Dual mode electrographic recording apparatus comprising a slow speed input generated by a typewriter keyboard and a high speed input via a computer. The recording apparatus of the present invention is characterized by the provision of a developer structure having two modes of operation during one of which developer material is applied to the recording medium along a recording zone traversed by the slow speed recorder and zone occupied by a stationary high speed recording structure.

9 Claims, 5 Drawing Figures
DUAL MODE ELECTROGRAPHIC RECORDER

BACKGROUND OF THE INVENTION

This invention relates, in general, to a dual mode electrographic recording apparatus and, more particularly, to a developer system for use therewith.

Electrographic recording or the art of electrophotography constitutes a recording process wherein electrostatic charges are placed on an insulating recording medium by means of electrically pulsed electrodes or styli. These electrostatic charges are rendered visible by the application of electrophotographic marking particles by means of a brush or brush-like structure. Subsequently, exposures of the particles adhering to the recording medium, to heat or solvent vapor renders the images permanent.

As is well known, the foregoing recording process is an effective technique for producing alphanumeric hard copy output at high speeds as well as at low speeds. Accordingly, one application for this process is a keyboard computer terminal wherein the recording mechanism is operated at a relatively low speed in response to the keyboard input and at a relatively high speed in response to input from a computer.

Heretofore, the utilization of dual recording speeds in keyboard terminals has been accomplished by the provision of different mechanical drive arrangements for moving a single recording structure through a recording zone. Such drive arrangements are quite complex, adding to the overall expense of the apparatus and reducing reliability thereof. Moreover, they seriously limit the maximum recording speed obtainable.

The provision of low and high speed recording structures operating in low and high speed recording zones, respectively, obviates the above-mentioned shortcomings of the prior art, particularly, in an arrangement which utilizes an incremented recording head for the low speed input while utilizing a fixed array of conductive styli positioned in the high speed recording zone, the latter of which eliminates the requirement for a complex drive arrangement for the high speed mode of operation. Movement of the low speed recording head can be accomplished simply and inexpensively through a stepping motor or a continuous motor in conjunction with a clutch mechanism.

In keeping with the optimum design criteria (i.e., simple construction, high speed differentials and minimum expense) with respect to the fixed and moving recording structures employed in the electrographic recording arrangement discussed above, it is necessary to provide structure having the capability of presenting marking particles to the recording medium in two different recording zones while employing a simple design configuration compatible with high and low operating speeds.

Accordingly, the general object of this invention is to provide a new and improved recording apparatus.

It is a more particular objective of this invention to provide a new and improved recording apparatus utilizing electrographic recording techniques.

Another object of this invention is to provide a new and improved developer system for use in a dual mode electrographic recorder.

BRIEF SUMMARY OF THE INVENTION

Briefly, the above cited objects are accomplished by the provision of a dual mode recorder including a dual mode developer system capable of presenting developer material to a recording medium along or in two separate spaced apart recording zones including a low speed recording zone and a high speed one. The developer system is so constructed that it uses a single supply of developer material. To this end, an elongated brush or brush-like structure, in one mode of operation, serves as a developer applicator for developing electrostatic images adjacent the high speed zone and in a second mode of operation serves as a donor for a second applicator brush or brush-like structure which develops electrostatic images "on-line" in the low speed zone.

Other advantages and features of the present invention may become more apparent from reading the following detailed description in connection with the drawings forming a part hereof.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of an electrographic recording apparatus representing the invention;

FIG. 2 is a fragmentary perspective view of a low speed recording structure and drive therefor, forming a part of the apparatus of FIG. 1;

FIG. 3 is a cross-sectional view of a modified form of a developer structure for use in the apparatus of FIG. 1;

FIG. 4 is a view similar to that of FIG. 3, but illustrating a different mode of operation; and

FIG. 5 is a block diagram illustrating one method of controlling the apparatus shown in FIGS. 1 and 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Referring to the drawings especially FIG. 1, reference character 10 designates generally an electrographic recording apparatus which can be used for printing images on an insulating medium 12. The insulating medium may be of any composition suitable for electrographic recording, for example, plastic-coated paper, predried paper or any other dielectric material having a sufficient charge retention capability, to hold electrostatic images at least until development has been completed.

The recording medium 12 is preferably in the form of an elongated web supported on a supply reel (not shown) from which it is spooled through actuation of the web transporting structure generally indicated at 14. The web transporting structure comprises a motor 16 drivingly connected, as schematically illustrated, to one of a pair of web feed rollers 18 and 20.

The web transporting structure 16 serves to move the recording web 12 through a high speed recording station 22, a first developing station 24, a low speed recording station 26 and a fusing station 28. The other developing station is at the recording station 26 to thereby provide "on-line" image development. A backing electrode structure 30 supports the recording web at the recording stations as well as the developer stations and has an elongated dimension which extends perpendicular to the longitudinal dimension of the recording web.
The backing electrode 30 cooperates with the high speed electrographic recording structure 32, stationarily supported at the recording station 22. The recording structure 32 has an elongated dimension which is substantially coextensive with the backing electrode to form therebetween a high speed recording zone. The recording structure comprises a stylus arrangement 34 which in the preferred mode of operation contacts the recording web 12, however, the styli constituting the array may be spaced from the web 12. The specific details of the array which are not shown may comprise a linear configuration, extending in the direction of the elongated dimension, of parallel styli or conductive electrodes which are electrically insulated one from the other.

The recording structure 32 is commonly employed for the generation of alphanumeric characters at very high speeds. With such a structure each character or symbol is composed of selected areas from a matrix of areas. For example, a plurality of $5 \times 7$ matrices may be employed, one for each alphanumeric character to be recorded by the recording structure along the width of the recording medium. The input to the fixed recording structure is derived from a computer and suitable interfacing logic components. Depending upon the specific results desired, the input may be serial or parallel. Other recording techniques can be employed for example, various types of optical character generators could be substituted for the electrographic system described, the primary requisite being in the speed with which the characters are to be generated.

The electrographic images placed on the recording web 12 are rendered visible at the developer station 24 through the application of electroscopic marking particles 35. The foregoing is accomplished by means of an applicator brush or brush-like structure 36 supported for rotation by a drive arrangement including a motor 38. In the embodiment illustrated in FIG. 1, the structure 36 comprises an applying member 42 having a generally cylindrical applying surface 40 mounted on a support member 44 which, in turn, is affixed to a shaft 46. The brush or brush-like structure 36 is rotated such that the applying member 42 moves through the marking particles 35 contained in the sump area of a developer supply housing or hopper 48. The marking particles or developer adhere to the applying member and are therefore carried thereby to the surface of the recording medium.

The drive arrangement and motor 38 are adapted for continuously rotating the structure 36 in the counterclockwise direction, as viewed in FIG. 1, during the high speed recording mode of operation. During a low speed recording mode, the drive arrangement rotates the structure 36 in the counterclockwise direction, in a manner to be described hereinafter.

A recording structure 48 pivotally affixed to a carriage assembly 49 supported for reciprocating movement at the low speed recording station 26 and through a low speed recording zone extending transversely of the recording web. A shaft 50 (FIGS. 1 and 2) supports the carriage assembly for such movement which is effected by a suitable motor 52 which as presently contemplated is a continuous drive motor, however, a conventional stepping motor may be employed. The output of the motor is selectively coupled to a drive pulley 54 by a clutch not shown in detail which is selectively engaged or disengaged by appropriate signals. The origin of these signals will be discussed in detail hereinafter.

The drive pulley 54 frictionally engages a cable 56 which is supported by idler pulleys 58 and 60. The cable 56 is attached to opposite sides of the carriage to thereby transmit the output torque from the motor 52 thereto. A carriage return mechanism (not shown) which may be a conventional clock motor is wound by the motor 52 during a recording cycle. Unwinding of the clock motor serves to return the recording structure to a start-of-recording position after each recording cycle.

The recording structure 48 comprises a stylus array 62 which is not shown in detail but may include a linear configuration of parallel conductive electrodes or styli suitably insulated electrically one from another. The array may be mounted in or on an insulative support forming a part of the recording structure through which electrical conductors may be provided to supply electrical recording signals individually to each stylus. These electrical conductors may terminate at any suitable place on the recording structure in the form of a socket or other type of electrical terminal to facilitate connection to or commutation with a source of recording signals.

In operation the recording structure 48 is driven from left to right, as viewed from the right in FIG. 1 or from the upper right of FIG. 2, across the recording medium 12 during the application of suitable recording signals to the stylus. During the stepwise movement, in a manner to be discussed hereinafter, of the recording structure a predetermined amount referred to as a character space, a character is recorded on the electrographic recording medium 12 in the form of a latent electrostatic charge pattern. The recording medium preferably remains stationary in the recording zone during the left-to-right traversal of the recording structure, during which an entire line of characters is recorded. At the terminal point of movement of the recording structure a suitable microswitch or other means may be actuated by the presence of the recording structure to actuate the aforementioned clutch associated with motor 52 to disengage the pulley 54 from the motor. The clock motor previously referred to may then unwind expending its stored energy to move the recording structure from right-to-left, to return it to its initial left margin position. The actuation of the switch which effects the carriage return may also be utilized appropriately for advancing the recording medium through energization of the motor 16.

A developer applicator 64 is provided for developing the latent electrostatic images formed by the stylus array 62. The applicator structure 64 is supported for rotation by a shaft 66 supported in suitable bearings (not shown), the motive power being supplied by a motor 68. As shown in FIG. 2, the applicator structure 64 comprises a semicircular applying member 70 mounted on a support 72 which, in turn, is supported by the shaft 66. The applying member 70 is shown to have a cylindrical developing periphery 74. A substantially planar surface 75 forms an acute angle with the stylus array 62, as viewed in FIG. 1, to thereby permit "instant viewability" of developed alphanumeric symbols.
The developing surface 74 is loaded with electroscopic marking particles 35 through contact with the brush-like structure 36 which in the low speed recording mode serves as a donor structure for the applicator 64. The drive arrangement and motor 38 is adapted to incrementally rotate the brush-like structure 36, approximately 90° each time the recording structure 48 completes a line of recorded information.

The shaft 66 is provided with a key-way 76 which cooperates with a spline 78 of the applicator 64 to provide a driving connection therebetween. The support 72 and the carriage assembly 49 are provided with bores for receiving the shaft 66 thereby permitting sliding movement relative to the shaft. To this end, the keyway 76 is coextensive with the shaft 66.

In operation, it is preferred that the applicator 64 be advanced through its developing cycle each time a character-shaped charge pattern is placed on the recording medium 12. In accordance with the foregoing, the motor 68 may either be a conventional stepping motor or it may be a continuously running motor which is associated with a clutch arrangement which provides for incremental rotation of the brush.

During the high speed mode of operation the applicator 64 is rotated approximately 90° counter-clockwise, as viewed in FIG. 1, so that it is out of contact with the recording web 12. Simultaneously, the stylus array which now occupies the left hand margin is retracted from the web. These functions may be simply perfected by employment of suitable controls for effecting momentary operation of the motor 68 to thereby rotate the applicator the required amount. The system, it will be appreciated, may be programmed to enable the clock motor mentioned hereinafter at any time the printer is in communication with the computer rather than the keyboard. This will effect movement of the carriage assembly 49 to its home position where a simple cam arrangement, now shown, in opposition to a bias member 80 is effective to retract the stylus array 62 from the recording web. During the rest of the high speed mode of operation the motor 68 will be inactivated.

As shown in FIGS. 3 and 4, a modified form of the developing system employed in the embodiment of FIG. 1, is generally indicated by the reference character 100. The development system 100, like the system illustrated in FIG. 1, is a dual mode development arrangement comprising a development member 102 which extends across the full width of web 12.

The development member 102 comprises a cylindrical drum member 104 the outer periphery of which may be coated with a layer 106 of polystyrene methyl methacrylate. This substance has a strong affinity for electroscopic marking particles and due to the rotating action of the member 102 through a supply of developer 108 comprising marking particles mixed with iron filings the layer becomes heavily coated with these marking particles. Rotation of the member 102 is accomplished by means of a drive arrangement including a reversible motor 110. During operation of the motor 110 such as to rotate the member 102 in the counterclockwise direction as viewed in FIG. 3, the member 102 acts as a donor for a semicircular brush structure 112 which may be similar to the brush or applicator structure 64. During counterclockwise rotation of the member 102, the low speed recording mode of operation takes place.

During the high speed recording mode of operation when the printer is under the control of a computer, the motor 110 rotates the member 102 in the clockwise direction. Simultaneously, as in the case of the embodiment disclosed in FIG. 1, the brush 112 is rendered inoperative in order to prevent double development. A magnet 114 stationarily disposed internally of the member 102 converts the development system 100 to a magnetic brush system during the high speed mode of operation with the member 102 rotating in the clockwise direction.

The iron particles or filings attract the electroscopic marking particles thereto and serve as a carrier therefor during the high speed operation of the system. The magnet 114, as shown in FIG. 4, causes a brush-like orientation of the marking particles and iron filings to which the particles adhere about the surface of the member 102 to thereby cause marking particles to be presented to the recording web at a recording zone 116. While the magnet 114 has the effect of forming a magnetic brush developer system during clockwise rotation of the member 102, it will be seen from a consideration of the field properties of the magnet 102 that during counterclockwise rotation of the member 102, the electroscopic marking and iron filings will be confined thereby to the bottom of the trough 120.

Having described the mechanical structure of the recorder and its development system, one possible way of controlling the modes of operation thereof will now be described in conjunction with the block diagram illustrated in FIG. 5. As can be seen the input to the high speed recorder head 32 is derived from a computer 130 while the input to the low speed recorder head is derived from a keyboard 132 forming a part of a computer terminal control 134. The terminal is adapted to be operated in the computer-input mode by a program control switch 136 and in the keyboard-input mode via a program control switch 138.

The keyboard 132 may generate an appropriate binary code uniquely identifying the alphanumeric symbol corresponding to the actuated key of the keyboard. This binary code, such as used in the American Standard Code for Information Interchange, is provided to the input of a conventional decoder circuit 140 which decodes the binary code to generate a character pulse on one of a series of parallel outputs indicative of the alphanumeric symbol selected at the keyboard 132. Output conductor 142 is intended to represent a number of outputs, each corresponding to a separate alphanumeric character of the symbols incorporated in the keyboard 132.

These outputs collectively provide one input to a stylus pulsing circuit 144 which may take various forms. For example, the pulsing circuit 144 may consist of a diode matrix having a number of character select input wires which correspond to the outputs of the decoder circuit 140. These wires are selectively coupled to read-out wires via diodes which are forward biased when their respective character select wire is energized. Another form which the pulsing circuits may take is a magnetic core matrix, having five columns and seven rows, wherein a particular character select wire associated with one of the outputs 142 intertwines an
appropriate pattern of magnetic cores corresponding to the alphanumeric symbol to be recorded. The pulsing circuit as well as the other parts of the block diagram of FIG. 5 are not intended to form a particular part of the present invention per se and, therefore, are shown schematically only since well known conventional circuits may be employed to provide their functions.

Output 146 from the decoder simply provides a signal indicative of the fact that a binary code has been decoded by the decoder 140. In this manner, for each character entered at the keyboard 132 which effects a decoding process in the decoder 140, an output signal is generated on the conductor 146. This effectively provides a control pulse or signal to the pulsing circuitry which may initiate, for example, in the case of a magnetic core matrix, a distributor circuit which would sequentially read out each column of a character matrix at a rate correlated to the speed of the recorder head 48. As each column is sampled by the distributor circuit, a group of parallel outputs would be energized depending on the cores set by the character select wire. The signals on these parallel outputs would be supplied to a suitable driver stage which would provide parallel recording signals to the stylus in the stylus array 62 via output 148.

Additionally, the signals present on the output 146 are supplied to a conventional counter circuit 150 via conductor 152. The counter circuit 150 is used to indicate at its output 154 when a predetermined number of characters have been decoded by the decoder 140. In a conventional arrangement wherein each recorded line on the recording web 12 will accommodate 80 characters, the capability of the counter 150 would be such as to provide an output pulse at the output 154 when a count of 80 has been arrived at by the counter 150. This may then be used to also reset the counter to its initial condition. The output pulse from the counter 150 may be suitably delayed by conventional relay device 156 for the time necessary for the stylus array or recorder 48 to move one character space in its left-to-right direction of movement.

In the foregoing manner, the delay circuit provides a signal indicative of the fact that the stylus array 62 has completed a recording traversal across the recording medium 12. This signal is employed to affect momentary energization from the motor 38 via conductor 158 to effect rotation of the brush-like structure 36 through an angle of approximately 90° counterclockwise, as viewed in FIG. 1. The utilization of the counter 150 and the delay device 156 is intended as exemplary only, of one manner for timely actuation of the brush-like structure 36 at the end of each recording traversal. This may also be accomplished by applying a microswitch, actutable by the presence of the carriage assembly 49 at the right margin of the recording medium. The actuation of such a switch may be utilized to momentarily energize the motor 38.

Simultaneously with the energization of the motor 38 via conductor 158, an escapement release mechanism 160, which may be in the form of a solenoid energized at the end of a recording cycle, enables the aforementioned clock motor in order to return the carriage 49 to its home position. At this time, the pulley 54 is disconnected from the motor 52, permitting carriage return. The web drive motor 16 may also be momentarily ener-

gized at this time to effect incremental movement of the web 12.

During a low speed recording cycle, the output pulses from the decoder 140 serve to pulse the motor 52 via conductor 162 and delay circuit 164. The motor 52 through its associated clutch causes movement of the stylus array the equivalent of one character space, only after the provided delay. The delay serves the purpose of allowing an adequate time for the stylus to place a symbol on the recording web before the stylus is moved.

A delayed output from the decoder 140 is also utilized to pulse the motor 68 an amount sufficient to effect rotation of the developer applicator 64. Since in the direction of recording, the applicator 64 trails the stylus array 62, development of an alphanumeric character is accomplished during movement of the stylus array to its next recording zone. In this mode of operation the brush 36 acts as a donor for the brush 64.

In the computer-input or high speed mode of operation the switch 136 of the terminal 134 is closed thereby enabling communication with the computer 130 in lieu of the keyboard. In this instance, binary coded signals from the computer are decoded by means of a decoder 166 receiving such signals from the computer via conductor 168. Where the input to the decoder 166 is a character at a time, the decoder and stylus pulsing circuitry 170 associated therewith may be the same as that utilized in conjunction with low speed recording. Where, however, it may be desired to simultaneously form all the characters to be printed, other conventional apparatus may be employed.

In order to develop a line of alphanumeric characters at a time, during the high speed mode of operation, the drive arrangement and motor 38 is continuously rotated and is appropriately energized by conductor 172. At this time the motor 68, either directly or indirectly through a suitable clutch arrangement, is momentarily energized to move the brush 64 to its inactive position where it is out of contact with the recording web 12.

We claim:

1. Apparatus for rendering latent images visible, said apparatus comprising:
   a first developer applicator having an arcuate surface capable of retaining developer, said first applicator being rotatably supported adjacent the path of movement of a recording member;
   a second developer applicator capable of retaining developer, said second developer applicator being rotatably supported adjacent the path of movement of said recording web;
   means containing a supply of developer through which said second applicator is rotatable;
   means rendering said second developer applicator operable in a first mode of operation to bring developer to a zone through which said recording member passes;
   means for preventing said second applicator from bringing developer to said zone, in a second mode of operation; and
   means operable to effect cooperative engagement of said first and second applicators during said second mode of operation whereby said second applicator serves as a donor for said first applicator.
2. Apparatus according to claim 1 wherein, said developer comprises electroscopic marking particles mixed with iron particles; and said means rendering said second developer applicator operable in a first mode comprises means for rendering said second applicator operable as a magnetic brush.

3. Apparatus according to claim 2 wherein, said means rendering said second developer applicator operable in said first mode comprises drive means for rotating said second applicator in one direction; and a magnet positioned adjacent the path of said recording web and disposed internally of said second applicator structure, said magnet being ineffective to render said second applicator operable as a magnetic brush during rotation of said second applicator in a direction opposite said one direction.

4. Combination donor and developer applicator structure for use in a developing system, said structure comprising:
   a member having a continuous surface, said surface exhibiting a relatively high affinity for electroscopic marking particles whereby rendering said structure suitable as a donor member;
   means supporting said member for movement in two directions; and
   means for rendering said structure operable as a magnetic brush during movement in only one of said directions whereby said structure functions as a developer applicator.

5. Combination donor and developer applicator structure for use in a developing system, said structure comprising:
   a member having a continuous surface exhibiting a relatively high affinity for electroscopic marking particles;
   means for selectively moving said member in opposite directions;
   means for rendering said member operable as a magnetic brush during movement of said member in only one direction.

6. Structure according to claim 5 wherein, said means for selectively rendering said member operable as a magnetic brush comprises a magnet stationarily disposed within said continuous surfaced member.

7. A dual mode electrographic apparatus comprising:
   a linear array of conductive styli;
   an elongated backing electrode defining a first recording station;
   means for selectively incrementing said linear array of styli through a first recording zone opposite said backing electrode during a first recording mode;
   first developer applicator means having an arcuate surface capable of retaining developer particles for bringing said particles to said first recording zone, said applicator being selectively rotatable about an axis substantially parallel to said first recording zone;
   a fixed linear array of conductive styli positioned opposite said elongated backing electrode and substantially coextensive therewith and forming a second recording zone therebetween;
   means for moving a web of insulative recording medium, first between said fixed array of styli and said elongated backing electrode and secondly between said elongated backing electrode and said incrementally movable array of styli;
   second development applicator means positioned along the path of the web between the first and second recording zones having a surface capable of retaining developer particles and rotatable about an axis parallel to the axis of said first developing applicator means;
   means rendering said second developer applicator operable in said first mode of operation to bring developer to said web at said first recording zone;
   means for preventing said second applicator from bringing developer to said web at said second recording zone, in a second mode of operation, while serving as a donor for said first applicator; and
   means operable to effect cooperative engagement of said first and second applicators during said second mode of operation whereby said second applicator serves as a donor for said first applicator.

8. Apparatus according to claim 7 wherein, said developer comprises electroscopic marking particles mixed with iron filings; and said means rendering said second applicator operable in said first mode of operation comprises means for selectively rendering said second applicator operable as a magnetic brush.

9. Apparatus according to claim 8 wherein, said means rendering said second developer applicator operable in said first mode comprises drive means for rotating said second applicator in one direction and a magnet positioned adjacent the path of movement of said recording web and disposed internally of said second applicator structure.