

[54] **ELECTROGRAPHIC RECORDING PROCESS AND APPARATUS EMPLOYING SYNCHRONIZED RECORDING PULSES**

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[51] Int. Cl.² **G03G 15/06**

[58] Field of Search **346/74 E, 74 CH, 74 ES, 346/74 S, 74 SB; 178/6.6 A**

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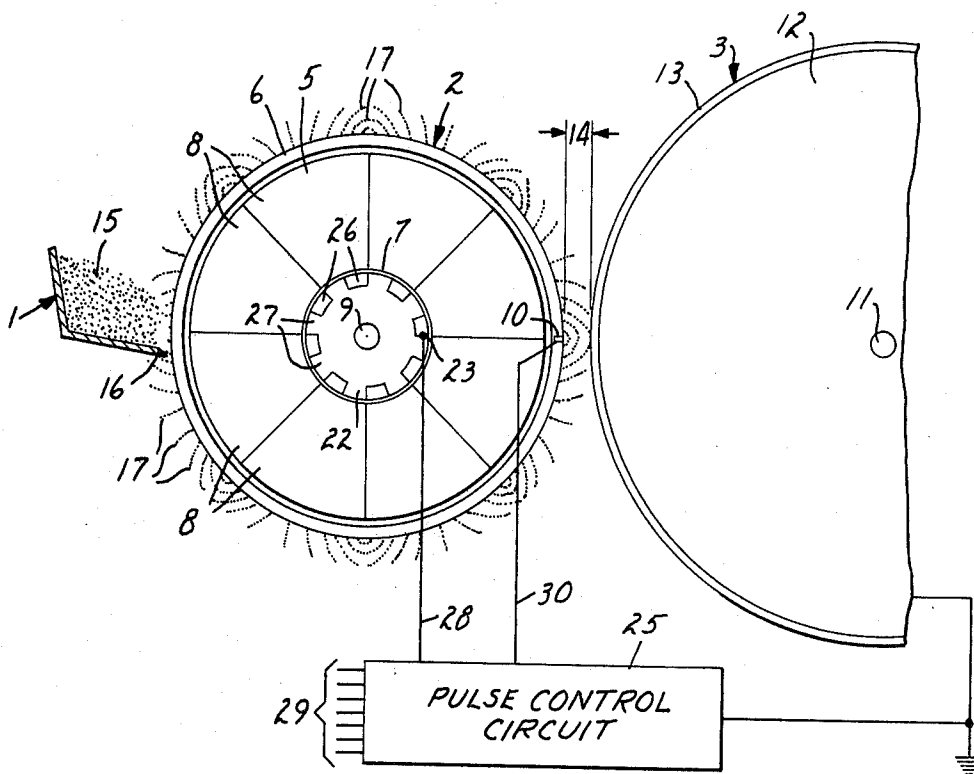
Assistant Examiner—Jay P. Lucas

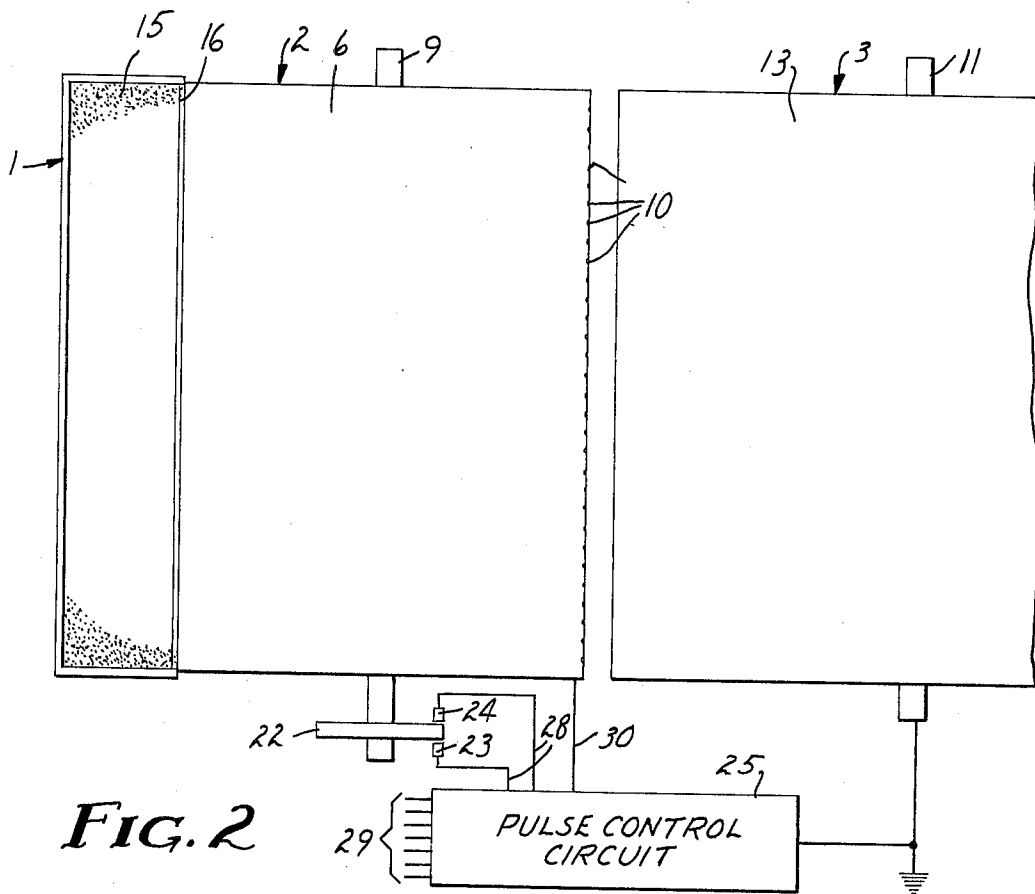
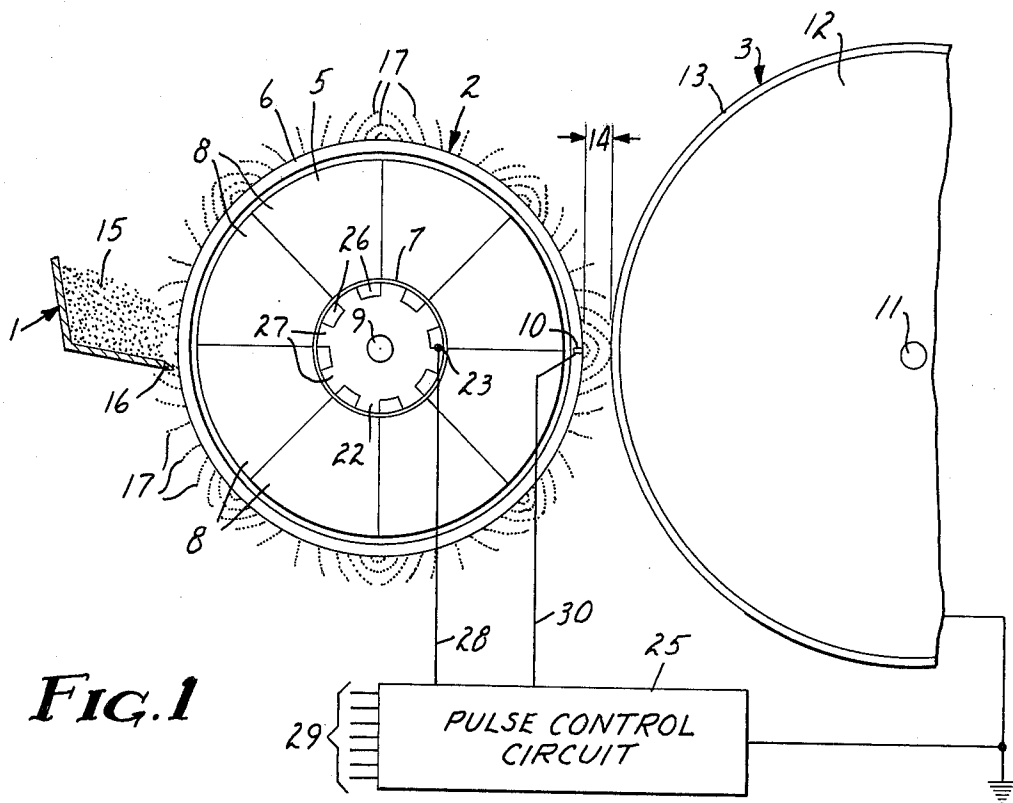
Attorney, Agent, or Firm—Alexander, Sell, Steldt & DeLaHunt

[57] **ABSTRACT**

An improved electrographic recording process and apparatus are provided wherein a recording medium is arranged between two spaced opposed electrodes, one of which is in contact with one side of the recording medium, and the other of which is a recording electrode that indirectly contacts the opposite side of the recording medium through an electrically conductive, magnetically attractable toner powder. Such toner is drawn into a recording region between the recording electrode and the recording medium by an alternating magnetic field, and an electrical record signal of short duration is applied to one of the electrodes at such time that the alignment of the toner in the recording region is at an optimum for providing toner deposition on the recording medium.

21 Claims, 8 Drawing Figures





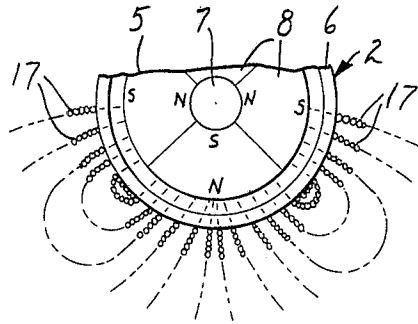


FIG. 3

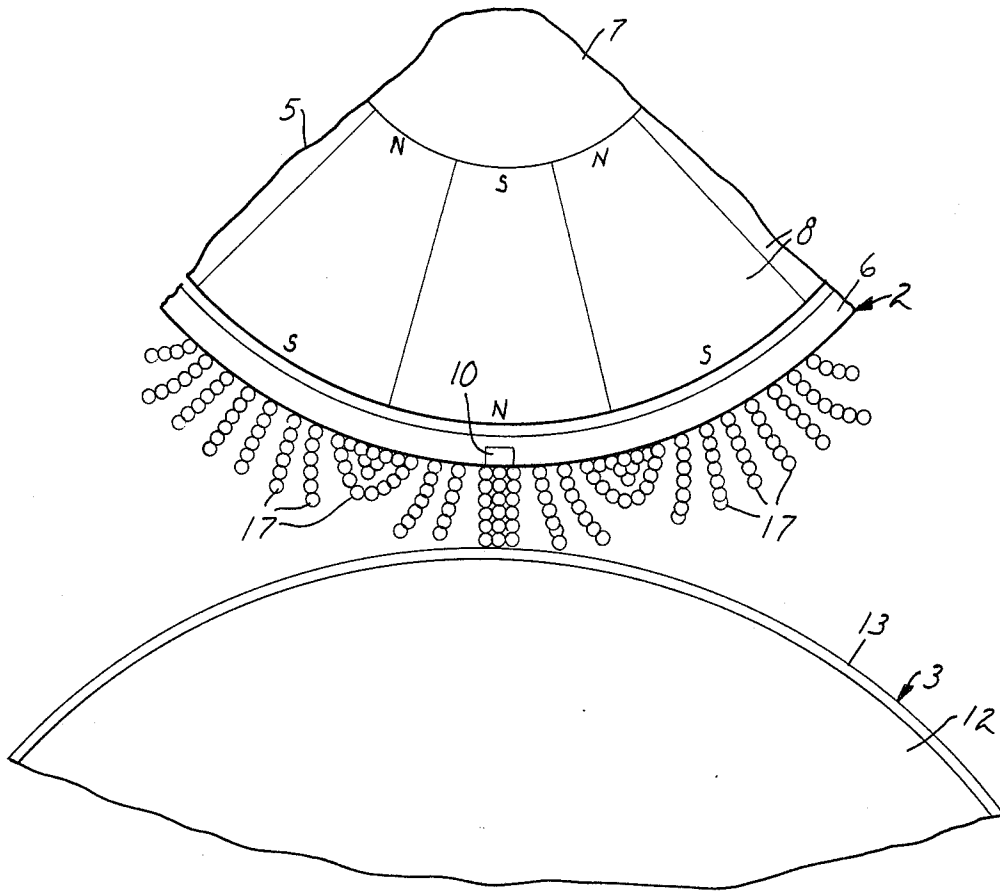


FIG. 4

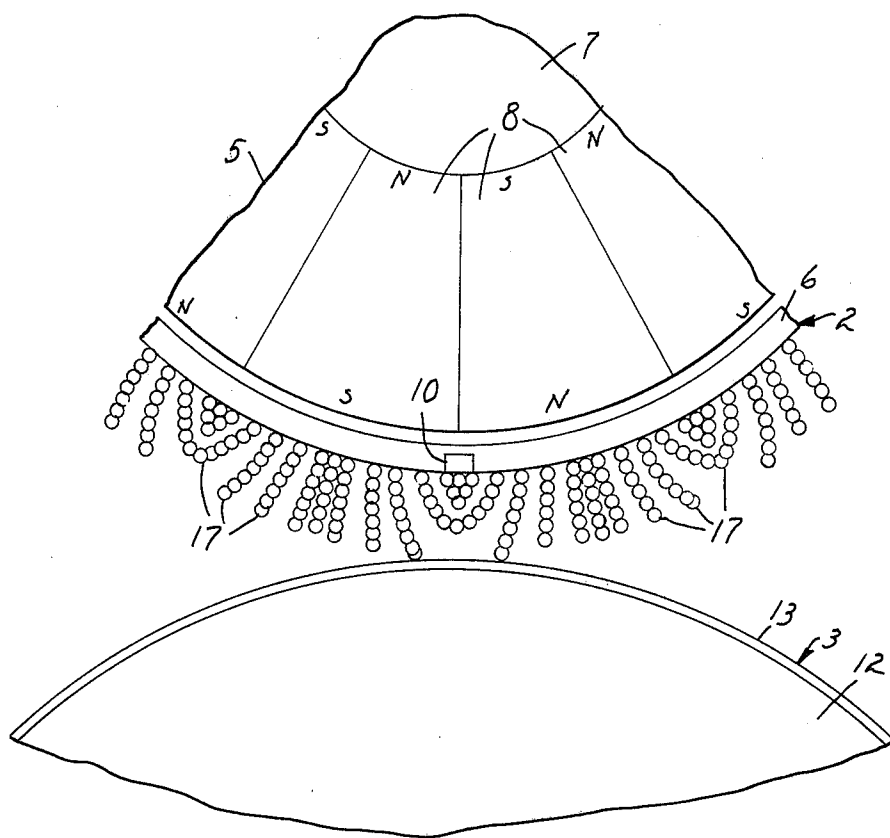


FIG. 5

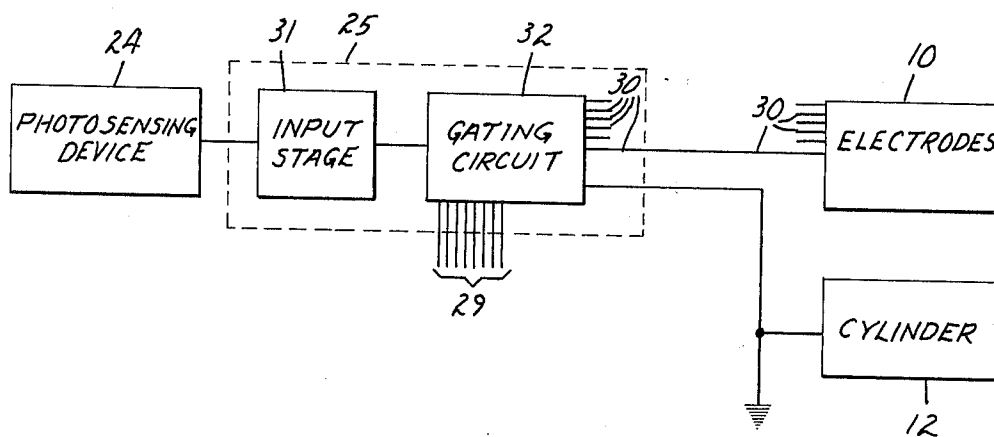


FIG. 6

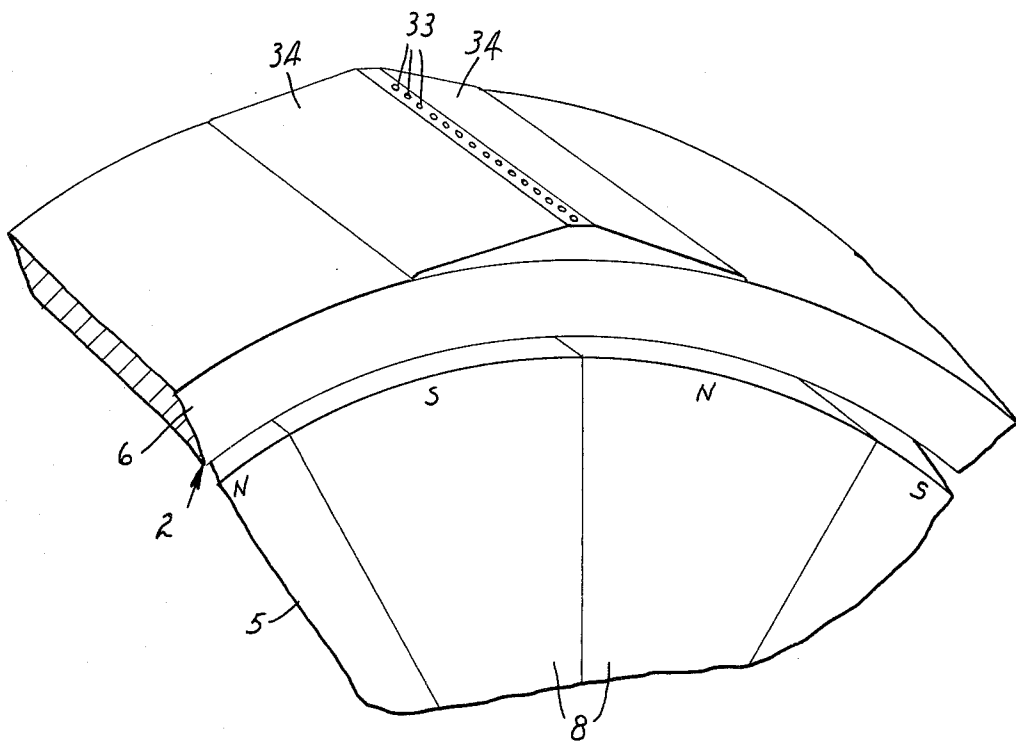


FIG. 7

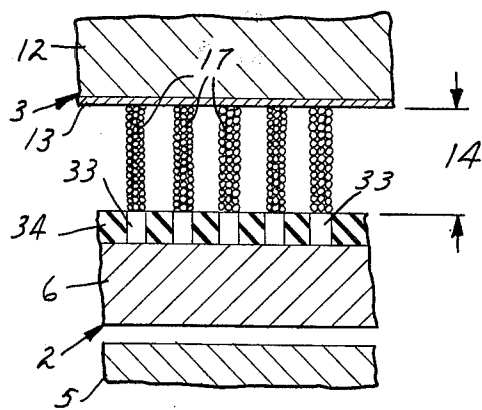


FIG. 8

ELECTROGRAPHIC RECORDING PROCESS AND APPARATUS EMPLOYING SYNCHRONIZED RECORDING PULSES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates in general to the field of electrographics and more specifically to an improved method and apparatus for electrographically recording toner images on a recording medium.

RELATED PATENT APPLICATION

A recording system to which the present invention is related is disclosed in copending U.S. Pat. application Ser. No. 353,139 filed Apr. 20, 1973, and includes a recording electrode that is pulsed with a voltage potential to produce a deposition of toner powder on a recording medium. In one embodiment of such system, the recording electrode is located on the same side of the recording medium as the toner, but no method for transporting the toner to the recording electrode is shown for that embodiment. One method for transporting the toner to the recording electrode of such a system would be the use of a rotating permanent magnet assembly with alternating "North" and "South" poles that produce a periodic cyclic attraction for the toner. However, a rotating magnet assembly has the deficiency that the amount and alignment of toner in the recording region would vary between minimum and maximum levels as a result of the cyclic magnetic force. Variation in the level of toner in the recording region, as well as the direction of the toner chains therein, may give rise to variations in the amount of toner transferred to the recording medium during the recording process and, thus, inhibit the recording of toner images at consistent and high quality levels of density and resolution.

The present invention provides an improved method for electrographic recording to produce high quality toner images on a recording medium at high speeds in a reliable, repeatable fashion with substantially no variation in the amount of toner transferred to the recording medium.

SUMMARY OF THE INVENTION

The present invention resides in a process and apparatus for improved electrographic recording of toner images on a recording medium. The apparatus of the present invention includes spaced opposed first and second electrode means with a recording region therebetween, a passive recording medium disposed in the recording region with a first surface in electronic contact with the second electrode means, an electronically conductive, magnetically attractable toner powder that is drawn into the recording region by a cyclic magnetic force to form an electronically conductive path between the first electrode means and the recording medium, and electronic circuitry for applying timed voltage potential pulses of short duration to one of the electrode means at a rate synchronized with the cyclic magnetic force. The recording process of the present invention involves drawing the magnetically attractable toner into the recording region by the cyclic magnetic force and applying the voltage potential pulses provided by the electronic circuitry to one of the electrode means when the amount and alignment of toner in the recording region is at an optimum condition for forming

a high density deposition of toner powder in the form of toner images on the recording medium.

In a preferred embodiment the first electrode means is mounted on an outer shell of a developer roll that includes an inner rotating magnet rotor formed with a plurality of magnet sectors. An indicator disk is coaxially mounted with the developer roll and rotates in correspondence with the rotation of the magnet rotor. Sensing means are associated with the indicator disk for sensing the rotation of the indicator disk and supplying a signal to the electronic circuitry that furnishes the voltage potential pulses to one of the first and second electrode means. The rotation of the indicator disk and the magnet rotor are synchronized such that the signal to the electronic circuitry causes the potential pulses to be supplied by the electronic circuitry when the first electrode means is substantially aligned with the radial axis of one of the magnet sectors forming the magnet rotor.

In a modified embodiment, the first electrode means is formed of a plurality of magnetically permeable electrodes protruding from the shell of the developer roll, and the magnet sectors forming the magnet rotor induce a magnetic field of relatively high intensity in each electrode. As a result, toner that comes within a close proximity to the electrodes is concentrated in the region at the outer end of the electrodes and extends out to the surface of the recording medium in the recording region. Because of such concentration, there is an area around each electrode that is void of toner, and also there is an isolation of the toner on each electrode from that on the other electrodes. Accordingly, consistent and high quality recording of toner images is achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic side view of an electrographic recording system incorporating the present invention;

FIG. 2 is a plan view of the system of FIG. 1;

FIG. 3 is a fragmentary, diagrammatic side view showing the alignment of toner particle chains on the periphery of a developer roll included in the system of FIG. 1;

FIG. 4 is a diagrammatic side view showing the manner in which toner chains on the developer roll of FIG. 3 bridge between the developer roll and a recording member at certain instances of time;

FIG. 5 is a side view illustrating the alignment of the toner chains on the developer roll of FIG. 3 at other instances of time;

FIG. 6 is a block diagram of the electronic circuitry employed in the present invention;

FIG. 7 is a fragmentary view of the developer roll of FIG. 3 showing an array of recording electrodes mounted thereon; and

FIG. 8 is a diagrammatic view showing a plurality of the electrodes of FIG. 7 and toner chains bridging between such electrodes and the recording member of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and with specific reference to the diagrammatic views of both FIGS. 1 and 2, there is shown a system that represents a preferred embodiment of the present invention for the electrographic recording of toner images on a recording me-

dium. Included in this electrographic system are a toner powder reservoir 1, a cylindrical developer roll 2 and a rotatable recording member 3.

The developer roll 2 preferably is of the type disclosed in Anderson, U.S. Pat. No. 3,455,276 and has an inner magnet rotor 5 and an outer cylindrical shell 6 characterized by low magnetic permeability and low electrical conductivity. The magnet rotor 5 includes a cylindrical, magnet support core 7 and a plurality of permanent magnet sectors 8 arranged about and extending parallel to the cylindrical surface of the support core 7 to define a cylindrical peripheral surface having alternating North and South magnetic poles. The developer roll 2 is disposed on an axle 9 and is constructed in such fashion that the support core 7 and the magnet rotor 5 rotate in a clockwise direction, whereas the outer shell 6 is spaced from the magnet rotor 5 and preferably is fixed in position. However, if desired, the outer shell 6 may be driven to rotate, but such rotation must be at a speed or in a direction that differs from the rotation of the support core 7. Arranged along a line that is parallel to the axis of axle 9 are a plurality of individual, spaced apart recording electrodes 10 (only one of which is shown in FIG. 1) that are disposed in the exterior surface of the shell 6 to lie substantially flush with such surface and define a first electrode means. The electrodes 10 are normally utilized to serve as a printing electrode matrix and each electrode 10 prints a dot, the definition of which is defined by its shape, density and distribution of density. For purposes of illustration the size of the electrodes 10 is enlarged in the drawings. Under normal conditions at least 200 electrodes per inch are disposed on the developer roll 2.

The recording member 3 is mounted on an axle 11 parallel to the axle 9 of the developer roll 2 and is preferably rotatably driven clockwise to rotate in the same direction as the magnet rotor 5 of the roll 2. The recording member 3 is formed of an electronically conductive cylindrical electrode 12 and an endless recording medium 13. The electrode 12 serves as a second electrode means and is positioned in a spaced opposed relationship with the electrodes 10 to define a recording region 14 therebetween. The electrode 12 also serves as a support means for the recording medium 13, which preferably is formed from an anodized aluminum, overlaid or coated on the periphery of the electrode 12 and is in electronic contact therewith. The term "electronic contact" is herein defined as that contact between two materials wherein the charge transport across the interface of the two materials is determined solely by the electronic properties of the two materials and not by other intervening or surrounding materials.

The endless construction of the recording medium 13 is particularly adapted for use in a display and viewing device. As previously recorded information on the medium 13 enters the recording region, such data can be erased by the electrodes 10 and new data recorded thereon where the old data existed, without any merging of the two. Use of an anodized aluminum recording medium 13, however, is not essential, nor must the medium 13 be fixed to the support cylinder. Instead a wide variety of materials may be employed to form the medium 13, including the use of a paper tape web that is fed through the recording region 14. Such a web could be coated on one side with a conductive material that

would contact the cylindrical electrode 12 and, thus, serves as the second electrode means. However, the recording medium 13 should have a lower limit of volume resistivity of 10^7 ohm-cm, and a relatively smooth non-tacky surface.

The toner powder reservoir 1 is filled with a magnetically attractable, electronically conducting toner powder 15, such as disclosed in Nelson, U.S. Pat. No. 3,639,245. The reservoir 1 includes a doctor blade 16 that extends in an axial direction with the roll 2 but is spaced therefrom, to meter the toner 15 in an even layer onto the outer shell 6 of the developer roll 2. The toner 15 is held on the periphery of outer shell 6 by the magnetic fields of the magnet sectors 8 and becomes arranged in the form of toner particle chains 17, as indicated most clearly in FIG. 3. The toner chains 17 align themselves with the magnetic flux lines of force of the magnet sectors 8. Due to the rotation of the magnet sectors 8 and the alternating disposition of the North and South magnetic poles thereof, the magnetic lines of force produced by the sectors 8 vary the alignment of each toner chain 17 in such fashion that the chains 17 fluctuate between lying adjacent to the surface of the shell 6 and protruding straight out therefrom. In this way, the toner chains 17 tumble about the periphery of the shell 6 in a counter clockwise direction at a rate not greater than the rotation of the magnet sectors 8.

The toner chains 17 are transported on the developer roll 2 through the recording region 14 and end portions of certain of the toner chains 17 physically contact the recording medium 13. Deposition of the portions of the toner chains 17 in contact with the recording medium 13 and one of the electrodes 10 occurs when a sufficient recording voltage potential is applied to either the electrode 10 or the cylindrical electrode 12 and the other is grounded to produce a voltage potential therebetween. Such voltage potential produces an electrostatic field that acts as a force pattern of intelligence for exerting a force on the portions of the toner chains 17 contacting the medium 13, which force opposes the magnetic attraction of the magnet sectors 8 for the toner 15 to produce a deposition of the toner 15 on the medium 13, as described in detail in U.S. Pat. application Ser. No. 353,139 filed Apr. 20, 1973, and naming Arthur R. Kotz as inventor, which application is incorporated herein by reference. The function of the recording medium 13 is to support the electrostatic field developed between the cylindrical electrode 12 and the portions of the toner in contact with the recording medium 13 when they are at differing voltages. The dominant electrical characteristic of the medium 13 is its volume resistivity, which may be nonlinear or polarity sensitive such as in photoconductors or semiconductors. Volume resistivity of the recording medium 13 must be of such value to produce an electrostatic field sufficient to deposit a required amount of toner on the medium 13. In general, as previously mentioned, a volume resistivity of 10^7 ohm-cm or greater is sufficient, but in no event should the volume resistivity be of such magnitude that there is not some current flow between the electrode 12 and the toner deposited on the medium 13 to relax the electrostatic force holding the toner on the medium 13 so that the toner can be subsequently erased from the medium 13 upon reentering the recording region 14.

Although the present invention encompasses the basic electrographic recording process taught by Kotz, the present invention adds a new dimension to the teachings of Kotz, which did not involve a rotating magnet rotor and set out no definite criteria for timing the application of record voltage potential pulses to produce optimum toner depositions on the recording medium 13. Applicants have found that the cyclic nature of the magnetic fields of force urging the toner chains 17 around the periphery of the developer roll 2 produces cyclic changes in the effective conductivity of the electrical path from the electrodes 10 to the recording medium 13 because of the constantly changing alignment of the toner chains 17 in the recording region 14. At times the toner chains 17 in the recording region 14 bridge between the periphery of the developer roll 2 and the medium 13 to provide conductive paths of relatively high conductivity between the electrodes 10 and the medium 13. At other times, the chains 17 in the recording region 14 bridge from one point of the developer roll 2 to another point thereon so that relatively low conductive paths result. The effective conductivity provided by the toner 15 in the recording region 14 because of bridging of the toner chains 17 between the electrodes 10 and the medium 13 is at a maximum when the electrodes 10 are substantially in line with the radial axis of one of the magnet sectors 8, as shown in FIG. 4. In contrast, nulls in the effective conductivity provided by the toner powder 15 in the recording region 14 due to bridging of the toner chains 17 between two points of the developer roll 2 occur when the electrodes 10 are aligned with the interface between adjacent sectors 8, as indicated in FIG. 5.

The present invention utilizes the variations in the effective conductivity and alignment of the toner chains 17 in the recording region 14 by synchronizing the application of record voltage potentials pulses to either the electrodes 10 or the cylindrical electrode 12 with the rotation of the developer roll magnet rotor 5 such that each pulse is applied when the effective conductivity of toner chains 17 bridge between the developer roll 2 and the recording medium 13 is at a maximum. In this way, a dense distinct pattern of the toner 15 is deposited on the medium 13. Furthermore, optimum deposition of the toner 15 is achieved with little variation in the amount of toner transferred to the recording medium 13 during each recording cycle.

Referring again now to FIGS. 1 and 2, synchronization between the rotation of the magnet rotor 5 and the application of the recording voltage potential pulses is furnished by an indicator disk 22, a sensing means which may take the form of a light emitting diode 23 and a photosensing device 24 (shown only in FIG. 2), and an electrode pulse control circuit 25. The indicator disk 22 is mounted on the axle 9 for the developer roll 2 and rotates in correspondence to the magnet rotor 5. The disk 22 is arranged with a peripheral portion between the light emitting diode 23 and the photosensing device 24. The peripheral portion of the disk 22 has alternate opaque and translucent panels 26 and 27 respectively, so the light emitted from the diode 23 is alternately transmitted and blocked.

In response to light received from the diode 23, the photosensing device 24 transmits an indicator pulse signal on a line 28 to the pulse control circuit 25 to indicate that one of the magnet sectors 8 is in an optimum

position with respect to the electrodes 10 for recording. When the circuit 25 receives this indicator signal together with a record pulse signal from one of a plurality of data input lines 29, the circuit 25 supplies a voltage potential record pulse on a line 30 to the electrode 10 corresponding to the data input line 29 from which the data pulse is received. There is an input line 29 and a corresponding output line 30 for each electrode 10. By applying controlled pulse width voltage record potentials to various of the electrodes 10 while one of the magnet sectors 8 is in an optimum position for recording, repeatably dense well defined dots are recorded on the medium 13.

The pulse control circuit 25, as shown in block form in FIG. 6, is formed of an input stage 31 that is actuated by the indicator pulse signals from the photosensing device 24. The output of the input stage 31 is fed to one input of a gating circuit 32 formed of a plurality of AND gates (not shown) that each receive the signals from the input stage 31. Each gate of the circuit 32 also has a second input that connects with one of the data input lines 29. When signals are received at both inputs of one of the AND gates forming the circuit 32, a voltage potential record pulse is furnished to the electrode 10 corresponding to the triggered AND gate.

Recording is performed in correlation with the indicator pulse signals produced by the photosensing device 24. However, each recording pulse need not be as long as the indicator signal pulses because the input stage 31 may include circuitry for expanding or narrowing the indicator pulse signals. A delay network may also form a portion of the input stage 31 to delay the indicator pulse signals received from the device 24. Therefore, the indicator pulses may be lengthened, shortened or delayed by the use of proper circuitry in the input stage 31. Another method for obtaining such control is to employ the indicator pulse signals solely as triggering pulses to actuate a pulse generating device that is variable to provide pulses to the gating circuit 32 at the optimum time for highest quality recording. Such circuitry is old in the art and for purposes of clarity and brevity will not be described herein.

Referring now to FIG. 7, the concentration of toner particles in the recording region 14 and the preferential alignment of the toner chains 17 in the recording region 14 can be improved by substituting magnetically permeable electrodes 33, for the electrodes 10. The electrodes 33 protrude from the developer roll outer shell 16 and are partially encapsulated by an insulating material 34 having a low magnetic permeability. The outer ends of the electrodes 33 are exposed to come in electronic contact with the toner powder chains 17 that enter the recording region 14.

The employment of magnetically permeable electrodes 33 increases the magnetic field density in the recording region 14 because the fields of the magnet sectors 8 magnetize, or induce a relatively strong magnetic field in the electrodes 33. The magnetic fields induced in the electrodes 33 cause the magnetic toner chains 17 in the recording region 14 to concentrate in the area of highest field strength, which exists at the outer end of the electrodes 33 and extends out to the surface of the recording medium 13. Due to the magnetic fields induced in the electrodes 33 there is a region near the electrodes 33 which is void of toner chains 17 because any toner in that region is attracted to the electrodes 33. There is also an isolation of the chains of toner 17

on each electrode 33 from those chains on adjacent electrodes 33 as illustrated by the array of five electrodes in FIG. 8 wherein associated magnetized toner chains 17 are shown tending to repel one another and to follow the lines of magnetic flux emanating from the electrodes 33.

The isolating and concentrating effects produced by the magnetic electrodes 33 on the toner 15 tend to reduce current flow between adjacent electrodes and to increase current flow through the toner chains 17 to those toner particles in contact with the recording medium 13. Consequently, even though the magnetic force on the toner particles in contact with the recording medium 13 is greater than that existing when non-magnetic electrodes 10 are used, the amount of toner 15 transferred to the recording medium 13 is greater with the magnetic electrodes 33.

Such improved recording is achieved by the use of electrodes 33 because there are more toner particles that both contact the recording medium 13 and have direct electrical continuity with one of the electrodes 33 due to the concentrating effect of the toner chains 17. Also, the electrical conductivity through the toner chains 17 bridging between the electrodes 33 and recording medium 13 is better (lower resistance) due to higher contact force between the toner particles forming the toner chains 17. Accordingly, when the electrodes 33 are pulsed with a record voltage potential pulse from the pulse control circuit 25, toner images of consistently high quality levels of density and resolution are deposited on the recording medium 13. It has been found that the highest quality images are produced when the record voltage potential pulses are begun just before the toner chains 17 bridging between the electrodes 10 and the medium 13 are removed from the recording region 14 as a result of the rotation of the magnet rotor 5. This occurs as the radial axis of one of the magnetic sectors 8 moves past a position of alignment with the electrodes 10.

The following non-limiting example is now provided.

EXAMPLE 1

This example involves use of an apparatus as shown in FIG. 1, modified with the magnetically permeable electrodes 33 of FIG. 8. The outer shell 6 of the developer roll 2 was constructed of a 2.5 in. inner diameter linen phenolic tubing, with a 0.094 in. wall thickness. The diameter of the magnet rotor 5 was 2.470 in., and had 16 magnet sectors 8 providing alternating North and South poles around its circumference to produce a field strength of approximately 700 gauss on the rotor periphery. A thin aluminum sleeve was positioned over and cemented to the magnet sectors 8 to hold them in place at high speeds. The electrodes 33 were constructed of 0.070 in. diameter iron music wire with each 0.120 in. long, and located on 0.140 in. centers across the exterior surface of the shell 6 in 0.060 in. deep holes. Each electrode 33 was individually connected to the pulse control circuit 25 by a nonmagnetic wire (such as copper wire) soldered to the iron music wire forming the electrodes 33. Smooth ramps of epoxy were employed to encapsulate each side of the electrodes 33 with just the ends of the electrodes exposed. The cylindrical electrode 12 of the recording member 3 was formed of aluminum alloy 4 in. in diameter, and having a commercially anodized coating forming the recording medium 13. The toner 15 was made accord-

ing to Nelson, U.S. Pat. No. 3,639,245 with a static resistivity of less than 10^5 ohm/cm. and preferably less than 10^4 ohm/cm. in an applied electric field of 1000 v./cm.

The magnet rotor 5 was rotated at 5,800 rpm in a clockwise direction causing the toner chains 17 to tumble about the peripheral surface of the developer roll 2 in a counter clockwise direction. The doctor blade 16 was spaced from the developer roll 2 to define approximately a 0.010 in. gap to meter an even layer of toner 15 to the roll 2. The rotational surface speed of the recording member 3 was 22 in./second and the gap between the recording medium 13 and the electrodes 33 was 0.004 in. To record, each electrode 33 was selectively pulsed by a 50 volt potential and the electrode 12 was grounded. For erasing previously recorded toner images the electrodes 33 were left at ground potential. The half period of the magnetic cycle (length of time each pole is under the recording styli) was 670 microseconds, and a recording pulse width of approximately 200 microseconds was applied at approximately the position at which the unloading of the toner from the electrodes 33 would normally occur if no voltage pulse was applied.

What is claimed is:

1. An electrographic recording process for the deposition of toner on a recording medium, which process comprises:

1. arranging first and second electrode means in a spaced opposed relationship to provide a recording region therebetween;
 2. arranging a recording medium in said recording region with a first surface in electronic contact with said second electrode means;
 3. drawing electronically conductive, magnetically attractable toner into the recording region by means of an alternating magnetic field so that the toner is interposed between said first electrode means and a second surface of said recording medium to form an electronically conductive path therebetween, whereby a portion of said toner is in physical contact with said second surface of said recording medium; and
 4. establishing voltage potential pulses of short duration between said first and second electrode means at such times that the alignment of toner in the recording region is at an optimum for providing toner deposition on the recording medium in response to an electrical force pattern of intelligence on the portion of said toner in physical contact with said recording medium and determined by the electrical potential difference established between said portion of said toner and said second electrode means, said electrical force pattern exerting a force on said portion of said toner which is greater than and in opposition to the force exerted on said portion by said magnetic field.
2. A process as recited in claim 1 wherein said voltage potential pulses are applied to said first electrode means.
3. A process as recited in claim 1 wherein said first electrode means is magnetically permeable and said alternating magnetic field induces a magnetic field therein.
4. A process as recited in claim 1 wherein said recording medium and said second electrode means

move in the same direction relative to said first electrode means.

5. A process as recited in claim 1 wherein said first and second electrode means are stationary relative to each other and said recording medium moves through said recording region.

6. A process as recited in claim 1 wherein said recording medium is a web.

7. A process as recited in claim 1 wherein said second electrode means comprises an electrically conductive cylindrical member.

8. A process as recited in claim 1 wherein said recording medium is bonded to said second electrode means.

9. A process as recited in claim 8 wherein said recording medium is formed of anodized aluminum.

10. A process as recited in claim 1 wherein said first electrode means is a plurality of electronically conductive, electrically isolated electrodes.

11. A process as recited in claim 1 wherein said alternating magnetic field is provided by a developer roll having an outer shell on which said first electrode means is mounted and an inner magnetic rotor with a plurality of magnet sectors to provide alternating North and South magnetic poles on its peripheral surface.

12. A process as recited in claim 11 wherein the application of said voltage potential pulses is synchronized with the rotation of said magnet rotor such that said pulses are applied when said first electrode means is substantially aligned with the radial axis of one of said magnet sectors of said developer roll.

13. A process as recited in claim 12 wherein indicator means are associated with said developer roll for providing signals indicative of the rotational position of said roll.

14. A process as recited in claim 13 wherein said indicator means comprises an indicator disk that is coaxially mounted with said developer roll and rotates in correspondence with the rotation thereof, and sensing means are employed to sense the position of said indicator disk.

15. A process as recited in claim 14 wherein electronic circuitry provides said voltage potential pulses to one of said electrode means and signals from said sensing means actuate said electronic circuitry.

16. An apparatus for the electrographic recording of toner on a recording medium and comprising:

1. a developing means having an outer shell and inner rotor member that rotates with respect to said outer shell, said inner rotor member having a plurality of magnet sectors to provide alternating North and South magnetic poles on its circumference;

2. a first electrode means mounted on the outer shell

of said developing means;

3. a second electrode means in spaced opposed relationship to said first electrode means to provide a recording region therebetween;

4. an electronically conductive, magnetically attractive toner powder;

5. toner supply means for supplying said toner powder to said developing means, which toner is attracted to the outer shell of said developing means by said magnetic poles of said rotor;

6. transport means for providing movement of the recording medium relative to at least one of said first and second electrode means and through said recording region, said toner providing an electronically conductive path in said recording region between one surface of said recording medium and said first electrode means, said second electrode means being in electronic contact with the opposite surface of said recording medium;

7. electronic circuitry adapted to apply voltage potential pulses of short duration to one of said electrode means; and

8. synchronizing means for monitoring the rotation of the rotor of said developing means and actuating said electronic circuitry to apply said pulses to one of said electrodes to establish a voltage difference between said electrode means at such time that the amount and alignment of toner in the recording region is at an optimum for providing toner deposition on the recording medium.

17. An apparatus as recited in claim 16 wherein said voltage potential pulses are applied to said first electrode means.

18. An apparatus as recited in claim 16 wherein said first electrode means is magnetically permeable and said alternating magnetic field of said developer roll induces a magnetic field therein.

19. An apparatus as recited in claim 16 wherein the application of said voltage potential pulses is synchronized with the rotation of said magnet rotor such that said pulses are applied when said first electrode means is substantially aligned with the radial axis of one of said magnet sectors of said developer roll.

20. An apparatus as recited in claim 19 wherein an indicator disk is coaxially mounted with said developer roll and rotates in correspondence with the rotation thereof, and sensing means are employed to sense the rotation of said indicator disk.

21. An apparatus as recited in claim 20 wherein electronic circuitry provides said voltage potential pulses to one of said electrode means and signals from said sensing means actuate said electronic circuitry.

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