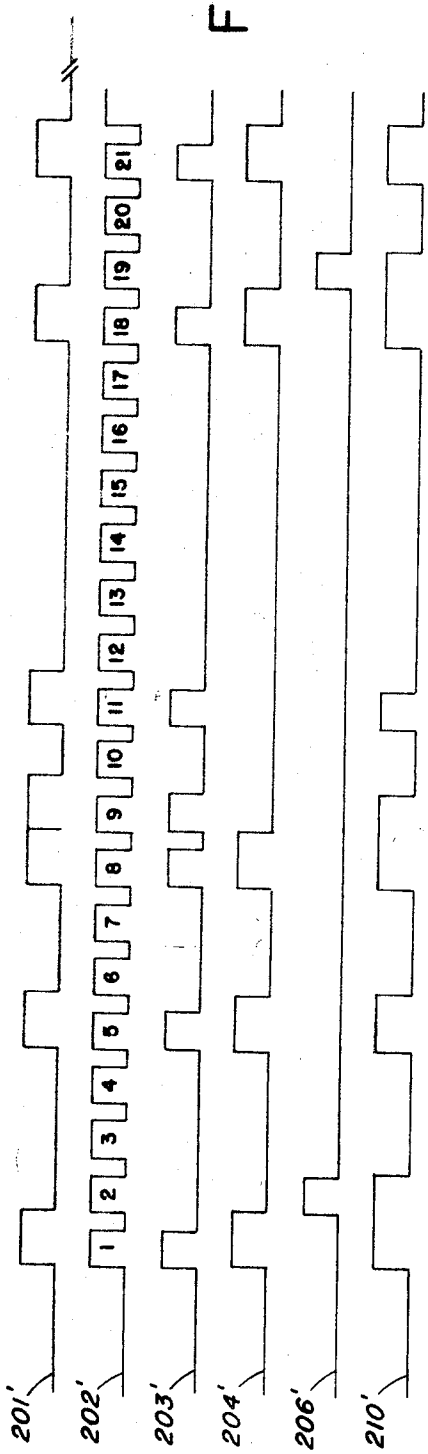
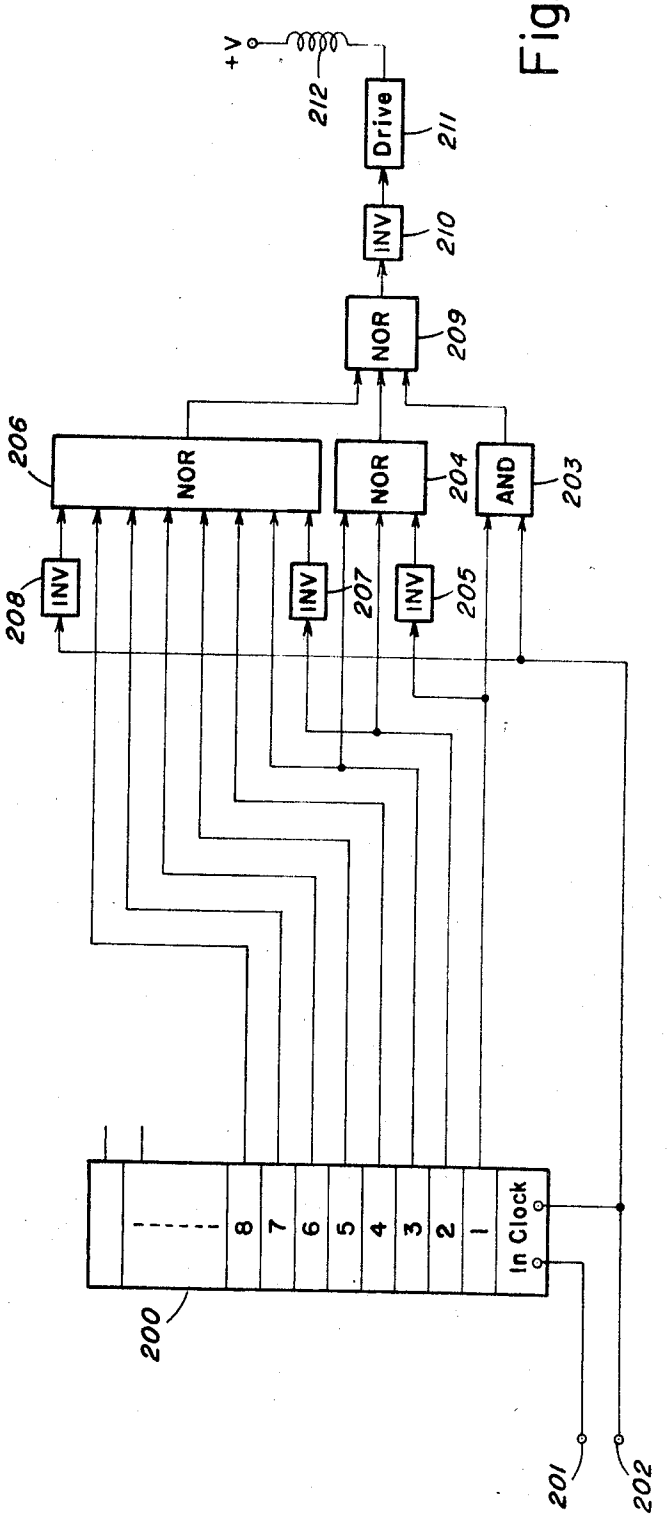

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11
12
13
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15
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17
18
19
20
21
201'
202'
203'
204'
206'
210'

Fig. 3.


+V
212
Drive
211
INV
210
NOR
209
206
NOR
204
AND
203
INV
208
INV
207
INV
205
8
7
6
5
4
3
2
1
In Clock
200
201
202

SELECTIVE FUSING

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 which 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 photo-receptor in accordance with modulated radiation imaged 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 wherein 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 divers 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, the fuser assembly must be energized each time a 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 through 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 accummulated in the assembly to assure an adequate fusing of the toner areas to the web.

In the implementation of either of the aforementioned selective 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 fixing 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 an intrinsic 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 preceding energization thereof. An attendant disadvantage of prior art selective fusing techniques is the failure of such techniques to vary the amount of heat emitted by the fuser assembly in accordance with the length of time such assembly has been permitted to cool. An attempt to overcome this difficulty has resulted in maintaining the fuser assembly at a quiescent temperature level that, in some instances, has caused the scorching of the support surface disposed therein.

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 the invention to provide a method of and apparatus for regulating the operation of a fuser assembly in accordance with selected conditions requiring the energization of said assembly wherein the heat accumulated by the assembly is a function of the expiration of time from an immediately preceding energization thereof.

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 the apparatus therefor.

An additional object of the present invention is to provide apparatus for selectively energizing a heating element that is maintained at a temperature level no lower than a quiescent level for variable time durations such that a substantially equal radiant energy level is attained thereby during each energization irrespective of the length of time that has expired since an immediately preceding energization thereof.

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 cooling to which said 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 surface in accordance with the intermittent movement of said surface through a fuser assembly.

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

In accordance with this invention, there are disclosed fuser regulating methods and the apparatus therefor, wherein the fuser assembly is selectively energized in accordance with the occurrence of preselected conditions such that the fuser assembly rapidly attains an operating energy level sufficient to fuse to a support surface the electroscopic particles supported thereon; said fuser assembly being energized for a preestablished minimum duration of time when the immediately preceding energization thereof occurred within a first time duration; and said fuser assembly being energized for variable durations of time in accordance with the inter-

val that has expired since the immediately preceding energization thereof.

The 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 typical selective printing apparatus with which the instant 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 waveform that is helpful in explaining the operation of the electrical circuit illustrated in FIG. 2A;

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

FIG. 4 depicts a timing diagram representing the voltage signals produced by the logic circuit of FIG. 3.

For a general understanding of 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. Like component parts are identified by like reference numerals throughout and primed reference numerals identify the waveforms produced by corresponding component parts identified by unprimed reference numerals. The printing apparatus illustrated herein employs electrophotographic concepts originally disclosed in U.S. Pat. No. 2,297,691, which issued to 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 photosensitive 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 fusing 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 precoded information thereon, which precoded information is determinative of the selective printing of the visible document information carried by the card. More particularly, if the precoded information scanned from the card by canning station B admits of a particular precondition, additional logic circuitry, not shown, responds to such scanned information to derive a print signal. The thus derived print signal is operated upon in a 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 the 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 areas 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, the electrostatic image passes through a developing station D in which there is positioned a developing apparatus generally indidicated by the reference numeral 13.

If the electrostatic latent image passing 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 latent images derived from data cards having print signals associated therewith are developed at station D. Hence, 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 is driven from a supply 13 through selective transfer mechanism 25, through fuser assembly 40, about strip driving means 16 and into a strip receiving tray 14. 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 ve-

locity 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 of 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 intermittent 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 numeral **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 oven fusing, hot air fusing, radiant fusing, hot and cold pressure roll fixing and fusing and flash fusing. Merely for the purpose of explanation, it will be assumed that the fuser assembly **40** is comprised of one or more quartz lamps connected in parallel relationship and 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. Additionally, the fuser assembly is maintained at a quiescent operating temperature when not energized, said quiescent operating temperature being slightly less than the temperature normally required to fix the powder image to prevent scorching of the support base. It is, therefore, readily apparent that the print signal derived from a data card is operated upon in a preselected 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 precoded scanning information, it is recognized that the support base is moved intermittently through the fuser assembly in an irregular manner. Consequently, the fuser assembly **40** 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 nontransferred electroscopic particles. Various other configurations and components may comprise the cleaning station F as is well-known to those of oridinary skill 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 by Mark A. Hutner et al, and now U.S. Pat. No. 3,700,324 and assigned to Xerox Corporation, the assignee of the instant 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 be unnecessarily 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 preselected conditions. Thus, in addition to the selected use as described with respect to FIG. **1,** the selective fusing techniques of the present invention may be employed for the preferential fusing of dense image areas while leaving low density or background areas unfused.

Turning now to the subject matter of the present invention, and in particular, to FIGS. **2A** and **2B,** there is schematically illustrated a conventional heating element **105** that may be typically included in the fuser assembly **40** of FIG. **1.** The heating element **105,** which may comprise a plurality of quartz lamps connected in parallel relationship, is coupled to a variable supply of voltage, generally designated by the reference numeral **100,** the latter being adapted to supply 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 the variable supply **100** includes bi-directional current conducting means **101** which may be a 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 a control voltage applied to the trigger input **101*a*** 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 threshold or firing level. Those of ordinary skill in the art will recognize that the bi-directional current conducting means may be a conventional thyrister. Once rendered conductive, the bi-directional current conducting means **101** is adpated to remain conductive until tthe voltage applied thereto commences a successive half cycle.

It may be observed that the control voltage applied to the trigger input **101*a*** of 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 formed 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 emitted 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 dividing means. Adjustable resistance means **106** is capable of being selectively connected in parallel relationship with 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 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** is correspondingly increased. Thus, the time of initial conduction during a half cycle is advanced and the duration of conductivity 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 the resistance value thereof enables a corresponding adjustment in the threshold or firing level of bi-directional current conducting means. Hence, a suitably wide range in the RMS voltage applied to heating 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 level of energization to radiate an 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 a proper fusing level when the voltage applied to said 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* of bi-directional current conducting means **101.** As illustrated in FIG. **2B,** this quiescent threshold level renders the bi-directional current conducting means conductive at a point on the positive half cycle of the AC voltage applied to the bi-directional current conducting means defined by the intersection of broken line **121***a* and AC waveform **120.** The bi-directional current conducting means **101** is rendered nonconductive 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 waveform **120,** the bi-directional current conducting means is again rendered conductive. It is appreciated that when the quiescent thershold level is applied to trigger input **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 the 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 trigger input **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 waveform **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 of the AC voltage, bi-directional current conducting means **101** is rendered conductive at the point of intersection of line **122***b* and AC waveform **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 means **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,** gating means **203, 204** and **206,** selective gating means **209** and driver means **211.** Storage means **200** is adapted to store a history of the preceding energizations of the heating element included in the fuser assembly **40** illustrated in FIG. **1** and, therefore, may comprise a plural stage 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 said card is provided with scanning information from which is derived a print signal. As described in copending application Ser. No. 221,229 filed Jan. 27, 1972, and now U.S. Pat. No. 3,700,324 a derived print signal is shifted through shift register means 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 said print signal is shifted through the shift 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 said predetermined position. As will 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 stages **1–8** 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 occurrence 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 of 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 copending application Ser. No. 221,229 filed Jan. 27, 1972 and now U.S. Pat. No. 3,700,324. Accordingly, the periodic shift signal may take the form of clock pulses 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 time required to transfer successive developed images from the photosensitive drum to 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 **40**.

The outputs of stages **1–8** of storage means **200** are coupled to the illustrated decoding means, which decoding means is adapted to analyze the sequence of the print signals that have been supplied to storage means **200**. The decoding means includes first gating means **203**, second gating means **204**, third gating means **206** and selective gating means **209**. First gating means **203** is comprised of a coincidence means including a first input terminal coupled to the first stage of storage means **200** and a second input terminal coupled to terminal **202**. Coincidence means **203** is adapted to produce a signal admitting of a pre-established minimum duration whenever a print signal is applied to terminal **201**. It is appreciated, therefore, that the coincidence means is adapted to produce an output signal in response to the application of a predetermined signal at each input terminal thereof. Accordingly, coincidence means **203** 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 **203** 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.

The second gating means **204** is adapted to sense the expiration of a first interval of time intermediate successive occurrences of a print signal and to produce a signal admitting of a second pre-established duration in response thereto. The second pre-established duration is greater than the aformentioned pre-established minimum duration. More particularly, gating means **204** is adapted to detect when more than two clock pulse periods have expired since the occurrence of the immediately preceding print signal. Such expiration corresponds to an elapsed time since the previous energization of the heating element included in fuser assembly **40** 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. Second gating means **204** includes a first input terminal coupled to a given stage, such as the first stage, of storage means **200** via inverting means **205**, a second input terminal coupled to a second stage of storage means **200** and a third input terminal coupled to a third stage of storage means **200**. An output signal is produced by second gating means **204** when the first stage of storage means **200** is occupied by a print signal but the second and third stages, respectively, of storage means **200** are not occupied by a print signal. Accordingly, second gating means **204** may comprise a conventional inverting OR, or NOR, circuit wherein a binary "1" is produced at the output terminal thereof when a binary "0" is applied to each input terminal thereof. Alternatively, the second gating means **204** may comprise a conventional AND gate, similar to the aforedescribed AND gate **203**, wherein a first input terminal thereof is coupled directly to the first stage of storage means **200** and the second and third input terminals thereof are coupled to the second and third stages, respectively, of storage means **200** via inverting means. The inverting means **205** illustrated herein may comprise a conventional logic negation circuit 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 third gating means **206** is adapted to sense the expiration of a second interval of time intermediate successive occurrences of the print signal, the second interval being greater than the aforementioned first interval. More particularly, gating means **206** is adapted to detect when more than six clock pulse periods have expired since the occurrence of the immediately preceding print signal. Should this condition obtain, it is appreciated that the time that has elapsed since the previous energization of the heating element included in the fuser assembly **40** is sufficient to permit cooling of the fuser assembly to a point whereat an extended energization thereof is preferred to achieve a suitable accumulation of radiant energy therein. It will soon be-

come readily apparent that the condition precedent to the activation of gating means **204** comprises a portion of the conditions precedent to the activation of gating means **206.** Hence, gating means **204** is adapted to produce a signal whenever the gating means **206** produces a signal. This fact enables a simplification in the construction and interconnection of gating means **206** such that the gating means may include a first input terminal coupled to the second stage of storage means **200** via inverting means **207,** second through seventh input terminals coupled to stages **3–8,** respectively, of storage means **200** and an eighth input terminal coupled to terminal **202** via inverting means **208.** The gating means may comprise a conventional inverting OR, or NOR, circuit similar to NOR circuit **204** or, alternatively, an AND gate similar to the AND gate previously described with respect to gating means **204.** It is recognized that if gating means **206** is constructed of commercially available logic components, an eight-input NOR circuit might not be feasible. Accordingly, the NOR circuit may be comprised of a pair of readily available four-input NOR circuits having output terminals coupled to a conventional AND gate.

Although not specifically illustrated herein, additional gating means, similar to those just described, may be provided to sense the expiration of other intervals of time intermediate the successive occurrences of a print signal. Similarly, the interconnections between gating means **206** and storage means **200** may adopt any suitable configuration to permit the sensing of the expiration of any corresponding interval of time.

The output terminals of AND gate **203,** NOR circuit **204** and NOR circuit **206** are coupled to corresponding input terminals of the selective gating means comprised of series connected inverting OR, or NOR, circuit **209** and inverting means **210.** It is recognized by those of ordinary skill in the art that the combination of NOR circuit **209** and inverting means **210** comprises a conventional OR circuit wherein a binary "1" is produced at the output terminal thereof in response to the application of a binary "1" to any of the input terminals thereof. The OR circuit comprised of NOR circuit **209** and inverting means **210** is connected to conventional driving means **211** which, in turn, is coupled to the energizing coil **212** of a conventional relay. Driving means **211** is adapted to respond to a switch energizing signal applied thereto to supply the energizing coil **212** with ground potential. Accordingly, driving means **211** may comprise a conventional transistor means having a base electrode coupled to the OR circuit comprised of NOR circuit **209** and inverting means **210,** a collector electrode coupled to the energizing coil **212** and an emitter electrode coupled to ground potential. The OR circuit comprised of NOR circuit **209** and inverting means **210** is adapted to selectively couple the signal admitting of pre-established minimum duration from AND gate **203** to drive means **211,** the signal admitting of a second pre-established duration from NOR circuit **204** to drive means **211** and the signal produced by NOR circuit **206** to drive means **211.** The OR circuit acts to combine the signals produced by NOR circuits **204** and **206** to couple a signal admitting of a third pre-established duration to drive means **211.** It is, of course, now apparent that the OR circuit is capable of coupling the signals produced by such additional gates that may be provided to drive means **211.**

The operation of the apparatus illustrated in FIG. **3** will now be described. It is 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 continually advanced and rotated, respectively. Consequently, it is expected that if one out of five data cards, for example, are to be printed, only one print receiving portion of the support base **9** will be moved through the fuser assembly **40** during the interval required to process the five data cards. Stated otherwise, only one print signal in the form of a pulse will be applied to terminal **201** notwithstanding the application of five clock pulses to terminal **202.** To facilitate the ready understanding of the instant invention, the example represented by the timing diagram of FIG. **4,** as read in a left to right configuration, will be assumed. This example is assumed merely for purposes of illustration and should not be considered to unnecessarily limit the instant teachings of the invention thereto. It will also be assumed that the fuser assembly and printing apparatus operatively associated therewith has been in operation for some time. At the first timing period under consideration, i.e., at timing pulse **1** of waveform **202',** the first print signal, represented by the first pulse at the left-hand portion of waveform **201',** is applied to terminal **201.** It is seen that this first pulse **201'** represents that a portion of the support base **9** has been advanced to the fuser assembly **40,** the heating element included in the fuser assembly must now be energized to attain a temperature sufficient to achieve the fixing of the electroscopic particles to the support base and the heating element has not been energized since the last occurrence of the immediately preceding pulse **201',** not shown. Thus, at clock pulse **1,** the print signal is shifted into the first stage of storage means **200** and stages **2–8** thereof are not provided with print signals. The storage means **200** may be responsive to the positive transition of the clock pulses **202'** applied thereto. Of course, the negative transitions of the clock pulses may be utilized to shift applied signals through the storage means, if so desired. Accordingly, AND gate **203** is supplied with a binary "1" by the first stage of storage means **200** and with a binary "1" by clock pulse **1** applied to terminal **202** to produce a first energizing signal admitting of a duration equal to the duration of clock pulse **1** as illustrated by waveform **203'.** Similarly, NOR circuit **204** is supplied with a binary "0" by the second and third stages, respectively, of storage means **200** and, after the invention of the binary "1" stored in the first stage of storage means **200,** with a binary "0" by inverting means **205** to produce an energizing signal admitting of a duration equal to the clock pulse period, as represented by waveform **204'.** It is apparent that the energizing signal produced by NOR circuit **204** represents that more than two clock pulse periods have expired since the occurrence of the immediately preceding print signal. Thus, at clock pulse **1,** the OR circuit comprised of NOR circuit **209** and inverting means **210** responds to the energizing signals applied thereto by AND gate **203** and NOR circuit **204** to supply driver means **211** with a switch energizing signal admitting of a duration corresponding to that exhibited by waveform **204'.** This switch energizing signal, represented by waveform **210'** and aligned with clock pulse **1,** activates driver means **211** which, in turn, energizes

the energizing coil **212** for a period of time equal to one clock pulse period. Hence, during this period, current flows from the source of energizing potential +V through energizing coil **212** to ground potential applied to the energizing coil by driver means **211.** Consequently, switch means **107** of FIG. 2A is activated and thereby opened, for a corresponding period of time. For the purpose of illustration, it will be assumed that one clock pulse period admits of a duration equal to approximately 332 milliseconds, the width of a clock pulse is approximately 230 milliseconds and the frequency of the AC waveform **120** illustrated in FIG. **2B** is approximately 60hz. The activation of switch means **107** for a duration of approximately 332 milliseconds will enable bi-directional current conducting means **101** to operate upon approximately 20 cycles of the AC voltage applied thereto to supply heating element **105** with a sufficiently high RMS voltage. The electroscopic particles disposed in image configuration upon the support base **9** will, therefore, be fused thereto. However, since the fuser assembly **40** had not been previously energized for a prolonged period of time, the heating element therein has cooled to a lower quiescent temperature. It is, therefore, preferred that the heating element be energized for a further duration to permit the fuser assembly to accumulate additional radiant energy whereby a higher temperature is attained. Accordingly, at clock pulse **2,** the print signal stored in the first stage of storage means **200** is shifted into the second stage thereof. This print signal pulse is inverted by inverting means **207** and the first seven input terminals of NOR circuit **206** are each supplied with a binary "0". Clock pulse **2** is inverted by inverting means **208** and the eighth input terminal of NOR circuit **206** is also supplied with a binary "0". The signal thus produced by NOR circuit **206,** depicted by the waveform **206'** in alignment with clock pulse **2,** admits of a duration equal to the clock pulse duration and is applied to driver means **211.** It is recognized that the signal produced by NOR circuit **206** represents that more than six clock pulse periods have expired since the occurrence of the immediately preceding print signal. Switch means **107** is thus activated for an additional 230 milliseconds (the approximate clock pulse duration) during the immediately succeeding clock pulse period. It may thus be observed that the switch energizing signal produced by the OR circuit comprised of NOR circuit **209** and inverting means **210,** and represented by the waveform **210'** is effective to energize the heating element of the fuser assembly for one complete clock pulse period and for one additional clock pulse duration.

It is apparent from waveform **201',** that at clock pulse **2** a print signal is not applied to terminal **201.** Hence, the next successive portion of the support base **9** is not moved through the fuser assembly **40.** This, of course, means that the image information derived from the data card corresponding to clock pulse **2** is not to be printed. Nevertheless, it should be noted that the additional energization of the heating element of the fuser assembly during the second clock pulse period, as just described hereinabove, is not sufficient to scorch or otherwise damage the support base that extends within the fuser assembly. Moreover, if the support base has been advanced at clock pulse **2,** the additional energization of the heating element would be advantageously utilized to fix the next successive developed image to the support base. At clock pulse **3,** terminal **201** is not provided with a print signal and, therefore, the fuser assembly **40** need not be energized. In addition, at this time, the first print signal that had been applied to terminal **201** is shifted into the third stage of storage means **200.** Similarly, at clock pulse **4,** that print signal is shifted into the fourth stage of storage means **200.**

Waveform **201'** indicates that the next successive print signal pulse is applied to terminal **201** during clock pulse period **5.** At this time, the immediately preceding print signal is shifted into the fifth stage of storage means **200.** Hence, approximately 1,328 milliseconds (i.e., four clock pulse periods) have elapsed since a given portion of the support base **9** was moved into the fuser assembly **40.** Moreover, approximately 766 milliseconds have elapsed since the energization of the heating element of the fuser assembly **40** was terminated. The fuser assembly has, therefore, cooled such that the accumulated energy therein has dissipated below the fusing level. At clock pulse **5,** AND gate **203** produces a signal illustrated by waveform **203',** which signal is applied to the OR circuit comprised of NOR circuit **209** and inverting means **210.** In addition, NOR circuit **204** responds to each binary "0" applied thereto by the second and third stages, respectively, of storage means **200** and to the binary "0" applied thereto by inverting means **205.** It is, of course, appreciated that the print signal occupying the first stage of storage means **200** is subjected to a logic negation by inverting means **205** to produce the last mentioned binary "0". Accordingly, a signal represented by the waveform **204'** and admitting of a duration equal to a clock pulse period is also applied to the OR circuit comprised of NOR circuit **209** and inverting means **210.** Consequently, at clock pulse **5,** the switch energizing signal, represented by waveform **210'** is applied to driver means **211** whereby switch means **107** is activated. The activation of switch means **107** results in the energization of the heating element **105** included in the fuser assembly **40** for a duration equal to one clock pulse period. The electroscopic particles disposed on the support base **9** in image configuration are thus fused to the support base. Furthermore, the energizing duration of approximately 332 milliseconds is sufficient to enable the fuser assembly to attain a desirably high temperature, thus accumulating an adequate amount of radiant energy.

A print signal is not applied to terminal **201** at the next clock pulse period **6** and, therefore, further movement of the support base **9** is interrupted. Thus, that portion of the support base that was previously advanced into the fuser assembly **40** remains therein and the accumulated radiant energy serves to properly complete the fusing operation. In addition, at clock pulse **6,** a binary "0" is shifted into the first stage of storage means **200** and the previous print signal is shifted into the second stage of storage means **200.** Accordingly, AND gate **203** and NOR circuit **204** are each disabled and thus do not produce output signals. Although the print signal stored in the second stage of storage means **200** is inverted by inverting means **207** and applied as a binary "0" to NOR circuit **206,** it is observed that the first print signal has now been shifted to the sixth stage of storage means **200** and, therefore, NOR circuit **206** is also disabled from producing a pulse signal. This, of course, is expected since not more than six clock pulse periods have elapsed intermediate the first and second print signal times of occurrence.

The next succeeding print signal is applied to terminal **201** at clock pulse **8** and is shifted into the first stage of storage means **200** as indicated by the waveform **201'**. Hence, three clock pulse periods have elapsed since the immediately preceding print signal was applied to terminal **201** and approximately 664 milliseconds have elapsed since the energization of the heating element included in the fuser assembly was terminated. At clock pulse **8**, the immediately preceding print signal is shifted into the fourth stage of storage means **200** and the first print signal is shifted into the eighth stage of storage means **200.** Accordingly, AND gate **203** responds to the print signal applied to its first input terminal and to the clock pulse applied to its second input terminal to produce the signal represented by waveform **203'** admitting of a clock pulse duration. Additionally, the elapsed time between successive print signals exceeds two clock pulse periods and NOR circuit **204** responds to each binary "0" applied thereto by inverting means **205** to produce the signal represented by the waveform **204'** admitting of a duration equal to the clock pulse period. NOR circuit **206** is inhibited from producing an output because the first print signal is applied to an input terminal thereof by the eighth stage of storage means **200.** The OR circuit comprised of NOR circuit **209** and inverting means **210** responds to the signals applied thereto by AND gate **203** and NOR circuit **204** to apply a switch energizing signal represented by the waveform **210'** to driver means **211.** Switch means **107** is, therefore, activated for a duration equal to a clock pulse period, thereby energizing the heating element **105** included in the fuser assembly **40.** Consequently, the electroscopic particles disposed in configuration upon the third successive portion of the support base **9** are fused thereto.

At clock pulse **9** an immediately succeeding print signal is applied to terminal **201,** thereby representing that the support base **9** is advanced through fuser assembly **40** to expose the next successive portion of the support base to a fusing operation. It is, therefore, appreciated that the image information derived from consecutive data cards are to be printed. Hence, at clock pulse **9** the first and second stages of storage means **200** are each occupied by a print signal, the fifth stage of storage means **200** is occupied by a print signal and the remaining stages of storage means **200** are not provided with print signals. It is, therefore, appreciated that only AND gate **203** is activated to produce an output signal represented by the waveform **203'**, which signal is applied by the OR circuit comprised of NOR circuit **209** and inverting means **210** as a switch energizing signal **210'** to driver means **211.** Thus, switch means **107** is activated for a duration equal to a clock pulse duration thereby energizing the heating element included in the fuser assembly **40.** As may be observed from waveform **210'**, the activation of switch means **107** for an entire clock pulse period during the immediately preceding clock pulse period eight and the activation of switch means **107** for a clock pulse duration during the clock pulse period **9** is sufficient to maintain the energization of the heating element for a total time interval of approximately 562 milliseconds. Hence, sufficient heat is applied to the electroscopic particles disposed in image configuration on support base **9** to fuse said particles to the support base. Thus, the printed images derived from the successive data cards are suitably fixed to the support base to form permanent copies thereof.

At clock pulse **10,** the immediately preceding print signal is shifted into the second stage of storage means **200,** the next preceding print signal is shifted into the third stage of storage means **200** and the next preceding print signal is shifted into the sixth stage of storage means **200.** It is therefore appreciated that an output signal is not produced by any of AND gate **203,** NOR circuit **204** or NOR circuit **206.** However, at clock pulse **11,** a print signal is applied to terminal **201** and shifted into the first stage of storage means **200** as represented by waveform **201'**. At clock pulse **11,** the third stage of storage means **200** is occupied by the immediately preceding print signal, the fourth stage of storage means **200** is occupied by the next preceding print signal and the seventh stage of storage means **200** is occupied by the third preceding print signal. Hence, only AND gate **203** produces an output signal, represented by waveform **203'** which, it is appreciated, admits of a duration equal to a clock pulse duration. The signal produced by AND gate **203** is applied as a switch energizing signal to driver means **211** by the OR circuit comprised of NOR circuit **209** and inverting means **210** as represented by the waveform **210'**. Consequently, switch means **107** is activated for the pre-established minimum duration to thereby energize the heating element **105** included in the fuser assembly **40** for a corresponding duration.

During the next succeeding clock pulse periods, the image information rotating on the photosensitive drum is not printed and, therefore, a print signal pulse is not applied to terminal **201,** the support base **9** is not advanced through the fuser assembly **40** and the heating element included in the fuser assembly is not energized. However, at clock pulse **18** image information derived from a data card and transferred to the support base **9** is to be fixed to the support base. Accordingly a portion of the support base upon which electroscopic particles are disposed in image configuration is advanced to the fuser assembly **40** and a print signal is applied to terminal **201** and shifted into storage means **200** as represented by waveform **201'**. None of the second to seventh stages of storage means **200** is occupied by a print signal but the immediately preceding print signal (i.e., the print signal that occurred at clock pulse **11**) occupies the eighth stage of the storage means. Consequently, both AND gate **203** and NOR circuit **204** produce output signals represented by the waveforms **203'** and **204'**, respectively. These signals are applied as a switch energizing signal to drive means **211** by the OR circuit comprised of NOR circuit **209** and inverting means **210** as represented by the waveform **210'**. Switch means **107** is thus activated for a duration equal to a clock pulse period, thereby energizing the heating element for a corresponding duration.

It is observed that more than six clock pulse periods (viz. seven clock pulse periods) have elapsed since the occurrence of the immediately preceding print signal. Also, more than six clock pulse periods have elapsed since the termination of the immediately preceding energization of heating element **105.** Hence, heating element **105,** which has cooled to a lower quiescent temperature, must be energized for an additional period of time to enable sufficient radiant energy to accumulate in the fuser assembly **40.** Thus, at clock pulse **19,** the immediately preceding print signal is shifted into the second stage of storage means **200** and the third through eighth stages of the storage means are not pro-

vided with stored print signals. Accordingly, NOR circuit **206** is activated to produce an output signal **206'**, admitting of a duration equal to a clock pulse duration, which pulse is applied as a switch energizing signal to the driver means **211** by the OR circuit comprised of NOR circuit **209** and inverting means **210.** Switch means **107** is thus activated for an additional interval during clock pulse period **19** to effect the required additional energization of heating element **105.**

At clock pulse **20** the last preceding print signal is shifted into the third stage of storage means **200** and at clock pulse **21** another print signal is applied to terminal **201** and shifted into storage means **200** as represented by the waveform **201'**. It is appreciated that more than two clock pulse periods have elapsed since the occurrence of the immediately preceding print signal and, in addition, more than approximately 434 milliseconds have expired since the immediately preceding energization of heating element **105** has terminated. Thus the proper fuaing of the electroscopic particles disposed in image configuration on support base **9** requires slightly more than the pre-established minimum duration of energization of the heating element. Consequently, at clock pulse **21** the first stage of storage means **200** is occupied by the print signal represented by waveform **201'** and neither the second nor third stages of the storage means is occupied by a print signal. Hence, an output signal represented by waveform **203'** is produced by AND gate **203** and an output signal represented by waveform **204'** is produced by NOR circuit **204.** The OR circuit comprised of NOR circuit **209** and inverting means **210** responds to the signals applied thereto to apply a switch energizing signal represented by waveform **210'** to driver means **211.** Accordingly, switch means **107** is activated for a duration equal to a clock pulse period, thereby energizing the heating element **105** for a corresponding interval of time.

It should now be fully appreciated from the foregoing description thereof that storage means **200** stores the time related history of the movement of successive portions of support base **9** through the fuser assembly **40.** Clearly, a variable time interval may elapse between consecutive movements. This, of course, is represented by the selected stages of storage means **200** which are occupied by print signals. Moreover, since the energization of the heating element of the fuser assembly is dependent upon the application of a print signal to terminal **201,** the selected stages of storage means **200** that are occupied by print signals provide an indication of the length of time that has expired between successive energizations of the heating element.

In the description of FIG. **3,** it has been assumed that conventional, commercially available TTL logic is utilized throughout for each of the AND gates, NOR circuits, inverting means, storage means and driver means. However, any of the specific logic components or arrangements may be replaced by other components or groups thereof which produce similar output signals in response to corresponding input conditions. Also, the precise mode of logic operation employed thereby may differ from that described hereinabove in a matter that is obvious to those of ordinary skill in the art. Furthermore, the logic circuit illustrated in FIG. **3** may, alternatively, be implemented by MSI logic, individual circuit components or MOS circuit chips. In addition, the variable supply **100** illustrated in FIG. **2A** may be replaced by other conventional sources of energy sufficient to supply the heating element **105** with an increased voltage in response to a switch energizing signal produced by the OR circuit comprised of NOR circuit **209** and inverting means **210** of FIG. **3.** Accordingly, a suitable high voltage source may be selectively coupled to heating element **105** through conventional switching means, the latter being adapted to be activated in response to the switch energizing signal produced by the aforementioned OR circuit. Moreover, the heating element **105** need not be limited merely to a conventional quartz lamp, but, alternatively, may comprise any suitable heat radiating device or other heating device conventionally utilized in fuser assemblies or other electroscopic particle fixing devices.

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, the specific numerical examples described hereinabove are intended to be merely illustrative of the operation of the apparatus disclosed herein and are not intended to limit the teachings of the instant invention. Accordingly, any suitable clock pulse period and clock pulse duration may be employed herewith. Moreover, storage means **200** may comprise any conventional storage device capable of storing a suitable history of the previous operation of the fuser assembly and, therefore, of the intermittently moving support base. NOR circuit **204** may be adapted to produce an output signal if three or more clock pulse periods have expired since the occurrence of the immediately preceding print signal. Similarly, NOR circuit **206** may be adapted to produce an output signal when any other convenient number of clock pulse periods have expired since the occurrence of an immediately preceding print signal. And additional gating means may be provided to produce output signals upon detecting the expiration of other clock pulse periods. It is, of course, recognized that these NOR circuits and gating means may, therefore, produce output signals admitting of any desired duration to energize the heating element of the fuser assembly in accordance with the particular interval of time that has expired since the immediately preceding energization of the heating element. Thus, it is intended that the appended claims be interpreted as including the foregoing as well as other obvious changes and modifications.

What is claimed is:

1. Apparatus for regulating the operation of a fuser assembly in accordance with selected information requiring the energization of said fuser assembly wherein the radiant energy accumulated by said fuser assembly is a function of the expiration of time from an immediately preceding energization thereof comprising:

sensing means for sensing the occurrence of a preselected information signal to energize said fuser assembly for a pre-established minimum period of time; and

energizing means coupled to said sensing means for energizing said fuser assembly for a period of time that is dependent upon the interval of time that has expired intermediate successive occurrences of said preselected information signal.

2. The apparatus of claim **1** wherein said sensing means comprises means for serially storing each preselected information signal and the number of predeter-

mined time durations separating successive ones of said pre-selected information signals in consecutive order; and

means coupled to said storing means for generating a first energizing signal admitting of said pre-established minimum period of time when a preselected information signal is stored in a first position of said consecutive order.

3. The apparatus of claim **2** wherein said energizing means comprises means for generating a second energizing signal when a preselected information signal is stored in a first position of said consecutive order and a number of predetermined time durations are stored in the next successive positions of said consecutive order, said second energizing signal admitting of a period of time that is a function of said number of successively stored predetermined time durations.

4. Apparatus for regulating the fusing of electroscopic particles to successive portions of a support base intermittently moving through a fuser assembly wherein said fuser assembly includes a source of thermal radiation coupled to a variable supply of voltage, comprising:

switch means included in said variable supply and adapted when energized to apply an increased voltage to said source of thermal radiation from said variable supply to increase the heat radiated by said source whereby said electroscopic particles are fused to said support base; and

means for energizing said switch means for a period of time when a portion of said support base is moved through said fuser assembly, said period of time being a function of the interval of time that has expired since an immediately preceding portion of said support base was moved through said fuser assembly.

5. The apparatus of claim **4** including storage means for storing the time related history of the movement of successive portions of said support base through said fuser assembly, said storage means being coupled to said means for energizing said switch.

6. The apparatus of claim **5** wherein said storage means comprises:

shift register means including an input terminal to which is applied a signal representing the movement of a portion of said support base through said fuser assembly; 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 said shift register means is a function of the history of the movement of said support base through said fuser assembly.

7. The apparatus of claim **6** wherein said means for energizing comprises:

first means for energizing said switch means for a pre-established minimum period of time when successive portions of said support base are moved through said fuser assembly within a first duration;

second means for energizing said switch means for a second pre-established period of time when a portion of said support base is moved through said fuser assembly at a time later than the expiration of a first interval of time after an immediately preceding portion is moved therethrough, said second pre-established period of time being greater than said pre-established minimum period of time; and

third means for energizing said switch means for a third pre-established period of time when a portion of said support base is moved through said fuser assembly at a time later than the expiration of a second period of time after an immediately preceding portion is moved therethrough, said second interval of time being greater than said first interval of time and said third pre-established period of time being greater than said second pre-established period of time.

8. The apparatus of claim **7** wherein said first means comprises first gating means coupled to the first position of said shift register means for producing a first energizing signal admitting of a pre-established minimum duration when said first position is occupied by a signal.

9. The apparatus of claim **8** wherein said second means comprises second gating means coupled to the first position of said shift register means and to a first preselected number of successive positions of said shift register means for producing a second energizing signal admitting of a second pre-established duration when said first position is occupied by a signal and none of said first preselected number of successive positions is occupied by a signal.

10. The apparatus of claim **9** wherein said third means comprises third gating means coupled to the second position of said shift register means and to a second preselected number of successive positions of said shift register means for producing a third energizing signal admitting of said pre-established minimum duration when said second position is occupied by a signal and none of said second preselected number of successive positions is occupied by a signal.

11. The apparatus of claim **10** wherein said first, second and third gating means are coupled to selective gating means, said selective gating means being adapted to produce a switch energizing signal admitting of said pre-established minimum duration when only said first energizing signal is produced, said second pre-established duration when only said first and second energizing signals are produced and a third pre-established duration when said first, second and third energizing signals are all produced.

12. The apparatus of claim **11** wherein said variable supply includes bidirectional current conducting means supplied with an AC voltage, said bidirectional current conducting means being initially conductive at a point in the half cycle of said AC voltage that is a function of a control voltage applied thereto such that an increase in said control voltage tends to advance the initial conductive point and a decrease in said control voltage tends to retard the initial conductive point, said control voltage being increased in response to the energization of said switch means.

13. In combination with a heating element that is maintained at a temperature level no lower than a quiescent level of temperature, said heating element radiating an amount of heat that is dependent upon the length of time expired between successive energizations thereof, apparatus for selectively energizing said heating element for variable time durations such that a substantially equal radiant energy level is attained thereby during each energization irrespective of the length of time that has expired since an immediately preceding energization thereof, comprising:

energizing means coupled to said heating element for supplying said heating element with energy;

storage means for storing signals representative of the history of the selective energization of said heating element;

first means coupled to said storage means and responsive to a selective energizing signal for energizing said heating element for a pre-established minimum duration of time when the immediately preceding energization of said heating element occurred within a first time duration;

second means coupled to said storage means and responsive to a selective energizing signal for energizing said heating element for a second pre-established duration of time when a first interval of time has expired since the immediately preceding energization of said heating element, said second pre-established duration of time being greater than said minimum duration; and

third means coupled to said storage means and responsive to a selective energizing signal for energizing said heating element for a third pre-established duration of time when a second interval of time has expired since the immediately preceding energization of said heating element, said third pre-established duration of time being greater than said second pre-established duration.

14. The combination of claim **13** wherein said storage means comprises plural stage 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, whereby the signals applied to said input terminal are shifted through said plural stages in timed relation such that the relative positions occupied by selective energizing signals is a function of the previous energizations of said heating element.

15. The combination of claim **14** wherein said first, second and third means comprise first, second and third gating means coupled to selective gating means; said first gating means including an input coupled to a first stage of said shift register means for producing a first energizing signal admitting of a pre-established minimum duration when a selective energizing signal is shifted into said first stage, said second gating means including an input coupled to said first stage of said shift register means and inputs coupled to a first preselected number of successive stages of said shift register means for producing a second energizing signal admitting of a second pre-established duration when a selective energizing signal is shifted into said first stage and none of said first preselected number of successive stages receives a selective energizing signal, said third gating means including an input coupled to a second stage of said shift register means and inputs coupled to a second preselected number of successive stages of said shift register means for producing a third energizing signal admitting of said pre-established minimum duration when a selective energizing signal is shifted into said second stage and none of said second preselected number of successive stages receives a selective energizing signal; and said selective gating means includes an output coupled to said energizing means for supplying said energizing means with a signal admitting of said pre-established minimum duration when only said first energizing signal is produced, a signal admitting of said second pre-established duration when only said first and second energizing signals are produced and a signal admitting of said third pre-established duration when said first, second and third energizing signals are all produced.

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