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[73]	Assignee	International Business Machines Corporation Armonk, N.Y.

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[54]	HIGH SPEED ELECTROSTATIC PRINTER	
	9 Claims, 15 Drawing Figs.	
[52]	U.S. Cl.....	355/3, 355/4
[51]	Int. Cl.....	G03g 15/04
[50]	Field of Search.....	355/4

ABSTRACT: Apparatus for achieving high speed electrostatic printing rates by utilization of a continuously rotating planetary drum drive mechanism. The invention consists of apparatus for causing a point on the surface of the drum to move with apparent intermittent motion past various functional stations in an electrostatic printing process.

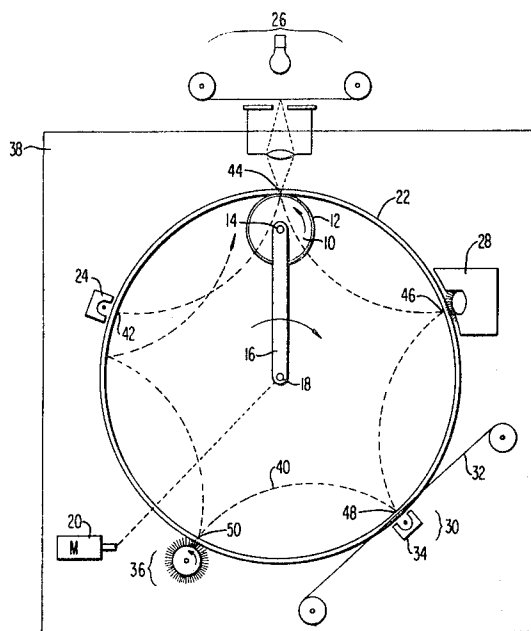


FIG. 1

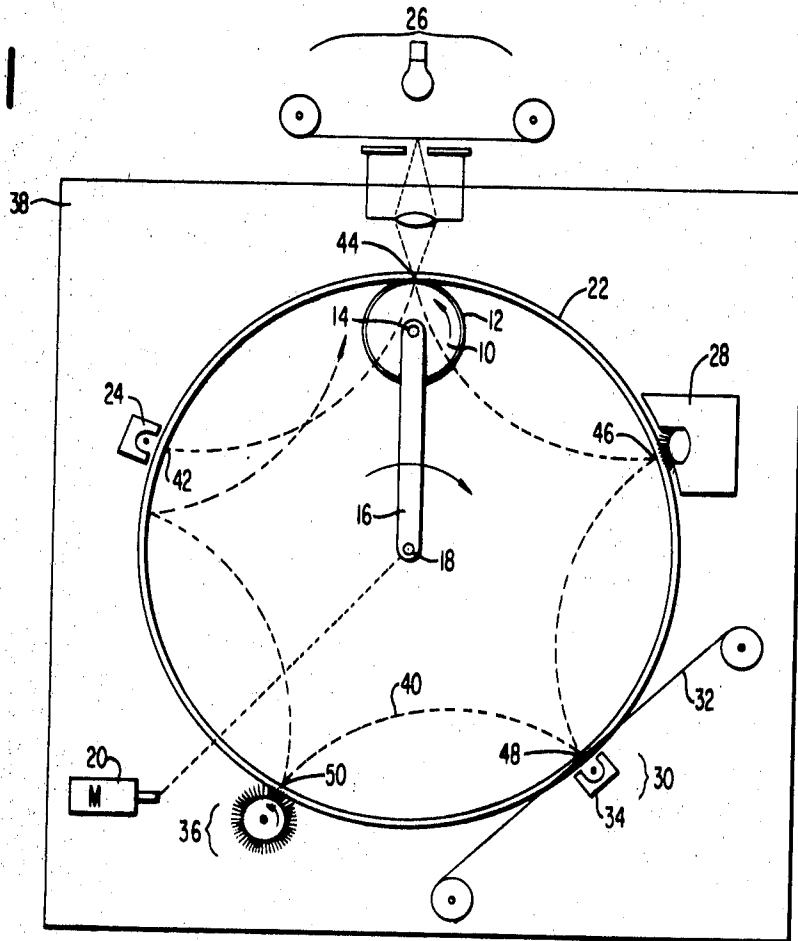
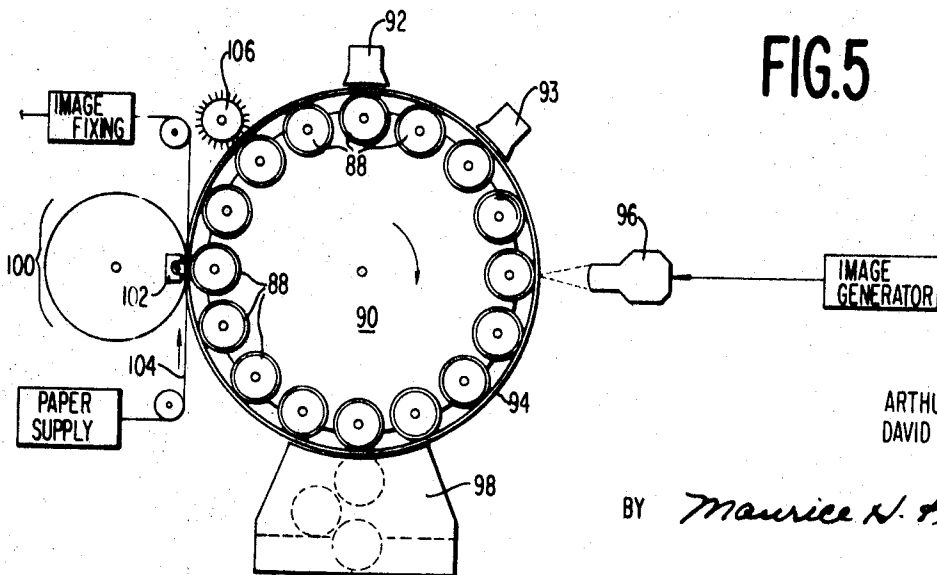


FIG. 5



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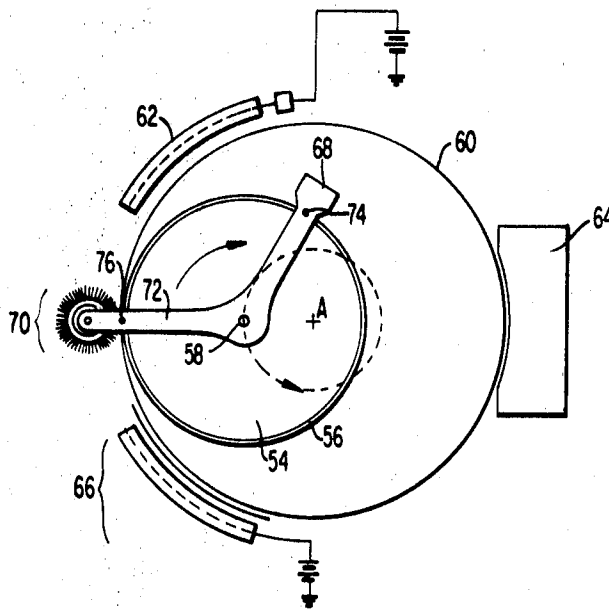


FIG. 2

FIG. 3

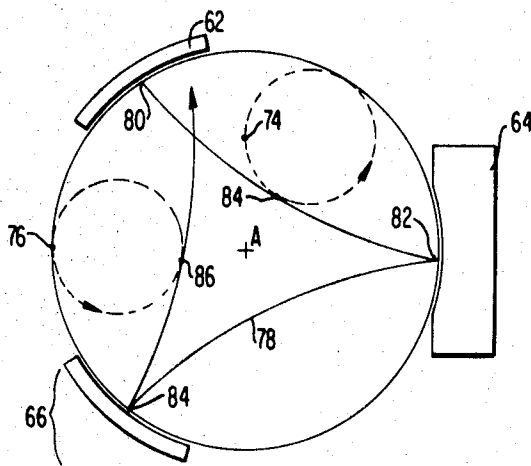
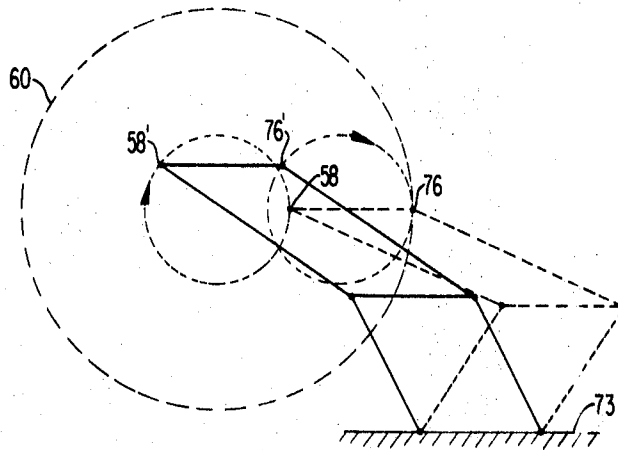


FIG. 4

FIG. 6

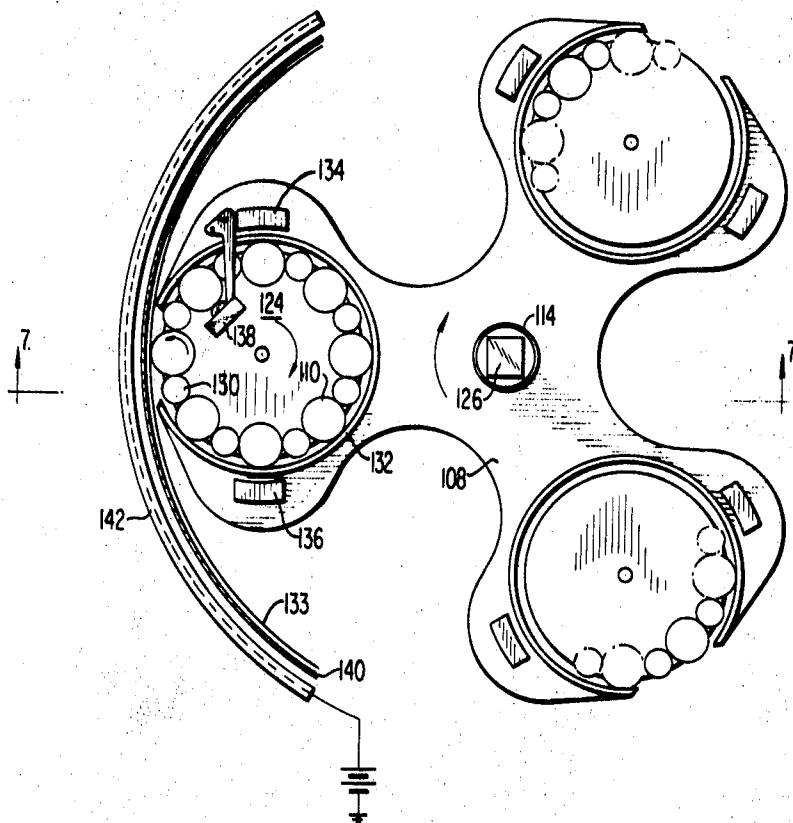


FIG. 7

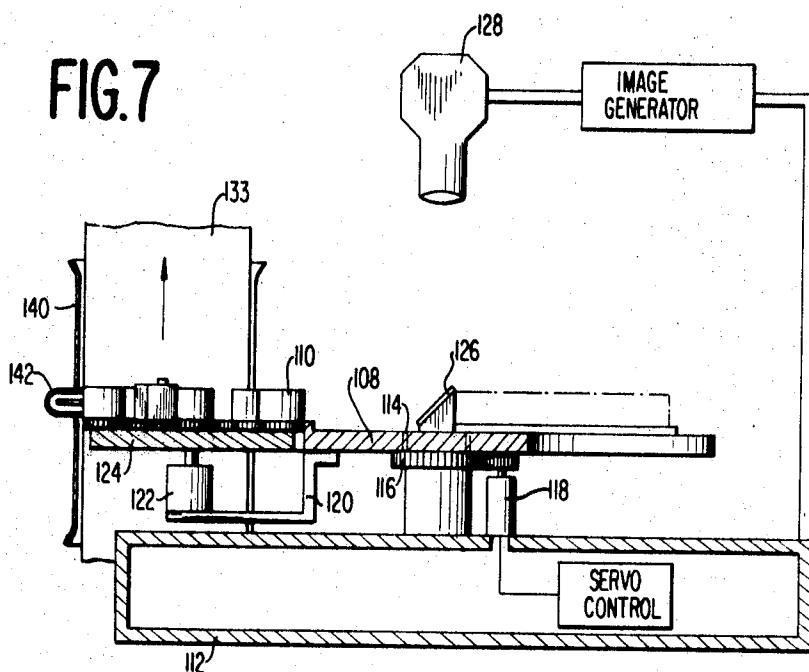


FIG.8

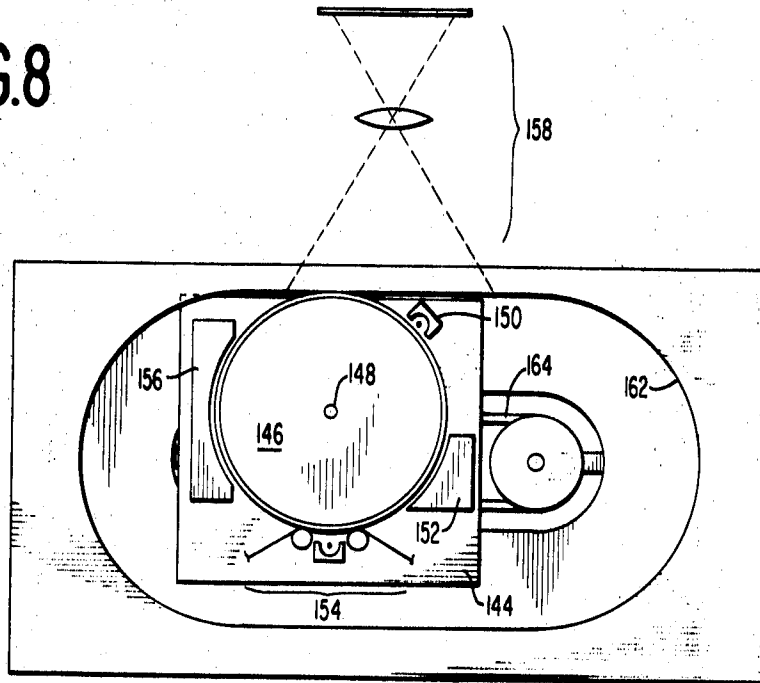


FIG.9

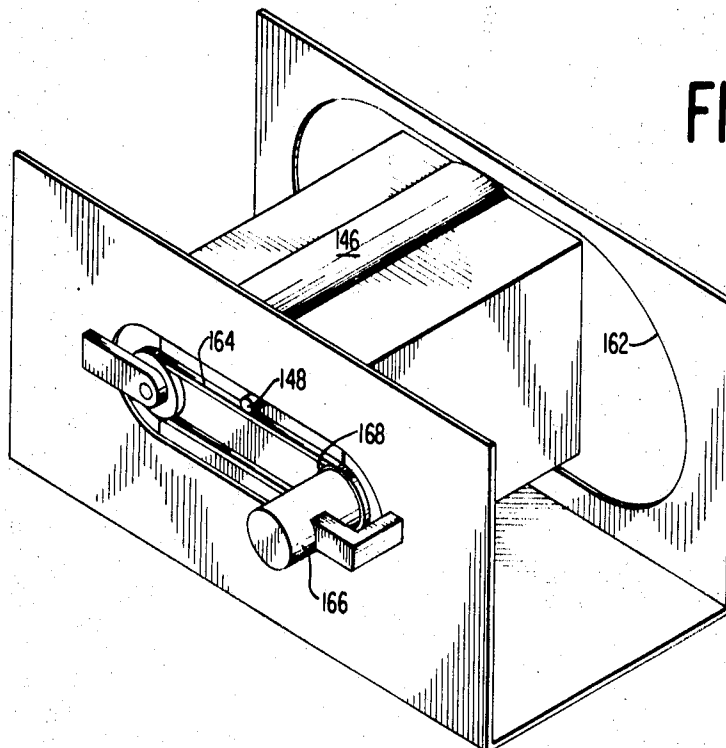


FIG. 13

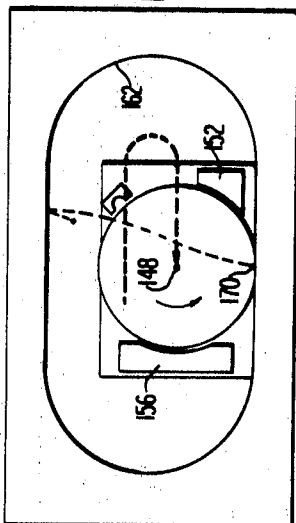


FIG. 14

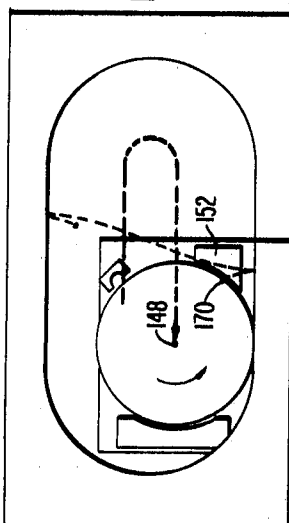


FIG. 15

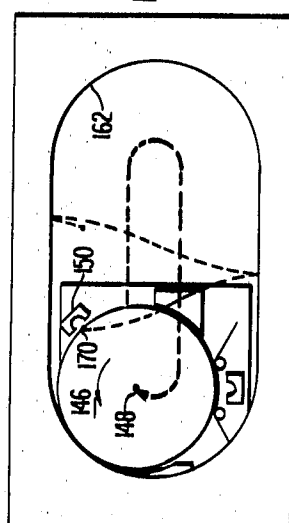


FIG. 10

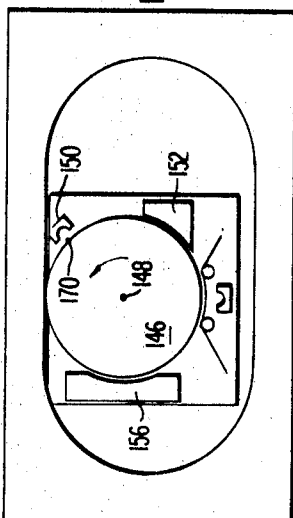


FIG. 11

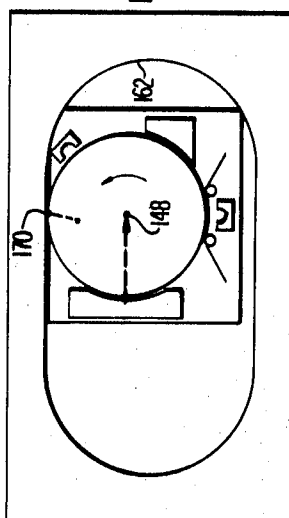
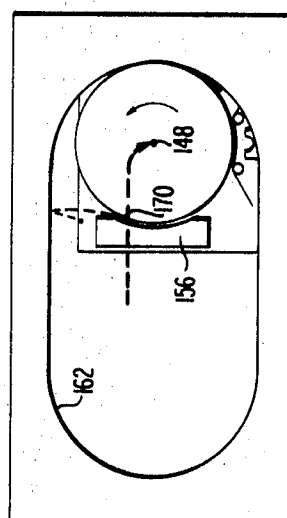


FIG. 12



HIGH SPEED ELECTROSTATIC PRINTER

BACKGROUND

1. Field of the Invention

This invention relates in general to electrostatic printing machines and in particular to improved apparatus for producing high speed electrostatic images.

The art of electrostatic printing, commonly known as "xerography," is well known in the art. The basic steps of the electrostatic image printing process may be described in the following manner.

A photoconductive insulating material is uniformly sensitized by a uniform electrostatic charge. Thereafter a latent image is formed on the surface of the insulating layer by exposing this layer, while sensitive, to a light pattern. The charge pattern formed by exposure of the sensitive plate may be developed by bringing electrostatically charged particles into contact with the surface area carrying the pattern, thus developing an image composed of particles deposited on the selectively charged photoconductive insulating layer. This developed image may then be transferred to a printing surface or utilized in some other way. The apparatus herein disclosed is particularly adapted to carrying out this process in a most efficient manner.

2. Description of the Prior Art

Known prior art electrostatic printing devices commonly consist of a plurality of functional stations arranged about the periphery of a circle in which a drum having a photoconductive insulating surface rotates. Each of the functional stations correspond to one of the process steps of the electrophotographic process as enumerated above. The drum carries the desired image from station to station sequentially along the periphery of the circle on which the stations are mounted. This type of device is commonly referred to as a drum-type printer.

A variation of the drum type printer, first suggested by Carlson in U.S. Pat. No. 2,357,809, was to use a continuous belt in place of the drum as described above. The "belt-type" device operated in exactly the same manner as the drum-type device. That is, images produced on a photoconductive insulating surface on the belt were passed from station to station sequentially as a particular point on the belt followed a closed path along the length of the belt.

Another variation known in the prior art utilizes a hollow cylinder and places the functional stations inside the hollow cylinder.

All of the above known prior art devices normally operate continuously while the drum, belt or cylinder is maintained at a constant velocity as it passes from station to station in a particular printing process. Normally the paper, or object to be printed upon, is kept in rolling contact with the photoconductive insulating surface. These devices have proved highly successful when copying of a complete sheet of information is desired, or continuous printing is necessitated.

In utilizing the prior art devices a situation might arise where it is desirable to print single characters at a time rather than printing a complete document. Such a situation arises when the intermittent output of a computer is used. Printing single characters with prior art devices becomes difficult, if not impossible. Two apparent solutions to this problem would be either to drive the drum, belt or cylinder intermittently by a Geneva mechanism or to intermittently disengage the paper from its rolling contact with the photoconductive surface. Both the solutions require additional mechanical equipment in order to achieve apparent intermittent motion on the part of the printing machine. At high speeds the momentum of the moving parts makes it extremely difficult to achieve high print output rates when these intermittent mechanical motion producing devices are used.

Another problem in prior art devices is that once the printing operation has begun the image receiving surface cannot be moved or realigned.

SUMMARY OF THE INVENTION

It is therefore a first object of this invention to print electrostatic images at a higher rate of speed than prior devices.

It is another object of the invention to intermittently print characters electrostatically in a printer utilizing constantly moving elements.

It is yet another object of the invention to print characters upon a medium which may be freely moved between printing operations.

The invention herein disclosed makes it possible to overcome the deficiencies of the prior art devices by utilizing continuously moving elements thus dispensing with any secondary mechanism necessary to impart intermittent motion to either the photoconductive drum or the paper upon which printing is to occur. Unlike the prior art devices, the invention herein disclosed utilizes a continuously rotating drum to impart an intermittent motion to the image itself rather than causing the drum or paper to move intermittently. This is accomplished by causing the photoconductive insulating surfaced drum to move in a planetary motion which in turn causes a point on the drum surface to move along a roulette. That is, instead of a particular point on the surface of the drum moving with constant velocity, the instant invention causes a point on the surface of the drum to move in a path wherein the point has zero relative velocity when it is adjacent to a particular functional station. The utilization of planetary motion allows the printing device of the instant invention to achieve incremental printing upon either stationary or slowly moving paper and allows paper to be moved freely between printing operations. In this manner a line, or even a character, at a time may be printed at a high rate of speed.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of the preferred embodiments of the invention, as illustrated in the accompanying drawings.

IN THE DRAWINGS

FIG. 1 shows schematically a plan view of one preferred embodiment of a printer built in accordance with the invention.

FIG. 2 shows schematically another embodiment of the invention wherein some of the functional stations are maintained at a fixed relative position with respect to the axis of the drum.

FIG. 3 shows diagrammatically a method for maintaining the fixed relative position of the functional stations for the device of FIG. 2.

FIG. 4 shows schematically the paths followed by particular points on the drum as shown in FIG. 2 as it travels through one printing cycle.

FIG. 5 shows schematically another embodiment constructed in accordance with the invention wherein a plurality of duplicate functional stations may be utilized to improve printing.

FIG. 6 shows schematically a partial plan view of a demand character printer built in accordance with the invention.

FIG. 7 is a sectional view taken through the lines 7-7 of FIG. 6 and also shows the image producing means for the device of FIG. 6.

FIG. 8 shows schematically another embodiment of the subject invention wherein continuous printing is realized in accordance with the invention.

FIG. 9 shows a partial perspective view of the embodiment of FIG. 8 and illustrates a typical drive means which may be utilized.

FIGS. 10-15 show the progressive stages of development of an image produced on a device of FIG. 8.

Referring to FIG. 1 it will be noted that there is shown a plan view of an electrostatic image producing device constructed in accordance with the invention herein

disclosed. In order to move an image from station to station there is provided a conductive drum 10 having upon its outer surface a photoconductive insulating layer 12. The drum 10 is mounted for rotation about axis 14 which is in turn mounted on drum carrier arm 16. Motor 20 rotates carrier arm 16 about pivot point 18, causing the photoconductive insulating surface 12 of drum 10 to be in apparent rolling contact with constraining means 22. Constraining means 22 may be any of a number of suitable means whereby drum 10 may be caused to rotate about axis 14 as if it were in rolling contact with a circle designated by constraining means 22. For example, constraining means 22 could be a ring gear meshing with a complementary gear attached to drum 14, or it may merely be a frictional engaging means sufficient to cause drum 10 to be in rolling contact with an imaginary circle, here shown as constraining means 22. It may even be desirable to utilize a separate drive mounted on carrier arm 10 to turn the drum at the proper rate of speed.

The various functional stations necessary to perform the electrostatic printing process may be described as follows. A charging station 24, which may consist of any suitable high potential source capable of imparting a uniform charge to the photoconductive insulating surface 12 of the drum 10. A latent image forming station, generally designated 26, which may consist of any known means for producing a latent image on the charged photoconductive insulating surface of the drum 10 such that selective areas are discharged, thus creating a latent image representing information or data to be printed. A development station 28 which may consist of any of the known various methods of developing latent images in an electrostatic printing process, such as, the fur brush or cascade developing devices known in the prior art. A printing or image utilization station, generally designated 30, which may comprise recording medium 32 and transfer corona 34. The final step in the process is that performed at cleaning station 36 where any remaining developer on the photoconductive insulating surface 12 is removed by any suitable means. It should be understood that all of the various functions performed in the electrostatic printing process are well known in the art and that particular configurations for each of the stations, structural variations of which are well known in the art, are left to the choice of the designer. For convenience, FIG. 1 shows as will hereinafter be explained, all of the above described functional stations mounted on a common support member 38.

In order to show how a particular generated character is intermittently moved from station to station it will be remembered that the drum 10 is moved past the functional stations as if it were in rolling contact with an imaginary circle. This motion, unlike prior art devices, causes a particular point on the photoconductive insulating surface 12 of the drum 10 to move not in a circular or curvilinear path, but in a more complex path, as designated by dashed line 40. The generic name for the curve traced by a particular point on the surface of the drum is a roulette. A roulette is defined as the path in a fixed plane of any point in a moving coincident plane when a given circle in the latter plane rolls without sliding on a given curve in the former. The particular roulette shown by the dashed line 40 in FIG. 1 is commonly known as a hypocycloid.

It will be noted by examination of FIG. 1 that any point on the surface of the drum 10 which coincides with the beginning of the dash line point 42 will also coincide with other functional stations at nodes or cusps 44, 46, 48 and 50. As a particular area on the surface of the drum, for example, one following dashed line 40 approaches each successive functional station it will be seen that the velocity of the point approaches zero at each node. It is at these nodes on the curve that the functional processes take place. An area on the surface of the drum of this invention, unlike those of the prior art, does not move with a constant velocity, but actually exhibits an intermittent motion with respect to the functional stations. By utilizing the hesitation produced as the area moves along the roulette the angular velocity of the drum 10

itself may be speeded up considerably thereby increasing the rate at which the printer can operate.

Of course, it will be realized, that in a configuration as shown in FIG. 1 it will be necessary to select a proper ratio of drum diameter to the diameter of the imaginary circle about which the drum apparently rolls in order to cause the nodes or cusps to fall at the proper points along the circle. This ratio controls the location of each functional station, as it is desirable that at least some of them be placed adjacent to the nodes. It should also be noted that it is desirable that the drum make nonintegral number of revolutions about its own axis while making a single revolution about pivot point 18. This is preferable in order to make optimum use of the photoconductive surface.

It will also be seen upon examination of FIG. 1 that the only time that the drum 10 is in contact with recording medium 32 is during the printing operation itself, thus, the recording medium is free to move in any direction between actual printing operations.

In FIG. 2 there is illustrated schematically another embodiment of apparatus according to this invention. In this embodiment there is provided a conductive drum 54 having on its surface a photoconductive insulating layer 56. Means, not shown, are provided, as in the embodiment of FIG. 1, for moving the axis 58 of the drum 54 about the dashed circle as indicated. Constraining means are similarly provided to cause the drum to roll on the inside of the imaginary circle 60.

In this embodiment, unlike that of FIG. 1, only the charging station 62, the development station 64 and the printing station 66 are located on the outside of the imaginary circle upon which drum 54 rolls. The latent image forming station 68 and the cleaning station 70 are mounted on a bracket 72 which is caused to move about point A as the axis 58 is rotated thereabout. The bracket 72 does not itself rotate but is maintained in a fixed attitude with respect to the machine frame. The bracket 72 may, for example, be stabilized by a linkage means as schematically illustrated in FIG. 3 and which will be described presently. Points 74 and 76 are designated for reference purposes and will be considered to refer to the point wherein the imaging and cleaning operations are respectively performed on the drum surface.

The latent image forming station 68 may be of any suitable construction and may, for example, consist of a fiber optics bundle connected to a remote image generating device, not shown. This station may also be any of the various known local image generation devices such as electrically charged type wheels or character generating light sources.

The cleaning station 70 may be any device capable of removing remaining particles of developer left on the drum surface 56 after the printing operation occurs.

Referring now to FIG. 4 which is a graphic view of the apparatus shown in FIG. 2 in operation, particular interest should be paid to the hypocycloid designated as 78 which is the path followed by a particular point on the surface as the drum starting adjacent to the charging station 62 as shown by point 80. Points 74 and 76 correspond to those points as designated in reference to FIG. 2. The dashed circles indicate the locus of these points as the drum and bracket move about point A. After a particular point on the surface of the drum is charged at point 80 it moves along the first leg of the hypocycloid 78 toward node or cusp 82, it passes under the imaging station at point 84 and continues its path until it reaches the node 82 at development station 64. The point then moves along the curve to the printing station 66 where it instantaneously hesitates at node 84 where printing occurs. The point then moves along the curve to point 86 where it will be under the cleaning station 70.

A comparison of FIGS. 2 and 4 will show that although the axis of drum 54 is moved in a counterclockwise direction, a point on the surface of the drum actually moves from station to station sequentially in a clockwise direction as clearly indicated in FIG. 4.

A brief description of FIG. 3 will illustrate a simple support means for maintaining bracket 72 in its proper position. A pair of parallelograms are mounted between bracket 72 and a stationary support 73. Each of the sides of the parallelograms is mounted such that it is free to pivot about its mounting points. For convenience the parallelograms are shown attached to bracket 72 at points 76, the cleaning station, and 58, the central axis of drum 54. The small dashed circles trace the points followed by the mounting points. The points 58 and 76 correspond to their positions as shown in FIG. 2 while the points 58' and 76' represent a position later in the cycle.

The embodiment shown in FIG. 5 includes a plurality of image transfer drums 88 supported on and translated by carrier means 90 which in turn is driven around axis 91 by a motor or other suitable drive means, not shown. This embodiment also shows the use of multiple functional stations. Here while only the charging stations 92 have been duplicated it may be desirable to duplicate any of the other functional stations. Carrier means 90 moves the drums in such a manner that they are in apparent rolling contact with constraining means 94, which may be a frictional engaging means, a gear or other device capable of allowing the drum to rotate about its own axis as if it were in rolling contact with constraining means 94.

Selection of the desired ratio of the drum diameter to the diameter of the constraining means will allow a sufficient number of nodes to be produced such that some of the functional stations may be duplicated. This duplication of functional stations will allow the apparatus to operate at an even higher speed than a device such as illustrated in FIG. 1, because of the increased time a particular point will be exposed to any functional station.

In order to aid in the understanding of the embodiment of FIG. 5, a complete printing cycle will be illustrated.

Starting with a particular point on the surface of a drum 88 which is originally adjacent to charging station 92 it will be seen that as carrier means 90 moves and rotates drum 88 to a position adjacent to charging station 93 the same point will be presented to charging station 93 and be given a second reinforcing charge. As the particular drum moves into position adjacent to latent imaging means 96, which may be an image projection device controlled by an image generator, a latent image is formed on the charged surface of the drum at the particular point as it hesitates adjacent to station 96. Subsequent to this as the carrier means 90 further moves the drum 88 adjacent to the development station 98 the latent image will be developed by deposition of finely divided particles of developer. The selected drum is then carried to a position adjacent to the printing station 100 where the transfer corona produced by electrode 102 causes the particles to be deposited on the printing medium 104 as the drum comes in rolling contact with the printing medium. The drum is then carried past cleaning station 106 where the same point which started adjacent to charging station 92 comes in contact with a cleaning means to remove any remaining particles on the surface of the drum 88.

Referring now to FIGS. 6 and 7 there is disclosed a high speed demand printer built in accordance to this invention. FIG. 6 shows a partial plan view of the device while FIG. 7 shows a partial sectional view taken through line 7-7 of FIG. 6.

A print head assembly 108 is shown which consists of three separate print heads upon which are mounted eight photoconductive insulating surfaced drums 110. Although the other two print heads are not described or illustrated in detail it will be understood that each of the three heads are identical in construction and operation. In describing this embodiment reference will be made first to FIG. 7 and then to FIG. 6.

Print head assembly 108 is supported in spaced relation to base 112 by bearing means 114. Rigidly attached to the print head assembly is a ring gear 116 which is driven by indexing motor 118 under the command of a servocontrol which causes indexing motor 118 to move print head assembly 108 one

character space at desired intervals between characters. Bracket 120 is adapted to carry a motor 122 which drives and supports drum carrier means 124 upon which drums 110 are mounted.

Mounted on a column and stationary with respect to base 112 is a reflecting surface 126. The reflecting surface reflects an image produced by imaging device 128 to the surface of one of the photoconductive insulating surfaced drums 110 when the drums are in proper position to receive an image.

Referring now to FIG. 6 it will be seen that photoconductive insulating surfaced drums 110 are in apparent rolling contact with constraining means 132. In order to allow drums 110 to come into rolling contact with a print receiving media it is necessary for a portion of constraining means 132 to be removed in the vicinity of the print station. To maintain the rolling motion of the drums 110 as they move past the printing station a plurality of idling gears 130 have been placed between each of the drums. The idling gears have been so placed as to maintain a constant speed of rotation for the drums as they come into rolling contact with the printing media.

Each of the print heads on print head assembly 108 carries with it a charging station 134, a development station 136 and a drum cleaning station 138. It will be understood that these stations may be built in accordance with any of the various known stations in the art. Not shown, but necessary for proper operation of the device, there are provided necessary energizing means for the stations and the motor 122 (FIG. 7). For example, power may be supplied to them through batteries mounted on the print head or through slip rings or any other known method.

Operation of the device shown in FIGS. 6 and 7 is illustrated by the following description.

Paper or other suitable printing media 133 is placed between paper guide 140 and the print head assembly 108 as shown. A selected portion of the photoconductive surface of a drum 110 is charged at charging station 134. The precharged drum is then carried clockwise (at the same time being rotated counterclockwise by constraining means 132) by drum carrier means 124 until it becomes adjacent to reflecting surface 126. At this time an image generator provides information to imaging device 128 whereupon a light image is projected on the charged surface of drum 110. The drum is thereafter carried to the development station 136 where the latent image is developed. The drum 110 now carrying a developed image is next caused to come into rolling contact with print receiving media 133 where the transfer corona 142 causes the developed image to be deposited upon the print receiving media. The drum 110 then proceeds to cleansing station 138 where any remaining development particles are removed, thus completing one print cycle.

It will be noted that a point on the surface of drum 110 will come to rest at a node or cusp adjacent to each functional station except the cleaning station, which is located, for efficiency, at a point on the curve described by the point where the velocity of the point is at a maximum.

Immediately after the developed image is deposited on print receiving media 133, a servocontrol energizes indexing motor 118 which in turn causes the print head assembly to advance one printing position in the direction shown. The printer is then ready to print the next character.

It may be seen from the geometric layout of the device—i.e., the provision for three print heads, that as one print head reaches the extreme right edge of the print receiving media another print head is immediately available to start a new line of printing beginning at the left of the print receiving media. It is understood that various methods may be utilized for presenting the printing media to the printing device. One method might be to provide means for slowly moving the printing media continuously past the print head in the direction shown in FIG. 7 wherein a printed line would be presented to the print head assembly at a slight angle such that when a first print head reaches the extreme right edge of the

printing media a second print head will be approaching the left edge of the printing media directly adjacent to a new line to be printed.

FIGS. 8 and 9 show yet another embodiment of an apparatus built in accordance with this invention. This embodiment is suitable for document copying or other continuous copying. FIG. 8 shows a schematic view of functional elements of the apparatus while FIG. 9 shows a portion of a typical drive means which may be used to operate the apparatus.

Referring now to FIG. 8 it will be seen that the electrostatic functional stations are mounted on a movable support member 144. A photoconductive insulating surfaced image transfer drum 146 is mounted on the support member 144 through axis 148 about which the drum is free to rotate. Situated about the drum 146 and mounted on support member 144 are, in sequence, a charging station 150, a cleaning station 152, a print station (generally designated as 154) and a development station 156. These functional stations may be of any desired construction as they are all well known in the art. It will be understood that the foregoing functional stations and the drum are mounted such that as the movable support member 144 translates these elements move with the platform maintaining a fixed attitude with respect to constraining means 162. Mounted above the apparatus there may be provided any of various known image forming stations generally designated as 158.

Means are provided for moving the support member 144 in a closed path such that drum 146 is constrained to roll along the inside of constraining means 162. It will be understood that the constraining means 162 may be of any of various devices useful to cause rolling contact to occur between the drum surface and itself, as herein described at various places above.

FIG. 9 is a partial perspective view of the apparatus of FIG. 8 and shows a drive means by which support member 144 may be caused to move in a closed path. Drive motor 166 turns pulley 168 upon which belt 164 is mounted. Axis 148 of the drum is affixed to the belt in such a manner as to allow the drum to rotate as the axis moves in a closed path. Guide means, not shown, are provided to maintain support member 144 in a nonrotating position.

Referring now to FIGS. 10—15 it will be seen that there is shown the various stages in the process of producing an image with the apparatus of FIG. 8.

Referring to FIG. 10 there is shown a point 170 on the surface of the drum 146 as it is adjacent to charging station 150. The direction of rotation of the drum is as indicated by the arrow.

FIG. 11 shows that as the axis 148 of the drum is moved along the heavily dashed line, the point 170 is caused to move until it is adjacent to the image forming station, not shown. It is at this point that point 170 comes to rest at the latent image forming station. This movement is accomplished by allowing the drum to roll along the constraining means 162.

FIG. 12 shows the third step in the process wherein point 170 after having been exposed at the image forming station is transported to the development station 156 along the dotted line as indicated. Particles of developer are applied to the drum while it moves across the central portion of constraining means 162.

FIG. 13 shows the progression of the point as it moves from the development station 156 to the print station 154. It will be noted that the point 170 has traveled almost directly across the closed path represented by the constraining means 162 while the drum has rolled along the surface of the constraining means. As the point 170 reaches the printing station it will be seen that it momentarily comes to rest, it is at this point that printing occurs.

FIG. 14 shows the next stage of the operation wherein point 170 has now moved until it is adjacent to the cleaning means 152.

As the drum 146 continues its path around the constraining means 162 it will be seen in FIG. 15 that the point 170 is once again returned to a position adjacent to the charging means 150, thus beginning another cycle of the operation.

As can be seen from the apparatus of FIG. 8, application of the instant invention is not necessarily limited to normal planetary action. FIGS. 10—15 illustrate that the apparent intermittent motion of a point on the surface of the image transfer drum may be achieved when the drum rolls along any closed surface. Although the invention has, for the most part, been described as being useful for printing on stationary media, slight changes in the actual diameter of the drum used will allow the apparatus described to print on media which is moving with respect to the apparatus. For example, if the surface of the drum is extended beyond the constraining means, the roulette followed by the point on the surface, instead of producing cusps as illustrated above, will produce a prolate curve having nodes. The relative direction of motion of the point at the extremity of the node will be opposite to that in which the point itself moves throughout a majority of the roulette traced. This variation would allow printing on a media which is traveling in a direction opposite to that which the drum is moving.

If, however, the diameter of the surface of the drum is made slightly less than the diameter upon which the drum rolls, a curtate curve will be produced in which case printing can be achieved upon a media which is moving in the same direction as the drum is rotating.

It is also foreseeable that the apparatus as disclosed may be utilized merely as an image producing device rather than as a printer. Such a device might be useful to produce a complete display of a low persistence trace appearing on the surface of a cathode ray oscilloscope. By utilizing an intermittently operated cleaning station, successive positions of the trace upon the face of the cathode ray tube may be superimposed on an already existing image previously formed on the surface of the drum.

While the invention has been particularly shown and described with reference to particular embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

We claim:

1. A high speed image producing device comprising:

a plurality of different functional stations, including an image forming station and an image utilization station; an image transfer drum having a central axis;

drum carrier means for continuously moving said central axis in a closed path past at least a first one of said different functional stations being mounted in apparent rolling contact with said drum; and

drum drive means for continuously rotating said drum about said central axis at a rate which causes the surface of said drum to be in apparent rolling contact with a line outside of and parallel with said closed path as said drum carrier means moves said central axis in said closed path, said drum carrier means and said drum drive means together causing an image formed at a point of a surface of said drum to move sequentially past all of said different functional stations, said drum drive and carrier means further causing said image to move past at least two of said different functional stations for each transit of said carrier means in said closed path, whereby said image produced by said image forming station is carried along a roulette having a cusp adjacent to said first of said different functional stations.

2. The device of claim 1 wherein a second one of said different functional stations is mounted adjacent to and in fixed spaced relation to said drum whereby said second station performs its function on the surface of said drum while a point on the drum is between cusps of said roulette.

3. The device of claim 1 wherein the line in which said drum is in apparent rolling contact is a nonintegral multiple of the

circumference of said drum whereby the entire surface of said drum will be utilized.

4. A high speed electrostatic image producing device of the type utilizing a plurality of functional stations, including a latent image forming station, a development station, and an image utilization station, and also utilizing an image carrying photoconductive insulating surface, the improvement comprising:

an image transfer drum having a central axis, said drum having the photoconductive insulating surface mounted thereon;

drum carrier means for moving said central axis of said drum in a path past at least one of the functional stations, said functional station being in apparent rolling contact with said drum; and

drum drive means for continuously rotating said drum about said central axis at a rate causing the surface of said drum to be in an apparent rolling contact with a line parallel to and outside of said closed path as said drum carrier means moves said central axis, said drum carrier means and said drum drive means together causing an image formed at a point on the surface of said drum to move sequentially from the latent image forming station to the development station and then to the image utilization station along a path in which the point on the surface of said drum approaches at least said one of the functional stations with a diminishing velocity, having a minimum velocity at a point adjacent to that functional station, said drum drive and carrier means further causing said image to move past at least two of the functional stations for each transit of said carrier means in said closed path.

5. A high speed electrostatic image producing device, comprising:

a support member;

a plurality of functional stations, at least some of which are mounted along the arc of a circle in fixed spaced relation to said support member, said functional stations comprising: a latent image forming station, a development station, and an image utilization station;

an image transfer drum for transferring images produced at said image forming station to said image utilization station, said drum having a central axis and being rotatable thereabout, said drum being movably mounted over said support member and lying inside the arc on which said functional stations are mounted, and said drum being constrained to roll along a closed path having a length greater than the circumference of said drum; and

drive assembly means for moving a point on the surface of said drum sequentially to said functional station, said drive assembly means comprising:

constraining means tangent to said drum and constraining said drum to rotate about said central axis when said central axis is translated;

drum carrier means for supporting said drum and for translating said central axis of said drum through a closed path parallel to said constraining means substantially throughout its length, said drum carrier means carrying said drum past at least two of said functional stations for each transit of said carrier means; and

drive means for moving said carrier means, said drive means, said carrier means and said constraining means together causing a point on a surface of said drum to describe a roulette having nodes at least some of which are adjacent to some of said functional stations, whereby an image produced on a surface of said drum at said image forming station will move along the roulette to said developing station and then to said image utilization station.

6. The device of claim 5 wherein said constraining means has the form of the arc of a circle, whereby the closed path upon which said drum rolls will be a circle.

7. A high speed electrostatic printing device comprising: a support member;

a plurality of functional stations, said functional stations comprising:

a charging station, a latent image forming station, a development station, a printing station, and a cleaning station; said charging station; said development station and said printing station being mounted in fixed spaced space relation on said support member;

a photoconductive insulating surfaced image transfer drum for transferring images produced at said image forming station to said printing station, said drum having a central axis and being rotatable thereabout, and said drum being mounted for planetary movement about a point on said support member;

support means for supporting said latent image forming station and said cleaning station, said support means being attached to said central axis of said drum and being movable therewith, said support means maintaining said latent image forming station and said cleaning station in fixed spaced relation to said central axis of said drum; and

planetary drive means for imparting motion to said drum, including:

drum carrier means for moving said drum past said charging station, said development station and said printing station; and

drum rotating means for rotating said drum about said central axis as said carrier means moves said drum, said drum rotating means and said drum carrier means causing a point on the surface of said drum to move along a path having cusps located adjacent to said charging, development and printing stations, whereby an image produced on the surface of said drum will move intermittently along the path from said latent image forming station to said printing station.

8. A high speed electrostatic printer comprising:

a plurality of functional stations, including:

a charging station, a stationary latent image forming station, a development station, a printing station, and a cleaning station;

an image transfer drum having a photoconductive insulating surface mounted thereon, said drum having a central axis and being rotatable thereabout;

a drum carrier having said drum rotatably mounted thereon, said carrier also having said charging, development, cleaning and printing stations mounted thereon in fixed space relation to said drum;

drum carrier drive means for moving said carrier in a closed path, a portion of said closed path being adjacent to said stationary latent image forming station; and

drum rotating means for causing said drum to rotate about said central axis in apparent rolling contact with a line parallel to and outside of said closed path as said drum carrier means moves said carrier through said closed path to cause a point on a surface of said drum to describe a curve having a plurality of cusps, at least one of which is adjacent to said latent image forming station, and a second of which is adjacent to said printing station, whereby an image produced at said stationary latent image forming station will be carried along the curve to said printing station.

9. A high speed electrostatic printing device comprising:

a plurality of functional stations including: a latent image forming station, a development station, and a stationary printing station;

a plurality of image transfer drums each having a photoconductive insulating surface thereon;

drum carrier means for supporting said drums and for presenting each of said drums sequentially to said latent image forming station and said development station;

carrier support means for moving said carrier means past said stationary printing station, said carrier support means having mounted thereon said latent image forming station and said development station; and

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drum rotating means for continuously rotating said drums about their central axes at rate which causes the surface of said drums to be in apparent rolling contact with said printing station as said drum carrier means presents said drums to said functional stations, said drum rotating means and said drum carrier means together causing said drums to be sequentially in rolling contact with said printing station and also causing a point on a surface of each drum to follow a path having a plurality of cusps, at

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least one of which is adjacent to said latent image forming station and second of which is adjacent to said printing station, whereby a point on a surface of each of said image transfer drums will move along the path from station to station having a minimum velocity at said cusps adjacent to said image forming station and said printing station.

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