Dec. 3, 1968 R. J. PLEITT ET AL 3,414,723

APPARATUS FOR ELECTROSTATIC LINE PRINTING

Filed March 16, 1964 2 Sheets-Sheet 1

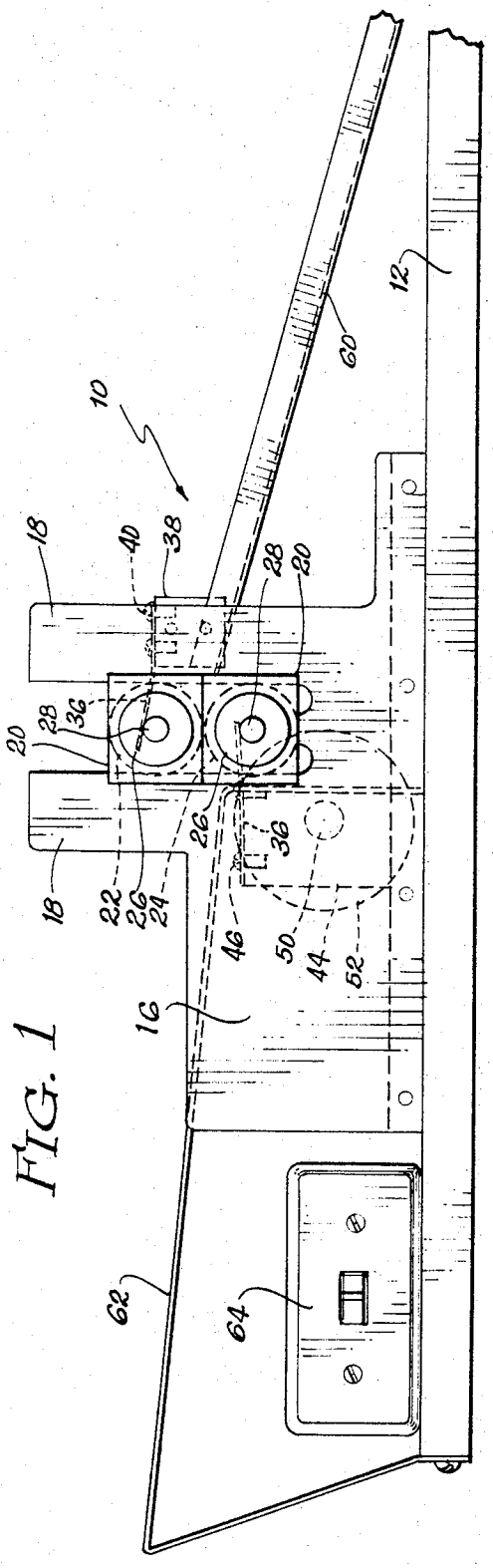

FIG. 1

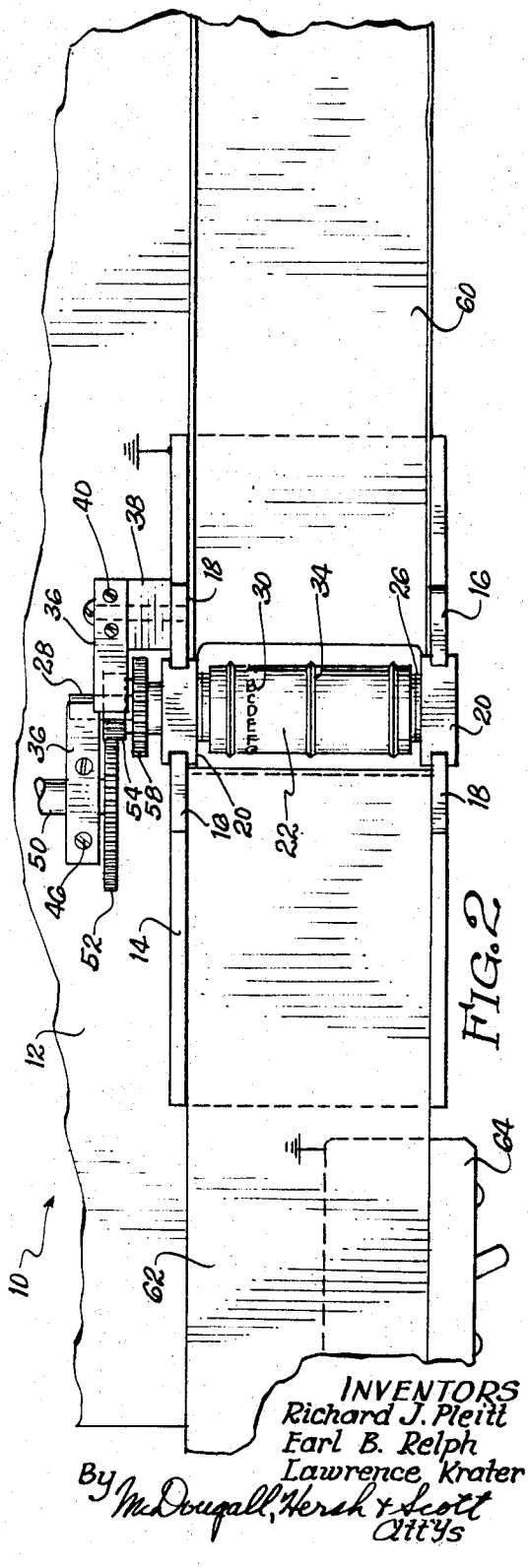

FIG. 2

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FIG. 3

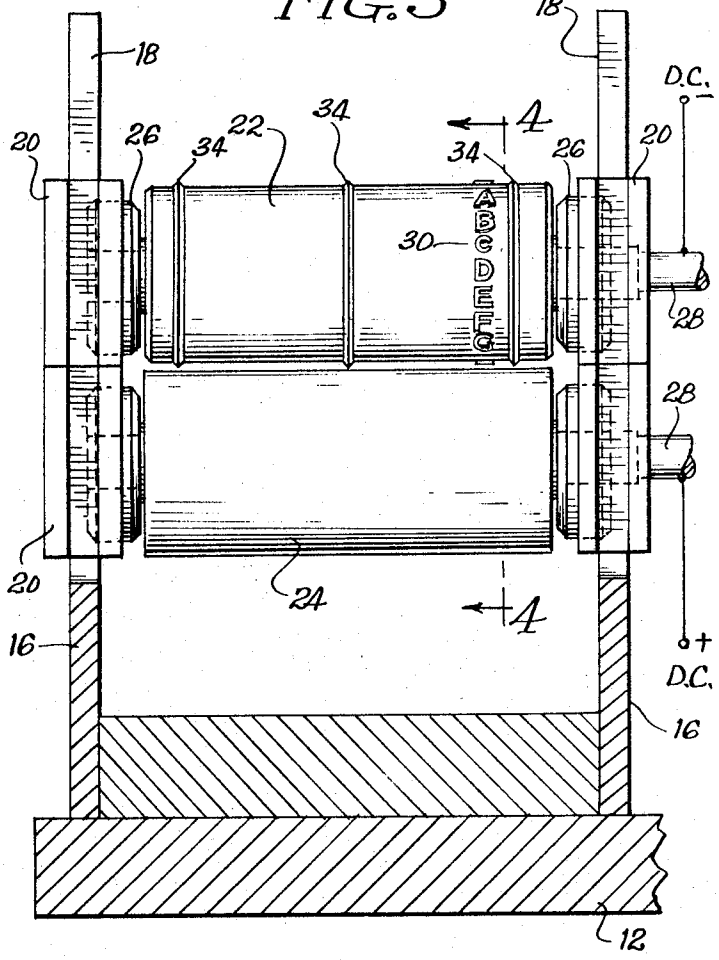
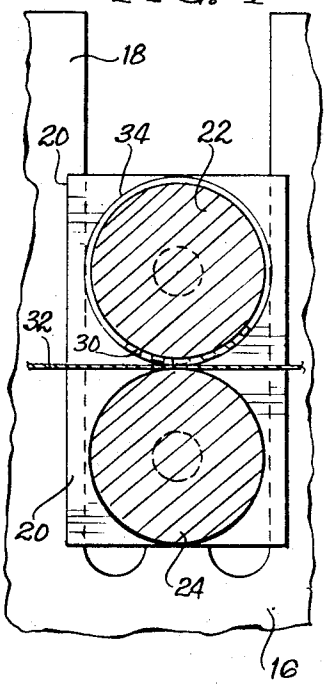


FIG. 4



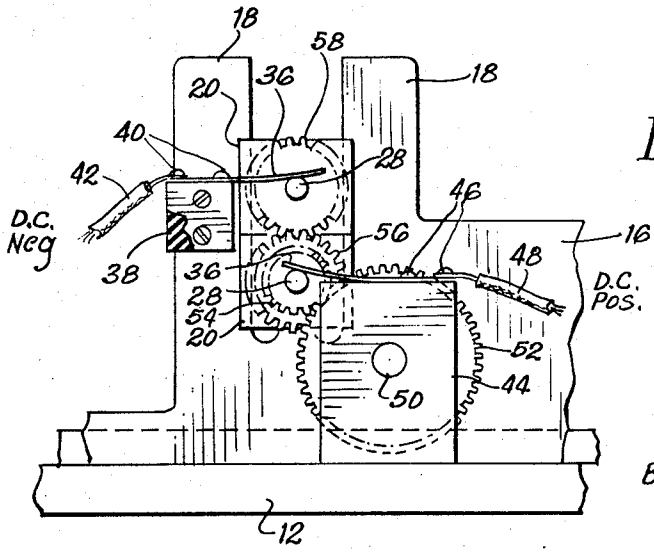


FIG. 5

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APPARATUS FOR ELECTROSTATIC LINE PRINTING

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ABSTRACT OF THE DISCLOSURE

An apparatus for forming latent electrostatic images on a dielectric sheet comprising a pair of opposed conductive rolls and image defining areas formed on the surface of one of the rolls and extending outwardly from the surface. A power supply is provided, and the rolls are included within the electrical circuit, and the dielectric sheet passing between the rolls will complete the circuit so that electrostatic charges are formed on the sheet in conformance with the images defined by one of the rolls. The dielectric sheet can then be passed to a developing station for treatment in accordance with conventional procedures.

This invention relates to an apparatus which is adapted for use in combination with electrostatic printers. In particular, the invention comprises an apparatus adapted to form latent electrostatic images which can be developed for providing a printed record of the images.

Various techniques have been developed whereby printed material can be produced through the use of electrostatic techniques. In the so-called Xerox process, an electrostatic image corresponding to an original is formed on a selenium plate by exposure of the charged plate to a light pattern corresponding to the original. The electrostatic image on the plate is developed and thereafter the developed image is transferred to a copy sheet and later fixed thereon.

In a system known as the Videograph process, latent images are formed through the use of a signal which is transferred to a cathode ray tube having an array of conductive wires in its face. The signal is imposed on the wires and the wires transmit an electrostatic charge through the tube for disposition onto copy paper which is advanced past the tube. The latent electrostatic image can then be developed through the use of materials attracted thereto. Dry or liquid developing systems are available for producing the visible image on the copy sheet.

In the systems referred to and in similar techniques, the latent electrostatic images are all formed in essentially the same manner. Thus, the images comprise copies of the material contained on an original or they correspond to material transmitted by radio signal or the like. It has been found that in the production of copy of a certain type, there are many occasions where the same subject matter is to be included on the copy in a repetitive fashion. Thus, in large scale operation, there may be extremely large numbers of separate pieces of material produced while every piece contains some portions which are identical to portions of all other pieces. In other instances, it may be necessary to repeat a particular sequence over and over throughout the production of large volumes of material.

It is an object of the instant invention to provide an apparatus which is uniquely suitable for the formation of latent electrostatic images on copy sheet, said images being identical or comprising a sequence of images which are to be used in a repetitive manner.

It is a further object of this invention to provide an apparatus of the type described which is adapted for use in combination with known systems for producing copy sheets by electrostatic techniques.

It is a particular object of this invention to provide an apparatus of the type described which is extremely satisfactory for use in the production of large volumes of copy material wherein the material must display identical portions or wherein a sequence must be repeated in the production of the material.

It is an additional object of this invention to provide an apparatus of the type described which is relatively simple to manufacture and operate and which can be easily incorporated in existing electrostatic copy constructions.

These and other objects of this invention will appear hereinafter and for purposes of illustration but not of limitation, specific embodiments of this invention are shown in the accompanying drawings in which:

FIGURE 1 is a side elevational view of an apparatus characterized by the features of this invention;

FIGURE 2 is a plan view of the structure shown in FIGURE 1;

FIGURE 3 is an enlarged elevational view illustrating the roll structure of this invention;

FIGURE 4 is a cross-sectional view taken about the line 4—4 of FIGURE 3; and,

FIGURE 5 is a fragmentary side elevation illustrating the roll drive and power imparting elements of the apparatus.

The apparatus of this invention generally comprises a roll structure which is adapted to transport a dielectric medium. Means are associated with the roll structure whereby an electric current can be applied with the dielectric medium included within the electrical circuit. Image defining means are brought into engagement with the dielectric medium while the medium is maintained in the circuit so that latent images are formed on the dielectric. Thereafter, the latent images can be developed by conventional techniques.

In the preferred form of this invention, the roll structure comprises upper and lower rolls which are formed of conductive material. The electrical circuit is provided by connecting one roll to a positive and one roll to a negative side of a power supply. The image defining means are formed integrally with one of the rolls whereby contact of these image defining means with the dielectric medium will result in the medium being interposed in the electrical circuit while the medium passes between the rolls.

FIGURES 1 and 2 of the accompanying drawings illustrate an apparatus **10** characterized by the features of this invention. The apparatus includes a base **12**, and mounted on this base, there is provided a roll support structure **14**. The support structure includes upwardly extending sides **16** which define arms **18** forming a cradle for receiving the blocks **20**.

On each side of the structure **14**, there are provided upper and lower blocks **20**, these blocks providing retaining means for upper roll **22** and lower roll **24**. Each of the rolls is mounted in a bearing **26** and each roll includes an extending shaft portion **28**. The blocks **20** are formed of Bakelite or some other insulating material so that the rolls are insulated from each other at their respective ends.

The upper roll **22** defines image forming areas **30** which can be engraved in the roll surface. As best shown in FIGURE 4, the image areas are raised with respect to the surface of the roll **22** and clearance is provided between these raised figures and the surface of the lower roll **24**. This clearance is sufficient to permit passage of the dielectric medium **32** between the rolls.

It will also be noted that the upper roll **22** is provided with a plurality of spaced apart annular rings **34**. These rings are dimensioned so that substantially the same clearance is provided between these rings and the roll **24** as is provided between the images **30** and this lower roll. The rings **34** function to hold the printing medium flat

against the lower roll. Accordingly, the printing medium will have good electrical contact with respect to the lower roll whereby image forming members **30** can be located in any position across the roll **22**.

The rings **34** can be formed integrally with the roll **22** in which case a plurality of straight lines will be formed on the printing medium in the developing stage. In many cases, such lines are unobjectionable, and they can be very useful where the medium comprises a test paper, testing the efficiency of a developing liquid or the like. The provision of the straight lines will provide a good indication of continuity in the printing operation.

In instances where the presence of the straight lines on the printing medium would be objectionable, the rings **34** could be formed of a dielectric material whereby they would not conduct and would, therefore, not form a latent image on the printing medium. The use of resilient bands would comprise one method for providing rings having insulating characteristics.

As previously noted, each of the rolls **22** and **24** includes a shaft extension **28**, and these extensions provide a convenient means for including the printing medium in the electrical circuit. As best shown in FIGURE 5, electrical contact can be provided by placing resilient strips **36** in a position whereby they will bear against the shaft extensions **28**. It will be appreciated that with the arrangement shown, electrical contact will be maintained during rotation of the shafts since the resilient character of the strips **36** will cause these strips to continuously press into engagement with the shaft extensions.

The upper strip **36** is secured to an insulating block **38** by means of screws **40**. A lead wire **42** is held in engagement with the upper strip **36** by means of a screw **40**, and in the embodiment shown, the wire **42** comprises a DC negative connection.

The lower strip **36** is attached to insulating block **44** by means of screws **46** and lead wire **48** is maintained in contact with the strip **36** in a manner similar to that described above. Since the wire **48** is a DC positive connection, the desired electrical circuit will be formed when the dielectric medium is interposed between the rolls **22** and **24**.

In accordance with this invention, at least the upper roll **22** must move in conjunction with the dielectric medium so that the image areas thereon will follow the progress of the medium. It is also preferred to provide a movable lower roll to complete the electrical circuit although a stationary grounding plane could be utilized.

To provide the preferred arrangement of this invention, the upper and lower rolls both move in conjunction with the movement of the dielectric medium therebetween. Synchronized movement of the respective parts can be provided by utilizing a drive means for the rolls **22** and **24**. In the embodiment shown, a drive shaft **50** is provided with a first gear **52** which drives gear **54**. The gear **54** is tied to the shaft of the lower roll whereby the gear **56** mounted on this shaft will rotate with the shaft. An upper gear **58** meshing with the gear **56** is tied to the shaft of the upper roll whereby synchronous movement of the upper and lower rolls is provided. In the gear system described, the gears are preferably formed of nylon or of a similar material to provide good wear characteristics, and also because such gears provide the necessary insulating characteristics.

In the operation of the construction shown, the dielectric material is fed along a path defined by the sheet member **62** whereby the medium is directed between the rolls **22** and **24**. A second sheet member **60** acts as a means for supporting the dielectric medium subsequent to the formation of latent images thereon. It will be understood that the dielectric medium can be passed to a developing construction of various known types. A switch control structure **64** is provided on one side of the apparatus to provide on-off control of the paper passing through the rollers. A separate switch, connected to the power source (not shown) is used to bring the rolls into the circuit for depositing the latent electrostatic image. It will be appreciated that the image forming ability of the construction could be eliminated at any time during passage of the dielectric medium therethrough. With this arrangement, the described apparatus can be employed to form images on only certain sections of a printing paper passing through the construction or the apparatus could be eliminated during an entire run.

The dielectric medium could be subjected to other electrostatic printing operations prior to passage thereof to the apparatus described. Thus, the repetitive images formed in accordance with this invention may be employed in combination with other images formed by other techniques. On the other hand, the apparatus of this invention could be employed alone where it was desired to provide copy repeating the same information.

The structure of this invention is also advantageously employed in procedures involving the testing of dielectric media, developing liquids or solids, or in other testing operations. As previously noted, the formation of straight lines on the paper provides a good indication of consistency. The repetitive characteristics of the described apparatus provide a highly suitable means for comparing different systems.

The arrangement illustrated in the drawings provides a DC source of power; however, other power sources are also suitable for the practice of this invention. Battery power is contemplated as well; however, unique results are secured in the use of time-varying pulsers. Where a pulser is employed, the wave shape, amplitude and frequency are inter-related to give the desired copy quality. Such factors will depend on the speed of the medium and rolls whereby the engraved image areas will contact the medium for a sufficient period of time to form the latent image on the medium.

In a suitable operating system of the pulser type, the system may be positive or negative going in reference to ground potential. As an example, a system which was maintained at —800 volts from ground and having a frequency of 1000 cycles per second was utilized. The on time of the system was 25 microseconds and the off time was 975 microseconds.

As previously noted, various arrangements are available with regard to the drive systems employed. The rolls themselves may be utilized as positive drive means for the medium or the drive means for the rolls may be synchronized with primary drive means so that a proper speed relationship can be maintained. In this connection, it will be appreciated that the intensity of a particular image can be varied by varying the speed of the medium and the rolls.

The system of this invention has characteristics which cannot be achieved if the engraved material were engaged with the dielectric medium in a static system. Thus, the instant invention provides a highly suitable means for controlling the time-constant in the application of the latent images whereby consistencies will be achieved. The combination of the engraved roll and a time-varying pulse of the type described is particularly advantageous in this respect.

In the appended claims where reference is made to engagement of the image forming means with the dielectric medium, it will be apparent that actual contact is not essential where the gap between the image forming means and the medium is sufficiently small.

The described assembly can also be employed for the application of an over-all pattern of electrostatic charge to the entire surface of the medium whereby the latent electrostatic image can be separately formed by exposure of the charged medium to the original or negative. In response to such exposure the charge will be removed from the surface of the medium in the exposed areas to leave a latent electrostatic image which can be developed in the manner previously described to bring out the image.

It will be understood that various changes and modifications may be made in the above described apparatus which provide the characteristics of this invention without departing from the spirit thereof particularly as defined in the following claims.

That which is claimed is:

1. An apparatus for forming latent electrostatic images on a dielectric medium comprising a roll supporting structure, a pair of conductive rolls rotatably mounted in said structure, a power supply characterized by a time-varying pulse, one of said rolls being connected to the negative side of said power supply and the other of said rolls being connected to the positive side of said power supply, means for transporting said medium through said apparatus and between said rolls whereby the medium is interposed in an electrical circuit as it passes between the rolls, and means defining images corresponding to the latent images to be formed, said image defining means comprising conductive portions integrally formed on the exterior surface of one of said conductive rolls and extending outwardly from said surface whereby the image defining means are included in said circuit, and wherein the spacing between said image defining means and the exterior surface of the other of said rolls is sufficient to permit passage of said medium therebetween with said image defining means and the surface of said other roll engaging said medium whereby the medium is interposed in said circuit during such passage so that electrostatic images are formed on the medium conforming to said image defining means, and including motor operated drive gears connected to each of said rolls, said rolls operating to drive said medium through said apparatus whereby the speed of said rolls determines the speed of the medium passing therebetween,

and wherein one of said rolls defines spaced-apart circumferential conductive rings formed integrally along its length, said rings having an outer diameter slightly larger than the diameter of the associated roll, the other of said rolls comprising a smooth roll, the surface of which is spaced from said rings by an amount sufficient to permit passage of said medium therethrough, and wherein said images are defined by the roll carrying the rings and are raised from the surface of this roll by an amount approximately equal to the height of said rings whereby latent electrostatic images in the form of lines extending longitudinally of said medium are formed simultaneously with the latent electrostatic images conforming to said image defining means.

2. An apparatus in accordance with claim 1 including resilient contact members connected in said electrical circuit, extensions formed in the shafts of said rolls, said contact members resiliently engaging said extensions.

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